

DRAMATIC UNIVERSE volume I

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How came I to be ? Whence am I ? To serve what

purpose did I come ? To go again ! How can I

learn aught—naught knowing ?

PREFACE

We cannot doubt that we men have our roots in the natural order, but we can and do wonder if our fruits belong to the same world. The question whether there is some affinity between the total man and the total universe, or whether we are but accidental intruders upon the cosmic scene, is one that must concern every man—for upon the answer hangs the decision as to the values that should rule our lives. A total question demands a total answer, and this could not be given except in terms of the whole of human experience—including all that man has learned in recent centuries about himself and the universe. Such an undertaking is manifestly impossible of accomplishment unless all experience can be brought into a coherent system capable of apprehension by that limited and capricious instrument, the human mind. The *Systema Universi* has proved a will-o'-the-wisp, leading many a powerful intellect into a morass of vain speculation. Since the failure of Hegel's *Cosmosophy*, Comte's *Panhyilism*, Fechner's *Panentheism*, and Bergson's *Panpsychism*—to name but four noteworthy essays at an all-embracing scheme—philosophers have turned away from the question of questions to follow the prevalent cult of specialization in the hope that to be precise about little things may prove safer than to be vague about everything.

Meanwhile the frontiers of human knowledge have been thrust back in all directions—history, prehistory, and palaeontology; ethnology and comparative religion; psychology and physiology; biochemistry, embryology, and genetics; physics, astronomy, and mathematics—each has brought its quota of well-ascertained facts that collectively have created a situation that has perhaps never before existed in the long history of human cultures. We need no longer speculate about many things that our forerunners assigned to metaphysics or theology; nor is it permissible to do so. Science has killed the old speculative philosophy, but has put nothing in its place. There is now before us the material for a new synthesis; but it is so immense in its extent and so bewildering in its variety that no one human mind can compass one hundredth part of it. No modern Pico della Mirandola could challenge the learned world to discourse on every known subject. No modern Descartes would venture to assert that he had mastered all the sciences.

And yet a synthesis is necessary; for unless all knowledge can be brought into a coherent system, we shall have either to abandon the hope of finding man's place in the universe or else to accept with pious

resignation, dogmas that disregard the lessons of natural science, and acquiesce in the continuing divorce of fact and value that has been the chief cause of our present bewilderment.

More than thirty-five years have passed since, in the spring of 1920, I became convinced that many intractable problems would be resolved if we could overcome the handicap of thinking in terms of events in space and time only, and could widen our horizons to include the unseen and unexplored dimension of eternity. I set myself to study the dilemmas of science and philosophy—such as the ether paradox or the antinomy of free-will and universal law—to see if the material for knowing eternity might not be lying unnoticed before our eyes.

Soon afterwards I met Gurdjieff, who made me see that to know more is not enough, and that it is necessary to be more if we would penetrate beyond the veil of space and time. In the succeeding years, I learned from him the elements of a comprehensive cosmology that gave promise of reconciling fact and value and of laying the foundations of a new Weltanschauung. Gurdjieff's cosmology, though magnificent in its bold outline, was nevertheless far from adequate in its treatment of the data of modern science. For many years I wrestled with the problem of reconciling the two. Finally, in 1940, I decided to make a fresh start, and the present book began to be written. Little by little I saw the fragments fall into place, and realized that the systematization of all human experience was more than a remote possibility. The task was quite beyond my own powers, and could not even have been attempted without the co-operation of specialists who helped me with what I regarded as the crucial problem—the demonstration that the mathematical and physical sciences required an ampler framework of dimensions than those of space and time, even as generalized by the work of Minkowski and Einstein.

The undertaking continued to expand, and it became clear that the two great problems of systematizing all fact and reconciling all values could be accomplished if only we could put aside for ever the narrow terrestrialism that is so strange a relic of the Middle Ages and still dominates all discussion of human destiny.

The present volume deals only with the systematization of facts; but it was written in parallel with the second volume, which I hope to prepare for publication within one or two years. Only when read together can the relevance of the work for the question of man's place in the universe become apparent. In the meantime, I wish to make it clear that this book is not a presentation of Gurdjieff's cosmology. It is my own essay, and much that it contains is derived from sources quite uncon-

nected with Gurdjieff's teaching. It aims at a presentation accessible, not only to professional philosophers, but to every reader who is prepared to undertake the not inconsiderable task of mastering the basic conception and gaining familiarity with the special terminology necessary in avoid misleading associations. Nevertheless, it could not have been written without the stimulation of Gurdjieff's inspired insight into the cosmic scheme, nor without the grounding in his methods which I have been fortunate to receive from him personally, and from his great pupil and exponent, P. D. Ouspensky.

Not long before Gurdjieff's death in October 1949, I spoke to him about this work and told him of the line I was taking. He showed by his comments that he fully grasped its implications, but disclaimed any personal interest, saying, "It is your work and not mine—all the same, it will be good publicity for Beelzebub", referring to his own book, *All and Everything*, published posthumously in 1950. I accept this assessment. In Gurdjieff's *All and Everything* there are insights far deeper than I myself could attain, and the reader who feels the need to find, not merely a new world-outlook, but a new way of life, is counselled to take Gurdjieff's work and study it as I have done. After perhaps thirty careful readings, I still discover in it new depths of meaning and—I am glad to say—new evidence that the main conceptions of my own work are in accord with the direct intuitions of a genius that I do not hesitate to describe as superhuman.

Among the many 'crumbs from the ideas-table' of Gurdjieff that have nourished my thinking, I count as of first importance the doctrine of Reciprocal Maintenance according to which every recognizable entity on every scale of existence participates in the universal exchange of energies—supporting and being supported by the existence of others. Reciprocal Maintenance is the corner stone of Gurdjieff's teaching in so far as it illuminates both fact and value, yet it is but one of his many daring and original conceptions. He left behind him no orderly system of thought, nor did he appear to be interested in systematic exposition

leaving it to his followers to reap the harvest of the ideas which he had sown.

Several books have appeared treating of one or other aspect of Gurd-jieff's teaching and methods, and still more have been inspired by his ideas without mentioning their source. I do not wish to claim Gurdjieff's authority for anything I have written, nor even for the interpretation I have placed upon his own written

word; but I do wish to acknowledge the inspiration of his teaching and, perhaps even more, the influence of his individuality upon my life.

The form of the book itself is an integral part of the exposition, for I hold that systematization of material demands systematization of presentation. The division into two parts corresponds to the dualism of rationalism and empiricism which the book seeks to reconcile in the correlative triads of Function, Being, and Will and Hyponomic, Autonomic, and Hypernomic modes of existence. Proceeding in this way, the rational and the empirical are forced at every stage to come to terms. Such a method would scarcely have been practicable even fifty years ago; for our empirical knowledge was then still by no means comprehensive enough to fill the vessel of rational speculation. Now the tables have been turned, and speculation—even the most audacious—is overwhelmed by the avalanche of empirical discovery.

Of necessity this work is uneven—in few of the subjects treated can I claim the assurance of a specialist—but I have set myself as far as possible to hold the balance between all the branches of science without regard to my own particular studies. Such a book must inevitably teem with errors, omissions, faulty selection of evidence, and inaccurate summarizing. It has not been my aim to produce a compendium of the sciences or a *systema naturae* in the seventeenth-century style. I have essayed the far more hazardous task of showing that experience itself when patiently interrogated will teach us its own lesson and answer the question whether or not man in his totality and the universe in its totality are manifestations of the same laws and made upon the same pattern.

I greatly wished to write in a language that would readily be followed by any serious reader. Unfortunately the subject-matter is so vast that the use of special signs to designate recurrent complex notions was unavoidable. For most purposes verbal signs have sufficed, but in Chapters 13-16 the use of mathematical symbolism could have been avoided only at the price of a greatly lengthened exposition. There is, however, little mathematics in the book—many hundreds of pages of mathematical analysis have been omitted or condensed into the three appendices—nor have I often attempted to marshal and present even a selection of the evidence in support of some of the assertions made. In consequence of these limitations of a practical nature, many passages have the appearance of unfounded speculation or, what is even worse, of a biased selection of illustrative material. I can only hope that those who realize that we must, at all costs, discover a means of looking at all that natural science has discovered in the last centuries as one coherent whole will be prepared to give the method a trial; and, if they are specialists in one or other of the subjects treated, will rather fill in the gaps and correct the errors than condemn the enterprise.

I have acknowledged my primary and overriding indebtedness to Gurdjieff. I wish also to express my grateful appreciation to those who have helped me in the task. The first is Mr. (now Professor) M. W. Thring, who devoted hundreds of hours to the search for a means of interpreting my conceptions of time and eternity in mathematical terms. Without his brilliant labours the central chapters of this book could not have been written. After him, the task was taken up by Mr. R. L. Brown, with whom I worked out the six-dimensional geometry of Chapter 15 and clarified for myself the all-important distinction—never hitherto made—between the three inner dimensions of time, eternity, and hyparxis. The latter term has been introduced to designate that time-like determining-condition by which coupling, interaction, and the arising of consciousness are made possible. In Chapter 4 on language,

I have been much helped by the advice and criticism of Mr. Henry Boys,

and in the biological chapters by Dr. Isobel Turnadge. Dr. Maurice Vernet has helped me both by his books and by many fruitful discussions and I have been greatly encouraged to find that we reached similar conclusions regarding the nature and role of life from quite different

starting-points. Mr. Anthony Pirie has read the whole work in proof.

My pupils at the Institute for the Comparative Study of History, Philosophy, and the Sciences have provided me with a touchstone by their reactions to the many readings of the manuscript in study groups and summer courses.

In the course of fifteen years since I started writing this book, it has been revised and completely rewritten at least a dozen times. The arduous task of interpreting my spoken and written word fell for the first nine years upon Miss Cathleen Murphy, and for the last five upon Mrs. Joan Cox. Mrs. E. Sawrey-Cookson has laboured for two years to improve the presentation. To these three ladies, and to many others who have helped me, I owe a debt hard to repay. My publishers and, in particular, Mr. Paul Hodder-Williams have stimulated and encouraged me in this undertaking; it is nearly ten years since we agreed that the book should be published. As year has succeeded year and the work has remained unfinished, their patient confidence that the task should and would be accomplished has never faltered. I am indeed grateful to them.

Notwithstanding all the help I have received, I am well aware how far the book falls short of the standards of a Hartmann or a Lotze. The only justification for its publication is the conviction that the task of systematizing all human knowledge can no longer be delayed and the realization that those better qualified as specialists—including professional philosophers—would fear to tread so hazardous a path.

The tasks remaining to be accomplished are twofold. We must first search for a coherent and adequate system of values that will help us to understand why we men exist and how we must live to justify our existence. The modern world obstinately—and rightly—declines to wear the old garments of systems and theologies that are neither sound in their cosmology nor true to experience. Henceforth we shall neither accept what we feel but do not understand nor yet act upon any 'categorical imperative' that fails to evoke the assent of our feelings. The human species—that must be regarded as an individualized being—is passing from childhood to adolescence. We can no longer be content with the naive beliefs and speculations that gave shape to our behaviour in the days of infancy.

As experience accumulates it must, more and more, take its place as the main source of judgments—but values discovered in subjective experience can be satisfying only if confirmed by convincing evidence that they are both valid and significant upon the cosmic scale also.

We should, above all, mistrust any value system that is applicable only to human life on the earth or to some fanciful picture of similar life in other worlds, here or 'beyond'. In the present volume I have emphasized the homogeneity of fact on all scales and all levels. What may be called the 'cosmic intuition' compels us to demand a similar universal homogeneity in any acceptable system of values. This requires, inter alia, a comprehensive reconciliation of value and fact that can be found only in some third principle capable of harmonizing all possible experience and of giving meaning to all possible existence. The endeavour to express the nature of this universal reconciling principle is the second task to be undertaken.

It so happens—and this may well be evidence that our destiny is guided, or at least influenced by, some Higher Power—that, at this critical phase, our knowledge of the universe, including that of human nature and human history, has grown immensely. There is every reason to expect that the advance will continue and will confer upon mankind a greater power of action than in any period of the past. The destructive and self-destructive activities of the human race have gained a terrifying momentum. Although there are signs of counteraction, mankind is still far from having grasped the extent to which values will have to be re-valued if we are to survive. Fortunately there are grounds for hoping that the growth of knowledge is preparing the way for a better grasp of the true significance of life on the earth and of the universal order. As we become increasingly aware of the laws that govern the universal transformations of energy we shall change our

attitude towards our value systems also. An important element in this revaluation must be the abandonment of

humanistic aesthetics and earth-bound theologies. All that exists, great and small, is concerned in the search for values, and we men must accept the fact that our little schoolroom, the earth, is not the centre of the universe.

We cannot, however, be satisfied with the mere negation of geo-centrality. If our values are to be both universal and positive, we must find some key to understanding the 'why' as well as the 'what' of the cosmic process. The postulate of the homogeneity of fact and value will prove to be an instrument of unlimited power and when applied to the elucidation of the Doctrine of Reciprocal Maintenance it can give us a working answer to all the fundamental questions of our existence. I cannot hope to do more than give expression to the little I have learned from others and understood myself of the cosmic scheme.

J. G. Bennett. Coombe Springs, June 1956.

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INTRODUCTION

To exist means to be what one is. It also means to be oneself in an environment that is not oneself. The boundary between self and not-self is the condition of existence, but it is also its limitation. In order to exist, every entity is called upon to resist the encroachment of its environment. Again, existence may be looked upon as the balance of persistence and decay. Living and dying are the weft and the warp of all our experience. In so far as they stand in opposition, every entity becomes involved in a process of adjustment between its own needs and the pressure of its environment. Sensitivity is the condition of this adjustment. The greater the sensitivity the greater the range of adjustment that is possible. This sensitivity can be regarded as a factor of reconciliation between the forces of endurance and decay. Consciousness is the awareness that accompanies sensitivity. We can thus measure the gradation of being by the degree of sensitivity of an entity to the forces that act upon it. Consciousness can then be defined as the condition of independent existence.

Consciousness has an incalculable range of variation, and we human beings can experience directly only a narrow band within this range. We can see here an analogy with electro-magnetic radiation, which has an immense range of intensities within which we can experience directly only a narrow band as visible light. Carrying the analogy further, we can compare the onset of visibility to that stage in the development of consciousness at which beings become aware of the need to understand themselves and also the world in which they live. This twofold need— which is in reality one and indivisible—is even more important for beings than the struggle for existence. The struggle for existence is only one aspect of adaptation. It may appear to be an active self-affirmation, but in truth it is closer to passive automatic reaction to the stimulus of the environment. The search for understanding is more than the struggle to live. It is the struggle to live fruitfully, fulfilling the aim and purpose of existence.

The transition from the struggle for separate existence to the striving towards harmonized co-existence requires consciousness of the environment no less than the consciousness of oneself. It must, however, be realized that 'consciousness of the environment' is a phrase that can have very different meanings. In one sense, it may be taken as the power

to recognize in the environment the means of satisfying one's own needs. In another, it signifies the awareness of a greater purpose that one exists to serve. Between these two senses there is a deep cleavage that is reflected in two different attitudes towards natural science. According to the first, man studies nature only for the purpose of gaining mastery over his environment and of securing thereby a place for himself and his

descendants. The opposite view—now rarely entertained—is that man strives to understand the natural order so that he may better recognize and fulfil the purpose of his existence. The second interpretation makes quite different demands, and offers quite different rewards, from those which are in question if we seek only for the means to extend our own powers. On either view, the natural sciences are regarded as an instrument for the attainment of human purposes. Nevertheless, both would concede that its significance depends upon the purposes to which it is directed. Quite a different attitude lies behind the view that the scientific method is complete and final, and therefore is the sole reliable source of true knowledge and the best guide to successful behaviour. This view is so widely held that we should begin by examining the claim of natural science to be the finest and final achievement of the human genius. The claim is commonly justified by invoking its successes in liberating man from superstitious fears of the natural order, in giving him the ability accurately to predict future events, and in enabling him to transform materials and to liberate energies in such a manner as to give him greater leisure and greater opportunities than he has ever enjoyed in the past. Some of the claims are of dubious validity. It is by no means certain that modern man is any more free from superstitious fears than his ancestors: the fear of demons has gone only to be replaced by fears of disease, poverty, and war that men in former ages could not have imagined. On the other hand, it is no doubt true that natural science has found a means of predicting with confidence future events of a certain kind; as, for example, the outcome of an experiment conducted in a carefully specified manner. This ability has contributed very largely to the development of modern technology and all that it has given mankind. The progress of technology makes available to man materials and energies that can satisfy his needs with ever less and less expenditure of his own energy and time. From time immemorial, leisure, in the form of freedom from toil, has been inseparable from man's dreams of paradise. It is therefore scarcely surprising that people have hoped, and still do hope, that the age of science may become the golden age of endless, unbroken bliss for all future generations. We have, however, to recognize that the ability to predict the future course of

events has been applied successfully only to the satisfaction of man's material needs. Its greatest triumphs have been in the physical and chemical sciences; although biology and economics have not been without evidences of growing success in forecasting the course of events considered until recently as unpredictable.

From before the dawn of history man has sought to know the future in order to ensure his own welfare, and whenever he has gained such knowledge he has used it on the tacit assumption that his own needs are paramount and entitle him to ignore the consequences that their satisfaction may have upon his environment. Man has always been ready to disturb the processes of nature even to the point of destruction in order to satisfy what he believes to be his own needs, and, in this respect, there has been no apparent change in his attitude since the time of the earliest Stone Age peoples of a hundred thousand years ago.

This desire to know the future springs from the instinct of self-preservation rather than from the impulse of service. Man distrusts the future because he does not understand time, and especially because he takes it for granted that he lives in one time only and that hence there is only one future that contains, not only all his hopes, but also all his fears.

We commonly overlook the obvious fact that any predictable future is already determined and nothing can alter it. This is the future of the physical world, and it unquestionably exists; for innumerable predictions about it have been made and fulfilled, and we have no doubt that similar predictions will be equally reliable in the future. There are, however, side by side with the predictable future many unpredictable futures resulting from the influence of conscious, and even of sensitive, intervention in the physical world. Such futures concern primarily the relationships between sensitive beings and their environment.

The predictable future is secure, but it is without hope. There are unpredictable futures, and the hopes they conceal are proportionate to their insecurity. These assertions may not be regarded as self-evident, and one of the secondary themes of the present book will be the discussion of the true significance of time, space, and eternity as the framework of events. We shall see that predictability is not an invariable characteristic of time. Nevertheless, we have to learn that the thirst for security can be satisfied only at the price of sacrificing

freedom.

If man begins to look beyond security and searches for a relationship to the unpredictable, he discovers that the conceptions hitherto employed by natural science are inadequate. The demand for predictability inevitably leads to the rejection of the unpredictable. The assumption

that science is concerned only with the knowable discourages the pursuit of the unknowable. And yet science itself constantly reveals the importance of the unknowable and unpredictable element in natural phenomena. So true is this that, in the present century, nearly all branches of science have been led to postulate, as a necessary part of all natural processes, events inherently unpredictable—such as quantum jumps in physics and genetic mutations in biology. The time appears ripe, therefore, for a far-reaching re-examination of the principles of natural philosophy. The superstructure has far outgrown its foundations, and the supreme importance of understanding man's place in the universe has been lost to view in the bewildering accumulation of facts that, for the most part, have interest only in their technological application. We are in danger of forgetting that the demand we make upon the universe to satisfy our own needs is likely to be met by a not less imperative demand made by the universe upon us to fulfil the purpose for which we were brought into existence. Forgetting this, our life becomes lopsided and unbalanced. The inevitable consequences of such disharmony are only too obvious at this present time.

Man must look beyond his own security in order to find a relationship with the unpredictable and the unknowable; but for this also the methods he has hitherto employed have proved inadequate. One of these consists in accepting the unknowable as infinite and therefore incomprehensible, and of continuing to seek a relationship without attempting to understand it. This is the way of 'revealed religion', and in past epochs the religious conception has played a dominant part in determining the course of men's lives. One serious difficulty in the religious way is that when more than one individual is concerned communication becomes necessary. Now, communication usually requires words, and words are the expression of thoughts. Organized religion is therefore obliged to express its relationship with the unknowable in some form of language, and this calls for certain assumptions as to the objective reference of its subjective experience. These assumptions then become the basis of communication and concerted action and, since by hypothesis they cannot be verified, they transform into dogmas to be accepted as valid. Thus the way of religion seems to involve, of necessity, the formulation of creeds. This is a hazardous procedure, but it has been justified by results. Just as natural science finds its justification in successful prediction of the course of events and the consequent reinforcement of man's material security, so does religion find its justification in providing men with a sense of moral security, and also in predicting the future of his conscious states. Religion has in the past succeeded in removing men's

fears of the unknown and unknowable, and therefore has been a most powerful factor in social security.

Formulated in such a manner, the aims and achievements of science and religion would appear to be complementary, in that the former succeeds in resolving man's problem of dealing with the difficulties of his knowable material existence, and the latter succeeds in adjusting his relationship to the unknowable and unpredictable element of all experience. In recent generations many have believed that these complementary roles need not be in conflict, and that a man could be wholeheartedly scientific in his attitude to facts and wholeheartedly religious in his attitude to values. Others, including perhaps the majority of scientists, have rejected this compromise, and have asserted the supremacy of the methods of observation and experiment over all other modes of knowing. Religious men have found themselves in a more difficult position for the reason that communication involves them in the use of language that belongs properly to the domain of the knowable. So it is that in all their utterances they are led into making assertions that have the appearance of referring to facts, whereas in reality they are but the verbal expression of an incommunicable experience.

Such are all attempts to express in words the intuition of deity or to discuss the problems of value in terms of such words as 'truth', 'beauty', and 'goodness'—all of which prove on examination to have no stable, verifiable

meaning. When reduced to its simplest and most significant terms, the aim of science can be said to be prediction of the knowable future, and the aim of religion to be adjustment to the unknowable pre-sent. When either aim is pursued to the exclusion of the other—or even in isolation from the other—they prove to be unrealizable. They would also be irreconcilable if natural science were to claim that all possible modes of human experience could be brought within a scheme of energy transformations, and if it could offer the hope that all future events could be predicted. Such a claim would imply that the progress of science could lead men to an earthly paradise, and would install the scientific method as the sole guide and arbiter of human destiny. In like manner, if religion were to claim that all possible experience could be accounted for in terms of revealed truth, and if in addition it could argue successfully that the knowable, predictable world of physical science is but a reflection of an ampler vision in which the unknown and the unpredictable prove to be the sole true reality, then the way of religion might in the future again occupy the place it held in the Middle Ages as the sole repository of all that is needed for human existence. Proponents of both views are to be found at the present time, but they

are a diminishing minority, for most thinkers, whether scientific or religious, are convinced that it is necessary to transcend the limitations of any one discipline and to seek for a principle of unity that will enable mankind to go forward into a new world, in which man will seek adjustment with both the knowable and the unknowable upon an equal footing.

It is no longer possible to seek for the satisfaction of ultimate human needs, either by the way of knowledge or by the way of faith as such ways have been followed in the past. The new principle of living must give expression to an intuition of reality that is no mere compromise between fact and faith, nor even a mere combination of the two. It must show how what we know and what we believe are at bottom one and the same reality.

Let us look at the requirements that such a principle would have to satisfy. In the first place, it must provide us with new categories of thought to take the place of the awkward and pitifully inadequate forms that we have inherited from Aristotle and the German transcendental philosophers. When these categories were formulated, natural science had not made the prodigious advances of the last two centuries. In any event, natural science must remain limited in its forms of expression so long as it is concerned almost exclusively with predictability. If science is to transcend its limitations, it must, first of all, recognize them. Then only will it be possible to step out of the narrow forms of thought within which the scientific intuition is now confined. It is necessary to be able to think and to speak in new forms about quantity as well as about quality.

Almost the same can be said of the religious experience which, for centuries, has been confined within narrow terrestrial notions of the nature of God and man. The universe as we know it today must inspire a sense of awe and reverence, deeper, because perhaps more inescapable, than that evoked by the conceptions of Deity that we find in the Old Testament, in Greek mythology, or even in the Sanskrit Vedas. In the present time religious men do not seem to feel a need to expand their conceptions of divinity, comparable to the compulsion felt by scientists to reform their modes of thought. Nevertheless, a religious man finds himself at a disadvantage when he seeks to defend his notions against the objection that they are perilously akin to the tribal beliefs that he would repudiate as outworn superstition. Terrestrial religious beliefs can no longer be sustained, but man clings to the forms of outworn creeds even when it is evident that their efficacy has departed.

It is necessary to make a bold step that is the more hazardous in that our search for an understanding of the unknowable and the unpredict-

able must yet not lose contact with that which can be seen and touched, Weighed and measured. We are handicapped at the outset by the in-capacity of the human mind to entertain in a single sweep of consciousness a large number of distinct, independent notions.

We cannot, in this instance, make use of one of the most powerful instruments of scientific research, namely, that of specialization. Specialization consists in isolating a phenomenon from the totality of experience in such a way that its own particular laws can be found and applied for purposes of prediction and control. We can know in part, but we can understand only the totality. We therefore debar ourselves from the start from the very possibility of understanding if we attempt to simplify our task by examining only that field of which we happen to have some specialized knowledge. If we seek to know our place in the universe, we shall not find it by observing only the stars, nor by studying atoms only. We shall not discover it solely in the laws of life nor solely in the data of psychology and historical research.

Here we encounter a sharp divergence in the formulation of the aims of natural science that can be expressed as the difference between know-ing 'how' and knowing 'what'. The average scientist is content to dispense with knowing 'what' provided that he can know 'how'. His search is for reproducible, and therefore predictable, processes that can subsequently be turned to account for the benefit of material needs. The manner in which such processes are described is well-nigh indifferent

so long as there can be a successful communication of the operations required for their performance. In this sense it can be said that a good patent specification is the ideal formulation of a scientific law, since it eschews all theory and all explanation, and seeks only to 'tell the workman what to do'. The proponents of such conceptions of the role of natural science are commonly called 'operationalists'. They repudiate the use of models—regarded as so important in the nineteenth century—and they reject as superfluous the demand to be told what entities and what relationships are present in the phenomena they describe.

electricity is commonly quoted as an example of 'something' of whose nature we know almost nothing and yet with whose uses we are thoroughly familiar. There are many varieties of the operationalist view, but all have in common the assumption that we can dispense with knowing 'what' providing we know 'how'.

Those who adopt conceptions of the second kind seek for understanding of human experience itself, in all its possible forms and manifestations. They feel the need to know what we are, what is the world in which we live, and what is our place in it. Since how we behave is, in the

long run, determined by what we are, it seems to them more important to penetrate to the latter than to stop short at the study of the outward manifestations that constitute the former. The concern with being is ancient, but its importance is obscured by the common attitude of today that is expressed in the phrase—'Does it matter what it is, so long as it works?'

Lack of concern with being is not unconnected with the distinction made earlier between the knowable and the unknowable, for we only know what things do—never what they are. It is commonly held that a sentence has meaning only when it can be reduced to a set of operations that the hearer can reproduce for himself. This would seem to render meaningless all attempts to speak about being or, more generally, to penetrate into the realities that cannot be described in terms of behaviour. There lies here a fallacy that consists in overlooking the fact that behavioural descriptions themselves depend upon the acceptance of a common set of categories. Inability to describe an element of experience is not necessarily evidence of confusion, but may be an indication that the categories used are inadequate and need revision. If we survey the present position of natural science, we are bound to recognize that there are many fields in which new and astonishing discoveries are being described in terms of ancient categories. This is one of the principal reasons why the progress of science has done so much to alter our external lives and so little to change our mode of thought. There is scarcely a field in which the categories of inherence and subsistence, of causality and dependence, of necessity and contingency, and the rest, have not broken down.

The modes of thought held by Kant and his successors to be native to the human reason have proved to be largely historical accidents. It is now widely acknowledged that the strictly mechanistic explanations of the natural order that held sway in the eighteenth and nineteenth centuries are no longer tenable. Many books

have been written to show that a scientific outlook is compatible with a religious conviction. Many scientists are ready to believe that the data of psychical research, and even of religious mysticism, must be taken into account in any attempt to construct a comprehensive world-picture. Nevertheless, these very data are commonly described and discussed in terms that belong to the Middle Ages and are quite foreign to the philosophy of modern science. Few people doubt that the universe is more interesting and more mysterious than it appeared to Auguste Comte or Herbert Spencer, but they still speak of it in much the same terms. In the present book we shall be concerned not so much with the ordering of facts nor even with

their interpretation, but primarily with the need to reconstruct language in such a manner that all human experience, whatever may be its nature, can be spoken of in consistent and coherent terms. This calls first of all for a far-reaching reconstruction of the categories of thought. In place of the arbitrary schemes that have been propounded by philosophers, from Aristotle, Kant, and Hegel to Alexander and Whitehead, we shall seek in experience itself for categories and principles that are capable of development progressively with the advance of science. The static systems, regarded in the past as settled once and for all by the nature of human reason, must be replaced by a dynamic system the movement of which will add anew dimension to our thinking and our forms of language. The aim of this book is, however, not solely to reconstruct language, but to show that it is possible to go beyond the distinction of 'what and how' to the 'thus and so' of all experience. It would not be sufficient, even if it were possible, to find answers to the questions, 'What are we and our world?' and 'How do we and the world behave?' We need even more to understand the relationship of 'what' to 'how' because upon this relationship depends the possibility of ordering and directing the course of our lives and perhaps of influencing the future of our world.

'Thusness' is of necessity elusive. We tend to become discouraged in our search for it, and turn to the much easier task of finding how things behave and so learning to predict and to utilize. The 'thus' of things is compounded of the unpredictable as well as the predictable. So long as we concern ourselves with the latter only, our experience must inevitably run along the tram-lines of cause and effect. We may appear to be influencing the march of events, but we do so only in the sense that alkali added to fat will turn it into soap, and acid precipitate again the same fat. All authentic change is creation, and this is possible only in the realm of the unpredictable and the unknowable. Notwithstanding its repudiation of any interest in these domains, natural science, nevertheless, has made all its progress by excursions out of the line of causality and by confronting the unpredictable.

The belief that the known and the unknown are but manifestations of one and the same reality is not enough. We require to bring both into relationship with our own experience. If this task is to be accomplished, no difficulties can be put aside for future study, nor can any authentic elements of experience be ignored. There is ample evidence, as a result of innumerable trials, that a unified world-conception cannot be reached in terms of our current forms of thought. We must accept the consequences, and be prepared to think in new ways, however strange and even repugnant these may be to our own cherished convictions. For

example, nearly every scientist is convinced that specialization is unavoidable and that any attempt to think in terms of the natural order as one coherent whole can only lead to vague generalities. In the present book we shall reach the conclusion that all natural phenomena can be thought of in terms of a small number—say, a dozen—categories and principles. We shall be forced to recognize, on the other hand, that current conceptions of space and time give an inadequate framework, and that it is necessary to add two other dimensions, each with well-defined characteristics. There are solid reasons for making such a step in the improved representation that is thereby made possible of the data of dynamical and physical science; but it is exceedingly difficult to re-adapt our thought to the conception that there are different kinds of time and space. The procedure of stretching the categories of thought to embrace the new data of science is irksome and in the material sense unrewarding. The heuristic value that is found in a good working hypothesis is not to be discovered in an improved way of thinking, and yet in the long run it is only the latter that will enable us to adjust ourselves to the new forms of experience that scientific discovery is bringing to our door and, moreover, bringing them to scientists and non-scientists, to the religious and the irreligious, to the thinking and

the unthinking alike. The canvas upon which the future picture of God, man, and the universe will be painted will need to be vastly greater than any that the mind of man has yet conceived. If we attempt to stretch it upon our present framework of categories and modes of thought, it will continue to sag. The task we shall attempt in the succeeding chapters is not to paint the picture nor even to stretch the canvas, but only to show that such an undertaking may one day be possible. The present impossibility of accomplishing a necessary task is no excuse for refusing to make a step towards its future realization.

POINTS OF DEPARTURE

i.i.i. First and Last Questions

The questions that really matter to man were asked long ago, and they still remain without an answer. There are no myths so primitive nor legends so ancient but they express man's quest for an understanding of his destiny and of his relationship to his Creator and his creation. So old are these questions that the earliest records of human speculation—such as the Epic of Gilgamesh and the Creation Hymn of the Rg Veda—express both the question and also disillusionment as to the hope that an answer will ever be found. We thus find at the outset one indubitable fact, confirmed by at least five thousand years of investigation during which all the resources of observation, experimentation, inspiration, and reason available to man have been brought to bear; namely, that our ultimate questions have never been answered and that we are still as far from answering them as we have ever been.

Our quest is still for the secret of human destiny. It is a journey into the unknown; but, since every journey must have a beginning, we can take as our starting-point the recognition that our goal is indeed unknown; that we do not know where and how mankind arose, and cannot tell whither we are bound nor what we should be doing. Man has always been thus ignorant of his destiny. He is today neither more ignorant nor less ignorant than he was a thousand, or five thousand, years ago. Recognizing this, we are bound to put aside any idea that there is progress in man's knowledge of the reason for his existence on the earth, and so may, perhaps, even reconcile ourselves to the prospect of living in everything, and for ever, in the domain of the relative and the uncertain. The theory of universal relativity has taught us that we must be prepared to abandon any expectation of precise and final answers. We have been forced to admit that precision and generality are to be achieved only if one is sacrificed to the other.

The scientist and the philosopher have tried to discard from their language such words as 'rather', 'somewhat', 'perhaps', and to avoid all forms of adjectives that end with 'ish'. They may not object to saying 'this colour is greyish', but they will not tolerate such expressions as 'this proposition is true-ish' or 'rather true' or even 'somewhat true'.

Yet such words that draw attention to the uncertainty and relativity of all our possible knowledge are indispensable if we are not to deceive ourselves and mislead others in what we say.

Throughout the past two thousand five hundred years the spiritual history of mankind has been a quest for the Absolute. The ultimate values—truth, beauty, and the rest—have been pursued in absolute terms. Philosophy has demanded of its doctrines absolute self-consistency, completeness, and adequacy. Science has sought for final principles of explanation and for rigorous laws of nature possessing universal validity. Religious devotees could not bring themselves to believe in a God whom they could not regard as absolutely incomprehensible and yet absolutely good—absolutely powerful and yet absolutely merciful. Art looked for the ideal of an absolute beauty, and for forms that should be final and imperishable. In political and social life, men have looked for ideal forms of society in which absolute justice could be combined with perfect equality and complete freedom. Belief in the possibility of discovering absolute values has been the guiding principle not only of the Graeco-Roman civilization and those that have descended from it, but also of the Islamic, Hindu, and Far Eastern civilizations. It has been accepted as a dogma throughout the Megalanthropic Epoch.* The motive behind the unquestioning acceptance of this dogma has been the desire to sustain man's illusion that he

stands at the centre of a world which he can know and master.

In each and every domain this dogma has proved to be untenable, and within the last century has been abandoned everywhere, either tacitly or overtly. The Epoch of the Absolute has ended and that of Relativity has begun. Nevertheless, we are still very far from having grasped the implications of our new world-outlook and therefore, in nearly every field, we are in the uncomfortable position of those who try to sit between two stools—unable resolutely to abandon all our absolute expectations, nor able yet to enter fully into the ways of thinking that belong to the new epoch. We must put aside the old search for the absolute—not as a search beyond our present powers, but rather as one inherently misguided. We have not so much to make a confession of failure as to admit that what we have tried to do should never have been attempted. There is, in any case, nothing to be lost; for absolutism has been dead these hundred years, and of those who still remain loyal to absolute conceptions—whether in religion, in science, or in politics—few have either faith in their profession or hope in their practice.

[* So called to draw attention to the exaggerated significance that has been attached everywhere to man and his powers of cognition and action. Cf. J. G. Bennett, *The Crisis in Human Affairs*, pp. 27 et seq.]

If it is impossible for us to make final or absolute judgments upon any subject whatsoever—even upon the forms of thought or logics that we shall adopt as a test of significance—then everything is to be regarded as uncertain, even uncertainty itself.* If uncertainty is adopted as a canon of thought, it again must not be taken as final. Nevertheless, we cannot hope to progress unless we make some assumptions as to that which is beyond our immediate experience of this present moment. The simplest and most plausible assumption we can make is that we men, with our equipment for apprehending the world, are a fair sample of the world we apprehend. If we discover that accident and uncertainty are never absent from our own experience, then we may reasonably suppose that they are present everywhere and in everything.+

1.1.2. The Drama of Uncertainty

To admit that all existence is uncertain and therefore hazardous may appear as the renunciation of all that mankind has striven for during the last two thousand five hundred years. It is held to the credit of the Greek philosophers that, in leading mankind into the age of reason, they banished for ever those mysterious fears in which primitive man was supposed to have lived. The Greek philosophers—from Thales to Aristotle—were all in quest of a final solution to the great human problem of the meaning of existence. Even Anaximander, with his principles of 'strife' and 'the fathomless', believed that he had put aside the mysterious and the arbitrary in favour of a law of universal and ultimate validity which could be known and allowed for in the ordering of human affairs. Those who, like Heraclitus, believed that the meaning of existence was to be found in the saying 'all things pass away and nothing abides' also took it for granted that beyond the perpetual flux there was something stable—the One and the Many; 'out of all, one; out of one, all'.++ In India, Gautama Buddha—contemporary of the early Greek philosophers—expounded his doctrine of universal causality, assuring his followers that the mystical fears by which they had been oppressed

[* Cf. A. N. Whitehead, *Process and Reality*, p. 4: "Philosophers can never hope finally to formulate these metaphysical first principles. Weakness of insight and deficiencies of language stand in the way inexorably. Words and phrases must be stretched towards a generality foreign to their ordinary usage; and however such elements of language be stabilized as technicalities, they remain metaphors mutely appealing for an imaginative leap."

+ Cf. Bertrand Russell, *Human Knowledge, Its Scope and Limits*, p. 527: "All human knowledge is uncertain, inexact, and partial. To this doctrine we have not found any limitation whatsoever."

++ Cf. C. Bailey, *The Greek Atomists and Epicurus*, p. 19.]

were illusory, and proclaiming that man could and must rely upon himself to work out his own salvation. In China, Confucius taught the reliability of human reason and adjured men to banish their fears of the unknown.

Since then a hundred generations have lived and died, and the banishment of mystical dread has been so successfully accomplished that modern man no longer fears the invisible. Instead, he finds himself confronted with the visible terrors of his own handiwork, and sees himself involved again in the uncertainty of history from which, until quite recently, he believed that he had been, or was soon to be, delivered. Belief in universal law has recoiled upon man, and in place of uncertainty he has found himself driven to the conclusion that inexorable causality shapes the future even to its minutest detail. Since this conclusion is fundamentally unacceptable to our human nature, we face a dilemma from which we cannot escape so long as we cling to any belief in absolute laws or final answers. This being so, we are forced to admit that rationalism can give no more than a false security that does not work in practice, and that it is necessary to look more deeply into the situation and to recognize that uncertainty and hazard must always be taken into account.

When this decisive step is made, we discover that we leave behind a great part of the difficulties with which human thought has been beset in the attempt to reconcile our human experience with belief in universal order and Divine Providence. If all that exists is uncertain, then it is not surprising that our human life is uncertain also. If uncertainty holds sway even in the operation of the Divine Will, then we can reconcile ourselves to the spectacle of human sufferings, against which we must revolt so long as we have to believe that they are a negative oasis set in a desert of perfection. Furthermore, the recognition of uncertainty and hazard in the working of universal laws restores significance to our own human strivings. If man is not a pawn in the hands of an omnipotent and omniscient chess-player, then he may be something much more significant; to wit, a being upon whom rests real responsibility for taking his own part in the universal task.

Conscious experience faced with hazard is a state of need, and need confronted with uncertainty as to its fulfilment is dramatic. Therefore we may speak of a dramatic universe, thereby drawing attention to the character which all existence acquires through the presence everywhere of relativity and uncertainty, combined with consciousness and with the possibility of freedom. Where there is no drama—no suspense—there is no deep significance. It is artificial and inconsistent to suppose that there

can be a drama of uncertainty and suspense in the life of man but none in the great universe.* In order to appreciate the full significance of the force latent in the idea of a dramatic universe, consciousness must be restored to the efficient status from which it was banished by the atomists and by their modern descendants the logical positivists; for, confronted by efficient consciousness, uncertainty is no longer blind chance.

We may see here the dawning of a new light upon cosmological problems which will disclose to us a supreme uncertainty in the ordering of the universe—an uncertainty that must reach its greatest intensities in the Divine Nature at the one pole and in the atomic nature at the other. We have to change in a thorough-going manner our attitude towards our human capacity for apprehending reality; for we must take into account not only the universal uncertainty, but also our own inadequate perceptions and our inability to understand even the little that enters our experience through the organs of sense.

1.1.3. The Limitations of Human Perceptions

It is very probable that one reason why we cannot find answers to our deepest questions is that we have not at our disposal the instruments we require. Our perceptions are limited and our capacity for thought has restrictions that no ordinary man can overcome. Our judgments are in the form of 'yes' or 'no'—more or less qualified and more or less clear. When confronted with complicated questions, we are obliged to resort to an artificial simplification that may, it is true, enable us to give definite answers; but, in the process of simplifying, we inevitably discard that which is the most important factor—namely, the concreteness of the situation itself.

In the realm of ideas, man can count up to two and sometimes, in specially favourable circumstances, as far as three. He has no notion at all of what would be required for entertaining richer combinations. This limitation applies not only to man's thought but also to his feelings and to his instinctive processes. His judgments of feeling reduce almost always to the choice between like and dislike, attraction and repulsion, interest and boredom. His instinctive reactions have the same dualism of pleasure and pain, of activity and repose, of stimulus and inhibition.

[* If we ask ourselves whether we are here saying anything that is not already implicit in the doctrines of Leukippos and Demokritos, we may perhaps answer in the phrase attributed by Aristotle to Thales: "All things are full of God." Cf. Aristotle, *Of the Soul*, A.5. 411; also H. Diele, *Die Fragmente der Vorsokratiker*, p. 22.]

Closely allied to the cult of the Absolute is the assumption that limitations—due, in fact, to the structure of our human organism and its psychic functions—are inherent in the larger world of which we men form so small a part. We commonly experience ourselves and the world as moments arising successively in time and uncritically take this temporal actualization as the only reality. There are, however, solid grounds for inferring that the temporal sequence we perceive in the natural working of our senses and our minds is by no means unique; but that, on the contrary, there are many different lines of time, actualizing in parallel. It seems, moreover, that these different lines of time must react upon one another in a way that our senses are incapable of perceiving. If this inference is correct, it follows that the greater part of the reality present at any given moment is inaccessible to human sense-observation.

We speak of the past as being dead and gone, and of the future as not yet existing. Because, with the means at our disposal, we cannot re-enter the past, we assume that no movement in that direction is possible. Because we cannot outstrip the march of time and penetrate into the future before it arrives, we assume that all existence is subject to the same limitation. Making always the same unwarranted assumption that our senses are instruments adequate for the perception of all that 'really' exists, we seek to explain to ourselves the meaning of our lives and our relationship to a Higher Power exclusively in terms of what we can see and touch. Such assumptions are very naive, and we can establish without difficulty that, so far from providing us with a complete and effectual means of perceiving reality, our senses distort in a characteristic manner all the messages that we receive from the outer world, thus presenting us with a foreshortened and incomplete picture by which we are constantly being misled.

We men exist on earth only for a very short period of time. The forty or fifty years during which we can work effectually to seek for the meaning of our existence and to fulfil our task on the earth would have to be lengthened tenfold if we were to have any real hope of achieving all that should be possible for man. To some extent the brevity of our personal lives is compensated by the collective memory of mankind stored in books, works of art, and other records. But we often forget how little, in fact, man can convey of his own experience by means of the written word. He can evoke feelings and he can transmit abstract knowledge, and to some extent he can also convey to others the manner in which these feelings and this knowledge were experienced, so that if they wish they may reproduce his own procedure. But the deeper understanding which is essential if human life is to enter a new epoch cannot be trans-

mitted or even shared; for it issues solely from a man's own unique experience. Through not realizing how little can be transmitted through books or works of art as he knows them subjectively, man comes to place undue reliance upon the spoken or the written word, thereby depriving himself of the possibility of using wisely the short life that is given to him in which to find for himself the answers to his questions.

The experience of the average man is also narrowly restricted and localized in space. He knows little beyond that particular small portion of the earth's surface upon which he chances to live. All his experience is related to a body of a certain size, whereas there are events proceeding within and around him upon scales of magnitude millions—and even millions of millions—of times smaller or greater than his own specious 'here

and now'. Although through scientific research he may have come to know of the existence of these events, he is quite unable to take them into account in assessing the significance of his own existence. That this is so can readily be verified by anyone who will take the trouble to answer the question whether he is able to conceive his actions being affected in any way by the needs or possible experiences of one single cell of his own body, or whether he can picture himself as being significant for a star.

1.1.4. Forms of Thought

If by 'thinking' we mean the conscious direction of mental processes towards a determined aim, we are bound to say that few people 'think' at all. The extreme rarity of consciously directed thought can be seen in sharp contrast with the general mechanicalness of all our human functions. Self-initiated, purposeful action carried through to an effectual conclusion plays almost no part in any phase of human life. The differences that we observe between one person and another consist, not in different degrees of conscious control, but in variations in the scope and effectiveness of the mechanism for automatic association and response. Even so-called 'intentional thinking' and 'directed attention' are, for the most part, only reactions whereby two regions in the central nervous system respond simultaneously to a given stimulus.

(a) Associative Thinking

Most of us only experience passively the stream of associations and mental images that are presented to us by the automatic working of our nervous system. The phenomena of 'interest' and 'concentration' can be traced to chemical reactions in the blood that intensify the activity of the vegetative nervous system as it impinges upon the working of the

thalamo-cortical mechanism. In such automatic processes, involving very large numbers of reactants, the resulting combinations depend effectively upon chance or accident, and, realizing this, we might well be led to the conclusion that even the great discoveries of science are no more than the unusual combinations that have a finite probability of arising in such cases. There is, however, in the specifically human nervous system a mechanism of selection that increases the probability that thought and feeling by automatic association may give an interesting or useful result. Even when we have allowed for this selectivity, a close study of human achievements must convince us that, however rare it may be, authentic creative thinking and feeling do sometimes occur in man, and that nearly all that is interesting and significant in human life has been initiated by these infrequent phenomena.

If we inquire further and seek for the factor that enables the automatic associating mechanism in man to enjoy at times moments of authentic freedom, we soon discover that this factor is closely related to the mysterious property of self-consciousness—a property that distinguishes man from any machine that he is able to construct. When we come to examine the role of self-consciousness, we can see that the quality of thought depends upon the number of independent ideas that can be embraced with their full significance within the compass of a single conscious state. Nearly all human cogitation consists, as we have seen, in the automatic association resulting from the successive presentation of ideas that themselves consist of the material of past sense-impressions. To this process the laws of probability can be applied to explain why it is that only one mental act in many thousand millions gives rise to any new or significant combination of ideas. It must be apparent that, if we seek to open new pathways for the mind, we must explore the possibilities that arise through combinations that go beyond the usual associative forms of thought.

(b) Logical Thinking

When a measure of discipline is introduced into the associative process, thinking tends to become logical. Since ancient times, logic has come to be identified with the rules according to which we make judgments as to the truth or falsity of propositions. These latter are the verbal forms in which ideas are confronted in pairs, whereas in ordinary associative processes there is no effectual confrontation. Logical thinking therefore

represents an important step forward from automatic association. A special effort, requiring either an unusual stimulus or a long training is needed before a man is able effectually to entertain two complete in-

dependent ideas at once and to see their mutual bearing. The result goes beyond the content of the ideas as they are immediately presented and can be called polar thinking. Two ideas, in so far as they are independent and mutually exclusive, form a dipole with its own field of force. Through the ability to experience this force-field, the trained logical thinker can make synthetic judgments within the limits of the ideas he is able to formulate. The difference between synthetic judgments and automatic association consists in the presence of polar experience. For example, the words 'being' and 'nothing' stand for two independent concepts that, when entertained as one single act of consciousness, appear at once both compatible and incompatible. The mental process whereby the two give rise to a third idea that harmonizes them without destroying their separate significance is called the dialectic. Hegel, for example, sees in 'becoming' a concept that reconciles 'being' and 'nothing'.* Any pair of independent ideas can be treated as a polar dyad. Thus 'kingship' and 'liberty' can be reconciled through the idea of 'responsibility', which can apply to both and yet is different from either.

Dialectical thinking is certainly of a different order from that which consists in the automatic association and comparison of ideas. Though difficult in its exercise, this form of thought is, nevertheless, extremely limited in its scope. Experience has shown that it is inadequate for finding answers to the practical problems of life, and, indeed, the great exponents of the dialectic—from Plato to Hegel and Marx—have proved unsatisfactory guides to practical life, whether private or public. The dialectic leads also to a defective linguistic form. Our usual language, though full of inconsistencies and ambiguities, can be adapted to the description of two-term systems. When the meanings of words and sentences are defined with special care, a logic is constructed that turns out to be the law of two-term systems. The procedure by which language is made to conform to these rules is, however, an unavoidable impoverishment. The ambiguities and inconsistencies of our ordinary speech are not a defect, and recognition of them is a reminder that experience has more dimensions than logic. Analytical and sceptical philosophers have, during a hundred generations, exposed the barrenness of two-term thinking, and it becomes necessary to examine the possibilities latent in higher modes of thought. In seeking to go beyond logic, we run the risk of falling from serious inquiry into fantastical speculation; but it is more profitable to make the attempt than to remain condemned to the sterility that has overcome philosophy through using forms of [* Cf. Hegel, *Logic*, trans. Wm. Wallace (Oxford, 1892), pp. 158-64.]

1.1.6. Concrete Forms and Magic

Even with counting, pairing, and the recognition of quality, the full significance of number is far from being exhausted. Numbers have meaning in their own right. The number two is not merely the symbol of duality; 'twoness' depends upon and defines the separation of oppo-sites. The number three is indissolubly connected with the very idea of relatedness. Three as a class concept is an abstraction from experience—three as a relationship is an integral part of experience itself. This leads us to seek for a property which can be called the concrete significance of number. Although we may be convinced that such a property really exists, we are also forced to admit that it eludes our attempts at classification. We are not, however, on this account entitled to dismiss concrete number as illusory, and still less to regard it as unimportant. If we are ever to free ourselves from the limitations of logical thinking, we shall have to discover a new significance in number; for number and logic, as we know them today, are inseparable.

It is said that the Greeks were inclined to over-emphasize the static aspect of number.* Certainly Plato seems to have looked upon numbers as having little more than arithmetical significance.+ It is, however, noteworthy that Pythagoras regarded the tetrad as more fundamental than the triad. Anaxagoras, with his 'four substances', has the same basic outlook. Nevertheless, Pythagoras and the early Greek philosophers were aware of the Egyptian tradition, for which numbers were the key to understanding reality. Aristotle argued in much the same way as the present thesis regarding the significance of the numbers one, two, and three.++

The search for the concrete significance of number is very ancient. It was already very old in pre-dynastic

Egypt—more than five thousand years ago. At some unknown period earlier than the first written records, man had already become convinced of this concrete significance, and must, therefore, have seen how a number can enter directly into events as experienced by himself. If we interpret 'concreteness' as the property whereby a given form enters our direct experience, we can recognize the close connection—persisting from the earliest times—between number and magic. Magic is the art whereby man seeks to influence events. It is therefore to be expected that belief in the concreteness of number should go hand in hand with belief in magic, and that with the repudiation of the one should come also the neglect of the other.

* Cf. A. N. Whitehead, *Modes of Thought*, p. III. + Cf. *Theaetetus*, pp. 204-5. ++ Cf. *Physics*, 1, vi.

The study of human origins demonstrates that magic has always played a part in the formation of human character and human institutions. We cannot therefore disregard magic in our search for an understanding of human destiny. There are two current attitudes towards magic. The one can be called the official attitude of science, philosophy, and religion. These disciplines reject magic as primitive superstition, interesting only in the historical and anthropological sense as showing how great a progress man has made since the tentative beginnings of his search for truth. The second attitude is that of an uncritical acceptance of magic, either under its own name or under other labels which dissimulate in various ways the belief that supernatural forces act directly in the life of man. Acceptance of magic, however, goes far beyond naive superstitions. We still believe in magic, although we call it by different names. The faith that technology or some form of social revolution could liberate man from the need to work and to suffer is in its essence indistinguishable from the crudest beliefs in the efficacy of magic. It very often happens—perhaps nearly always—that the rejection of magic pictured in one form and blind faith in magic pictured in another are to be found side by side in the same person or in the same civilization.

If, then, we are to make a right assessment of the task before us, we must recognize the need to steer a course between naive acceptance and equally naive rejection of the reality of concrete forms. This middle course consists in admitting that concrete forms must certainly exist, but that man such as he is has not the means to penetrate deeply into their essence.

1.1.7. The Gradual Approach

Whitehead has reminded us that narrowness in the selection of evidence is the bane of philosophy. Any system can be made to appear plausible, so long as we reject and ignore those elements of experience that have no place in it. If, however, we set ourselves the task of treating all experience with the same respect—whether it be rational or irrational, scientific or unscientific, communicable or incommunicable—we find ourselves very quickly out of our depth. Since every rational argument must involve at least one non-rational premise, no one can question the limitations of human reason. The scientific method of observation and experiment cannot take account of the unrepeatable and the exceptional, which occupy so great a place in our aesthetic experience. Moreover, there are laws which defy communication because they are laws of understanding and not of knowledge, and which yet are no less certain

and no less universal than those which can be expressed in the language of words and symbols.

Quality is an authentic element of all experience, but it cannot be known in the same manner as quantity is known. Our intuitions of quality are different from those of quantity and they cannot be expressed in the same language, and yet all experience, whatever its nature, is an awareness of qualities. No system of thought can ignore quality without incurring the risk of a sterility that is the more deadly for being often self-satisfied and blind to its own limitations.

Nevertheless, the task of confronting all possible experience is beyond the power of any man; and we should be foolish to embark on it unless we are prepared to go slowly, searching for the elements which are both simple and also universal, but not expecting to grasp their full significance. We can then hope gradually to

build up a world-picture, at first in outline only, afterwards filling in details where we find it possible. This can be called the 'method of progressive approximation', and it will be discussed in detail in a later chapter. Its chief characteristic is that it starts with a total concept that is necessarily vague and faulty; rather than with a concept that, though perhaps precise and convincing, is necessarily abstract and incomplete. We shall begin with the total givenness of all experience and, without forgetting the limitations of our powers of perception and thought, try to see that totality as one. We shall not look therein for simplicity or clarity. We shall not expect that we shall be able to express our intuitions in satisfactory language or to communicate them otherwise than most inadequately. We have, moreover, to accept the inevitability of error. The immediacy of sense-perception and the reliability of logical deduction have little part in the attempt to penetrate to the form of experience, which is in the true sense metaphysical—that is, beyond the senses and not subject to the limitations of thought. The concrete form for which we search is a mockery to the empiricist—but it is also a stumbling-block to the rationalist. Moreover, we embark upon our task with the presupposition that it can never be finally accomplished. Nevertheless, it is the search that matters, for it is the manifestation of the true human nature, the meaning and the place of which we are striving to understand.

Chapter Two THE PROGRESSION OF CATEGORIES

I.2.I. Categories and Principles

We should at this point pause to settle the meaning of certain expressions that we have used and shall need to use further. The first to require clarification is the distinction between 'concrete' and 'abstract'. A concrete statement is the direct expression of the full content of a given experience; an abstract form is one from which some elements of experience have been omitted, thereby enabling attention to be directed to some particular aspect of the situation to the exclusion of others.

Abstraction is generally unavoidable, for it compensates for the limitations of our human powers of perception and thought. We have further to distinguish in our experience different stages, beginning with un-differentiated sensation and passing through perception and image-formation to the higher modes of cognition—the final goal being the attainment of Objective Reason. These stages have some of the characteristics of a spiral path up a mountain that returns to the same panorama hut upon a different level and so with a different perspective. Primary sensation is concrete and higher cognition is also concrete, but the ascent from the one to the other can scarcely be made without some sacrifice of immediacy, that is, without some degree of abstraction.

The first step from sensation to perception is made by an ordering process that depends upon the presence in our experience of certain primary data. We shall define as the categories those elements of experience that on the one hand are given immediately, and on the other appear to have a general or universal character. Used in this way, the word 'category' approximates to the Aristotelian 'different kinds of notions corresponding to the different forms'.* The categories are the means whereby we begin to construct from our immediate experience an orderly picture of our world. They are thus at once the completion of perception and the start of reasoning. When we begin to reason, we fix our attention upon the categories and seek to express the meanings they

[* The ten original predicaments—substance, quantity, quality, relationship, place, time, configuration, possession, activity, and passivity—do not form a progression nor, as Kant pointed out, are they much more than inspired guesses. Nevertheless, Kant himself was rightly criticized by Hegel for failing to recognize that there must be some principle of interpretation applicable to the categories themselves.]

bear for us by means of words or symbols. The formulae so constructed can be called the principles. The categories, being the elements of our immediate experience and therefore certain, are concrete; whereas the principles, being the expression of our comprehension of these elements, are abstract and therefore subject to our own uncertainties and limitations. The categories emerge from our experience by a process of discovery.

Even when no categories are named nor any principles formulated, the elements of experience are nevertheless recognized. Moreover, their emergence from the stream of immediate presentations proceeds in a definite sequence. Hence it is that the categories themselves form an ordered series and can be defined by the minimum number of terms that a system must possess in order to exemplify them. The first category is that of wholeness, which requires only one single term; namely, an element of experience that stands out in our awareness as present and persisting. If we go further and say that this element is itself and not other, we have already made the step to a two-term system and the category of polarity.

Polarity thus emerges as an inevitable consequence of the recognition of wholeness as an element of experience that is not its totality. The antithesis of 'this and not that' leaves us with two bare, or unrelated, terms. We discover, however, that the elements of our experience are always related; hence we find emerging the third category of relatedness, which requires at least three terms for its exemplification. Relatedness, in turn, is incomplete unless we bring it back to immediate experience with the characteristics of 'thus and so'. Since we find ourselves always obliged to take our experience as 'thus and so', we have to admit the fourth category of subsistence. Once again it is necessary to go beyond 'thus and so' in order to take into account all that might be, but is not, present. This additional element of our experience is the category of potentiality that requires five independent terms for its exemplification. These are followed by the categories of repetition (requiring six terms) and structure (requiring seven terms). This series must be continued until as many terms are included as are required to give the measure of concreteness that we are capable of grasping. Naive realism is satisfied with a one-term scheme in which there are no distinctions of subsistence. Naive dualism cannot go beyond polarity. Thus, at each step in the progression of the categories we find a greater 'sophistication'. The series has no end, except in the limitation of our own understanding. Examining the categories, we find that each has a field of significance conterminous with all experience. Nevertheless, the categories themselves can never exhaust experience for, whatever number we may reach, some

degree of abstraction remains and an additional element must be admitted in order to move towards a greater concreteness. We have therefore to study the categories as an endless progression, at each step of which there is a corresponding principle through which we state what we are able to understand of the category. Thus the growth of understanding requires, on the one hand, the discovery of the categories and, on the other, a deepening of our appreciation of their significance.

We have to be on our guard against supposing that the principles tell US anything that we have not already found in our experience. There is a serious misuse of language that consists in giving expression to our desires, beliefs, or fantasies and calling them 'scientific principles'.* The principle is no more than a device for retaining in our memory those elements of experience that we discover to be both immediate and universal, but, because of their presumed universality, principles are more than statements of fact. They correspond to a definite stage in the transition from sensation to reason.

1.2.2. The Numerical Series of Categories

Our categories are to take the place of the Kantian categories, some of which—for example, wholeness and subsistence—are given the same names and are defined by him as concepts by which alone anything in the manifold of intuition can be understood, + The Kantian categories do not go far enough, because they remain within a logical or dualistic framework. Aristotle, with his predicaments and post-predicaments, realized that there is a finer intuition that comes with deepening experience, but both Aristotle and Kant disregard the significance of objective number.

The integers attached to each category are not merely symbols, but designate the minimum number of terms which must be present in a given system in order that the corresponding category may be fully exemplified. For example, we cannot exhibit the nature of relationships by means of two terms alone; for, as Plato recognized, we cannot hold in our thought two independent ideas without a third to reconcile

[* Cf. Professor Herbert Dingle, Presidential Address to the Royal Astronomical Society, February 13, 1954, in *Nature*, Vol. 173, pp. 575-6: "... when it happens that we have published in the name of science, so-called 'principles' that all celestial movements are circular and all celestial bodies immutable, it becomes my duty to point out that this is precisely the kind of cerebation that science was created to displace. . . . In cosmology we are again, like the philosophers of the Middle Ages, facing a world almost entirely unknown."

+ Cf. Kant, *Critique of Pure Reason*, 2nd edn., pp. 105-23.]

them.* Likewise, potentiality requires five terms because it is necessary to distinguish between what is and what might be, as well as to account for all the relationships into which a given system can enter.

It must be noted that the principles cut across the distinction of physics and metaphysics attributed by the accident of name to Aristotle, who saw more clearly than his disciples that the real problem of the philosopher is not to look beyond experience but to understand it. It is in this same sense that 'every man is a philosopher'; for our ability to find answers, not only to our deepest but also to our immediate practical problems, depends upon the grasp—conscious or intuitive—that we have of the principles and their operation. It is in this sense that Gurdjieff asserts that one of the fundamental strivings for man must be 'to know ever more and more concerning the laws of world creation and world maintenance'.+ Whether we realize it or not, our ability to order and direct our lives depends upon the extent to which we grasp the operation of the principles, and especially those that have an active character; namely, those which correspond to the odd numbers. It can be said that the principles of wholeness, relatedness, potentiality, and structure are dynamic—that is, self-transcendent—whereas the even-numbered principles of polarity, subsistence, and repetition are static or closed—that is, self-sufficing.

It will be convenient to set out the first twelve members of the series of categories as follows:

Dynamic Categories	Static Categories
I Wholeness. One-term.	2 Polarity. Two-term.
3 Relatedness. Three-term.	4 Subsistence. Four-term.
5 Potentiality. Five-term.	6 Repetition. Six-term.
7 Structure. Seven-term.	8 Individuality. Eight-term.
9 Pattern. Nine-term.	10 Creativity. Ten-term.
11 Domination. Eleven-term.	12 Autocracy. Twelve-term.

Here it must be emphasized that number twelve is not a terminus ad quem but a convenient resting-place. The principles continue with the categories, and the series has no assignable termination. For example, the tenth principle of creativity is important for any study of the universe, but for lack of understanding of the true distinction between

[* Cf. Plato, *Timaeus*, 31 : "Two things cannot be held together without a third; they must have some bond of union, and the fairest bond is that which most completely fuses and is fused into the things which are bound; and proportion is best adapted to effect such a fusion."

+ Cf. Gurdjieff, *All and Everything*, p. 386.]

the numbers from eight to twelve, we shall not attempt to express it in a verbal formula.

Before proceeding to consider the categories separately, we must note again that they are not derived in sequence merely by the addition of a fresh term. Polarity arises not solely by the juxtaposition of two wholes but by the formation of a dipole. Relationship is not merely the reconciliation of opposites, but the totality of a system in which three independent factors are joined to make one. Subsistence is neither a pair of dipoles nor wholeness plus relationship, although it includes both of these. It also imports into the four-term system the property of uniqueness that Hegel calls 'being thus-and-so'. Potentiality can be expressed as two triads forming a dipole, but it has its own peculiar quality that none of the earlier categories can convey. Repetition again carries us a step further towards the concreteness of experience in which to 'cognize' is to 'recognize'. Structure is not only repetition plus wholeness ($6 + 1$), potentiality plus polarity ($5 + 2$), or subsistence plus relatedness ($4 + 3$), but all these, together with the unique property of independence; that is, of having the ability to reproduce in a part the character of the whole.* The categories serve only as means for recognizing certain properties of our experience and for studying them both separately and in their mutual relevance. Moreover, the principles have no end-point that we can represent to ourselves in thought, but they return again and again with increased significance as our own experience of life grows towards understanding.+

1.2.3. Wholeness

Wholeness is omnipresent but relative.

Observing our experience and the behaviour of both living organisms and inanimate objects, we can discern a pattern of energy-exchanges to which we can apply the general term 'response'. There are different gradations of response that we express by words such as 'reaction'— 'sensation' — 'perception' — 'discrimination' — 'understanding'. The terms of this series are not well-defined, nor can we determine without further inquiry whether one form of response is independent of another.

[* The apparent similarity of the series of categories to Hegel's 'progression of the notion' must not mislead us into supposing that we have returned to the 'science of the experience of consciousness', of which Hegel claims that "finally when it grasps its own essence it will indicate the nature of Absolute Knowledge itself". Cf. G. W. F. Hegel, *Phenomenology of Mind*, trans. J. B. Baillie, Vol. I, p. 89.

+ Hegel's progression is absolute but finite, whereas the series of principles given here is relative but infinite.]

Nevertheless, we can recognize a 'scale of response' that ranges over all that we know. If we now introduce the word wholeness, we are bound to admit that its meaning is relative to the gradation of response of which the object in question is capable. Inanimate objects can scarcely be said to recognize other wholes. A crystal, for example, can take up material from a solution for its own growth, but it does not respond specifically to the presence of another crystal, like or unlike itself. We can recognize selective responses in mechanisms, such as slot-machines, that we ourselves construct, but their ability to react selectively to specific wholes, such as pennies, derives from human experience. Plants appear to have some little power to recognize and respond to other objects as wholes.* Animals—even the most primitive—show a higher gradation of response. The response to wholeness is unmistakable in animals endowed with a nervous system; but it is sensed rather than perceived. The discrimination of wholeness in man proves on examination to be less than we might suppose. Our speech implies that the names we use are wholes, but we seldom verify the meanings we intend to convey. There is, however, convincing evidence that man in a heightened state of consciousness acquires a direct perception of wholeness that goes far beyond name and form, and penetrates in some manner into the very essence of the thing perceived.

Such considerations lead us towards the conception of wholeness as a property that is encountered in all experience, and as one that admits of degrees and is therefore relative. Since our habitual language takes no account of the relativity of wholeness, a reconstruction becomes necessary. Let us, for example, consider a group of words that illustrate various aspects of wholeness, such as 'unity', 'coherence', 'togetherness', 'completeness', 'order', 'organization', 'organism', 'self-hood', 'individuality'. The meanings of these words show

a certain gradation, in so far as we can recognize that we pass from a more abstract to a more concrete conception of the meaning of wholeness. There are, however, in such words as 'organism', implications of subsistence and structure that go beyond bare wholeness. If, then, we ask ourselves what are the gradations of wholeness, we see that they are determined by the extent or degree to which a given object is itself and does not merge into something that is not itself.

We have to make here an important generalization; namely, that there is always meaning in the question: 'To what degree is this object itself?' We notice that all objects are not unified to the same degree—some are more coherent than others. Thus, a living organism has a greater degree

[* Cf. J. C. Bose, *Response in the Living and the Non-Living*.]

of wholeness than a collection of dismembered limbs and organs on a dissecting table.

In order to designate the property of an object that constitutes its gradation of wholeness, we may use the term 'togetherness' and, since it is desirable to emphasize that wholeness is inherent in the object itself and not in the way it is perceived, we may ascribe to every whole a precise index; namely, 'the degree to which a given whole exists independently and is distinguishable from its immediate environment'. The principle of wholeness asserts that the property of being oneself is universal and omnipresent and yet relative.*

1.2.4. Polarity

The assertion that two objects are connected implies that they are also in some way separate. Words such as 'opposite', 'contradictory', 'divided', 'contrary', 'exclusive', all imply a disconnection that would be meaningless if there were no connection. We may use the term dyad in a special sense to designate any pair of terms between which both connection and disjunction can be recognized. 'Man and woman' is a dyad, and other examples that can be readily recognized are 'heat and cold', 'present and absent', 'inner and outer', 'like and dislike', 'greater and less', 'true and false'. Such pairs as 'wood and paper', 'tea and coffee', 'yesterday and tomorrow', 'perhaps and rather' are also dyads, since in each pair of terms we can recognize a common property that gives meaning to the opposition. However, the two terms of a dyad need not have any essential property in common. Indeed, the connection may be no more than the fact that they happen to be brought together by some accidental association of ideas. For example, 'cooking and yesterday morning', 'greater than and copper', can both be taken in such a way as to exhibit two ideas set in opposition and yet associated in a specific connection.

With these explanations, we can assert that any and every pair of wholes, existing or non-existing, can be regarded as a dyad in the sense above indicated. Although all pairs are dyads, the greater majority are trivial in that the two terms stand to one another only in a weak opposition and with an insignificant connection. Even where the polar opposition is clearest, there remains in every dyad some unopposed element common to both members of the pair. For example, heat and cold are not entirely exclusive terms, because there is some heat even in the coldest object. Truth or falsehood can never be asserted absolutely of any dyadic proposition.

[* Cf. J. C. Smuts, *Holism and Evolution*, London, 1924, p. 98: "Wholes are basic to the character of the universe."]

The principle of polarity can be formulated shortly.

Polarity always gives rise to force. We must be careful not to make the mistake of supposing that a force is the same thing as a relationship. Positive and negative electric charges cannot exist together, and therefore cannot be said to be related to one another, although in juxtaposition they do produce a force. Through polarity, everything that exists is in a state of strain which polarity itself can do nothing to relieve. Hence polarity can never be a final principle of explanation.* As modes of expression, wholeness is too comfortable

to be satisfying and polarity is too uncomfortable to be endured. The dyad is always a source of disturbance, compelling us to penetrate more deeply into the matter in hand.

Without force nothing can move, but force alone does not make movement possible. The world viewed as a system of dyads would consist of connected but unrelated wholes, of opposites seeking reconciliation but unable to find it. The number two cannot get beyond itself. The dyad is closed, but its closure is not that of completeness.

Through polarity, we find everywhere in our experience oppositions of order and chaos, of good and evil, of truth and falsehood, of self and other; but polarity can show us neither how these oppositions arise nor how they can be resolved.

1.2.5. Relatedness

All real relationships are reducible to the combination of three independent elements standing to one another as affirming, denying, and reconciling influences.

A relationship is not itself a whole, nor is it a property of the wholes which it relates. Hence no principle of relatedness can be reached merely by combining wholeness and polarity. Since logic is based on these two latter principles, relatedness goes beyond logic. Hence it is that the attempt to study relatedness by way of the dyad 'terms and relations' proves unsuccessful.+

[* Cf. Roubiczek, *Thinking in Opposites*; also the insistence in Hindu literature upon the need to 'transcend the pairs of opposites'.

+ Cf. R. H. Bradley, *Appearance and Reality*, pp. 32-4: "Relations are nothing intelligible, either with or without their qualities. In the first place a relation without terms seems mere verbiage; and terms appear, therefore, to be something beyond their relation. . . . The conclusion to which I am brought is that a relational way of thought—that is, one that moves by the machinery of terms and relations—must give appearance and not truth."]

If relationship cannot arise from two terms alone, nor from anything derived from either of them, it must require at least three terms; and we discover it to be that very property which enters experience through the triad. The most important, and in some ways the most difficult, idea to be grasped is that a relational triad is constituted only to the extent that the three terms present are independent. If any one of the three terms can be inferred from the other two, then we are dealing not with a relationship but with wholeness or polarity. For example, heat—cold—iron do not constitute a relationship, for heat and cold are not independent factors. If, however, we take fire—heat—iron, we suggest a relationship whereby fire and iron are related through heat, heat and iron through fire, and heat and fire through iron. In the former case we have only the conception of the force of heat and cold confronted in a piece of iron, but not of a relationship. The requirement of independence introduces an element of order that we do not find in the principles of wholeness and polarity. A relationship is not characterized by the mere fact that three terms are present, since it is also necessary to take account of the manner in which they come together. For example, the triad child—mother—father, which stands for the evocative power of the child over the relations of man and woman, is quite different from the triad father—mother—child, which represents the generative action of the male principle confronted with the female.

It must further be noted that each of the three terms of a triad makes its own specific contribution to the character of the relationship. One of the terms will always have the character of affirmation, or activity; the second will have that of denial; while the third will appear neither as active nor passive, but as the reconciliation of the other two. We may find it difficult to recognize these characters in every situation, because of the many different forms in which they can be manifested. Affirmation is always positive and

active, but it can have many different shades; denial can range from violent opposition to inertness and passivity; and within this range there can be such other characteristics as receptivity, response, and co-operation. The third character may be no more than the result of the meeting of active and passive forces, or it may appear as an act of freedom bringing into existence a situation that without it would not have arisen at all. The two triads already discussed differ in the significance of the child as third term. In the first triad the child is pure potentiality—that is, freedom, whereas in the second, it is the temporal actualization—that is, the result.

Because of all the different gradations of meaning that can be taken by the three primal characters, relationships can have an endless variety,

but all can be reduced to triads. An apparent relationship of the kind A bought B from C for D shillings* is really two triads—one a 'buying' triad and one a 'price' triad. Moreover, it is not a true tetrad; for the terms B and D are not independent, since the price D is meaningless without reference to the object B. Similarly, Russell's pentadic relationship—'A minds B's love for C more than D's hatred of E'—is composed of four triads with the relationships 'love', 'hatred', 'minding', and 'more than'.

1.2.6. Subsistence

Subsistence is the limitation of existence within a framework that requires for its definition not less than four independent terms.

We pass from relationships to subsistence by the recognition that existence is always presented to us 'thus and so'. This requires a four-term system. The tetrad is, in an obvious sense, a combination of relations and the objects related, and, hence, stands for a situation that is more concrete than the triad alone.+ To specify an event, we require four independent terms. Usually these are taken as three parameters of space and one of time, but we must not make the mistake of supposing that a tetrad is composed of two different kinds of terms. Subsistence means for us persistence in time and extension in space, but these two are not in practice inseparable. What we actually observe is change, which can be represented as a system of bodies in relative motion. The main point to be noted is that subsistence refers to particular situations. Every tetrad is unique, but the price it pays for this uniqueness is that it cannot become other than itself. Thus the principle of subsistence is essentially static. It is further to be noted that the fourfold framework need not be that of sense-experience in space and time. We could conceive of a pattern as subsisting within a timeless framework of space combined with the property of renewal. It is even probable that there are modes of being that subsist in an invisible world of space and potentiality. Hence it is necessary to formulate the principle without explicit reference to space and time.

Subsistence completes the first cycle of categories that can be called the 'categories of bare existence'. With the second cycle we both continue and repeat the progression to reach a fuller and more concrete experience of subsistence and individuality.

[* Cf. Bertrand Russell, *Human Knowledge, Its Scope and Limits*, p. 277. + When Plato uses the phrase 'standing four-square', he betrays an intuition that a three-term system is somehow incomplete and unstable.]

1.2.7. Potentiality

Potentiality or multiple subsistence arises when at least two similar triads share a common member in the initiating position. It therefore requires a system of not less than five independent terms. So far as we identify knowledge with sense-perception, we are bound to say that what we perceive exists and what we cannot perceive does not exist. Nevertheless, the status of actual and potential cannot be reduced to the simple opposition of existence and non-existence. Existence as a field of possible actualizations is not the 'bare existence' of Hegel, which is 'absolute indifference',* but rather 'being determinate'. To assert that B and C

exist potentially in A is equivalent to saying that there are two triads ApB and AqC, both equally real where p and q are events having A as their initial moments.



According to our ordinary conceptions of space and time, the combination of ApB and AqC is impossible, for the two events B and C are required to occur at the same time and place. If, therefore, the proposition 'B and C are both potential in A' is to have a meaning, this meaning must be referred to a framework more ample than that of space and time alone. From such considerations we arrive at a five-dimensional representation-space, and also at the conclusion that potentiality requires a minimum of five independent terms.

Our sense-perceptions are confined to actual presentations. This might be, for example, the triad ApB. The unactualized possibility given by the triad AqC remains unperceived and, according to usual views, is to be regarded as non-existent. Reasoning based on the supposition that what is potential is non-existent leads to serious errors. In the long run it forces us to conclude that all our experience is inexplicable. The simple consideration that unactualized potentialities may at any moment become actual should be sufficient to convince us that they cannot be treated as non-existent. The principle of conservation of energy can hold only if potential energy is fully equivalent in its existential status with the

energy of motion.

In that it is the first condition of independence, potentiality endows experience with that which is lacking in the earlier categories. The two relationships ApB and AqC can—but not necessarily do—represent for A the situation of choice, whereby one or the other becomes actual by

[* Cf. G. W. S. Hegel, *Logic*, trans. Wallace, p. 169.]

virtue of what A is, and not as a result of antecedent causes. Hence it can be seen that not less than five terms are required in order to give a meaning to the conception of independence.

Potentiality is always more than subsistence. Everything that exists has potentialities for actualization that outstrip the relationships that it can sustain within any concrete situation. This is as true for inanimate objects as for living beings. All existence is exemplified in the seed that carries in its genetic pattern a potency for variation that can never be fully realized. Bradley's criticism of the 'dance of bloodless categories' could never be directed against potentiality rightly understood, for in it flows the bloodstream of existence, ever replenishing the source from which the temporal process is sustained. Potentiality is the eternal element in all experience.

1.2.8. Repetition

Repetition is the property whereby identity, difference, and relatedness are combined in a single system, and for this a minimum of six terms is required.

Experience teaches us that the words 'same' and 'other' are mutually dependent in the sense that we cannot speak of either without importing some of the meaning of both. There is nothing in the first five principles which requires that 'same' and 'other' should be bound together in this way, and therefore we have to recognize a new characteristic of our experience. If we consider the system A B C D E F, we can see that this can be regarded as two independent triads A B C and D E F, or as two tetrads A B C D and C D E F, which share half their terms. Such a system enables the combination of same and other to be established, and can, therefore, be called repetition. It is not too much to say that the principle of repetition is the basis of

epistemology, for without it there could be no recognition and, hence, neither knowledge nor the possibility of understanding.

When we examine the minimum number of terms which a system must have in order to exemplify the principle of repetition, we can see that it is not sufficient to make the distinction between actual and potential, for this distinction could arise in a static system where nothing occurs. Potential energy can be stored up indefinitely, but it does not renew itself. Repetition requires the twofold action of a disturbing and a resisting force—that is vibration. It follows from this that to pass from potentiality to repetition, six independent elements must be present in the situation, for disturbing and restoring forces are conceptions that have no meaning in terms of the first five principles.

One aspect of the sixth principle can be appreciated if we remember that all precise knowledge, all measurement, is possible only through the observation of repetitive processes. The measurement of time—the determination of length—the discovery of proportions—all require repetitive instruments such as clocks and rulers, and the recognition of likenesses and differences in what we observe.

Nevertheless, the epistemological significance of repetition is only a secondary feature. Repetition not only gives us what we know but makes us what we are. We could understand nothing and do nothing if life did not repeat. Potentialities might really exist, but without repetition we could make nothing of them.

The ancients accepted cyclicity as axiomatic, and took it too much for granted to be able to see its place. Gianbattista Vico was perhaps the last philosopher to see in repetition a cosmic principle of explanation. Since his time secularity, or the belief that events proceed in a definite direction, has superseded his concept of reflux. And yet its importance remains, only, not as a principle unique and ultimate, but rather as one of the categories without which no valid thinking is possible.*

1.2.9. Structure

A structure is a self-regulating system capable of relatively independent existence. For this seven terms are required.

The word 'structure' is used in this context in the most general sense. There is a series of words for organized wholeness such as 'atom', 'molecule', 'cell', 'living being', 'organism', 'self', 'world', 'system', 'cosmos', that differ in meaning chiefly in the aspect of structure they serve to emphasize. The word 'atom', though commonly used for a very small particle, really means 'the smallest whole within which a given type of structure is fully exemplified'. 'Cell', 'living being', and 'organism' refer to the autonomous wholes that have the property of self-maintenance. 'World' and 'system' imply concreteness and self-sufficiency.

Structure must be applicable equally to the shapes and proportions of structures in space, to the combination of rhythms and cycles in time, and, in the widest sense, to everything that participates in the universal process as a more or less independent system.

It is by no means obvious that the principle of structure can be exemplified only in a system with at least seven independent terms, and it is necessary here to appeal to our concrete experience.

[* Cf. P. D. Ouspensky, *A New Model of the Universe*, Chap. 10, and Rodney Collin, *The Theory of Celestial Influences*, for an illustration of the breadth of vision made possible by a thorough-going acceptance of the principle of repetition. Ouspensky, in particular, recognizes repetition as a six-term system.]

Nevertheless, many examples of the seven-foldness of independent structures could be cited. Astronomers require seven independent quantities—the semi-major axis, the eccentricity and inclination, the longitude of the ascending node and perihelion, the epoch and the period—completely to define the orbit and position of a planet. Engineers need seven independent thrusts rigidly to fix a massive body. Such observations lend colour

to the ancient belief in the special significance of the number seven.* But it is not enough that seven-foldness is frequently observed, for the principle requires that it should be associated pre-eminently with self-regulating structures.

Self-regulation is a property that could not have been foreseen from an examination of the first six principles taken alone. It requires them, but it transcends and transforms them. Some idea of the manner of the transformation can be expressed in the following table, which sets down the component categories side by side with the corresponding elements in the principle of structure.

Category	Element
1. Wholeness.	Identity.
2. Polarity.	Direction.
3. Relatedness.	Interaction.
4. Subsistence.	Maintenance.
5. Potentiality.	Significance.
6. Repetition.	Renewal.
7. Structure.	Endurance.

A thorough investigation would go beyond what is necessary or possible at the present stage, and a simple example, taken from our observation of the growth of an acorn to an oak tree, must suffice. If we examine this process in detail, we can see that it would not be complete or significant without seven independent steps, as follows:

(i) Fertilization.	(v) The sapling.
(ii) Inner differentiation.	(vi) The tree.
(iii) Germination.	(vii) The end of life. (iv) The seedling.

The process starts from the moment when the ovum of the oak flower is fertilized. Before that instant there was no single whole in which all the possibilities of the future oak tree were present. At that moment of fertilization, the future oak tree, with the whole structure of its existence, is in a state of pure potentiality—within the limits of its hereditary determination everything oak-like is potential but nothing yet is actual.

[* For numerous examples see Richard Samuel, *Seven, the Sacred Number*, London, 1887.]

Thereafter, actualization proceeds continuously but in distinct transitions, at each of which a frontier is passed and a new land of promise is entered. The flower dies—the acorn is formed—the acorn ripens and falls to the ground. Here is the moment of crisis, for, each year, millions of acorns mature but few germinate, since in order to do so the acorn must fall among favourable conditions such as pressure and a spot of fertile ground with the requisite dampness. From germination comes the seedling. Once again there is a well-marked transition and, as nourishment begins to be drawn from the soil, the husk of the acorn is discarded. In the next stage—from seedling to sapling—the plant struggles for light and air. If it finds a place in the sun, the sapling becomes a tree of the forest and, unless destroyed by disease, by fire, or by the woodman's axe, it grows until

it reaches maturity. It then begins to decay, and when its strength is finally exhausted, its life-cycle is completed and it dies. This is the structure of its life. This structure is something more than the wholeness of the oak tree; it goes beyond the relationships and transactions with its environment; it is a cycle, a rhythm composed of the minor rhythms of day and night, of winter and summer, of growth and decay.

By such an illustration, we can give expression to the universal principle of structure. What is true for the oak tree is true for our own lives; it is true for every completed cycle of human endeavour, and it is true for the snow-crystal and also for the galaxy.

Every completed structure conforms to the one universal pattern. In the first moment, everything is potential and nothing is actual; at the last moment, everything has become actual and all the potentialities are exhausted. From the standpoint of the forest, the various life-cycles of the trees are recurrent processes by which its existence is maintained. The life of the forest itself is a recurrent structure, with its interwoven rhythms, its daily and seasonal periods, and its self-renewal in the life and death of the individual trees.

A similar analysis applied to any completed structure would reveal the same sequence of seven steps. The difference between the principle of structure and the preceding principles is unmistakable. There is only independence when there can be exchange with the environment by which self-maintenance is self-regulated.

1.2.10. Individuality

The eighth category brings us to the recognition of an element of experience that cannot readily be communicated. It is the property of being a free agent, that is, a self. Individuality is foreshadowed in the

first category of wholeness and the way to it is opened by the seventh category of structure. The cycle of seven categories exhausts all those characters of existence that lack the property of self-hood. An individual is a self, both as a unique centre of subjective experience and also as a source of initiative. There resides in true individuality an authentic power of choice and hence the ability to direct and determine the course of events. We cannot find individuality where there is not already structure, but not every structure is eo ipso an individual. That which individualizes a structure can be recognized as a special form of consciousness, but we cannot penetrate into the true nature and significance of individuality until we can recognize it in forms of existence other than our own. Nevertheless, individuality has for us a special importance since it is the pre-eminently human category by which men are distinguished both from animals and from the higher gradations of existence. This must not, however, be taken to mean that all men or even most men truly exemplify the category of individuality; for there is potential individuality that may never become actual, as a seed is a potential plant that may never see the light of day.

The principle of individuality can be stated as follows: Individuality is the source of initiative residing in organized structures. It may be actualized or potential only. In either case it requires eight independent terms for its exemplification.

I.2.II. Pattern

The word 'pattern' can be taken in a passive signification as the observed result of an orderly process. Thus we speak of the 'pattern' of a carpet. It can also be understood in a more active sense as that which serves to direct and order the process itself. In this way we speak of a carpet made 'from' a pattern. The order we recognize in the carpet is the pattern and it is also derived from the pattern. The German word 'gesetzmässigkeit', barely translatable into English as 'law-conformableness', conveys some of the twofold transitive and intransitive character of 'patternedness'. The universal significance of pattern is connected with the possibility everywhere and in everything of the affirmation of order in the midst of chaos. We do not, therefore, penetrate to the full significance of pattern as an element of all experience until we recognize that experience would lose all coherence if there were not always and in everything active sources of order. It is in

this sense that pattern constitutes the ninth category of experience. It cannot be discovered except by passing through experience of individuality, and this determines its place in the progression of the categories.

The principle of pattern can be now stated:

All experience is pervaded by the influence of active sources of the order residing in the patterns of organized structures. Pattern requires not less than nine independent terms.

I.2.I2. Creativity

Pattern suggests the maker of patterns. Our contemplation of experience cannot rest upon the recognition that there is a source of order, since order is not ultimate. That which can separate order from disorder is the power to create patterns. We cannot be directly aware of this power except in our own consciousness; but we can infer its presence from our observation of the world-order. Creativity, as Berdyaev has rightly taught, cannot be the ultimate category. "Only the recognition of created being permits an original creative act in being, an act which produces something new and unprecedented. If everything in being was not created, but had always existed, the very idea of creativity could not have been born in the world." "In every creative act, there is absolute gain, something added."* The word 'absolute' here falsifies the picture, nevertheless we must understand that in creativity there is an authentic addition to the sum total of experience; but this must remain subject to the condition of its being a possible addition. This condition is guaranteed by the category of pattern that stands towards creativity as potentiality stands towards repetition. We shall therefore take as our tenth category of experience the element of creativity which lies behind all patterns. The principle of creativity reads:

In all experience there is evidence of a creative activity that is not only the source of order but also the vehicle of disorder. The polar character of creativity calls for a system of not less than ten terms for its manifestation.+

I.2.I3. Domination

Domination is the power that reconciles order and disorder without participating either in the one or in the other. It corresponds to the third category of relatedness transferred to the plane of universal processes. The eleventh category is discovered in experience as necessity. It can be recognized in Spinoza's dictum 'nature abhors a vacuum' or in the saying of Richard Frank 'necessity is the mother of invention'. All the tensions of the existing universe are reconciled by the community of needs. Necessity as the law that knows no law points to a category

[* N. Berdyaev, *The Meaning of the Creative Act*, London, 1955, pp. 128-9.

+ E.g. the eightfold individuality together with the polar force of order-disorder that is the source of pattern. We shall see later that creativity cannot be the source of a new Reality.]

that has the power to produce its own opposite. This is domination which cannot be found until we have passed beyond creativity, for necessity, as the Greeks saw, is prior to creation. We can formulate as the principle of domination :

Domination is the power that reconciles order and disorder through the agency of creativity. It is the highest form of relatedness to be discovered in experience and requires eleven independent terms.

1.2.14. Autocracy

The twelfth category completes the cycle of primary experience. All derived powers imply a power that is underived. Since experience discloses the presence of laws, there must also be that element which is a 'law

unto itself. We should here mark well the subtle but indubitable distinction between the 'law that knows no law' and the 'law unto itself. The former relates and the latter subsists. We meet in all our experience with the evidences of an element beyond necessity, that acts without dominating, wills without creating, and unifies all possibilities. This element is the autocratic power of the primary affirmation. Nevertheless, we should not regard the twelfth category as terminating the series and exhausting all experience. The first twelve can be called 'categories of fact' as distinct from 'categories of value'. These latter cannot enter experience except by way of a new cycle that requires and implies the former and yet can in no way be inferred or derived from it. Autocracy is thus the last category of the natural order, but it is also the precursor of the categories of the moral order. The first twelve categories will suffice for the study of natural philosophy undertaken in the present volume. In the next volume we shall enter the second duodecimal cycle to establish a system of values.

Before leaving the twelfth category we should note that in recognizing one autocratic power as the source of all phenomena we find also the great methodological rule of universal similarity according to which all that we learn from any element of experience should have a bearing upon all other elements. Though creativity itself is free, there is an autocratic master pattern that requires all subordinate patterns to conform to its own ultimate plan. This is the twelfth principle:

Autocracy is the primary affirmation by which all possible experience is brought into existence whether as the potential pattern or the actual process of the universe.

THE ELEMENTS OF EXPERIENCE

1.3.1. Hyle

Experience is the given totality. From it alone we can learn, and we must listen to what it has to tell us. In describing what we discover, we are accustomed to use such words as 'I', 'we', 'you', and 'the world', but we must not be misled by custom into supposing that there must be immediate data of experience to which such words correspond. They may prove on examination to be conventions to which we adhere without asking ourselves what meaning, if any, they have for us. Indeed, when we reflect seriously, we make the discovery that 'I', 'we', 'you', and 'the world' are not given directly in experience after all. The child, who does not use the words 'I' and 'you' and knows no world but his own authentic experience, is in closer touch with reality than we are.*

The central problem of metaphysics—namely, being and the possibility of knowing it—is a real problem, but it is not so important or far-reaching as is sometimes supposed. It arises as a consequence of the distinction between the categories of wholeness and polarity.+ This leads to the separation of subject and object and to the distinction we tend to make between self and not-self. These separations and distinctions are not the total experience, nor are they even primary aspects of it. By recognizing that this is so, we are freed from the necessity of examining many questions that philosophers have thought important.

Obsession with one aspect of experience to the detriment of others is the main cause of disagreement between philosophers. By reason of polarity, there must always be an aspect of experience in which it appears as incomplete and inconsistent. Consequently no philosophical system can ever be constructed that is both adequate and free from

[* The reader is asked to tolerate a continuing vagueness in the use of the word 'reality'. Experience is the given, and we have not yet any means of deciding the question whether or not there may be something beyond the given. By 'reality', therefore, we may mean no more than authentic, as opposed to fictitious, experience, or we may mean very much more. For the present we must leave it there.

+It is necessary at this point to draw attention to a simple trap in which we are liable to be caught. Being is a

real problem and knowledge is a real problem, but the two are not the same, for, as we can learn from experience, being cannot be known.]

contradictions.* The categories cannot be explained away. So-called non-metaphysical systems, which in all ages there have been philosophers to advocate, disguise the verity that experience is paradoxical. Natural science may appear to be non-metaphysical, but this is only because its methods consist in isolating groups of phenomena in such a manner as to ignore contradictions, or at any rate to minimize their effect.+ There is, for example, a fundamental contradiction between physics and biology—that is, between the laws of matter and the laws of life; but this does not greatly trouble investigators in either field, since by the nature of their profession they are entitled to specialize. If, however, we aim to understand all experience, we cannot permit ourselves the same licence as do those who pursue the more limited objective of some specialized knowledge.++

We can recast the ancient question: 'Of what stuff is all reality made ?' in the form: 'Of what stuff is all experience made ?' Ordinarily we tend to imagine that there must be two kinds of stuff corresponding to the distinction between subject and object. For example, if we look at a table it seems as if there are two quite different kinds of stuff present: one the 'inner' stuff of our awareness, and the other the stuff of the table itself, which is somehow 'outside'. This means that we make the Cartesian distinction of 'thinking substance' and 'extended substance'. This is rather like saying that because a stick has two ends, it must be made of two different materials, whereas the ends are only aspects of the stick and have no 'existence' apart from it. What exists is the experience itself. To affirm this is not to deny polarity, but to restore it to its right status as the binary aspect of experience. The event—looking at the table—is a whole, the togetherness of which derives from our awareness. It is also a relationship in which our interest or concern enables our

[* The demand for consistency and freedom from contradiction has been the bane of Western philosophy. It has affected even philosophers who, like A. N. Whitehead, in their attitude towards the central problems of life have been touched by the spirit of the new epoch. Cf. A. N. Whitehead, *Process and Reality*, p. 3: "Thus the philosophical scheme should be coherent, logical and, in respect to its interpretation, applicable and adequate." Whitehead, himself, shows that this demand can never be met.

+ Cf. H. Levy, *A Philosophy for a Modern Man*, Chap. 2, 'How a Quality is Modified'.

++ Cf. Husserl, *Philosophie als strenge Wissenschaft*: "Thus true science, in so far as it has become definable doctrine, knows no profundity. Every science, or part of a science, which has attained finality, is a coherent system of reasoning operations, each of which is immediately intelligible, thus not profound at all. Profundity is the concern of wisdom; that of methodical theory is conceptual clarity and distinctness. To reshape and transform the dark groping of profundity into unequivocal rational propositions; that is the essential act in methodically constituting a new science." See also *Philosophical and Phenomenological Research*, Vol. X, p. 197, for Ludwig's discussion of Husserl's metaphysics, which helps to bring out the limitations of an attempted phenomenology that ignores the categories.]

organs of perception to respond to the impressions received from the table by selecting them from the totality of sense-data present at a given moment. It is therefore only under the category of polarity that the words 'I' and 'the table' have their usual meaning.

It is necessary to stress these distinctions because we have the strongly formed habit of thinking in dualistic terms; that is, of attending to the aspect of polarity to the exclusion of the other elements present in experience. On account of this habit of thought, all sorts of fictitious questions arise, and here again philosophers have wasted much time and energy by treating them as if they were real. The classical example for Western philosophy is the insistence of Descartes that his awareness of things is different from his awareness of himself.* The division between attribute and substance is another example of this error.+ It is commonly assumed that we know only the attributes and not the substance, and that the attributes we find in

experience are 'mere appearances'; whereas, in fact, there must be a 'real' substance to support them. Upon reflection, it is not hard to see that we have no isolated knowledge of attributes such as yellowness, roundness, heaviness, and so on. All we know is that wholes present themselves to us with certain recurrent features that enable one to be distinguished from another. Wholes given in experience are neither bare substance nor bare attribute, and thus the principle of wholeness is incompatible with any such division. This applies to another error; namely, that of objectifying the distinction of 'matter' and 'spirit'. If by 'matter' and 'spirit' we mean two mutually exclusive constituents of reality—one conscious and active and the other unconscious and passive—then wholes are neither spiritual nor material. No such divisions are reconcilable with the principle of wholeness. This is not all, however; for they are equally inconsistent with the principles of relatedness and subsistence. They are polarity run riot—dualism usurping a position to which it is not entitled.

The objection to the various schemes—of substance and attribute—of

[* Cf. Rene" Descartes, *Discours de la Methode*, edn. Cousin I, p. 158: "The more I doubt, the more I think, and the more I am certain of my own existence. But it must never be forgotten that I am only certain of my existence as a thinking being, not of my bodily existence. I am conscious of myself as one whose whole existence consists solely in thinking." It seems incomprehensible today that Descartes should not have seen that the certainty refers, not to his own existence but to the givenness of experience.

+ Descartes defines a substance as that which can exist and be conceived without the help of anything else. Cf. *Reports. quartae*, p. 122. Although in practice Descartes was a dualist, dividing reality into thinking substance and extended substance, he recognized that, in the long run, this is not a workable scheme. Indeed, he acknowledged, "There is in the strict sense only one substance; that is, God" (*Principia Philosophica* (1644), I, p. 51).]

spirit and matter—of idealism and realism—is not so much that they lead to contradictions as that they fail to lead to anything concrete. There is little evidence that anyone has lived better or worse as a result of choosing one metaphysical system rather than another.*

We are in search of understanding, and this comes to us through the broadening and harmonizing of our experience. If we put aside the distinction between experience and non-experience, as transgressing the limits of our subject, we are led to the conclusion that there can be only one stuff of which everything is made. It does not follow, however, that all materials are the same. There is, for example, one stuff called wool, but this does not mean that all wool is the same; there is only one stuff called water, but ice, water, and steam are not the same.

When we examine experience, we find that the differences that we observe are more striking than the samenesses. If experience is all of one single stuff, then this stuff must be very versatile; for it has to account for all the properties of matter and energy, and, hence, it must be expressible in terms of such observable and measurable quantities as, for example, the three independent physical magnitudes of mass, length, and time. The stuff of experience must also be capable of combination—for wholes are composite, and of being exchanged—for wholes are not invariant but constantly interact with one another. In the course of all these interactions and transformations, the single stuff must exhibit varying degrees of response, including those of life and conscious experience. Moreover, with all these various manifestations, it must remain throughout the stuff of experience.

The ubiquitous character of this 'stuff' is well expressed in the saying of Anaxagoras: "There is a portion of everything in everything." + Anaximander, in his doctrine of 'the fathomless' also recognized, and grappled with, many of the problems of a single-stuff theory of relativity—and it was tentatively formulated by Plato as 'the indeterminate Dyad' upon which Aristotle later set the seal of his approval.

Later philosophers have also adhered to this same conception of the stuff of experience. P. D. Ouspensky quotes Gurdjieff as stating that everything is material, but that "the concept of materiality is as relative as

[* This refers only to strictly metaphysical systems; that is, those concerned with the question of what being is and how we can know it. Where philosophers have, either intentionally or accidentally, touched the principles of relatedness and structure, their influence upon life has been considerable. Hegel has influenced history, not because of his ontological speculations but because—in his *Progress of the Notion*—he introduces an unbalanced version of the triad. Descartes and Leibnitz did much to destroy religious beliefs not by faulty metaphysics but by deflecting attention from the relativity of wholeness that earlier thinkers, such as Thomas Aquinas, had succeeded in grasping.

+ Cf. C. Bailey, *The Greek Atomists and Epicurus*. Oxford, 1928, p. 36.]

everything else"* The definition of wholeness as omnipresent but relative provides the key to understanding this dictum. We realize, if we seek for the bond which holds our composite experience together, that togetherness itself is given in our experience. Moreover, we do not find any evidence that the stuff which presents itself as the stuff of our experience changes its nature from one moment to another.

This discovery requires some examination, because it is often taken for granted that we do, in fact, encounter different stuffs—one of thoughts and one of things—one inside and the other outside our 'consciousness'. If we look more carefully, however, we find that all such distinctions break down. If I try to separate thoughts and things into two kinds of experience, my thoughts appear to be altogether inside myself and things altogether outside. A chair or a table is a classical example of a 'thing'. In some sense my body is also a thing, but the fact that I have used the qualifying phrase 'in some sense' shows that I do not always regard it as such: for example, when I am distinguishing between things as inanimate objects and animal bodies as animate objects. If my brain is a thing, are my thoughts things or are they 'myself'?+ Moreover, I may be able to distinguish between my thoughts and my awareness of them, but I am then led on to ask whether my awareness itself is a thing or whether there is some quintessential or transcendental self—a mind—that is behind my awareness. Is there for ever behind all that is thing-like a spiritual stuff of mind that is not thinglike? The very fact that I am doubtful where the division is to be made—or even whether the division is anything but a matter of convenience—is sufficient to destroy any belief that the distinction is self-evident. ++

It might seem that there is something artificial and unfair about beginning any discussion of such a nature with such things as tables and chairs. Some philosophers will argue that tables and chairs are mental constructs, and that therefore we must start the argument with our thoughts and go from them to the world that is their object. The dualism of subject and object then seems quite clear and straightforward—'I' am one member of a dyad opposed to a 'chair' as the other member;

[* Cf. P. D. Ouspensky, *In Search of the Miraculous*, p. 86.

+ Descartes reasoned thus far, but in assuming that he had now reached a new kind of reality, he overlooked the psychological fact that thought and the awareness of it can be separated in our experience.

++ Cf. J. Dunne, *The Serial Universe* (London, 1928). Dunne suggested that an infinite regress of levels of awareness is of the very nature of reality, and he concluded that spirit and matter are only relative terms. He thus made the very important discovery that our experience shows us the relativity of wholeness, but his theory leads to apparent contradictions which can only be resolved when the principles of relatedness and structure are also taken into account.]

'I' am not like the 'chair' and the 'chair' is not like me. It is therefore assumed that there are two kinds of stuff. But what are we to say of our subconscious reflexes? Are they subject or object? I find it impossible to assert that my sensations are a different kind of stuff from my thoughts; but a study of physiology convinces

me that there is a continuous transition from the sensations of which I am aware to the physiological processes of which I am never conscious. As a result of the researches of biochemists, we are assured that there is no decisive step from physiological processes to chemical, electrical, and physical changes. Sights, sounds, and smells all lead out into the physical world, and once again we cannot tell where we are to halt, and affirm that we have reached the point where spiritual stuff ends and beyond which is mere senseless matter.

Any thorough examination of experience must thus convince us that there is only one stuff of which it is all made. We may adopt Aristotle's use of the term **'hylē'** to denote what Gurdjieff calls the 'prime-source-cosmic-substance'. Hylē is not the formless ground—*τὸ ἀπειρον*—of the early philosophers, but substance capable of receiving form and character.* This stuff is neither spirit nor matter, and it is not even correct to describe it as 'spirit-matter'—that is, as the twofold context of experience; for to do so over-emphasizes the aspect of polarity, a tendency against which we must always be on our guard. According to our conception of the homogeneity of all possible experience, hylē is that which is actually perceived and, therefore, itself phenomenal. Hence not the same as Aristotle's *ἐνέργεια* or *ἐντελέχεια* which is the presumed reality that underlies phenomena. We know hylē through its manifestations, and these in their totality are all that it is possible for us to know.†

1.3.2. The Triad of Experience

It is necessary here to consider the scope and purpose of the analysis undertaken in this chapter. We started with experience as the given and have examined its content. In doing so, we have gone far beyond the limitations of the human mind, and have extended the concept of 'experience' to make it almost as comprehensive as such words as 'universe', or even 'Reality'. It would, however, be illegitimate to assume, without

* Cf. Aristotle, by whom *ἡλὴ* is defined as *τὸ ἀπαραίμητον γενέσθαι καὶ φθορᾶν δεκτικόν*, and also as *τὸ ἐξ οὗ γίνονται εἶδος*. (*Meta* - 6, 7 - 2).

+ Single-stuff theories usually take the form either of pan-psychism—the assertion that everything is consciousness, or pan-hylism—that is, universal materiality. W. K. Clifford made the suggestion that there is a single mind-stuff, the combinations of which give rise to non-living, living, and conscious forms of existence. Cf. *Lectures and Essays* (1879); also Wm. James's criticism in *Principles of Psychology*, Chap. 5.

further consideration, that in an ultimate sense *esse est percipi*—to be is to be experienced—and that there can be no reality beyond experience. We must content ourselves with noting that we are for ever debarred from experiencing what is by definition inexperiential, and must proceed with our task of examining the data available to us.

Experience itself is not homogeneous: it has elements differing in their essential nature—namely, the elements of function, of being, and of will. All three elements must enter into any possible experience and, since they can be described and defined without reference to any particular form or centre of experience, they can be called primary.

An analogy, which we owe to Ouspensky, illustrates the relation between function, being, and will. He compares man to a room in which there are several objects, each having a given function. One might be a

typewriter, one a sewing-machine, one a bed, the fourth a musical instrument, a fifth a microscope, a sixth a telescope, and so on. While the room is in darkness the bed can be used, but the machines can operate with at best very uncertain results and some cannot work at all. If one candle is lighted in the room, the machines will work better. The microscope and telescope are still useless, but something can be done with each of the others one at a time, if the candle is brought near to it. If now, in place of the candle, a bright lamp is lighted, all the machines can be used—even simultaneously—except the telescope, which has no purpose inside the room. The microscope can be turned to account, for enough light can be focused through it to resolve fine details. We may picture to ourselves that with its aid new results are obtained which none of the other machines can give; and that the working of the latter can be improved. Finally, we can suppose that the shutters are flung open, the light of day streams in, and the working of all the machines is now free and unrestricted. The telescope unfolds possibilities that were not even suspected so long as the work was confined within four walls.

In the analogy, the machines correspond to function, the illumination to being. Since the machines cannot use themselves, we ask 'What uses them?' It is will that does so, more or less effectively according to the amount of light present; the use to which they are put depends upon function; the quality of their work depends upon being. The situation, as a whole, is the result of all three factors, and each of them pervades it through and through. Down to the smallest detail process—that is, function—is present; everywhere there is light—that is, being—though not necessarily the same degree of illumination; and everywhere there is an impelling factor—that is, will—whether it be a directive intention or only the automatic operation of external influences.

1.3.3. Process and Function

Wherever we turn our attention we find something going on; and, moreover, going on in a more or less orderly and recognizable manner, and these regularities—that is, the observable features—are the actual or potential subject-matter of our knowledge. What we know in this way can be called process.

The conclusion we have now reached as to the arbitrary and misleading character of all attempted divisions of subject and object, or matter and spirit, can well be expressed by saying that process has no frontiers. Indeed, so universal and inescapable is process that we might be tempted to say that it is the content of all possible experience, and even to go so far as to identify it with 'Reality', or the totality of all that is.* The concept of process seems to hold its own even against criticism in terms of the categories, for whenever it presents itself to our experience we find in it wholes, polar opposites, relationships, and structures.

Nevertheless, though we have defined process as the entire content of our knowledge, there are still elements in our experience that remain unaccounted for. We find that, so far as process is concerned, the content of a dream may be the same as that of a waking state. We may dream of looking out of a certain window and seeing the same tree as we should see when awake, and may even feel the same emotional reactions. It is evident that the all-important difference between the dream-event and the waking-event cannot be accounted for in terms of process alone—many other effects of deception and illusion must also be taken into account. The believer in spiritualistic phenomena, for instance, passes through an identical experience whether the voice he hears is produced by fraud or by some supernatural agency. Moreover, sense-perception itself plays tricks on us. If we did not know the techniques of cinematograph projection, we might accept the delivery of our senses that the movements of the figures on the screen is continuous and not a succession of intermittent images. There are yet other and subtler discriminations. For example, it may be that when walking through the fields in spring in a state of moody preoccupation, this state suddenly gives place to a joyful perception of the birds singing and the scent of the earth. We do not know anything new: the scents and sights are the same as they were a moment earlier, but our experience has acquired a new dimension. We may also consider process in terms of behaviour; we may ask the simple question: Is a man identical with his behaviour? If it is not to ignore something essential in our experience, our answer will be: No,

[* The title of Whitehead's *Process and Reality* may give the impression that process and reality are the same thing, whereas his 'eternal idea' stands outside process.]

a thousand times no! Such an answer provokes the further query: Do we know the presumed man behind the visible mask; he who suffers and rejoices, hopes and fears? We shall probably reply that we do not know him, but that he knows himself.

Reasoning such as this is a dangerous path to follow, for it may lead into the pitfall of the dualism of two kinds of 'knowables'—one the behaviour known objectively, and the other the man who knows himself subjectively. This dualism would, if accepted, undermine the conclusion that there can be only one stuff, and would again involve us in all those contradictions and confusions that we seemed to have escaped. Fortunately experience itself can rescue us from this predicament; it tells us that the man does not know himself any more than we can know him. He cannot know himself, for what he is is not a process, and hence, by definition, is outside the scope of knowledge. All that we can know is what is going on, and in this respect it makes no difference whether the process that goes on is inside us or outside us.

Our ingrained habit of accepting formulae without criticism has led us to take it for granted that the time-honoured phrase 'know thyself' means what it seems to mean. It is, however, subject to the fallacy of misplaced concreteness, for it assumes that there is a Self that can be brought within the compass of knowledge. If the word 'Self' means anything, it cannot refer to the processes that are given to us as the content of knowledge.*

We can define the term function as 'the knowable element in experience'. This means that function has certain differentiations that are not implied in the word 'process'. Functions are the behaviour of wholes. Wholes are related to one another, and we know them because we can recognize structures or patterns of function. The step from experience of process to the knowledge of function is made by way of the categories. In order to think about our experience, we must make use of the categories. They enable us to make the step from our direct awareness of process to a knowledge of functional regularities. There is the universal process constantly actualizing itself. Through our self-awareness we experience this process from within, and through our sense-perceptions we experience it from without. All that we know in this manner is function. Function has always the same character wherever and whenever we find it. It may be the function of my mind in which thoughts

[* The writer of the *First Alcibiades*, in referring to the eye which must look outside itself in order to see, presents an argument that should lead to the conclusion that the Self cannot be known. Nevertheless, by confusing what is and what goes on, he has done much to fix in men's minds a faulty interpretation of this much-quoted phrase.]

are flowing, or it may be that of a clock which records the passage of time. Functions are, however, something more than mere activity. They are behaviour; that is, the working of some mechanism. A clock is a mechanism, and its function is to tell the time; the mind is a mechanism, and its function is to think. In our organism, the whole system of sensory and motor nerves—of spinal and cerebral ganglia—is a mechanism, and its function is to direct and co-ordinate our organs in response to stimuli received from the outer world. It will be noticed that in every reference to function it is taken for granted that it is concerned with what goes on in time and space. Function has this character of becoming actual, and therefore we are able to go beyond the limitations of our human experience and to give an extended definition of it as all reality actualizing itself through its several parts.

Every description, of whatever kind it may be, is of necessity functional. A whole can be described completely, down to the smallest detail, in terms of function. For example, the life of man over a given period may be specified with any desired degree of accuracy by enumerating all that is going on in his thoughts, in his feelings, movements, sensations, organs, tissues, and so on. Although in these terms the account might be

complete, it would not show how the various activities were united in his consciousness. At any given moment there will be present in him mental associations, fluctuations of feeling, instinctive processes, and bodily movements. He may be aware of one or more of these functional activities or, possibly, of none at all. They may have formed part of one and the same experience, or of two or more unrelated experiences, or have been outside 'his' experience altogether. Nevertheless, whatever may be their relation to the world of his private experience, all these activities are of the same kind. They are homogeneous in their nature, and their homogeneity overrides the frontiers of selfhood and the limitations of here and now. Hence we conclude that, being the know-able element in the universal process, function is everywhere and in everything. This does not, however, mean that function is the given totality; that is, experience itself. There are non-functional elements in experience, equally pervasive and equally significant, and we must now extend our inquiry to discover their nature.

1.3.4. Being as Togetherness

Being is a second element in all experience that is equally pervasive with function but entirely distinct. To appreciate the role of being we might compare experience to water that is through and through com-

pounded of hydrogen and oxygen. Just as hydrogen cannot give water unless combined with oxygen, so also being cannot give experience unless united with function. As water can, under certain conditions, be partially dissociated into its constituent elements,* so also can experience be partially dissociated to give being that is not wholly blended with function.

One great difficulty in exposing the theme of the present book consists in the fact that our ordinary language is applicable almost solely to distinctions of function, whereas we need to make communications about being and will also. For the unknowable element in all experience we have used the word 'being', but it is necessary to examine very carefully the meaning which this word has to bear. Being is given no less immediately in our experience than function, but it is given in a different way. Being concerns the status of our experience. For instance, the difference between the dreaming and the waking state is a distinction of being rather than one of function. Being imports the concreteness that makes experience non-illusory. The most significant character of being is that it is relative—the more the being, the fuller and more concrete the experience; the less the being, the less is the experience complete and exempt from illusion.

Being is not actualized. It is not a process, but to say that being is not a process does not mean that it has no connection with time. There is, for example, the fluctuation of inner-togetherness typified in the distinction between the sleeping and the waking states. Being does not become; but this does not mean that becoming is independent of being, for every whole is actualized according to the degree of its own inner-togetherness. A whole with very little inner-togetherness is actualized as part of the general process in which it is present. For example, the air in this room, consisting of molecules in random motion, stands near the lowest gradation of inner-togetherness. It has scarcely any history except as part of all that is going on in this house. Higher in the scale the artist, in the moment of an intense inspirational experience of a new vision of reality, has an inner-togetherness that is almost entirely independent of his environment. Such a moment is 'the point of intersection of the timeless with time'—a fusion of being and function. Similarly, to a scientist may come a supreme moment of unification in which ideas that were separate, and seemingly irreconcilable, become joined in a synthesis from which a new hypothesis is formulated. Whenever we examine such a moment, we find in it this character of an

[* E.g. by the addition of salts that ionize some of the water molecules to give hydrogen and hydroxyl ions, or by the action of heat.]

enhanced inner-togetherness, a breaking down of barriers, a unification of the separate. The facts remain unchanged but acquire a new reality.

1.3.5. Will as the Active Element

'How?' and 'Why?' are questions that can be answered only in terms of the will. All other questions can be prefaced by 'What ?' We must be careful to notice that the word 'what ?' is ambiguous, since to ask 'What is this ?' is entirely different from asking 'What is this doing?' Correctly, we should use different words for asking questions about being and about function, but it is convenient here to put into one class all questions of 'What ?' in order to specify the remainder that cannot be asked in this form.

Wittgenstein says "not how the world is, is the mystical, but that it is" and he adds that the "contemplation of the world sub specie aeterni is its contemplation as a limited whole".* He recognizes that being-questions cannot be answered in functional language, but he does not distinguish the two ways in which any functional account is incomplete. He recognizes that laws do not describe function, but he sets down conditions under which propositions about function may or may not be true. From this it should follow that it is laws alone that answer the question 'How?'; whereas all functional statements tell us only what is going on.

At the other extreme, Wittgenstein says, "of the will as subject of the ethical we cannot speak".+ Here, again, we have to distinguish between the differences of being upon which ethical—and indeed all other— values depend, and the possibility or impossibility of a given relationship between different levels. In other words, we must distinguish between levels of being and laws of being, just as we must distinguish between what is going on and the laws which prescribe what can go on. In each case the laws are manifestations of will. We have further to consider the meaning of the question 'Why?' This question can be put in the form, 'Upon what ultimate law do all proximate laws depend ?' The answer to the question 'Why?' presupposes a level of being at which it is possible to rest, and to remain satisfied with the answer that it requires no answer.++ There will, however, still remain the need to show how this level can be related to other levels, and here we again encounter the problem of will.

[* Wittgenstein, *Tractatus Logico-philosophicus*, 6.44 and 6.45.

+ *Tractatus*, 6.423.

++ *Tractatus*, 6.521 and 6.522.]

It will now be apparent that the questions 'Why?' and 'How ?' differ only in that the former is ultimate and the latter is proximate. If we could know enough about 'how' we should then see 'why'. The power to see 'why' and 'how' as a single question is that which we call understanding. This power is never fully attained, but each time we come to grips with our experience and persist in our questioning, we can hope to come one step nearer to understanding. Understanding is the will to live fully within the limits of our authentic experience.

It now becomes clear why Gurdjieff refers to will as the 'omnipresent active element' that in any given situation breaks down into three components. In its universal aspect, will remains isolated from the particular events that we need to explain. The incomprehensible character of will as the urge inherent in everything towards its self-realization has to be admitted in every philosophy. It is common ground to realism and idealism, to spiritualism and materialism. The world goes round, and there must be something to make it revolve. To pretend that we know what makes the world go round is nonsense, for we can never stand aside from the process.

It is a quite different matter when we ask the question, 'How does this particular piece of world go round ?'; for then we can answer in terms of laws. The omnipresent active element then shows itself under its three aspects of the laws of function, the laws of being, and the laws of will. Seen from one view-point, the laws appear as a restraint placed upon an arbitrariness of function; seen from the opposite, however, they indicate that every small 'how' can be merged into a larger 'how'. Therefore we find that the laws are not passive or negative, but are active and affirmative.

A man is what he is and does what he does. That this is so would seem to make of him an individual until we reflect that the same is true of anything else that exists—even totally degraded energy in the form of heat. The all-important question about man is whether it is possible for him to be an individual; that is, can he become an independent source of initiative? By definition, such a question belongs to the will, for the answer prescribes the possibility or impossibility of a given situation—that is, the laws by which it is governed—and also how it came about and, ultimately, why it is thus. Will, therefore, is seen to be not only the universal active element but also the particular active element in every recognizable whole.

Neither being nor function is unique, but will is always unique. It is the affirmation, I AM. This must, however, be understood as meaning no more than 'it is possible for me to be thus and impossible for me to

be otherwise'. The significant character of will is that it has its own laws and, therefore, is not the blind urge that Schopenhauer and his followers supposed it to be. Through ignoring its laws, we lose sight of the cosmic significance of will and the impossibility of accounting for anything whatsoever without reference to it.

1.3.6. The Aspects of the Triad of Experience

The homogeneity of experience has been stressed in order to combat the view that there are different substances; that is, different kinds of reality. The assertion that experience is made of one single stuff does not, however, entail the absence of distinctions or localizations. The distinctions, or secondary aspects of the triad, may be suggested by the following episode:

It is summer, and I am walking in the country. My attention is occupied with planning a lecture that I am to give tomorrow, when I hear a distant church bell. At that moment I look over the fields and notice some cows being driven in for milking and, by association, Gray's 'Elegy' comes into my mind. Immediately, and again by association, I contrast it with J. F. Millet's picture 'L'Angelus'. I am annoyed by these trivialities, and feel that my instinctive satisfaction with the peace of the countryside has been disturbed. All this has occupied at most a few seconds, and the event can be localized rather closely in space and time. It has been happening to me on this June evening, here and now. The constituents of the event—the countryside, the church bell, the poem, and the painting—are common property, and even my thoughts, occupied with planning some future action, suggest a very characteristic and well-known human situation.

(a) The Three Aspects of Function

A functional account of this event can be given in three different ways. The first way is to treat it as a fragment of the total process that is the existence of the universe. The event proceeded just so and not otherwise, and thereby added its quota to the self-actualization of the Whole. There took place, through me, a transformation of energy. Sense-impressions and memories, together with the momentum of my inner functions—thoughts, feelings, and the like—came together to produce a new combination, part of which had been fixed in the past and part transmitted to the future as a set of possibilities. When the word is used in such a context, we are referring to function in its cosmic aspect.

The second way of describing the event is to refer it exclusively to my own experience. I can trace back the preceding events that brought me to this spot on this particular afternoon and also those that fixed in my memory the 'Elegy' and 'L'Angelus', and made possible the associations that they evoked. The whole description hinges upon me—my history and the mechanics of my own bodily and psychical functions. I am such, and the events occurred in such a way. Wholeness, relatedness, and structure all enter into it, but the characteristic feature is that it is my own act of cognition. In order to express this particular character, we may say that knowledge is the subjective aspect of function. This definition of knowledge must be taken in a wide sense, as including not only intellectual cognition, but also emotional and instinctive attitudes, bodily habits, and so on—all of which prove on examination to be homogeneous with intellectual knowledge. We can go further and say that since function is universal, knowledge must be universal also. On this subject,

Gurdjieff quotes the aphorism, 'To know means to know all'.

The third method of description could be called that of an impartial observer. He sees a man of such and such appearance, walking over the brow of the hill, evidently occupied with his thoughts. The man appears to hear the sound of the church bell, for he raises his head and looks across the fields. His gaze rests upon a herd of cows for a few seconds. Then he turns his eyes away from them to the corn-field. There is a slight contraction of his face muscles that suggests an irritating thought. The observer goes to speak to him and is told of his experience. This account verifies and amplifies the conclusions drawn from observing the man's external behaviour. This third method of description shows the objective aspect of the event, and leads to the definition of behaviour as the objective aspect of function.

It is possible to give three descriptions because there are different perspectives, not because there are three different events. Moreover, all three descriptions refer to function only. They can be made to correspond with any degree of accuracy and detail, but only so long as we confine ourselves to the perceived process, interpreted in terms of the categories.

(b) The Three Aspects of Being

If we now try to make a corresponding analysis of the same kind in terms of being, we find that we lack the appropriate language. We have at present no measure of being that is independent of subjective experience. The event described has some force of inner-togetherness—

certainly less than that of a more vivid experience, certainly more than that of a state of half-conscious day-dreaming. But even from the subjective aspect we cannot yet assess the quality of consciousness present. For the external observer there is nothing but a very uncertain inference to be drawn from the degree of coherence and consistency apparent in the outward behaviour.

These disappointing results should not lead us to the conclusion that being is of necessity inarticulate. By definition, being can be experienced but not known. If we experience it only vaguely, it is because we have not trained ourselves to find discriminations of the sort that we have learnt to make in our observations of function. A power of self-observation, usually attainable only by special training, is required to recognize the fluctuations of togetherness that occur constantly in the sleeping and waking states of man—loosely termed unconsciousness and consciousness—and to assign them to the appropriate gradations of being. Nevertheless, even without such power the connection between the different states of consciousness and the degree of togetherness of our inner world must be evident to anyone who examines his experience from time to time during his waking hours. It is this that is referred to in the analogy by representing being as the intensity of illumination in the room. Thus we reach the conclusion that consciousness is the subjective aspect of being, and so is correlative to knowledge, which is the subjective aspect of function.

If we now ask ourselves whether there is anything in being that corresponds to behaviour, we make a most interesting discovery. Being has indeed an external aspect, and this is discoverable in the state of aggregation of the hyle. The relativity of matter gives us the observable measure of being. The denser or more opaque the aggregation of the hyle, the lower the level of being. The finer or more translucent the state of the hyle, the higher the level of being. Moreover, the words 'higher' and 'lower' correspond here to the intensity of inner-togetherness of a given whole. For example, the observable aspect of water-being is the degree of aggregation of its molecules by which we distinguish ice from water and water from steam. Wherever there is such a means of discerning the degree of aggregation of the stuff of experience, we have a means of making an objective assessment of being. Obviously the example of water is only an analogy, for what we observe here are functional changes, and, as always, we are confronted with the difficulty that being cannot be 'known'. Therefore the objective assessment of being must usually be made in terms of the visible changes of function that accompany the invisible transformations of being.

It is, however, a matter of direct experience for most of us that we encounter in other people a greater or less translucency. This is often quite independent of functional manifestations, and may be found in its greatest intensity where functional activity is least. Function is univalent, whereas being is multivalent.

We can now apply to the elucidation of the nature of being some of the conclusions previously reached; that is, firstly the relativity of wholeness; secondly, the definition of being as the intensity of inner-togetherness of any given whole; and thirdly, the conclusion that there can be only one stuff of experience—that is, hyle—whose differentiations must consist in various states and degrees of aggregation and combinations of the aggregates. The state of aggregation of the hyle—or the primordial stuff of experience—present in a given whole can be called its 'materiality'. The higher the level of being the less is it materialized, and the lower the level of being the more is it materialized. Moreover, this degree of materialization is the only aspect of being that presents itself externally. Hence we come to the definition of materiality as the objective aspect of being. Being is, and must always remain, inaccessible to knowledge. Nevertheless, by learning to become sensitive to the degree of materiality present in a given whole, we may find a clue to the appreciation of being.*

Here it is necessary to interpose some considerations upon the universality of consciousness. We commonly use the word 'consciousness' to mean 'a form of awareness identical with, or analogous to, that present in man'. It is only by convention that we restrict the meaning of words to an anthropomorphic context. The word 'consciousness' can mean 'the form of awareness associated with the state of inner-togetherness of any whole, irrespective of its nature, constitution, scale, or duration'. With such an expansion of meaning the word gains universal significance, and we do not have to extricate ourselves from the difficulty of defining consciousness by reference to function. Being can then be defined as the cosmic aspect of itself.

The argument from human consciousness to universal consciousness does not lead to pan-psychism, provided that we take into account the relativity of being. This thesis is ancient and was familiar to Plato and Aristotle. In a pithy formulation, Cicero argues: "From sentience and vitality in the individual to an a priori sentience in the universe." The priority of universal sentience over individual sentience was axiomatic for the Neo-Platonists, such as Plotinus and Proclus.

[* Cf. Chhandogya Upanishad, VI, 1.2.]

(c) The Three Aspects of the Will

There remains for consideration the third component of the fundamental triad; that is, will. Will in its cosmic aspect is universal. We

cannot conceive a multiplicity of motive forces, each completely independent of every other. This would indeed be an irredeemable chaos, for there would be no overriding authority whereby the independent wills could ever be harmonized. The very fact that we discover coherence in our own experience must convince us that there cannot be an ultimate conflict of entirely separate wills; yet experience teaches us also that will is subject to limitation, for contingency and uncertainty are no less given in our experience than are regularity and order. We find a pattern incompletely realized—something predictable, something unpredictable.* Nevertheless, some intuition of universal order gives us the assurance that in our survey of the universe we are not witnessing a meaningless play of unconnected wills—equivalent to blind chance driving where it listeth. Here we meet the overwhelming contradiction of all contradictions—that of unity and multiplicity. The sharpness of the contradiction is such that it is impossible for us to rest at either extreme. In the domain of will, unity and multiplicity are both unacceptable terms. The inadequacy of ordinary language compels us to modes of expression that must lead to contradiction. If we use the term 'The Will', the form of language is that of the singular number; but we must contrive to invest it with a deeper significance from which any distinctions of one and many are banished. The property whereby one single unlimited will manifests itself as manifold and limited is authoriz-mos, or the acceptance of self-imposed restrictions. From this property will acquires the objective character of law. Law is the form of all process and, since all experience is of process,

law is universal. When applied to a single whole, law is the form of all its possible manifestations. So, every whole, on every scale, has its own law. Furthermore, since wholeness is relative, law must also be relative.

We require a word to express the meaning of will in its subjective aspect. This latter must be distinguished from the other two modes of apprehension; namely, the knowledge of function and the consciousness

[* Cf. Whitehead, Modes of Thought, Lecture V, pp. 117-42: "There is a large element of accident in a single sentence of a lecture. . . . Special forms of order exhibit no final necessity whatever. There is no sharp division. There are always forms of order partially dominant and partially frustrated. Order is never complete; frustration is never complete. . . . The universe is not a museum with its specimens in glass cases. Nor is the universe a perfectly drilled regiment with ranks in step, marching forward with undisturbed poise. Such notions belong to the fable of modern science. . . .The universe is more than a process."]

of being. Will neither is anything nor does anything, and we can therefore neither be conscious of it nor know it. Nevertheless, it has its own discriminations, but these concern form rather than function and the manner rather than the content of events. We apprehend form through participation, and the quality or degree of this participation is our understanding. Understanding is that inner condition by which we become aware of the operation of will. Every situation confronts us with its own characteristic 'why', 'thus', and 'how', and our ability to apprehend this intrinsic character of the situation derives solely from understanding which is the subjective aspect of will.

The affirmative character of will justifies its description as 'that which uses the functions under the conditions created by consciousness'. This must not, however, lead us into the error of supposing that the will 'does' anything. It is the affirmation of a form or pattern to which events must conform. Hence we find the objective aspect of will to be law. There are no laws of function, but rather regularities of behaviour. There are no true laws of being, for being has no differentiations. Therefore, law, in the objective sense of the term, must derive solely from the omnipresence of will. Will is that which is everywhere the same and yet everywhere unique, and the role of the understanding is to achieve cognosis of this omnipresent active element of all experience, and to make apparent what is required in order to conform to its demand.

1.3.7. The Primary and Secondary Forms of the Triad

The results so far reached can be summarized by means of a table in which the primary form of the triad, function-being-will, is shown resolved into the three secondary forms of each component of this triad, corresponding to the cosmic, objective, and subjective aspects of every experience.

The Fundamental Triad of Experience

Components	Function	Being	Will
Aspects			
Cosmic:	Function	Being	Will
Objective:	Behaviour	Materiality	Law
Subjective:	Knowledge	Consciousness	Understanding

It will be noted that the terms function, being, and will appear in both the primary and the secondary forms of the triad. It may be objected that an element of universal experience, being by hypothesis omni-

present and hence independent of any particular form of existence, should not be treated as an aspect of the limited experience of a given whole. It seems, however, preferable to adopt this presentation rather than to

introduce new terms, such as, for example, 'process' for 'function of a given whole', or 'existence' for 'the being of a given whole', since such a procedure would disguise the significance of the primary elements as factors which enter into every possible experience. Furthermore, we may observe that the three aspects of each primary component themselves constitute a triad.

Knowledge is that which reconciles the behaviour of the individual to the universal function.* Consciousness is that which enables the material presence of an individual to exist in harmony with the universal being. Understanding is that which allows the individual, without losing his own identity, to play his part in the self-realization of the cosmic will. Thus, in each case the cosmic and objective aspects of wholeness find their reconciliation within the subjectivity of the whole itself.

Finally, we can take each of the nine components of the secondary triads as independent factors out of which new triads are incessantly being formed, and so giving rise to all the diversity of universal and particular events.

[* This has been the view of many schools of philosophy, particularly that of Spinoza, whose conception of the relation between knowledge and function has much in common with that formulated here (cf. *Ethics*, Prop. 25-42). Spinoza regards 'essential knowledge' as nothing but the direct intuition of the eternal principles that govern the essence of things. Partial or incomplete knowledge is "the only cause of falsity. . . . Knowledge of the whole requires purification of the intellect" (*Ethics*, trans. Boyle, pp. 69, 241-63). For Spinoza, knowledge applies to the emotions and instincts as well as to the thinking functions, and in its highest form is the same as our 'understanding', and therefore not knowledge at all.]

Part 2 - Epistemology

Chapter Four LANGUAGE

2.4.1. Communication

The isolation of each human centre of experience or 'mind' from other 'minds' is one of the primary data of experience. There can be a more or less effectual interpenetration of functional activity, but there is little or no interpenetration of consciousness. It must be supposed that this isolation of consciousness is characteristic of our human situation and not of consciousness as a cosmic reality. Being, in its relativity, is compatible with forms of consciousness very different from ours—for example, it is possible that entities exist that though distinct in nature can, nevertheless, communicate by a merging of consciousness without the intervention of any functional activity as we know it. Even in human experience there occur rare moments when such a merging of consciousness appears possible. The fullest normal state of human consciousness is one in which a man is aware of his functional activity and the presence of an attention that directs it. Some such consciousness may be present also with the higher animals, though this must be even more rare. With the lower animals and inanimate objects we can safely exclude the presence of any awareness comparable to the attentive consciousness possible for man.

Communication is therefore to be looked upon as a characteristically human problem—as psychological rather than metaphysical. Whether or not it is possible to know what is going on in other minds is a question of fact, to be decided by the same procedure as other questions of fact; namely, by observation, experiment, and analysis. We do not doubt that we can and do communicate with other minds, and we know, moreover, that communication is sometimes adequate and reliable; while at others it breaks down completely, and the sharing of experience proves impossible. Since communication is necessary in every situation where two or more human beings set out to achieve concerted action, the study of the conditions that make adequate communication possible is a general human need.

According to the third principle, every relationship requires three terms, and communication as the third term

establishes a relationship between two centres of being-awareness, or two 'minds'. In discourse,

for example, the speaker and hearer are related through the spoken word. Where the bodily functions are concerned, a gesture may take the place of words. Here communication is by imitation; by the arousing of a common emotional state; and also by direct action, as when one man will grasp another's arm to attract his attention. The form of communication that is chiefly important for natural philosophy is that which employs language.

Language comprises all forms of communication in which a sign, symbol, or gesture stands for an object referred to, and the reference is recognized by the persons using it. A few definitions will help to clarify the distinction intended:

Language: Communication between minds through the medium of some functional activity such as speech, writing, mathematical and logical shorthand, gestures, inflexions, rhythms, or pantomime.

Sign: A sound with or without a corresponding ideographic mark that evokes in two or more people the memory of a recognizable simple experience. Hence the rule 'one referent—one sign'.

Symbol: A sign that evokes in two or more people the memory of a connected group of distinct experiences differing not only in functional content but in the correlative states of consciousness. Hence the rule 'symbols are multivalent'.

Gesture: A manifestation that evokes in two or more people the direct experience of the totality of all memories relevant to a given situation and produces a response of the will.

Linguistic Element: A sign, symbol, or gesture is a linguistic element and speech is the art of combining linguistic elements for the communication of experience.

Language, as the communication of experience, is to be distinguished from art and magic, which are also means of mutual action between people. In art there are also linguistic elements, but these do not merely stand for experience; for they are part of—and sometimes may be even the whole of—the experience that they represent. Through art, states of consciousness can be shared; the being content is primary and the functional is secondary. Similarly in magic there are linguistic elements, but these are used as a means of doing. Magic is an act of will, and the functional and being content of magic is subordinate to the will content.

In order to clarify further the role of language, we must make a distinction between direct and indirect communication. In all language, whatever may be its form, the communication is indirect; a sign, a

symbol, or a gesture is not the object referred to, nor does it partake of its nature. This can be expressed approximately if we say the language is communication about; anything that can be referred to by means of a sign can be 'spoken about'. It is important to bear in mind, however, that since language is homogeneous with function, it can verify its reference only in so far as the object of discourse is functional; whereas communications about being and will, though made in functional language, cannot be verified by functional operations. Consequently, different forms of language are required for each of the three constituents of the fundamental triad of experience.

It must be emphasized that this theme is not 'linguistics' as commonly understood, but the multi-dimensionality language must acquire in order to be adequate for the three kinds of communication covering all the three aspects of experience.

2.4.2. Meaning

The primary function of language is the communication of meanings. Ogden and Richards* have shown how

many problems that should be faced are evaded, and how many unnecessary difficulties are also created by indiscriminate use of the word 'meaning' to refer to completely different elements of our experience. We should therefore define the word 'meaning' as carefully as possible, and endeavour to use it only within the limits of the definition. Since language refers to meanings, we cannot ascribe meanings to language itself. Moreover, the indirect character that we have attributed to linguistic communication consists precisely in the fact that words have no intrinsic meaning. A linguistic element has meaning only by reference to an experience that can be shared. Moreover, the experience must be recurrent and therefore capable of being recognized. The definition of meaning that we shall adopt can accordingly be formulated as:

A meaning is the recognition of a recurrent element in experience, and a linguistic element has meaning only in so far as it refers to a recurrent element of experience recognized by those who use it.

The concept of meaning can be related to the categories in the form of a tentative series of rules or canons of linguistic usage set out in the following table.

[* Cf. C. K. Ogden and I. A. Richards, *The Meaning of Meaning*, 8th edn. (Cambridge, 1946). This invaluable criticism of language, together with L. Wittgenstein's *Tractatus Logico-Philosophicus*, 2nd edn. (London, 1937), provide an admirable introduction to the theme of the present chapter.]

Meanings and the Categories (i) Wholeness: Every sign, symbol, or gesture used in language is in respect of meaning a recognizable whole. (ii) Polarity: Meanings arise by exclusion as well as inclusion; that is, they have context as well as content. (iii) Relatedness: Every meaning serves to connect an experience to a referent; the content is relative. (iv) Subsistence: An act of communication comprises four elements: the communicants P and Q, the object of reference O and the linguistic element S that 'stands for' O. (v) Potentiality: Every linguistic element has more potential meaning than can enter any actual communication. (vi) Repetition: A meaning is the recognition of a recurrent situation. It becomes articulate when associated with a linguistic element. (vii) Structure. Language has a sevenfold structure.

This table requires some elucidation. The general rule, 'one linguistic element—one meaning', is only valid as applied to signs. Taking into account the relativity of wholeness, we can see how the meaning of a given concept is relative to the fullness of experience from which it is derived. A meaning based on two or three recurrences of a given experience cannot be as full as that based on many hundred recurrences, each of which adds its own quota to the content of the meaning.

The distinction between content and context turns upon recognition. A context is a recurrent set of related entities within which we recognize one or more elements. What we recognize in this way develops by repetition into the 'meaning' of the experience. The meaning has thus two polar components, one that affirms and the other that denies it. The negative component is the context against or out of which we take the positive meaning. The context is thus no less necessary for meaning than the content, and for the purpose of communication it provides the common ground. We shall use the term stable context to denote a set of experiences that are shared by different people and are recognized as recurrent. Within this context specific elements having a common meaning can be discussed, clarified, and delimited. By this process the act of

communication acquires subsistence—people begin 'to understand one another'. The category of potentiality is very important for the understanding of communication. It is an immediately verifiable datum of experience that we never can say all that we mean, nor mean all that we say.

The sixth and seventh categories help to fix the true status of language, and show that it corresponds to the level of organized existence; for the categories of recurrence and structure apply directly only to fully organized wholes, and where language does not conform to the canon of structure, communication must in some way break down.

Passing from general considerations, we can consider a few particular examples of meaning. The meaning of the word 'table' is the recognition of a group of sense-impressions, the general pattern of which is recurrence, and the experience of which is common to human observers—past, present, and future—accustomed to living in furnished houses. It will be noted that we do not say that meaning derives from recurrence or even from the recognition of recurrence; for according to our definition the meaning is the recognition and the recognition is the meaning. What we do not mean we cannot recognize, and what we do not recognize we cannot mean. Moreover, no experience isolated from the context of recurrences could have a meaning. The word 'table' itself is a conceptual sign; that is to say, its meaning is reached by way of interpretation. The process of interpretation may be different for different people, and therefore the meaning of 'table' can also vary. For an inhabitant of Persia or Turkestan it will mean a low object around which people sit or kneel on the floor; whereas for a European it will mean one at which they sit on chairs. Thus it can be seen that the potential meaning of the conceptual designation is, and must be, always fuller than it is for any actual moment of use. If now we take the sound written 'ugh' and treat this as a word, we can call it an expressive sign. Its meaning—though different in character from that of 'table'—is also a recognition; namely, that of an emotional state of displeasure or distaste, the experience of which recurs in certain contexts and can be shared.

The transition from repetition to structure takes us from grammar into syntax, and brings us to a consideration of the meaning of sentences and of communication by means of linguistic forms as distinct from single signs. Whereas the adequacy of a sign can be tested by reference to the categories, a sentence has a content beyond adequacy; namely, that of truth or falsehood. The content of a true sentence is knowledge; but not all knowledge is expressible in sentences, nor do all sentences express knowledge. Moreover, in accordance with the principle of structure, a complete language should comprise seven distinct qualities, of which two only are the adequacy of reference and the expression of true knowledge. There are also in language the properties of feeling, tone, and intention that Richards adds to those of reference and truth. Apart from

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these, there are the qualities of form and rhythm, all of which play a part in the expression and communication of meanings.

Finally, there is the character of the context; that is to say, the aspect of experience to which a particular form of language applies. In this sense we can distinguish the forms of language that correspond to the different functional activities of man—thought language, feeling language, and instinctive language. These are the subjective counterparts of the objective distinctions—language of function, language of being, and language of will.

2.4.3. Fictitious and Authentic Languages

The two main defects of language are lack of discipline and excessive specialization. Our spoken language has a certain wealth of content due to the shades of meaning that every spoken sentence acquires by vocal inflexion, rhythm, and bodily gesture. Nevertheless, it is an undisciplined language, and therefore useless for the purpose of establishing a common understanding of the deeper modes of experience, except for the rare

cases where meanings can be verified by ostensive definition. Our ordinary language is full of recognized recurrences and hence of meaning, but it is vague and confused. On the other hand, specialized languages, though probably entailing a strict discipline, nearly always achieve precision at the expense of content, and so sacrifice the very meaning that they are seeking to convey. Fictitious language is for the most part that in which linguistic elements are used without verification in experience. The reference breaks down, and again meanings are lost. The problem of adequate communication arises in acute form when it is a question of sharing knowledge of non-functional experience. What we know is function, and there is no inherent obstacle to the sharing of functional knowledge. This knowledge is gained by observation—and we can observe ourselves in a way that is not fundamentally different from that in which we observe others—but it does not enable us to know human consciousness that can never be observed either in ourselves or in another. Language can never wholly bridge the gap that separates function and being, but communication about states of consciousness and acts of will is, nevertheless, possible.

A vague realization of the different qualities of language has been responsible for the tendency to regard language as if it were mysterious. The truth is that, notwithstanding its varied resources, language always depends upon reference. We can speak about being, but we cannot communicate being. We can speak about acts of will, but we cannot communicate will itself. On the other hand, in our speech we can both

speak about function and also communicate function. For speech is behaviour, and when used for communication, there is a correspondence in the behaviour-pattern of the speaker and the listener. The same applies to the writer and the reader of the written word, and to all other forms of language.

Any criticism of language should start by exposing the vagueness and imprecision of ordinary usage. It must, however, be a constructive criticism, in the sense of building up to a more complete form of communication applicable to all forms and gradations of meaning. The aim must be to produce an authentic language having a sufficient variety of forms to enable all varieties of meaning to be communicated.

Wherever there is effective communication there is an authentic language. Authentic language need not be specialized language. Much of the language of ordinary human discourse is authentic in so far as it relates to material objects and their functions. Domestic and economic life proceed more or less adequately through communications in which no criticism of the language used need arise. Here adequacy is achieved by the exigencies of the situation. This brings the words used into a direct relationship with the recurrent elements of experience from which they derive their meanings. Adequate communication is also achieved in scientific and technical discussions and texts. Here for the most part words are only used to designate a pattern of functional behaviour. Meaning in reference to the being of the entities to which they refer is neither sought nor attained. For example, we use the word 'electricity' to mean 'that unknown something which participates in the recurrent experience of electrical occasions'. Although restricted in their meanings, the signs used in such language can be effectual because the experiences to which they refer do, in fact, recur and can even for the most part be intentionally reproduced.

The breakdown of ordinary language begins when we leave practical life for the discussion of abstract or philosophical questions. The fictions that serve well enough for communications about existence become sources of both deception and self-deception when we assign them uncritically to existence itself. We find, however, that with due care and using the method of progressive approximation, we can find words and sentences by which we can express and communicate our recognition of the categories of experience.

The reconstruction of language in the domain of function is a relatively simple task that can be performed with the aid of the categories and principles of experience. The formation of language appropriate for communications about being and will is a task of a different order. We

can, therefore, discuss the problem of language under five heads, the first of which consists in examining the defects of all spurious forms of language and various spurious linguistic constructions in which there is no

effectual communication. The second is to ascertain why ordinary language can sometimes be used successfully. The next four consist in studying the requirements of the authentic languages of function, being, and will.

The four forms of authentic language can broadly be described as follows:

(i) Mixed Language: Words and sentences used in ordinary human intercourse without distinctions of meaning and successful only in a stable context.

(ii) Sign Language: The language of philosophy; in which there is the effectual communication of simple meanings without shades of being-significance.

(iii) Symbolic Language: Theoretical language; in which symbols are used with due regard to the relativity of meanings, permitting effectual communications regarding being-discrimination.

(iv) Gestural Language: Practical language; in which effective communication is possible in all domains of function, being, and will, by the combination of all three types of linguistic element.

2.4.4. Spurious Language

Before embarking on a study of the four types of authentic language, we should examine some of the defects of spurious language and the consequences of its use. Spurious language consists in words and sentences taken out of a stable context and used without verification of meanings.

Nearly all discourse concerning religious, philosophical, political, and historical questions is tainted with the defects of spurious language. Participants attempt to communicate without due verification of the meaning of the linguistic elements they use, and mostly without regard to any canons of grammar or language. The misunderstandings that constantly arise in human intercourse are due in the main to the disregard of meanings. No serious attempt is made to relate linguistic elements to any immediate experience, or to take account of the fact that meanings can only be discerned when there is a recurrence of common experience within a recognized context.

Through disregard of the categories or of any even approximately equivalent discipline of thought and language, many fictitious signs and

meaningless sentences are used without questioning their validity. Thus a sign which should name a recognized recurrent whole is used to refer to situations that exist only in the imagination.

In ordinary language, words are seldom used correctly except in reference to material objects and their functional transformations observed through the senses. For all inner experience concerning human consciousness and for the description of processes that are not directly given in sense-experience, words for the most part are signs for nonexistent or very dubious wholes. For example, people continue to use such words as 'Christianity', 'Democracy', or 'Bolshevism' when there is no element of experience of which these words could be a sign.

We have already remarked how the word 'meaning' itself has become a spurious word that has the effect of creating the illusion that something is being said, simply because we do not ask ourselves what 'meaning' means.

Failure to make necessary qualitative distinctions is a further source of the debasement of language. Psychology is an example of a field of discourse in which authentic communication is well-nigh impossible because authors and speakers almost invariably disregard the distinction between the functional activity, the state of consciousness, and the act of will. The confusion is all the greater in that the sentences used purport

to be making the very distinctions that they ignore.

2.4.5. Authentic BUT Mixed Language

The defect of spurious language that consists in disregarding the differences of being and function is remedied in ordinary discourse by modulating spoken words and sentences with the aid of tonal inflections, rhythms and cadence, gestures and postures. All these means for amplifying verbal communication can be classified as personal and subjective in so far as they fail in the absence of a personal relationship. We feel the need thus to supplement the deficiencies of the bare sign, but the result is to produce not an authentic language but, rather, a mixed form that can be effectual only against the background of a stable context. The gesture and tone of voice that for a Chinese or a Tibetan will indicate a recurrent significance and hence a distinction of meaning might have for a Frenchman or a German an entirely different significance. Even between two people speaking the same language and referring to the same subject, some degree of common understanding of abstract questions can arise only after frequently repeated attempts have established a common context.

It should be noted here that authentic language does not depend upon the importance of its subject-matter. Authentic objective language begins when due attention is paid to meanings. Such language cannot dispense with the discipline through which a common stable context is established, but in this case the discipline is intentional and its purpose is more or less understood by the participants.*

Thus the first requirement for any authentic language is that those who are to use it must share in its creation; that is, in the establishment of a common stable context. Moreover, the process cannot be exclusively performed through signs, because the signs themselves will require verification, and it is necessary to take into account emotional, instinctive, and other factors that influence the attention of those concerned. Let us suppose, for example, that a group of people wish to establish a common authentic language for describing elements in a sunset. They may for this purpose meet together to watch the sun setting under many different conditions in order to recognize the recurrent elements by which the meaning of the experience can be interpreted. If, however, the persons concerned differ in their capacity for emotional and instinctive response, and also in the extent to which their perceptions have been trained, the meanings that they will see will be different and the signs adopted will fail to establish an authentic communication. In general the establishment of a stable context can be achieved in one of two ways, the first of which can be called the method of technical reference, and the second that of logical abstraction. Technical reference is the situation that arises when a functional activity, shared by the participants of discourse, provides the common stable context. The words and sentences then used acquire meaning from previous recognition of the recurrent features in the situation. Technical reference is, however, effective only where functional activity of a mechanical kind is concerned; otherwise it may be found that even such a technical discussion as 'What has gone wrong with the engine of the car ?' or 'Why was the soufflé spoilt ?' can break down through the disappearance of a common context in which the disputants can share.

Language made effectual by technical reference has been responsible for the greater part of human co-operation in the functional activities of life. Nevertheless, we find that even the simple and obvious method of deriving the meaning of signs from the recognition of common recurrent experience is ignored in most conversations. A particular defect prevalent in technical language is to ignore the relativity of wholeness and treat all entities as if they had the same existential status. In situations that [* Cf. Gurwitsch, *Philosophical and Phenomenological Research* (1947), p. 653.]

are technical or scientific in the commonly accepted sense, some care is taken to select signs and symbols that refer to the subject-matter of communication. In general language, however, the words used have a long history during which they have been applied to situations that have undergone change or even ceased to exist. The result of this is that such meaning as words may convey lags behind the transformation of the entities to which they refer.

The method of logical abstraction proceeds by assigning conventional meanings and considering the construction of sentences by which relationships of meaning can be expressed and communicated. By this procedure the difficulty of finding a stable context is reduced and historical fluctuations of meaning minimized in their effect. The construction of abstract languages is, however, an almost wholly negative procedure, for when carried to the limit it becomes merely the communication of conventional meanings divorced from experience. If, on the other hand, language is reconstructed to give signs that refer only to material objects and the behaviour pattern of living beings—including men and women—then we obtain one of those systems—of which semiotics is an example— from which not only are distinctions of being and will excluded, but even those elements of function that belong to the emotional, instinctive, and other non-intellectual elements of functional experience. In order to discover common meanings, there is needed a process of communication and joint verification, and it is thus that the transition from mixed language to the authentic language of philosophical signs is made possible.

2.4.6. Sign Language

One of the chief tasks of philosophy is to establish a stable context for the discussion of all questions of general interest to man. For this purpose it requires to assign meanings to certain elements of experience that are not directly given in sense-perception, but derive from a process of interpretation that sometimes is lengthy and complicated.

A complete philosophical language is created only when those who intend to use it have established a context of experience in which all the necessary meanings can be recognized.

We are concerned with human communications; that is, with the transfer of meanings from one mind or centre of consciousness to another by means of behaviour. Owing to the isolation of each centre of consciousness, it is not possible for any two to have exactly the same elements of experience, and therefore meanings can never coincide

wholly and in every respect. When therefore we set down the requirement that each sign should have a single meaning, we must take into account the approximative character of the process of recognition and interpretation.

The common stable context of discourse is only set up gradually by way of a recurrent process of 'trial and error'; that is to say, of experiment and verification. As compared with the mixed language of ordinary discourse, the true philosophical language can be both adequate and free from ambiguity. The construction of a system of unambiguous signs is, however, not a task to be taken as a preface to the use of philosophical language; on the contrary, it is in the process of communication combined with verification that signs can acquire an unambiguous, definite relationship to meanings. The task represents, nevertheless, an undertaking indispensable for effectual communication beyond the limitations of technical reference. As it progresses, effectual communication in regard to abstract topics becomes possible. Nevertheless, communication still remains functional in character, and does not go beyond the sharing of knowledge.

A sign is the means of drawing attention to one definite group of similar experiences, and it is effectual only when there is a one-to-one correspondence between signs and the recurrent elements of experience. This is easily accomplished in regard to material objects such as tables and chairs, but it is only with difficulty and great care that the meaning of experiences for which we use such words as 'attention', 'memory', 'desire', 'hope' can be recognized and signified. All such words carry in the mixed language of ordinary speech chance suggestions and unverified assumptions that lead inevitably to misunderstanding.

The elimination of superfluous elements from the meaning of a sign must not be carried out in such a manner as to deprive it of the generality required in philosophical discourse. We do not derive from our experience the knowledge that is possible, because we do not interpret; that is to say, we fail to bring together in our

thought recurrent elements that are connected in fact. For example, we observe our own behaviour and find in it a variety of meanings, but not the overriding significance expressed in the sentence 'man is a machine'. We do experience, and that repeatedly, patterns of behaviour that consist in automatic reactions in which we have neither initiative nor choice, but we do not see the total significance of these observations, and we therefore use the sign 'man' to mean something which does not exist.

One consequence of this failure to recognize the meaning of human experience is that almost all philosophical discussions of man and his

place in the natural order are ineffectual. Knowledge of the kind that is required to bring the requisite depth of meaning into the signs used cannot be acquired without effort and discipline, and in general it is a work that must be shared with others. Recognition of functional recurrences can be transformed into valid knowledge only with the help of the categories. Nevertheless, the categories themselves are efficacious only in so far as we recognize their meaning in our own experience, and can share that meaning in a common context with others. They are the primary signs in terms of which the meaning of other signs can be expressed. Consequently the requirement of a stable context involves a smaller number of independent meanings than might have appeared. Our knowledge of the categories is at first slender and unreliable, and can grow only through the examination of experience and the communication of the results between those who seek to establish a common language.

The categories are the basic linguistic elements. Each of them can serve as a sign, a symbol, or a gesture, according to the fullness of meaning that we can recognize in our experience. Their primary application consists in the formation of a valid and coherent system of philosophical signs. They can serve this purpose because they satisfy the canon of philosophical language that one sign could have one meaning. It must, however, be remarked that, approached in this manner, our knowledge of the categories is functional only. In so far as they refer to being and will, we can only 'know about' them. Signs do not serve to give us either consciousness or understanding. On the other hand, we regard function as co-extensive with all existence, and therefore functional signs must be available for any possible reference. With the help of an adequate philosophical language, we can refer to all levels of being and all manifestations of will.*

The powers, and also the limitations, of philosophical language derive from the use of unambiguous signs. In our ordinary mixed language we frequently use signs as if they were symbols and symbols as if they were signs. This gives ease and flexibility to the literary language; but these gains are at the expense of clarity and coherence. If a sign is to be admitted into philosophical language, it must be shorn of any symbolical associations and made to correspond to a definite concept. This latter is reached by the interpretation of experience; namely, the process by which a recurrent element is recognized and disengaged from its context.

[* We may note that the discussion has many features in common with that of Spinoza who—especially in the *Ethics*—defines three gradations of language, of which only the third is authentic by reason of its direct reference to ultimate principles.]

Thus, the process whereby a concept is formed is at the same time one whereby a sign acquires a meaning. In psychological terms the clarification of a sign and its meaning requires reflective attention by which it is constantly referred back to the context from which it derives its meaning. When we reflect upon such words as 'memory', 'hope', and 'effort', we can see that in ordinary language they are used as linguistic elements pointing towards an unclarified mass of experiences. To reduce such elements to signs demands a severe discipline that a man can, in general, practise only in solitude. Hard though this discipline is, it is manifestly insufficient for communication unless the participants in discourse can verify that each has carried through a similar procedure and has identified the same recurrent elements in experience from which the meaning of a given sign is derived. Successful intercourse requires, further, that reflective attention should be sustained in the act of communication, to ensure that the sentences used bear the meanings intended. When the written word is interposed between the participants, there is the added difficulty that sentences tend to take the

character of symbols and evoke associations foreign to the intended meaning.

There are, however, no inherent defects in the human functions that should prevent the construction of a philosophical language in which every important sign, whether written or used in verbal communications, would have a unique meaning. The current lack of such language is mainly due to the fact that the systems of education practised throughout the world are satisfied with technical reference and remain indifferent to meanings. Because of this indifference, educated people feel little or no discomfort when using words without bestowing any degree of attention upon the recurrent experiences to which they are presumed to refer, and without verifying that the hearer assigns the same, or indeed any, meaning to what he hears. It is evident that a rational education calls for the development of an unambiguous system of signs and a clear literary form.

It must be understood that the formation of an authentic sign language is a most arduous undertaking. It demands from those who engage upon it an unflinching determination to reach effectual communication. There must also be a development of attention by which the recurrent elements in experience can be recognized and interpreted as the meanings of the signs employed. Finally, there must be discipline in the use of language; the integrity of signs must be preserved, and this can be achieved only at the price of constant vigilance.

There can be philosophical language appropriate to psychology, to history, to natural science, to art, politics, and religion—and even to

specific activities within any of these domains. It is not the subject-matter that distinguishes the philosophical language, but the possession of an adequate system of signs related to a common context of experience. It follows that each philosophical school must construct its own language for the purposes of the particular task in which it is engaged. Hence philosophical languages take diverse forms according to their origin. Nevertheless, wherever there are two or more authentic languages of signs, it is possible to translate from one into the other, because they are all derived by the same process of interpretation from recurrent elements in the common experience of mankind. We have, for example, formulated the categories according to our own discovery of meanings in all varieties of experience. The system so constructed is not closed to other systems, and through the discipline of reflective attention a correlation of meanings is possible. In this manner, all authentic philosophical language can be brought into a single scheme of unambiguous signs.

It does not, however, follow that the signs established by a philosophical discipline carry meanings that can be recognized from the sound, the form, the etymological derivation, or the common usage of the words employed. Signs do not carry their meanings on their sleeves, nor indeed any meaning at all, except for those who have created these meanings in a common effort to establish a stable context of experience. Those who wish to communicate by way of the language of signs must themselves acquire a co-ordination of functions that permits clear and unambiguous speech.

Every element of experience that can be recognized is the source of a meaning, and every meaning can be represented by a sign. The language of signs can thus ideally be made adequate for communications respecting the meaning of all possible forms of experience. The relationship between meanings can be expressed by sentences; a properly constructed system of sentences is philosophical discourse. Wherever in our experience we can discover repeated and therefore recognizable elements, we have the possibility of philosophical discourse.

2.4.7. Symbolical Language

From our study of the categories we can see that the relativity of wholeness introduces a dimension which no system of signs can adequately represent. The very word 'whole' when used as a sign cannot carry all the meanings of wholeness that we encounter in our experience. This can readily be seen if we examine such a sentence as 'a man is a whole'. Such a sentence evidently has different meanings according to

whether we regard man from the physiological, the psychological, the social, the philosophical, the historical, the religious, or various other possible perspectives. The sentence has, moreover, meanings different not merely in content but in their very nature, according to whether we interpret the word 'man' as applying to function, being, or will.

The transition from the language of function to the language of being is made when signs are replaced by symbols. The difference lies in the way in which experience is apprehended. The construction of a sign is performed according to the interpretation of experience; that is, by clarifying and delimiting the meaning recognized in a recurrent situation. The sign lifts the meaning out of its context and gives it a status of its own. In this process the integrity of the experience is sacrificed: as, for example, when we create the signs 'brain' and 'mind' to clarify the meaning that we find in the physiological and the psychological approaches to the act of thought. We may use the term intuition to designate the process of recognizing meanings without interpretation; that is, without extracting them from the context of experience. Intuitions can never adequately be expressed or conveyed by means of signs, because they recognize the meaning of the context as well as the meaning of the element symbolized. If, for example, we use the word 'thought' as a symbol, we must be prepared to forgo clarity and definition and to accept it as referring to the relationship of a finite centre of consciousness towards the stream of awareness present in that centre. Although it is possible thus to indicate in words the place of the symbol 'thought' in the context of experience, there is neither clarification nor delimitation that entitles the word 'thought' to rank as a sign. On the other hand, it is also more than a sign because it takes in all the meanings that we associate with such words as 'perception', 'recognition', 'association', 'awareness', and also 'mind' and 'brain'.

Intuitions are the raw material of being-language as sense-impressions are the raw material of function-language. Every word relating to being must have a flexibility of meaning that takes account of the fact that every whole is relative and every context unlimited. In order to create a language of being, we need to have a set of symbols each standing for a group of related intuitions.

The language of being must have one more dimension than the language of function, and hence where signs may be single-valued, symbols need to be multi-valued. The power of a symbol consists in connecting different gradations of wholeness. Signs cannot be used to express both the content of different levels and also the relationship between the levels. For example, only confusion can arise if the word

'surface' is used as if it had the same meaning when applied to an atom as to a table. The word 'surface' should therefore properly be used as the symbol of our intuition of the property of wholeness whereby every whole A divides existence into a part that is A and a part that is not A. The intuition has no fixed meaning that can be designated by a sign.

If there were not different levels of being, a sign-language could be created that would be adequate for designating all possible meanings. Because there are different levels, a given situation can have more than one meaning, and these meanings require to be distinguished. For this, symbolism is necessary. It is not, however, the perception of different levels that is symbolical any more than the recognition of meanings is itself a sign. In a very broad sense we can define all awareness of the simultaneous presence of different levels as 'mystical experience'. Mystical experience can either be left as intuition or interpreted to give a theology. In the second case, the mystic makes use of signs and treats his experience as if an unambiguous meaning had been discovered and was being expressed. Alternatively, he may endeavour to preserve the multivalence of the experience and if so his utterances are symbolical. In most mystical utterances, signs and symbols are confused and communication is ineffectual.*

The confusion is greatest when the mystic uses ordinary words with a meaning that for him has the force of a symbol but is taken by the reader as no more than a sign. If the reader wishes to discover the intended meaning of what is written, he must constantly remember that words taken as signs lack the dimension of consciousness, which for the mystic is the most significant element of his experience.

The meaning of a symbol can never be fully known. Always there is in it that which transcends function and points obscurely to the consciousness of being. Therefore, when we are confronted with a symbol, we must look into our own experience in order to discover what is reflected there. We find that we ourselves are present in the symbol and the symbol in us, for it is not an abstract sign that can exist apart from living experience.+ In function-language signs can be tied down to external

[* Cf. N. Berdyaev, *Spirit and Reality*, p. 146: "From the manner in which many mystics describe their experiences, they might appear to be the exponents of monism, pantheism, anti-personalism, anti-humanism, or of an attitude denying human freedom and love. But, as we have already observed, the idiom of mysticism is untranslatable into theological and metaphysical terms. But the problem posed by the mystics still remains unsolved and disturbing."

+ Cf. L. A. Reid, *Aesthetic Meaning*, *Proc. Arist. Soc.*, 1955, Vol. LV, p. 227. "Symbol and meaning in aesthetic experience are constantly shifting, what was meaning becoming symbol for further meaning."]

meanings, but in being-language symbols thrust us back towards experience and so can serve to link one experience with another. The sign is an instrument of knowledge, whereas the symbol evokes a state of consciousness.

It may help to clarify the distinction between the first three forms of language if we again take as an example the use of the word 'man'. In the mixed language the word 'man' is used without reference to any stable context. In a single conversation the word may be used with different meanings, and more often than not the meaning that is valid upon one level of experience is applied to the interpretation of a level upon which the word should be used as a sign for a machine or at best an animal. In the language of function, the word 'man' can be defined by reference to the categories. In this way an unambiguous set of sign-words can be delimited, each of which refers to an authentic recognizable recurrent element in human experience. All that can be known about man can be expressed and communicated, providing the participants in discourse have discovered in their own experience the meanings to which the signs refer. Having passed through the discipline of self-observation and mutual interrogation, the members of a philosophical school interested in the study of man can communicate without fear of deception or confusion. Notwithstanding the adequacy of the communication, it is nevertheless incomplete. What it is to be a man cannot be conveyed by signs. In order to express man-being, we must enter into all the experience of humanity and participate in the different levels of experience and gradations of being of which mankind is constituted. There is no longer one stable context, but a hierarchy of contexts so different that the meaning found at one level may contradict the meaning found at another. The context of discourse on one level cannot be merged with the context of another. Mankind is a sevenfold structure, and each of the seven qualities or gradations constitutes an independent context of meanings. Although the distinction of levels cannot be made the object of conceptual signs, an intuition of their relationship is nevertheless attainable. The word 'man' then becomes in the true sense a symbol when it is used to express the whole range of meanings to be found in human experience.

The power of symbolism cannot be grasped in functional terms. Symbols must be invested with the intuitions of being before they can serve as instruments for the second or theoretical language.

In the mixed language of ordinary speech words are used indiscriminately as both signs and symbols. When this is done, the result is a spurious significance, a deceptive meaning that has lost touch with

experience. It would be generally agreed that a symbol has no content save the experience for which it stands, and that, hence, the use of symbols for communication requires a special discipline that is very different in character from that which is needed for the philosophical language of signs. The context of sign-meanings is functional but that of symbol-meanings is conscious. It has been emphasized repeatedly that states of consciousness can neither be known nor communicated, and therefore symbolism in the sense just formulated would seem to be impossible. Nevertheless, an authentic language of symbols can be created by a group of

people undertaking any common endeavours in the field of consciousness. The creation of theoretical being-language is also the work of schools, but of a different order and subject to different discipline and demands from those required from schools upon the level of abstract philosophical language. The language of being is an instrument in which meanings are not discovered by interpretation but created by effort. Those who attain to the use of symbol-language have themselves passed through the inner transformation that liberates consciousness from function. In such people different levels of being are consciously discriminated; therefore different, and even contradictory, meanings can be experienced in a single intuition. Only people so transformed are capable of participating in being-discourse.

Symbolism rests upon the categories of experience, but moulds them into a richer unity. Symbolism is not analytic but synthetic. The problem of communication meets here with an obstacle that does not exist in the functional language where a single stable context can be discovered and shared. The meaning of symbols is not found but created; communication depends upon mutual recognition of the steps by which the meaning of a symbol has been reached. Not everyone who wishes can arrive at the possession of symbolical language. One may know what needs to be done but one may not have the force to do it.

2.4.8. Gesture Language

The communication of understanding is not achieved either by sign or by symbol. If being is apprehended by intuition, will can be understood only through participation. The language of will, going beyond the communication of meanings, reaches a common affirmation—an act of will in which the participants share. Before we can approach the study of will-language, we must remove a common misconception as to the possibility of communicating understanding. Both understanding and the communication of understanding are impossible without a shared stable context of knowledge, being, and will. Men can understand one

another in ordinary life only where domestic or economic forces impose upon them a relationship of being and a community of action; yet by a strange, but not uncommon, aberration people assume without question that they can understand ultimate realities that are, in fact, utterly beyond their reach. Goodness, truth, justice, and other manifestations of conscious will, that no ordinary man can even begin to apprehend, are discussed in the mixed language of sign and symbol in which the words used have no recognized meaning. It must, moreover, be remarked that successful concerted action is no evidence of a common understanding. It is the technical reference and not the understanding of the participants that produces unity of action. For example, a game of cricket is a technical reference that brings into play acquired techniques and by its rules and customs ensures a sequence of concerted actions on the part of the players and spectators. This sequence includes not only the bodily activities but also the mental experiences of curiosity, expectation, the evocation of memories, and the emotional satisfactions of success and failure. We may observe in this context a recurrent element that we express by the sign-word 'team-spirit' and the meaning of the sign is held in common by all those who speak about the game, but the meaning of team-spirit is not the same as the meaning of 'common understanding'. The former is external; it is produced by the technical reference, and when the technical reference ceases—that is, when the game comes to an end—a new technical reference, such as an economic dispute between employers and employed, may substitute a quite different meaning for that which the word 'team-spirit' possessed during the game.

Although understanding is wrongly attributed to many human situations, it can nevertheless be found in a germinal form wherever there is an authentic relationship of will. Since the relationship of will is doing, we shall employ the term gesture to denote the mode of expression by which the language of will is created. To grasp the significance of gesture, we should compare the three modes of expression:

Signs: Each true sign has a single meaning, but the meaning is the recognition of a recurrent element that runs like a thread through the context of experience. Many experiences are needed in order to establish a single meaning. There is, however, a one-to-one correspondence between sign and meaning.

Symbols: A symbol has as many meanings as there are gradations of being to which it refers. The symbol has not only meaning, but it is also a direct experience of being. The power of a symbol cannot be discovered by way of interpretation but only through intuition. Neverthe-

less, because one symbol can have many meanings and is applicable to many situations, it must necessarily fail in respect of concreteness. It does not fully relate the experience to its context.

Gestures: Every gesture is unique. Bearing its own meaning, it requires neither interpretation nor intuition. Different gestures may be similar and similar gestures may be repeated, but the uniqueness of the gesture remains its dominant characteristic. The gesture is not taken out of the context, but made in the context.

For better or worse, every gesture is an act that determines the future course of history. The scale of the act may vary greatly. Sometimes it will be very small and the consequences hard to discern. At others it may be so great that all human experience is changed by it. A gesture is eternal—that is, timeless—and yet it reverberates both in time and in space. It is never repeated and yet it recurs.

The uniqueness of gestures corresponds to the uniqueness of understanding. The understanding of one situation cannot be transferred to another. Understanding is always new because it is always an act of will, and the language of understanding must itself be an act of understanding. In the language of gesture, no word, no act, ever means the same thing twice. It is the language of the whole man, and it can be used only by a man who is himself a fully structural whole. The 'gestures' of ordinary men are no more than the automatism of their functions. The meaning of such gestures does not belong to those who make them, but to the universal processes into which they are merged. We must therefore not be misled by the fact that a gesture is sometimes a sign or a symbol.

A further point that here requires to be noted is that the ascription of gesture to the highest order of language must not be confused with the theory of language that regards its origin as rooted in pantomime.* The belief that words are gestural in origin may be valid, but wrongly interpreted in the theories that regard language as having developed from the automatic gestures of the brutes.

We must also here refer back to the distinction made at the beginning of this chapter between language, art, and magic. Neither art nor magic are properly speaking language, although they employ both symbol and gesture. Even in the highest language the gesture stands for the understanding. It is not a mode of action.

[* Cf. Sir Richard Paget, *Human Speech*, p. 174: "Human speech arose out of a generalized unconscious pantomimic gesture-language—made by the limbs and features as a whole (including the tongue and lips)—which became specialized in gestures of the organs of articulation owing to the human hands (and eyes) becoming continuously occupied with the use of tools."]

Nevertheless, at the highest level, language, art, and magic do merge. Experience, communication, and action are separate only when there is a divided will. With unity of will, language of gesture breaks through the divisions of function and being. Where understanding is perfected, gesture becomes a universal language. Whoever perceives the gesture of the perfected individual understands it according to his own capacity, but he is not left untouched. It is this action that brings gesture language into intimate relationship with art and magic. Communication by way of gesture has different levels of perfection. At the lowest it depends upon a common context established by common endeavour, but at the highest the context of the gesture is the whole of human experience. The individual who is capable of making such a gesture is himself a creative power. For the gesture does more than produce the context. It is itself the context of its own expression.

We find ourselves of necessity in the realm of speculation when we endeavour to carry our analysis of language beyond the context of our own experience. We do, however, encounter in the history of mankind examples of gestures that continue to reverberate and that convince us that this language is indeed the

supreme act of communication.

Chapter Five KNOWLEDGE

2.5.1. The Meaning of Knowledge

Knowledge is evidently some kind of link or bridge between sameness and difference. In a perfectly homogeneous situation there would be nothing to know; while confronted by complete heterogeneity, knowledge would be impossible. Nevertheless, the mediating role of knowledge cannot readily be expressed in a formula. Let us begin, therefore, by examining various situations in which knowledge is a factor. If we are late for an appointment, we may excuse ourselves by saying, 'I did not know the time', or else we may say, 'I did not notice how late it was'. Since these two statements have roughly the same meaning, it would seem that we know what we notice and what we fail to notice we do not know. Experience teaches us that noticing is usually the perception of differences. We 'notice' what attracts our attention by some unexpectedness—by standing out from its environment—by 'differentness'. We soon cease to notice an object that remains always the same, either in relation to ourselves or to its environment.

The disappearance from our attention, and hence from our immediate knowledge, of that which remains the same is not only an important psychological fact but it is also an indication of the limitations of knowledge itself. What we appear to know is always the transition from same to other. It would be more accurate, however, to say that we cannot know what things are but only what they do. When we speak, we frequently appear to be referring to what things are; but if we suppose that this is so, we deceive ourselves. Nearly all our conversation is about knowledge—about what we know or suppose we know. One of our handicaps is that we tend not to notice that which we do not already know, and hence our knowledge lacks the means for recognizing and correcting its own defects. Knowledge is subjective, and cannot stand apart from itself in order to test its own limitations by reference to some objective standard.

There is a false objectivism that loses touch with experience and decries as 'psychologism' the very necessary practice of examining meanings by inquiring whether or not we discover them in our experience. The *cogito, ergo sum* of Descartes cannot be discussed objectively

until we have satisfied ourselves whether any single word in the two phrases has a clear and fixed meaning for us. 'I think, therefore I am' appears to be a statement of fact; but it is really an assertion of being, for it affirms that there is in man an 'I' that can be conscious of his thoughts.*

There is an equally false subjectivism that assumes, without weighing the evidence, that the laws of the universe can be discovered in our own habits of thought. Plato recognized that there must be some correspondence between the knower and the known; but the significance of this conclusion differs entirely according to the views a philosopher may hold as to the nature of substance. If knower and known were made of different stuffs, there could be no direct relationship between the two. Knowledge would have then to be treated as some kind of hybrid substance able to participate in the nature of both subject and object.

It seems clear, therefore, that the right way to approach the study of knowledge is to examine the part it plays in human life. It plays a part because it is connected with belief. On the whole, what we believe is a factor in our behaviour—not completely decisive but always significant. We have therefore to distinguish between the kind of belief that constitutes knowledge and that which does not. We incline to connect knowledge with the truth and falsehood of beliefs, and, moreover, we usually take it for granted that beliefs can be formulated as propositions in verbal terms; that is, as sentences. If a belief thus formulated is proved in experience to be true, it is regarded as knowledge; but when proved to be false, it is branded as illusion or error.+

Such a process of trial and error is too restrictive, partly because there can never be a sharp division of beliefs into those which are wholly true and those which are wholly false. This is, however, not the whole point; for

there is a large range of beliefs that are never expressed in verbal form and, indeed, could never be wholly so expressed. Such beliefs refer mostly to 'knowing how'. A surgeon may know how to perform a delicate operation or a singer may know how to produce a certain quality of sound, but they could not communicate their knowledge in words or sentences that would convey the meaning of their experience to the layman. Even as between two experts, there is a point at which verbal communication breaks down; yet the presence of knowledge is recognized in such phrases as: "Yes, I see how you do it."

[* Cf. G. Ryle, *The Concept of Mind* (London, 1949). His discussion of the 'ghost in the machine' (p. 16) is one of the latest of a long series of critical inquiries made since the time of Gautama Buddha that have led to the conclusion that words such as 'I', 'myself', and 'soul' correspond to nothing that we find in our experience.

+ Cf. Bertrand Russell, *Human Knowledge*, p. 270.]

By applying this—the operationalist—theory of knowledge, some defects in communication are avoided. Knowledge, regarded as the adaptation of behaviour to function, corresponds to what we discover in our experience, and does not involve us in any awkward questions as to the meaning, of truth. Such questions arise when knowledge is defined in terms of the triad belief—truth—knowledge, in which belief is a subjective state.* The operationalist theory of knowledge is therefore a step in the right direction; but to make it adequate we must recognize that intellectual, or verbal, knowledge is only a fraction of possible knowledge.

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We must eliminate such pseudo-knowledge as consists in automatic phrases or sentences, such as 'Julius Caesar crossed the Rubicon in 40 B.C.', or 'The companion of Sirius is a White Dwarf. Such sentences, unless they can be related directly, or even indirectly, to our own life and experience are mere 'information', and do not concern our present problem. We shall use the word 'knowledge' in a sense that goes beyond mere 'information', and so implies that it is a factor in determining behaviour. On the other hand, we have to bear in mind the distinction already made between knowledge and understanding—the former being an aspect of function only and the latter an aspect of will. The use of the word 'knowledge' in this discussion will be further restricted to the functional correspondence between different elements of experience. A conviction that experience is of one and the same stuff throughout obliges us also to use the word 'knowledge' in such a way that it is applicable to all wholes. Moreover, we must use this word in such a way as to apply it equally to the situation of 'knowing what' and to that of 'knowing how'. Such is the difference between recognizing a motor-car when we see one and knowing how to drive it; but we must avoid using the word in such a way as to suggest that two quite different kinds of experience are involved. If we look closely, we find that all knowledge is really 'knowing how'; that recognizing a motor-car means knowing how to distinguish it from a bicycle or an aeroplane, or from any other whole that may present itself to our experience.

[* Cf. Bertrand Russell, loc. cit., p. 161: "A belief is a certain kind of state of mind or body or both—truth is a relationship of correspondence." P. 170: "Every belief is true if there is a fact having to the picture the kind of similarity that a prototype has to an image."

+ The operationalist account of knowledge goes back to Newton's 'hypotheses non fingo'. This was given a fresh significance by Mach, and was made the basis of scientific explanation by Bridgman. Cf. P. W. Bridgman, 'The Nature of Some of our Physical Concepts', *Brit. Journ. for the Phil. of Sc.* Vol. I, No. 4, p. 257. J. O. Wisdom in *Foundations of Inference in Natural Science* (London, 1952), Chap. 9, discusses operationalism and shows why it is necessary to go beyond the verbal formula.]

2.5.2. Knowledge as Order in Function

Let us agree that some meaning can be ascribed to the words 'the key knows its own lock'. They have something in common with such a sentence as 'I know my own front-door'. When we use the word 'know' in such a context, the idea of correspondence is not far from the surface of our thought. In the first sentence, the

correspondence between the pattern of the key and the wards of the lock is almost the only element of knowledge present. The second is more complex, but we are certainly referring to the correspondence between a pattern of memories and habits and the configuration of the houses and the street in which we live.

In the act of making a new key, we take a blank and file it away until the required pattern is actualized. Out of the indiscriminated multitude of possibilities inherent in the blank we have selected one and excluded the remainder. Similarly, if we examine the various forms of knowledge that we meet within our experience, we can see that there is always a like process of selection and arrangement in order to bring about a correspondence between two different wholes.

We thus revert to the relationship between knowledge and behaviour that we have already noted. We can say—in the broadest sense—that the knowledge present in any whole is a set of correspondences between its inner patterns and those of other wholes with which it reacts. If there is no such connection, knowledge is trivial and ineffectual, and produces no significant consequences.

The converse proposition—namely, that knowledge is in itself the guarantee of appropriate response—is obviously untrue. There are three reasons for the possible failure of knowledge to evoke such response. Firstly, there may be its own functional inadequacy; that is, the imperfect correspondence between the pattern of cognition and the pattern of perception. Secondly, there may be a lack of being-intensity, by reason of which knowledge may lapse from consciousness and therefore be useless. Thirdly, there may be defects of will, which may prevent the requisite form of process from being actualized. Knowledge alone can only give automatic adaptation, and this is by no means always 'appropriate' to the situation.

There is no qualitative difference between the knowledge present in a man and that present either in an animal or in an inanimate mechanism. We can confirm that this is so by examining the process whereby the growth of knowledge goes beyond the mere accumulation of random traces of past impressions. We can establish that in every whole—living or non-living—there is a more or less developed form of memory. This has been proved experimentally by J. L. Bose, and subsequently

confirmed by many other investigators. In his classical investigation, Bose showed how the response-mechanism of inorganic bodies has fundamental features in common with that of plants and animals. These features include fatigue under continuous stimulation, hysteresis, and the reversal of response under the action of stimulants and depressants.*

In vertebrate animals—and especially in man—the registration and ordering of sense-impressions takes place in the grey matter of the brain. There are two distinct ways in which this can occur. In one case, impressions may collect in the neural schemata solely by repetition of similar impressions. These, being revived in the memory by association only, need have no objective reference, and hence no bearing upon effectual behaviour. The ordering process in such a case usually ceases at this point, and there is no subsequent development.+ The received impressions are preserved as information and no more than this. In the other case, if the impressions are confronted with previously noted experience, especially if they are tested by an effort of attention—that is, by reflection—they become part of a coherent structure, available to promote successful action.

Knowledge, in both senses, is order; but reflective knowledge has the special property of relating the inner order to the outer, and for this reason it can promote effectual—albeit automatic—action. Thus it becomes apparent that the acquisition of knowledge involves a special relationship, in which the registration of sense-impressions is only one component of a triad. We do not usually suspect how small a part reflection plays in our actions; but the man who reflects, and strives to relate the new impressions to the structure of his previous experience, saves himself from the chaos of disordered information. Even instinctive knowledge, acquired apparently without struggle by the individual, is nevertheless the fruit of the functional strivings of innumerable generations of remote ancestors. It is this reflective character that we express by defining

knowledge as the ordering of function. Randomness—that is, disorder—arises spontaneously; but ordering requires a specific strain or effort.++

The potential functions of a man go far beyond either his mental associations or his bodily behaviour, and the ordering of function as a

[* Cf. J. L. Bose, *Response of the Living and the Non-Living* (London, 1902).

+ Cf. G. G. Campion and G. Elliot Smith, *The Neural Basis of Thought*.

++ The argument here turns upon the connection between order and probability. As Boltzmann has shown, the degree of order present in a system is inversely proportional to the logarithm of its probability, and perfect order is therefore infinitely improbable.]

whole can surpass the result of training each group of functions taken separately. For example, we train our thinking brain to clear and logical thought; we seek to discipline our emotional reactions; we exercise our bodies in order to develop their powers; but, for the most part, we overlook the importance of achieving a harmony and a balance as between the several functions to enable them to work together as one whole. Without such harmony and balance there can be no valid knowledge. In order to know the meaning of our experience we need to think what we feel and to feel what we think. In addition, thoughts and feelings must be brought into harmony with the instinctive and motor functions before we can come to any completeness of knowledge. There is a further limitation upon knowledge; namely, that it is a relationship of one to many. The order present within a single whole has to correspond to an immense number of other wholes, and to a still greater number of possible combinations of these. It is trite to say that we can only know a small fraction of what is knowable, but we must remember that this also means that our behaviour can correspond only to a small fragment of the situation present to our experience. Even that small fragment can only be imperfectly known, because it is apprehended from the limited—and possibly very narrow—perspective of our own localization in time and space. Our knowledge of the fragment may lead us to action very different from—even directly opposed to—that which we would see as appropriate if we had knowledge of a larger whole. For instance we may refuse to drink a bitter medicine, because we know that this would result in an immediate unpleasant sensation, while remaining ignorant of its necessity for our future well-being. Such a picture is symbolic of the whole situation of man. We cannot discover the sense and meaning of our own existence unless we can see it upon a sufficiently large scale. The question 'What are we to make of our life?' turns in the first place upon the possibility of knowing the degree of correspondence that could exist between the pattern of our personal history and the pattern of the great cosmic process in which we are involved.*

2.5.3. Non-discriminative Knowledge

We have noticed that knowledge cannot exteriorize itself in order to apply some objective criterion of truth to its own content. This is strictly the case only when applied to knowledge as the regulating

[* Cf. Karl Jasper, *The Way to Wisdom*, p. 15: "Philosophy is the principle of concentration through which man becomes himself by partaking of Reality." Its aim is "to open man to the comprehensive in all its scope".]

factor in automatic behaviour; that is, when it is without inner discriminations. We have to qualify this statement when we take account of the relativity of being.

Let us consider a few examples which will show that there can be knowledge that is authentic, although of a primitive, non-discriminative character.

A man sets out in his car to drive to a familiar destination. He performs a series of complicated co-ordinated actions over a period of half an hour or so. These include starting and driving the car, selecting and following the correct route, and a whole sequence of adjustments to the movements of pedestrians and of other

vehicles. Let us assume that the man is deeply preoccupied with some question unconnected with his driving or with the road he follows to his destination. He does not, as it is said, 'give a thought' to his driving, but nevertheless he arrives successfully and punctually at the end of his journey. His sensory and motor functions have performed a task which, if analysed in terms of all the separate adjustments between the internal and external situations, would prove to be immensely complicated.

If we ask in what respect do the actions of this man differ from those of someone who could not drive very well and who had not previously made the same journey, we would probably answer that the first man 'knows' how to drive and 'knows' the way, whereas the second does not 'know' how to drive and has little 'knowledge' of the route. What, then, is this 'knowledge'? We find that it consists almost entirely of a store of previously experienced sense-impressions, arranged and connected with each other in a certain way, and, moreover, that 'knowledge' of this kind is authentic and can be effectual without intellectual awareness of the process by which it is acquired or used.

Consideration of a familiar minor episode will provide further data. A dog sleeping on a hearth-rug is bitten by a flea and scratches himself with his hind-leg without waking. In some sense, he can be said to 'know' that the scratch-reflex will relieve the irritation. This 'knowledge' is not registered in his head-brain, because the reflex persists even if the dog is decerebrate; that is, if the brain connection is severed from above the thalamus. Knowledge of this primitive kind need not depend upon any prior experience of the organism concerned; it is transmitted by heredity and forms part of the innate instinctive-reflex mechanism; and, indeed, far more complicated patterns of instinctive behaviour are somehow 'known' without any prior sense-experience from which the 'knowledge' could have been acquired.

Simple authentic knowledge, resembling instinct, can also be

acquired from experience. Lloyd Morgan has described experiments with a new-born chick that is offered a diet of pleasant-tasting, wholesome maggots mixed with bitter, poisonous lady-birds. The chick, after one or two unpleasant experiences, ceases to peck at the bitter-tasting lady-birds.* In a general definition of knowledge, we are bound to say that the chick now 'knows' the difference between lady-bird and maggot; and so makes a distinction in place of the single undifferentiated reaction to every small bright object lying on the ground.

It would not be easy to define knowledge in such a way as to exclude the elementary discrimination of the chick while yet admitting the complex discrimination of the driver of the car in the first example. It is by no means necessary that consciousness of self, or even the most diffuse self-awareness, should accompany this knowledge. It would not be difficult to construct a feed-back that would display the same behaviour pattern as the chick's. Such a mechanism need not be designed in advance to respond differently to the two kinds of stimulus, but could itself 'learn' to discriminate through repeated experiences of success and failure. The new science of cybernetics+ has shown how the feed-back by which this result is achieved is much the same with the machine as it is with the living organism. The feed-back mechanism consists in relieving the strain that arises between the whole concerned and its environment. Moreover, the peculiar property of knowledge is that the relieving of the strain does not diminish, but rather increases, the possibilities of more complex actualization in the future. The chick that ceases to peck at the poisonous lady-birds not only relieves a present discomfort, but secures the possibility of growing up to lay eggs or to crow upon the dung-hill. Ernst Mach described how the discovery of what appeared to him a convincing account of sense-experience resulted in setting him free from the greatest intellectual discomfort of his life.++ The ordering process—the relief from strain—

[* The behaviour-pattern of the chick, confronted with the lady-bird and the maggot, is the leit-motif of Lloyd Morgan's Gifford Lectures. Cf. *Life, Mind and Spirit*, pp. 100-8.

+ The term cybernetics was coined by Norbert Wiener from the Greek word for a helmsman. The hypothesis

of cybernetics was discussed by J. O. Wisdom, *Brit. Journ. for Phil. of Sc.*, Vol. II, No, 5, pp. 1-22: "Cybernetics does not, of course, show that human beings are machines. Many thinkers would hold that they are, but the important question concerns the kind of machine they are likely to be." Wisdom concludes that the cybernetic model is inadequate, but that it is possible that mechanisms as yet undiscovered may be found that will approximate more closely than feedbacks to the working of the brain. Cf. also N. Wiener, *The Human Use of Human Beings* (Chap. 7), for a discussion of the philosophical implications of cybernetics.

++ Cf. Ernst Mach, *The Analysis of Sensation*, Preface to the 4th edn. (London, 1914), p. xiii.]

is not knowledge itself, but is the mechanism whereby knowledge is acquired. This same mechanism is present at all levels and is that which leads us to strive—though it may be unconsciously—to know the world in which we live.

The possibility of non-discriminative knowledge is not limited to human or even animal experience. We can conceive a well-prepared card-index—containing in readily accessible form knowledge of any subject, more detailed and more accurate than the greatest specialist could boast—which could, in theory, be fitted with a feed-back mechanism that would enable it to write intelligent replies to a great variety of questions.

A final example will illustrate the manner in which the word 'knowledge' can be defined so as to give it a meaning that is universal and applicable to all occasions, inanimate as well as animate. In the growth of a crystal from a solution, the molecules of the solute arrange themselves in a definite way at the surface of the growing crystal. They do so by a mechanism which unmistakably has something in common with that which produces the scratch-reflex of the dog, the successful driving of a car, or the discovery of radium. In all cases there is a transition from disorder to order in the functional actualization. C. N. Hinshelwood recognizes that the ordering process is common to living and non-living matter, though he does not deny that life may have some characteristic other than the creation of order which the non-living matter cannot reproduce; and in another passage he emphasizes the absence of adaptation.*

2.5.4. Polar or Discriminative Knowledge

Non-discriminative knowledge means functional order that can issue only as automatic behaviour. Only where there is a distinction of quality can there be selection and adaptation. The power to recognize differences of quality demands a separation of consciousness. Without this, there cannot be a comparison of two functional orders with that suspension of judgment which is the prerequisite of choice. The gradation of knowledge in which two functional orders are simultan-

[* Cf. C. N. Hinshelwood, *Structure of Physical Chemistry*, p. 434: "The first problem on the physical plane to consider, is the creation of order by living things. Unstable and reactive substances are built up in reactions which go with a not inconsiderable increase of free energy, and the question has from time to time been raised whether, in the course of these happenings, something has directed them along paths other than those prescribed by the second law of thermo-dynamics. This, however, is no more so than it is in the growth of a crystal, where a regular geometrical lattice emerges spontaneously from a chaotic solution."]

eously apprehended and compared can be called polar or discriminative.

According to the principle of polarity, simple division into two orders can give rise to a force, but not to a relationship. In general, when two sets of orders are compared, one will present a higher degree of activity than the other, and will therefore stand towards the other as affirmation towards denial. There is thus an arising of the 'yes or no' that is one of the elements of choice. There is no true 'yes or no', however, unless there is a difference of quality, recognized and appreciated in a single moment of consciousness. This is discrimination, by which knowledge passes from automatic adaptation to selective response.

Since passive adaptation is the vegetative state, we can also apply to non-discriminative knowledge the term 'vegetative' to distinguish it from selective or 'animal' knowledge. In general, all animal existence is polar; for here there is an interplay of causal and purposive factors that everywhere makes itself felt.* The animal is at one and the same time a causally determined physico-chemical mechanism and a living being, seeking—consciously or unconsciously—to realize an end or purpose. All true animal activity therefore requires the second kind of knowledge as well as the first.

When translated into the human sphere, polar knowledge is chiefly concerned with the adaptation of means to ends, thus satisfying Dewey's definition of knowledge as "a belief that promotes success". Nevertheless, polar knowledge does not effectively relate its possessor to the object, and there remains the polar distinction of knower and known as well as the polar opposition of affirmation and negation.

In this connection, it is worth noting one consequence of the absence of relatedness in polar knowledge. This is the experience of the comic or of the tragic. In our human life, we find occasions when there is a separation of forces without the possibility of an appropriate response. Affirmation and denial then both remain suspended, and we experience a state of tension that can be relieved only artificially by laughter or tears. This is the form of behaviour that issues as the reconciling force when we are confronted with the comic occasion that requires of us a denial that it would be absurd to make. In the tragic situation, on the other hand, there is also a suspension of forces in which the affirmation proves impossible owing to the absence of a reconciling or relating force.

[* Cf. Hans Driesch on the distinction of entelechy and causality in *The Science and Philosophy of the Organism*, 2nd Edn. (London, 1929), p. 250. See also E. S. Russell, *The Directiveness of Organic Activity* (Cambridge, 1946), pp. 8 and 175.]

In the ordinary occasions of life, polar knowledge can be efficacious because there is usually available a course of action that can reconcile the opposing forces; as, for example, when we have to choose between present pain and future pleasure, or the reverse. Nevertheless, polar knowledge is always lacking in objective reference; that is, in the means of self-verification.

2.5.5. Relational Knowledge

The appearance of relational knowledge coincides with the birth of understanding. It can arise only through experience, which enables one inner functional order to reconcile two others, either outer or inner. By knowledge of this kind, otherwise unrelated facts can be welded into a coherent system. Moreover, its effect upon behaviour is not to produce the primitive adaptation of 'yes and no', but discriminative choice.

The triadic relationship can break through the polar barrier that separates the subjective and the objective experience of man. Relational knowledge stands at the mid-point between the knower and the known, participating in the character of both. It can be shared by those who possess appropriate means of communication in one of the forms of authentic language. Non-discriminative knowledge, on the other hand, has little significance valid outside the particular whole within which it resides. It cannot be communicated or shared. Polar knowledge is also incommunicable, for it depends upon a particular occasion to supply the third force. Even when it is apparently general in character, polar knowledge cannot escape from the immediate subjectivity of the being in whom it is present.

The connection between relational knowledge and understanding can be seen if we examine the manner in which it is acquired. Whereas the more primitive forms of knowledge develop by simple addition of experiences—whether sense impressions or inner associations—relational knowledge requires the prior arising of polarity. By this means, the new and the old are confronted. There is a moment of criticism—of suspended judgment—which is not allowed to pass into an automatic response, because there is already present the reconciling experience that demands its own place in the triad. Consequently, the suspense of

judgment is not automatic but conscious, and in this suspense there is not only an ordering of function but also an act of will.

Relational knowledge should be normal for man, who is endowed with a threefold nature, each part of which is able to transmit one of the three forces in the triad. It cannot, however, arise spontaneously, as is

the case with knowledge of the second kind. Therefore, it can only appear in those beings in whom some measure of understanding has already been attained. A relationship in the true sense is like the gold of the alchemists, that cannot be produced unless some trace of gold is already present.

Man seeking to acquire relational knowledge must observe two rules: the first consists in suspending judgment so long as there is a possibility of doubt; the second requires that the reconciliation of contradictories should be pursued perseveringly, however difficult—or even hopeless—the task may appear.

The limitation of relational knowledge consists in its subjectivity. The triad itself does not establish the existence of the occasion. The step from indirect to direct knowledge can only be made when there is the power to participate, by which the knower is not only related to, but actually merges with, the known. This leads to the fourth gradation of existential knowledge.

2.5.6. Subjective and Objective Knowledge

According to the principle of structure, every complete whole must have seven distinguishable qualities. The transition from the third to the fourth gradation of knowledge corresponds to that point at which the inner development of a process has exhausted its primary impetus, and can only acquire a new character with the help of a fresh impulse from an external source.

The first three gradations of knowledge can all be called 'subjective', because the object of knowledge is placed outside the act of knowing. These three gradations can be specified as follows:

- (a) knowledge that leads to reaction,
- (b) knowledge that leads to discrimination, and (c) knowledge that leads to relationship.

In terms of the triad, the first, non-discriminative, can be regarded as 'one-force' knowledge; the subject is passive—the active principle being the external impression or impulse, and the reconciling force being the general environmental conditions. In the same way polar knowledge can evidently be seen as 'two-force' knowledge; for the separation of active and passive principles then enters into the subject. Only with the third gradation do the three forces of the triad enter the subjective experience of the knower.

Although we refer to three gradations of knowledge, it must be understood that it is only in a secondary sense that they are steps taken

one after the other in order of time. Each gradation of knowledge has itself inner distinctions, and a very confused picture must inevitably result if these are not recognized. Reactive knowledge can be very primitive—as in the ordering of the molecules on a growing crystal—but it can also be the means whereby a fully-developed being recognizes and accepts his own place in the universal order. Between these two extremes, there are gradations corresponding to the level of consciousness. From this it follows that the growth of knowledge proceeds in at least two different dimensions—one corresponding to the progression of the categories and the other to the expansion of consciousness. There is, however, also a third factor in knowledge which depends upon the will and can be termed 'the ableness to participate'. Knowledge can grow in two ways—one is by simple accretion like new entries in a card index. This does not lead to any change of quality. The transition to a different gradation is possible only with a corresponding change of consciousness and understanding. Thus the growth of knowledge as distinct from its mere accumulation cannot be an

independent process. The quality of knowledge depends primarily upon the quality of the knower; that is, the level of his being and the form of his will.

In order to express the different modes in which knowledge can be experienced, we commonly use such words as 'sensation', 'perception', 'cognition', 'intuition', 'inspiration', and 'illumination', the meanings of which usually remain undefined, or at best are defined with reference to some artificial theory of knowledge. In such definitions there is invariably a confusion of knowledge with elements that belong to consciousness and understanding. For this and other reasons, no consistent account of the limits and possibilities of human knowledge can be given without introducing a more exact classification, based upon experience that is not exclusively human. The absurdity of any attempt to reduce all knowledge to one—or to even a few—modes of thought can be seen if we reflect that there must be seven qualities of knowledge and that within each of these seven qualities there must be seven levels of consciousness; and also that each of the resulting forty-nine combinations will take different forms according to the seven possible manifestations of will.*

It is necessary to insist upon these distinctions in order to remove the suggestion that the first three gradations of knowledge characterize only the lowest levels of existence. The terms 'vegetative', 'animal', and 'human' knowledge represent distinctions applicable only to a

[* See Chapter 2, p. 45. Cf. also in this connection, Gurdjieff, *All and Everything*, p. 472.]

particular type of functional experience—namely, that of multi-cellular organisms living on the surface of the earth—but they do not correspond to biological classes. It is, for instance, possible for a plant to have knowledge of a kind that is inaccessible to any animal or to a human being. There are many plants that have the power to synthesize substances possessing bio-chemical activity, such as the vitamins and the alkaloids—a power that requires a knowledge that no animal and very few human beings can acquire.*

A fundamental distinction has to be made between subjective and objective knowledge. This distinction arises because, according to the principle of structure, the transition between the third and fourth gradations is possible only with the help of an outside force. In all gradations of subjective knowledge there is the separation between knower and known, whereas in all gradations of objective knowledge this division is absent. Nevertheless, objective knowledge itself has quite different qualities according to the four steps that follow the first interval, or point of discontinuity. All knowledge is ordering of function; but whereas subjective knowledge can be acquired without change of being, objective knowledge arises through, and establishes, an essential change of both being and will in its possessor. Following the three gradations of subjective knowledge, we may specify five further gradations of objective knowledge as follows:

(d) value knowledge,

(e) effectual knowledge,

(f) transcendental knowledge, (g) true knowledge, and (h) revealed knowledge.+

2.5.7. SUBSISTENTIAL OR VALUE KNOWLEDGE

Subsistence is the first category of concreteness. To know subsistence is thus more than to know a relationship; it is the beginning of concrete knowledge as opposed to abstract knowledge. The latter is knowledge of the part separated from the whole, whereas the former is knowledge of any given object, not only in and for itself, but in and for a larger whole within which it finds its place and its significance. Knowledge of the fourth gradation therefore requires an active participation that is absent from the first three, even in their highest manifestations.

[* Cf. *All and Everything*, pp. 824-5. To say that the cinchona 'knows how' to make quinine is as significant and as true a statement as that a bee knows how to make a honey-comb or a beaver knows how to fell a tree.

+ Cf. J. G. Bennett, *The Crisis in Human Affairs*, p. 104.]

Generally speaking, the significance of subsistential knowledge is disregarded because the step from abstract to concrete experience is not understood. It is often assumed that the transition from abstract to concrete is the same as that from universal to particular, and that this step can be made without any change in the character of experience. This is a quite erroneous assumption; for recognition of existence is only possible if one exists oneself. For the most part, people 'know about' themselves in the same way as they 'know about' other things; that is, without the taste of what it means to exist. It is possible to know subjectively without knowing that one knows; objective knowledge begins only when there is self-knowledge.

Knowledge of self is significant only when it distinguishes between different levels of experience within the same being. Self-knowledge is thus the condition prerequisite of value knowledge; for without it there can be no standards of comparison and therefore no discrimination of values.

The realization that one may know as much as one pleases, but that it is useless if one does not know what matters, is the shock that makes possible the arising of subsistential knowledge. Relational knowledge has a quality of completeness that polar knowledge lacks, but it does not suffice for the needs of existence. There evidently can be different degrees of intensity in subsistential knowledge, but it always conveys a feeling for values. Knowledge 'about' may leave us indifferent, but to know that a given whole is what it is can never have this result. In the subjective state of consciousness man is closed to the existence of the object he contemplates, whether it be his inner life or his outer world.

Although subsistential knowledge is concerned with the being of its object, it is in the true sense knowledge and not consciousness or understanding. The power of subsistential knowledge is to bring about an order within the functions by connecting intellectual and physical apprehension with an emotional attitude. Out of this connection comes the moment of knowledge by which the experient himself undergoes a functional change. It must further be noted that the twelve categories of Chapter 2 prove inadequate for the expression of value knowledge.

2.5.8. Potential or Effectual Knowledge

Value knowledge alone does not ensure appropriate action for the attainment of that which is known as possessing value. For this it is necessary to separate again from the experience of knowledge in order to set it against the background of non-knowledge. The fifth gradation can be called either knowledge of potentialities or effectual knowledge. It produces the greatest intensity of action between the

functional centres. Whereas in the fourth gradation the knower can make a right assessment of the data presented to him, he remains closed to the hidden possibilities. The fifth gradation is an opening of himself to what might be, and hence it is connected with sensitivity. He then begins to know the ungiven as well as the given. There is in this knowledge the polarity of actual and potential that produces a force and, because the knowledge is objective, the resulting action is effectual. Until this gradation is reached, there is in all knowledge a blind spot; namely, that which is unable to see the hidden potentialities —thus obliging the subject either to infer or to guess. With the fifth gradation, potentialities may become no less apparent than actualities. Since there has to be a choice of the kind that involves sacrifice in order that out of many potentialities one event should become actual, the fifth gradation of knowledge is one of maximum tension.* It stands midway between the ultimate knowledge that is accessible only by way of revelation and the primitive knowledge that is present in every whole, irrespective of its perfection or imperfection. In effectual action there is always a step in the dark, for all the potentialities can never be known. On the other hand, where there is no knowledge of potentialities at all all action is blind. In human experience, authentic effectual knowledge is very rare, and yet, by reason of its sensitivity, it is the condition of all innovation and of all creative activity.

It must be understood that the natural order requires that effectual knowledge should be present wherever a cosmic function is to be performed. In nutrition and reproduction there is effectual knowledge of food and sex. In eating there is not only a relationship and a knowledge of existence, but also a functional adaptation that takes into account the possible transformations of food as well as the immediate experience. Thus we see that even at the fifth gradation of knowledge there are different levels, but the quality of the experience is the same throughout. It is the operation of a force that brings the actual and the potential into a sharp contrast with one another and issues in an act that is both causal and purposive. An examination of the conditions required for effectual action will show that there are always five distinctive elements present; namely, three to establish a relationship, a fourth to introduce a discrimination of values and a sense of existence, and a fifth factor that takes into account the latent potentialities.

[* Cf. Gurdjieff, *All and Everything*, p. 759. Cf. also F. H. Heinemann, *Are There Only Two Kinds of Truth?* *Phil. and Phen. Res.*, xvi, 1956, p. 378. "A priori knowledge can no longer be restricted to 'necessity', it refers to 'potentiality' and to 'probability' as well. In short the two realms of knowledge are not monomorphic but polymorphic."]

2.5.9. Cyclic or Transcendental Knowledge

The sixth category endows experience with the power of reconciling dependence and independence. Each whole returns upon itself—closing its own cycle—and, at the same time and by the same means, enters into, and becomes linked with, all other wholes completing and closing their own cycles. In passing from the fifth to the sixth gradation, knowledge transcends the distinction of actual and potential by penetrating into that region where actual and potential are incessantly interchanged and interwoven. Knowledge of this kind must always escape from the limitations of any particular experience; for the closed cycle can neither know itself nor know another, except by way of self-transcendence.

Transcendental knowledge means knowledge that cannot be given in the data of sense-experience alone. The senses do not perceive the return of cycles into themselves. Although by the sixth principle everything that exists must be composed of vibrations, the senses perceive either a movement that is not recurrent—like that of the sun across the sky, or a quality that does not move—like a musical sound or a colour.

To perceive in everything the return of cycles is to go beyond effectual knowledge into a region where the ultimate reality already begins to make itself felt. The sixth stage of knowledge is thus dominated by the end rather than by the beginning; yet it lacks one essential element by which knowledge becomes self-evident—that is, self-verifying. Everywhere transcendental knowledge makes itself felt in the mutual adaptation of cycles in every manifestation of the universal existence. It is only our ordinary human thought—remaining abstract and ineffectual—that is unaware of the universal rhythms. Even where such knowledge is apparently acquired, it is, nevertheless, abstract and subjective, whereas transcendental knowledge is direct participation in the universal return; it is the discovery of the self in everything, and the recognition of one pattern underlying all the diversity of phenomena.

2.5.10. Structural or True Knowledge

Knowledge of the seventh gradation can be defined as true; that is, directly self-verifying. At this stage, knowledge penetrates into the very structure of reality, and sees the operation of the universal laws. Here the dualism of freedom and necessity is harmonized; to know means to know all, including the place of each part in relation to the whole, its actual and potential destiny, and the means whereby the cosmic purpose

in any given occasion can be fulfilled. True knowledge is effectual not merely for the particular whole within which it is lodged, but for the ordering of the universal process. The possessors of true knowledge are themselves both creators and also regulators—able to transmit consciously all the three forces of the triad and to produce, upon the scale of their own existence, the balancing of structures.

True knowledge is not absolute knowledge nor even final knowledge, for it is limited by the level of being and the form of will with which it is associated. Any given whole can reach the limits of its own possibilities of attaining true knowledge; but in so far as it has the power of transforming its own being and of liberating its own will, it can progress beyond this limit.

It is sometimes held that consistency is a test of true knowledge. This view, however, leads to many difficulties, especially in the domains of religion and art, but also unmistakably in the realms of philosophy and science. Knowledge can be true, self-evident, and self-verifying, and yet be confined within the limits of a given whole. When it is present, the functions of that whole are completely harmonized and well-ordered. There is a complete adaptation of the inner and the outer worlds. This brings with it right action and also the power to create order and to disseminate it. Nevertheless, knowledge and power continue to be relative to that particular whole, and the corresponding knowledge in another whole may be inconsistent with it—and even contradictory. In this lies the principal distinction between knowledge and understanding; for knowledge, being an ordering of the functions only, is necessarily limited by the functions and their powers. Understanding, being a property of the will, can never be inconsistent or contradictory—either within a given whole or as between different wholes. This is expressed in Gurdjieff's aphorism: "To understand means to agree. Where there is not agreement, there is not understanding."

We may appropriately end this section by quoting Gurdjieff's aphorism of knowledge, the meaning of which can be recognized from the preceding discussion:

"To know means to know all. Not to know all means not to know. It is possible to know all, and, indeed, to know all it is needful to know very little. But in order to know this very little, it is necessary first to know pretty much."*

[* Quoted by P. D. Ouspensky in his London talks on Gurdjieff's teaching in the year 1922.]

2.5.11. Revealed Knowledge

According to the principle of structure, the step from the seventh to the eighth gradation is an act of completion that requires a fresh shock. A completion is at the same time an act of relinquishment, and the eighth gradation of knowledge is only reached when all ordinary-knowledge is laid aside and abandoned and consciousness lies open to the light of revelation. Revealed knowledge is thus possible only for a complete individual. All lower gradations of existence lack the power to recognize and to accept the revelation even if they should happen to be direct witnesses of its manifestation.

Revealed knowledge is not confined to religious experience, but may be encountered in the ordinary situations of life where there is on the one hand a sufficiently exhaustive preparation by way of functional effort, and on the other a realization that the goal is unattainable by these means. The essential feature of revealed knowledge is that it cannot be ascribed to any functional activity within the whole to whom it is given. In the moment of revelation, the barrier of separateness is broken down, and herein it is a characteristic of the eighth category which is both totality and unity.

Since revealed knowledge is habitually associated in men's minds with religious beliefs, reference to it may appear to be out of place in the study of the principles of natural philosophy. Nevertheless, it has often been observed that the progress of scientific knowledge depends upon sensitivity to a process that is not reducible to thought or sensation.*

Without revelation, there can be no consistency in the knowledge that is accumulated in the myriads of separate centres of consciousness and derived from quite independent sets of facts, arranged and ordered by separate functional mechanisms. We must therefore conclude that a full theory of knowledge can only be established when full account is taken of all the eight gradations herein discussed. It is further necessary to

take into account the influence of consciousness in determining the level of knowledge within any particular gradation, and also the form of will that imposes upon each functional order its own special form of manifestation. Bearing all these requirements in mind, it is scarcely surprising that men fail to establish a simple consistent epistemology.

[* Cf. James R. Newman, *Mathematics and the Imagination*, and the descriptions therein of the way in which the French mathematician, Henri Poincare", analysed the process of hypothesis formation: "The subliminal self is in no way inferior to the conscious self; it is not purely automatic; it is capable of discernment; it has tact, delicacy; it knows how to choose, to divine. What do I say? It knows better how to divine than the conscious self, since it succeeds where that has failed. In a word, is not the subliminal self superior to the conscious self? You recognize the full importance of this question."]

Part Three - METHODOLOGY

Chapter Six THE METHODS OF NATURAL PHILOSOPHY

3.6.1. The Method of Progressive Approximation

According to temperament, men are inclined either to hold to the old truths and suspect the new, or to make a cult of the new and despise the old. Through failing to find a middle way between these extremes, mankind is burdened with misunderstood discoveries that have degenerated into superstitions and has lost results of the greatest value achieved through the labours of the past. The dangerous belief that progress consists in replacing 'falsehood' by 'truth' is one of the chief obstacles to the advancement of true learning. The acceptance of a thorough-going relativity requires that we should always remember that we can know only partial truths, and that each fresh attempt to set up a system of universal validity is nearly always to build in the void, and the result, as the Russian proverb says, is only "To pour from empty into empty". There is a great mass of human experience extending over tens of thousands of years—including great discoveries made, misunderstood, and forgotten—and yet the latest discovery ever appears to be not only best but final.

Man already knows nearly enough to answer the questions that really matter to him, but he cannot understand what he knows and therefore he cannot use it. It is very tempting to seek for explanations of this; for it is usually possible to construct a verbal formula or a mathematical expression that will fit a variety of observations which, when dignified by the name of 'theory' or 'a law of nature', gives the illusion that a 'truth' has been discovered. The value of such theories and laws is commonly assessed by the possibilities they give of predicting the results of experiments not yet made or of enabling quantitative assessment to be made of the likely outcome of a new process. Theories are said to have heuristic value when they point the way to successful observations or experiments. The wealth of such theories—abounding in all branches of science—would appear to be evidence of a very satisfactory position and, if successful experimentation were all, we could suppose that we were making steady headway towards understanding the true character of the universe, or at least of a great part of it. We

must, however, make a distinction between the successful application of theories and the understanding of what they really mean. The former is the transition from science to technology, and the latter is the search for a valid cosmology.

Science and technology are the flower of the modern world. They have arisen through the discovery that, by attention to certain elements in experience and disregard of others, men can acquire knowledge that is effectual in increasing their adaptation to their world. This discovery has led to the method of specialization that has proved so powerful a factor in the progress of science. The spectacular achievements that can be placed to the credit of science tend to disguise the real sacrifices that such specialization entails; the actual outcome being that the more we know the less we understand. At times we are astonished and dismayed at the results of piling up knowledge, and yet we do not see what is happening; namely, that we are confusing

passive adaptation with active 'doing', and mistaking slavery to our techniques for mastery of them. Because we have prized knowledge and ignored understanding, science and technology have hitherto proved sterile so far as concerns the attainment of objective aims for the welfare of mankind.

Nevertheless, science does not lead to technology alone. It has brought to man new knowledge that can, and must, have decisive importance for cosmology; that is, for the aim of understanding himself and his place in the universe. This knowledge, however, can serve its purpose only when scientists are ready to recognize that their task is but half done when the bare facts have been established. The separation of fact from value is only a provisional expedient to simplify the first stage of the scientist's work. Heisenberg, Eddington, Schrodinger, de Broglie, and other great mathematicians and physicists of the present century have realized that pure science leads to a doctrine of values that is very close to that of revelation.* The self-imposed task of the scientist is to reduce the confused data of sense-experience to an orderly system. This he does by selecting from the data of experience groups of regularities that appear to have some significant features in common, and treating such groups as if they could be isolated from the rest of experience.+

The method of isolation and reassembly of groups of data is convenient

[* Cf. Werner Heisenberg, *Philosophic Problems of Nuclear Science*, trans. F. C. Hayes (London, 1952) p. 71: "The core of science is formed, to my mind, by the pure sciences which are not concerned with practical applications."

+ Cf. H. Levy, *A Philosophy for Modern Man* (London, 1938), pp. 33-85, for a simple exposition of the doctrine of isolates, levels of quality, and the distinction between atomic and statistical isolates.]

and even necessary, but it is not sufficient to ensure progress in the direction of greater understanding. This latter requires an evolution of meanings; that is to say, not merely the exchange of one set of signs for another but a deepening of the significance of the signs and symbols used.

For the deepening of meanings, we need to return again and again to experience and thereby to enrich the content of our language. The method is that we have called progressive approximation; for its aim is rather to discover and express the meaning of what is already known than to seek for new discoveries. When this method is followed, the new and the old are given equal significance and the task of the investigator is to select, to eliminate, and to refine; so that the meaning of what remains should be clear and, being clear, can be understood. The process is neither analytic nor synthetic. It does not consist either in drawing conclusions from what is already known or in seeking for what is unknown, but in knowing what is known. Only this can lead to effectual knowledge in the sense defined in the last chapter. This method is in some respects opposed to our customary habits of thought, whereby we suppose that it must be possible from the start to say clearly and finally anything that can be said at all. We are accustomed to regard repetition as a defect of exposition and to suppose that an experiment once made need not be repeated unless some doubt is cast upon its accuracy. Progress in thought appears to us to be made by observation and inference; that is, by moving from the known towards the unknown. We do not recognize that we never give ourselves a chance to know anything as it should be known, because, with what we have attained only partially assimilated, we turn away restlessly in pursuit of new knowledge. The method of progressive approximation consists in returning again and again to examine the same material of experience in order to search for new depths of meaning and to transform these meanings into understanding.

3.6.2. The Discrimination of Meaning

We shall use the word 'fact' to denote the content of knowledge both actual and potential. Fact for us is, therefore, all that we know and all that we could know. By making use of the connection that we have found between knowledge and function, the definition can be made independent of our private experience. If knowledge is the ordering of function and fact is the content of knowledge, then we can say that fact is the

experience of functional order.

Fact is in two respects poorer in content than experience. The content of consciousness and understanding is not fact, and even our experience of function is only fact in so far as it is reduced to order and becomes knowledge. Nevertheless, the content of all knowledge is the world of fact, and what is not fact cannot be known.* Experience teaches us that we never know a simple fact. The nature of function is such that it is complex and composite. Fact is composed of facts, and each experience of order on any scale is an atomic fact.

Let us take an example of an event in which a man draws two balls at random from a bag containing fifty, each labelled and numbered. This event comprises three moments and its actual and potential content can be represented by the following diagram:

Moment 1	Moment 2	Moment 3
Potential. Any one of 50	Any one of 49	Any one of 48 may be drawn.
Actual. Bag with 50	One ball numbered 46	17 balls. numbered 17 drawn out.
Past	Present	Future

Fig. 6.1.—Potential and Actual States.

We can suppose that our inquiry is taking place at moment 2, when the first ball is being drawn. Moment 1 is now past and moment 3 is future. The event as a whole can be known as a single fact, but it can also be known in terms of six different facts—three actual and three potential. From the standpoint of fact as we have defined it, all six have exactly the same status, although they have quite different status in terms of the sense-experience of the man who is drawing the balls. For example—assuming him not to be clairvoyant—the potentialities of all three moments are unperceived, and he is aware only of what he sees and touches. This does not mean, however, that he knows what he sees, nor does it mean that he does not know what he does not see. In either case, knowledge is not direct and immediate, but indirect and mediated by his functions. Facts are never given directly in sense-experience, for they arise only after an ordering process has been accomplished.

[* Cf. Wittgenstein, Tractatus, Section 1.]

Moreover, we can know not only the present facts, but past and future facts; we can know potential facts as well as those that are actual.

The instruments whereby we attain knowledge of fact are various. They include sense-experience, introspection, memory, reflection, inference, imagination, hallucination, and dreaming. But all facts, however they may be known, are always of the same kind. An event of yesterday is a fact in so far as we infer from memory that it occurred; our recollection of the event is another fact because we could isolate it from the first. At any given moment there are facts already completely actualized from the past, facts in the course of actualization, and there are facts with the potentiality of actualization in the future. Tomorrow's sunrise is a fact, although it has not yet been actualized, and may even not be actualized if in the meantime the earth should happen to be destroyed. Mirages in the desert are facts and so are the castles in Spain of our fantasy. Even the wildest ravings of delirium are facts, for they can be known. Again, twice two is four are a fact, even though there may be no particular event, potential or actual, to which the statement refers.

In the domain of fact there is a twofold multiplicity. There are many knowers of fact and there are many facts known. No one knower knows all facts; of this we can be certain. It is also probable, but not certain, that no one fact is known to all knowers. Moreover, what is a fact for one knower may either be a different fact for another or even can be no fact at all. Hence, with fact there arises always the problem of communication.

Three conditions must be fulfilled in order that an item of experience should qualify for designation as fact:

- (a) It must be experienced,
- (b) It must be functional in character, and (c) It must be known.

The last requirement distinguishes fact from function in general and makes fact relative to a particular experience. It is not legitimate to say 'so and so may be function, but it is not function for me'; but it is quite legitimate to say 'so and so may be a fact, but it is not a fact for me; for it has not entered my experience and I do not know it'.

If, however, I say 'so and so is a fact but it is not important', I am making an assertion that is more than factual—I am giving expression to a judgment of value. 'Important' is a value word and its meaning is relative to a state of consciousness. We can easily verify that our judgments of the importance or unimportance of any element of experience varies according to our state of consciousness. It has very little to do

with the functional content of the experience itself. There is hardly any functional manifestation that at one moment may not seem important and at another unimportant. We must therefore conclude that values cannot be known. This agrees with their ascription to the element of consciousness in our experience.*

The study of values must be divided into two distinct domains. In one we seek an answer to the question 'What are values?' and in the other we seek to answer the question 'What does the word ought mean?' This corresponds roughly to the subject-matter in Kant's two Critiques of Judgment and of Practical Reason respectively. The former question must be answered in terms of being and consciousness, and the latter in terms of understanding and will. The first may be called aesthetic and the second ethical. To deny that there can be either aesthetic or ethical knowledge does not put an end to the search for values, nor does it deprive practical life of its meaning. So long as our attention is directed only towards the functions, we cannot expect to discover anything beyond the facts. But, in spite of ourselves, we continue to make judgments of value and to feel ourselves subject to an ethical demand.

The standpoint of logical positivism is justified in so far as it asserts that we can never know either what is valuable or what we ought to do. + We can be conscious, however, of what is valuable and we can understand what to do. We can never make a sharp, unambiguous distinction between fact and value, because neither pure fact nor pure value can be experienced separately. Hence, philosophic discussion about the relations between the two has almost invariably an artificial and unsatisfying flavour. It is very convenient to be able to study being without reference to functional activity, but we must not be led into the error of supposing that function and being can subsist one without the other. When we meet with problems of value, we cannot do without

[* Philosophers find it hard to decide whether value-words are concerned with knowledge or with emotive or conative states. Those who reject the view that we can know what is important usually believe that the foundation of moral philosophy or ethical theory is destroyed by such rejection. There are several errors in such an opinion. One error is to regard cognition and emotion as antithetical. Thought and feeling both belong to function and are forms of knowledge, even though feelings cannot be fully expressed as propositions. Cf. 'Moral Theory, Ethical Judgment and Empiricism', contributed by S. Cavell and A. Sesonske to *Mind* (1952), Vol. LXI, p. 543.

The dispute between cognitive and non-cognitive theories as to the character of value-judgments demonstrates that we are not dealing either with pure experience or with pure knowledge, but with the undefined territory that lies between experience and fact.

+ Cf. H. Reichenbach, *The Rise of Scientific Philosophy*, p. 277.]

knowledge; but to resolve them we are compelled to go beyond knowledge. If all our experience could be described in functional terms—and therefore known—the advance of knowledge might ultimately provide us automatically with the means of answering any and every question. It is just because the questions that touch us most deeply cannot be answered in terms of knowledge alone that we are compelled to add a new dimension to our inquiry. In order to find this, we must return to experience.

The 'important' is that which we cannot know because it is by its very nature unknowable—it is value and not fact that really matters. Saurat, indeed, adopts the extreme position that to know anything deprives it of value, and that faith in God is only significant because we are incapable of 'knowing' that He exists.*

Values are associated with interest, and interest depends upon potentiality and the ability to adjust the actual and the potential to one another. When an event is a 'foregone conclusion', it ceases to be interesting. A situation in which there were only one potentiality would be devoid of values. Conversely, we can say that the greater the wealth of potentialities inherent in any element of experience, the more do we feel that it demands of us a judgment of value. To a first approximation, we can say that when experience is regarded from the standpoint of its actual content, we discover facts, and when it is regarded from that of its potential content, we discover values.

Facts make no demands upon us and values make a demand that we are powerless to satisfy; for the character of values is such that the realization of one must involve the sacrifice of another. Values and facts can be regarded as the affirming and denying elements that, unless reconciled, produce only the polar force of frustration and dissatisfaction. We may use the word meaning to designate that which reconciles fact and value, provided that we remember that this use requires that meanings should be associated rather with will than with consciousness or function. We must recognize also that this interpretation of the word 'meaning' implies that values in the absence of fact mean nothing. A world of pure value must collapse into a dream of unfulfilled potentialities, just as a world of unrelated fact could only be a dead world. Always and in everything there is a need to reconcile not only fact and value but one level of values with another. In the domain of fact there is incoherence; in that of values there is a conflict of loyalties. The discovery of meanings on each scale and every level

[* Cf. D. Saurat, *Death and the Dreamer* and *The Three Conventions* (New York, 1926).]

is the task of the understanding. The present use of the word 'meaning' is consistent with that adopted in Section 2.4.2. where it was defined as the recognition of a recurrent element in experience; for, as we shall see later, recurrence is characteristic of the reconciling element and recognition depends upon the combined action of value and fact.

A meaning is something different in nature from either a fact or a value. We do not know meanings, and we cannot experience them consciously. This is why, as we have seen in the study of language, the communication of meanings is itself a triad in which the sign, the symbol, or the gesture serves to transmit the act of will. In the evolution of language, the starting-point is the communication of knowledge; but the aim of language is to achieve a transmission of meanings. In the inner experience of an individual there is a similar transformation, that begins with the mutual liberation of consciousness and function but leads towards understanding of what the experience means. We use such terms as 'natural', 'authentic', and even 'real' to indicate that we recognize a meaning in a given experience, and such words as 'spurious' and 'illusory' to indicate that a given expression does not mean what it purports to mean. We also use words such as 'true', 'false', 'beautiful', and 'ugly' in an attempt to convey meanings. Reflection will show us, however, that the meaning of anything is to be what it is. The more a given entity is able to be itself, the more meaning does it acquire. 'Ugly', 'beautiful', 'true', 'false' are terms that convey meanings only when they are set in a stable context of recognized facts. Nevertheless, they are value words and therefore relative to being. Truth is significant not as a criterion of knowledge nor as a quality of experience, but as something that reconciles the two. Beauty may be a 'pure' value—this we shall examine later—but the meaning of the word cannot be

found except in a context of fact.

3.6.3. Phenomena as Primary Data

'Pure' knowledge divorced from being and will is an abstraction that has no place in any possible experience. A similitude of such 'pure' knowledge may be given by a well-arranged card-index, locked away in some cupboard and forgotten by its owner. Every concrete experience is a blending of function, being, and will; and if, for some reason, we need to study any one of the three separately, we can best do so by placing ourselves in a perspective that will reduce to a minimum the relative significance of the other two. When, for example, we concern ourselves with the problem of knowledge, we are almost bound to make a compromise that consists in separating the functional

element in our experience and treating it as if it could exist by itself. For experience as seen from the perspective that minimizes the distinction of being and will, we shall use the term phenomenon.* Fact is then to be seen as the result of reducing phenomena to knowledge. The fact is thus, roughly speaking, all that we can know and the phenomenon is all that is present in a given state of consciousness. In order to 'know' what is present—the fact—it is necessary to eliminate from phenomena all non-functional elements. It follows, therefore, that the content of knowledge must be less than the content of phenomena.+

The reduction of phenomena to facts is an example of the method of progressive approximation, which alone is consistent with the retention of meanings. Phenomena are the raw material of knowledge. They include inner as well as outer experience, memories, mental associations, and the awareness of feelings and organic sensations. The unobservables that we can only infer from sense perceptions are no less phenomenal than the sights, sounds, and other impressions that relate us to material objects outside our own bodies.

We have defined experience as the totality of the given, independent of any particular centre or state of consciousness. Phenomena are experience referred on to a specified mode of consciousness; namely, that of a normal human being. The phenomenal world is the world that presents itself to an ordinary man in his normal states of consciousness, prior to any discriminations of fact and value. By 'normal' is implied that we exclude hallucinations and fantastical inventions that are not susceptible of verification by observation or experiment. A 'normal state' is one that can be reproduced and studied and, where needful, measured and expressed in quantitative terms.

[* Kant's distinction of phenomenon and noumenon turns upon sensible and non-sensible intuition. This introduces a dualism that can scarcely be reconciled, for 'either sensible or non-sensible' seems to exclude any middle term. Nevertheless, Kant realized that the term 'noumenon' could be used in different ways. Subsequent interpretations have been concerned mainly with his negative doctrine of the thing "so far as it is not an object of our sensible intuition". He says, however, "but if we understand by it an object of a non-sensible intuition, we thereby presuppose a special mode of intuition, namely, the intellectual, which is not that which we possess, and of which we cannot comprehend even the possibility. This would be 'noumenon' in the negative sense of the term" {Critique of Pure Reason, p. 268}.

+ The mundus sensibilis—if by this we understand the whole that is given in immediate experience—is richer than the mundus intelligibilis—if by this we mean that which is given coram intuitu intellectuali, for our intellectual intuition is, in the Kantian sense, subject to the categories. On the other hand, the noumenon in what Kant calls "the positive sense of the term" is more than that which is given in immediate experience, for it is not subject to the limitations of the particular form of consciousness present.]

3.6.4. The Place of Values in Natural Philosophy

Addressing ourselves to the study of fact, we tend to assume that it is not legitimate to search for answers to the questions of 'whence', 'whither', or 'why'. This procedure proves to be convenient and effectual; but we

must be on our guard against the fallacy of supposing that a true conclusion entails a valid premise. Fictitious and conventional distinctions can be useful as instruments, but their use is legitimate only so long as we keep clear of situations where they themselves enter into the subject-matter of our inquiry. The task of natural science is to deal with fact, and it is entitled to put aside questions of value; but this does not justify the denial that such questions are significant.

We must be wary, however, when we set about circumscribing the field of our inquiry. By failure to pay attention to possible defects of language, we may overlook significant distinctions and so invalidate our findings. It may be easy to describe facts, for they lend themselves to classification in terms of observed regularities; but the very generality of some of our conclusions is deceptive, and we must understand why this should be so. The methods we commonly employ for dealing with facts are complicated, but on the whole they are successful. They all have one feature in common, namely, they start by eliminating distinctions that arise by way of consciousness. Such elimination is necessary, for without it we should be involved in contradictions, since there can be simultaneously present in our experience two different states of consciousness, each of which is aware of an apparently different set of facts. The resulting contradiction may take the form of inattentiveness, so that we do not notice that we are not doing what we intended to do. When such a situation arises in the course of a scientific experiment, we regard it as a failure and make a fresh start. Scientific observation and experiment, by which we seek to extend our knowledge of fact, are conducted on the assumption that everything has been done to minimize any effects that may be due to changes in the state of consciousness of the observer. Even the positive attitude towards consciousness as a factor in judgment is treated with suspicion by most scientists.* Even

[* Cf. R. G. Hopkinson, 'Factors Affecting Choice and Judgment', in *Nature* (1952), p. 556: "The attitude of the general science graduate to experiments involving subjective judgments is curious and illogical even if understandable. He is taught, throughout his study period, to believe that those things which he measures during the course of his 'practical work' are facts, inviolable and true. His faith in them transcends the faith of religion. Above all, he believes the dogma of Kelvin that we must measure in order to understand. He rarely succeeds in grasping the principle of uncertainty in physical measurement, and many years may pass before he realizes that all measurement demands a judgment on the compromise between accuracy and expediency. As a result, he dismisses all experiments which involve direct subjective judgment as being 'vague and inaccurate'. This dogmatic attitude is not confined to the young graduates."]

where subjective judgments are unavoidable, the influence of the state of consciousness is reduced as far as possible by multiplying observations and using the method of statistical reduction.

When we pass from the general assessment of scientific data—that is, of facts—to the actual conduct of an experiment, we see that even the observation of phenomena is impossible without value judgments. A scientist wishes to establish facts and often claims that he does so without any judgment of value. This is self-deception, however, for success in scientific investigation depends upon choosing a field of experimentation likely to give interesting and 'valuable' results. Even when the experiment is decided upon and accurate observation becomes the principal aim of the worker, the separation between fact and value is still impossible—even in the very procedure that seeks to make it. When discordant observations—attributable to carelessness or faulty experimental procedure—are noted and set aside, he is making judgments of value and not of fact. Even in this negative sense, value is experienced as interest, curiosity, desire, and so forth. These impulses make themselves apparent through their influence upon our attention. We attend to what interests us and, in attending, our state of consciousness changes. In a wider sense, value is discovered when we can stand aside from the data of immediate sense-experience and survey the whole scene against past and future events. In the highest sense of all value is experienced *sub specie ceternitatis*. For such a level of consciousness there is no separation of knowledge, judgment, and decision, and therefore it corresponds to the attainment of objective reason. Our ordinary consciousness can only separate fact and value to the extent of its limited powers; it sees the phenomenal world only, and even that incompletely.

Wholeness is relative. In our limited experiences we never find wholes that are perfectly integrated. Wholes are also structures, and we never find them complete. Because of imperfection and incompleteness, there is always an element of bewilderment in our attempts to make sense of the world about us. This bewilderment alternates with wonder and admiration as we discern beyond the immediate confusion the outlines of the universal pattern. The bewilderment and the wonder are equally valid elements in our experience; they are like the poles of a magnet that serve to orientate us towards understanding. From our experience of chaos and cosmos, we have to forge the instruments by which we can raise ourselves to the perspective of objective reason. There is nothing obligatory about such methods; for some purposes, and under some conditions, one method may prove more convenient than another. It

will be found that the methods that are suitable for dealing with fact are, on the whole, inappropriate for the study of problems of value. The selection of methods sometimes can be subjective and even quite arbitrary, so that one which works well for one man will not suit another. Thus, although we can prescribe methods of procedure that will prove useful for our future inquiry, they must not be taken as either comprehensive or suitable for all purposes.

3.6.5. The Homogeneity of Fact as a Basic Postulate

Unreflecting sense-experience, when reduced to order, gives rise only to very limited forms of knowledge. The possibility of a transition to knowledge which is universal, valid, and applicable depends upon the discovery—by reflection—of the categories. Our knowledge of the categories is fact, but it is fact of a very special kind—namely, fact harmonized with value and meaning. The achievement of this harmony is the goal of the work of progressive approximation. At an early stage in this work we acquire the conviction that fact is a system. This conviction enables us to formulate the basic postulate of the homogeneity of fact. We can thus establish a firm basis for our reasoning, and can regard fact as one realm, any part of which can be reached by means of an operation of a kind we already know how to perform. It is one of the principal tasks of natural philosophy to examine the implications of this postulate, and to apply it to the extension of our knowledge of fact beyond the limitations of our own immediate awareness. This task cannot be performed by attention to fact alone, for it needs constant appeal to meaning in order to select from the endless presentations of experience those phenomena that can best enrich our knowledge.

The progress of science consists in finding improved means of passing from phenomena to facts. This progress is sometimes deceptive; for phenomena are pregnant with data—set moving by a good hypothesis—which must be marshalled and controlled. Thus the formulation of a scientific theory is comparable to opening a gate in a crowded sheep-fold. At first one or two bold ewes tentatively venture out; others follow, and in the end the exodus becomes a scramble, and both shepherd and sheep-dog are needed to control the flock. The temptation to multiply knowledge of fact is aggravated by the aim of achieving 'practical results'. We do not notice that knowledge of fact does not add to our understanding of phenomena, but merely serves to increase our adaptation to the functional mechanism of the world in which we live. This adaptation we are pleased to call 'control of nature', not

noticing that it can equally well be described as 'control by nature'. Knowledge brings us into gear, but it does not set us free.

The problems connected with the transition from phenomena to fact are the subject-matter of natural philosophy, the task of which is to ensure that we realize the significance of the passage from experience to knowledge. Even with the simplification gained by confining our attention to the experience of ordinary consciousness, the task of reducing the data of natural science to a single scheme grows more difficult year by year. There is a vast, incessant increase in the volume of data that constitutes our knowledge of fact. This is due in part to the systematic recording of sense-experience, and in part to the use of some apparatus that serves to extend observation far beyond the immediate delivery of the human organs of sense. Indeed, the quantity and variety of facts that have been discovered are so great that in the present century scarcely any

attempt has been made to build from them a single structure that could be called 'knowledge of the phenomenal world'. In default of this, order is sought within various limited fields. This procedure works remarkably well in so far as we are content to specialize, but it tends to divert our attention from phenomena and to make us believe that fact is somehow directly given to us in our experience. Any suggestion that there could be a single structure in which all knowledge would find its place is distrusted by scientists who bear in mind the failure of the 'system builders' of the last two centuries, the discrediting of speculative philosophy, and the dominating position that analysis and criticism have recently acquired—all of which situations are mainly due to a limitation, introduced almost unnoticed, in the transition from phenomena to fact. This limitation consists in the assumption that cause and purpose are somehow discovered in our sense-experience. Facts are usually described in terms of a process in time, and these descriptions can scarcely avoid the use of the language of causality and purpose. Indeed, these notions are so deeply embedded in our ordinary language that it is hard to express ourselves, or even to think, without making use of them.

In the twentieth century, natural science—by the sheer momentum of discovery—has weakened belief in much that was formerly regarded as solidly established truth. New discoveries have opened two lines of philosophical inquiry. One follows the old method of specialized hypothesis that enables phenomena to be described and dealt with as facts, and these in turn to be used for the purpose of technological advance; the other explores the hazardous no-man's-land that lies between phenomena and facts. The latter is dangerous ground for those

theorists who believe that safety lies exclusively in the methods of observation and analysis. The experimental scientist, however, must needs remain in the danger-zone; for it is here that phenomena reveal themselves. Thus arises the recurrent misunderstanding between theoretical and experimental scientists; although in some branches of science it has already been found necessary to admit new facts of a kind that do not conform to the old rules of logic and cannot even be adequately expressed in words.

In the past—in consequence of the uncritical adoption of certain loosely formed assumptions—scientists developed the habit of regarding the discovery of special regularities in a limited field as somehow more respectable and praiseworthy than the recognition of general principles—branding these as 'metaphysical'—and preferred to direct attention to what they called 'generalizations' from observation and experiment. Since generalization in any form means going beyond immediate experience, the legitimacy of such a procedure can only be taken for granted. More recently, however, scientists have come to recognize that an uncritical attitude towards general principles is not only bad philosophy but bad science. They have realized that many universal principles that formerly were accepted as having universal validity have subsequently proved incompatible with observed facts. For example, the natural philosophers of the nineteenth century in no way questioned the principle of continuity—*natura enim in suis operationibus non facit saltum*—which appeared to be experimentally established for ever by the work of Joule and Kelvin. Perhaps the greatest shock to the complacency of physical scientists came with Planck's demonstration that upon the atomic scale there is discontinuity—nature does, in fact, operate by jumps. The principle of uniformity—which likewise was taken for granted in the nineteenth century—led to the wild-goose chase after mechanistic explanations of all phenomena, including those of life and consciousness—a chase of which physicists and biologists alike have begun to weary.*

3.6.6. The Postulate of Universal Similarity

According to the principle of structure, a single pattern underlies all

[* Cf. The International Encyclopedia of Unified Science (1938). Unified science, as advocated by Neurath and others, seeks to reduce all explanations to a single level of existence. Margenau remarks: "Characteristically, the proponents of the Unified Science movement picture science as a kind of surface, as a two-dimensional structure. They are fond of calling it a mosaic, a picture-puzzle into which the missing pieces must be skilfully fitted." He very rightly comments: "It will never do to picture science as a two-dimensional

surface; by ignoring its depth, we falsify its nature." *The Nature of Physical Reality* (New York, 1950), p. 19.]

the diversity of phenomena. We cannot understand this principle nor fully grasp its meaning. Relying upon the method of progressive approximation, however, we can permit ourselves to be bold enough to formulate a postulate based on this conception even before we can understand or apply it, because we have an intuition of its truth that is deeper than the contradictions of our more superficial experience of phenomena. This we may call the postulate of universal similarity. As a practical measure, we can employ the postulate, a rule to be applied in the reduction of phenomena to facts. It is according to this postulate that we make the assumption that the correspondences we recognize are all partial manifestations of one universal pattern. We must seek, therefore, to penetrate more deeply than is required for the discovery and clarification of universals. We soon find that indiscriminating knowledge, as expressed in the common forms of language, always implies, though usually without recognizing that it does so, a universal similarity.

Natural science has to make basic, that is, metaphysical, assumptions as to its subject-matter, but seeks to justify these assumptions by appeal to experience. It remains true, however, that it is not sense-experience alone that assures us of the uniformity and continuity of phenomena. On the contrary, we find a heterogeneous and discontinuous stream of impressions. Similarly, in our inner world we discover an equally heterogeneous, and not less discontinuous, stream of automatic associations.

We are accustomed by long habit to interpret our sense-impressions as material objects and their behaviour, and our associations as thoughts and thinking. But behind these interpretations lies an assumption as to the structure of both the one and the other that requires an act of faith. We believe that nature does not play tricks upon us, and also that our automatic associations are mostly related to our sense-impressions. We also are forced to make the assumption that memory is more or less reliable. Through making these assumptions uncritically, we tend to overlook the disorder and complexity of our immediate experience.*

Nevertheless, natural scientists in the eighteenth and nineteenth centuries were not wholly at fault in the procedures they followed. Their error consisted in a mistaken belief in the adequacy of their methods and the finality of their judgments. The search for universal laws was made on the assumption that these would prove to be simple and

[* Cf. H. H. Price, the symposium of the Aristotelian Society on the Causal Argument for Physical Objects (1945), p. 92. Price criticizes the appeal to direct experience, which he calls 'sensibilism', saying, "I think he (Dr. Ewing) underrates the complexity and the untidiness of the sensibilistic worlds"; and adds, "The more complex nature is, the better I like it."]

expressible in terms of human knowledge. Newton's laws of motion were regarded as a foretaste of laws even simpler and even wider in their scope. There was in these centuries a strange disregard of the phenomenon of contingency and a consequent refusal to accept uncertainty as an element of fact. That science made great progress notwithstanding this refusal is due to an unconscious reliance upon the rule of universal similarity. The doctrine of Lord Kelvin that measurement is the sole source of reliable knowledge cannot be accepted without criticism, but it has, nevertheless, a solid foundation in the principle of universal similarity. When we make the assumption that a foot-rule remains the same whether we apply it to measuring either a wall or a length of cloth, we are invoking this principle. Scientific induction has, indeed, no justification beyond the delivery of our experience that similar situations do recur. These examples are sufficient to show how widely the characteristic of universal similarity casts its net, and how it can serve to knit together many of the assumptions without which natural science could not work. When applied with due care—that is, having regard to what we find in our experience—the postulate of the homogeneity of fact and the rule of universal similarity can provide a solid basis for the unification of the sciences.

It has become increasingly clear that observation cannot be divorced from the observer. This realization has resulted in a return to phenomenalism as opposed to objectivism in science. But the real significance of the

change in attitude has not yet been generally grasped. We revert to phenomenalism because we find that we are unable to disregard the elements of being and will that are present in every moment of experience, and that this discovery points to the direction in which the unification of the sciences is to be sought. It is obvious that, so far as attentive observation is concerned, we have to take into account the role of consciousness in perception. The difference between one scientist and another lies largely in the ability to 'see' the phenomena they observe. Phenomena are not historical; they are, and have always been, there for experience. Fact is historical; it is the accumulated result of man's reduction of phenomena to the status of knowledge. Each significant step in the history of fact is made by recognizing a contradiction. The mediocre scientist sees only the same facts, for he is adapted to this limitation by his knowledge of what the experiment he is making should yield and this blinds him to that which is actually present. The scientist of genius sees that which contradicts the present fact; that is, the phenomena itself.

This is not all, however, that is involved in the direct perception of

phenomena; the form of will present in the observer must also be taken into account. Experience teaches us that not only may two scientists see different and apparently contradictory factors in the same situation, but they may also perform different experiments, based on these opposing views, in order to unmask the phenomenon. The great scientist is not the one who knows the fact but the one who has the will to change it. This is true experimentation, and it is very rarely attained. Even the scientist of genius, however, selects his experiment 'as he must'; that is, according to the form of will that is present in him and that he himself is unable to change. He is always guided consciously or unconsciously by his feeling for universal similarity.

3.6.7. The Postulate of the Stratification of Existence

Selection in the course of reducing phenomena to facts would be a practically insoluble problem if we had no means of distinguishing classes of phenomena that can be assigned to the same gradation, or level, of existence.* The postulate of the stratification of existence provides such a means. By the principle that wholeness is a single-valued property, all existence can be divided into strata lying between the distinct levels of the intensity of inner-togetherness, and to each stratum may be assigned a numerical value according to a single scale—the universal scale of being.+ This principle alone would not suffice to enable us to decide whether a given entity should be assigned to one or another given stratum, if there were not also a principle of separation deriving from the principle of polarity.

Furthermore, the strata must be interrelated; for otherwise we should have to treat existence as constituted by a series of closed systems and therefore as incomprehensible. The stratification of existence, however,

[* The doctrine of levels of existence has been familiar to European thought since Aristotle constructed the first scale of being. The idea has been made explicit by MacTaggart in *The Nature of Existence*. He wrote: "If there are two varieties of thought of which one is higher and more comprehensive than the other, it will be impossible from the nature of the case for the lower and narrower to be directly aware that the higher is valid. From the very fact that the higher will have canons of thought not accepted by the lower, it must appear invalid to the latter, which can only be forced to accept it by external and indirect proof of its truth."

Needham has applied the idea of levels to organization (cf. *Time the Refreshing River*). The important thing in all these conceptions is that the series of existents is recognized as having an order from a lesser to a greater degree of integration.

+ The concept of a scale of being can be traced back to the Chaldean cosmologists from whom it was brought to the west by Anaximander and Anaxagoras. Its history can be traced through Plato, Aristotle, Albertus Magnus, Lamarch and Geoffroy. Though now discredited, it was revived in a new form by Bergson, Alexander, and Lloyd Morgan. For an excellent account, see E. S. Russell, *Form and Function* (London, 1916). Cf. also Gurdjieff, *All and Everything*, p. 757.]

has the peculiar quality of that although each stratum is closed to the others, yet it is only relatively so. The closure of the strata can be called statistical inaccessibility—statistical in the sense that there is only a very small probability that an entity existing upon one level, while remaining what it is, will be transferred to exist upon another. This situation can be expressed by a rider to the postulate; that each cosmic stratum, is statistically inaccessible to all other strata*

The stratification of existence enables phenomena to be studied with reference to particular forms of order, without taking into account the general disorder or the presence of other forms of order. In this manner there arise the different branches of science, each of which has as its subject-matter a defined stratum of existence. Hitherto natural scientists have not directed very serious attention to the problems concerned with the relationship between different strata, but have confined their efforts to elucidating the factual laws operative on each level.+

The laws that govern the relationship between strata are not wholly factual but involve relationships of value. Through the method of progressive approximation, however, it is possible to establish a general scale of existence in the first place, and thereafter to clarify the relationship between levels. Such clarification is mainly concerned with meanings, and it therefore goes beyond the strictly limited task of reducing phenomena to facts.

3.6.8. The Postulate of Complementarity

The connection between the odd and the even numbered principles shows that neither series can be understood without reference to the others.++ We have seen an example of this in the need to bring into account both wholeness and polarity in order to formulate the postulate of the stratification of existence. Universal similarity can be recognized

[* Cf. J. W. Gibbs, *Elementary Principles in Statistical Mechanics*. 'Statistical Inaccessibility' is a conception borrowed from Gibbs's treatment of the energy distribution in systems having a very large number of components. The canonical distribution $C \rightarrow A_0 \rightarrow E/O$ occurs when different levels interact, but only to a very small extent.

+ Cf. J. Needham, loc. cit., Lecture XX, vi. 'Levels of Organization': "What has not yet been done, however, is to elucidate the way in which each of the new great levels of organization has arisen. It must always be remembered that though we can chart out quite fully the laws existing at a given high organizational level, we can never hope to understand how they fit into the picture of nature as a whole; that is, how they join with the next higher and next lower levels."

Quoting this passage, Kostler contends that Needham writes with "unconscious irony"; for that which has not been done was the primary aim of scientific explanation. Both miss the point; namely, that legitimate abstraction is the foundation of natural science, but that natural science is only an abstract discipline and that its apparent concreteness is fictitious.

++ See Chapter 2, p. 34.]

in the principle of structure, but other principles also must be taken into account. The ancient saying of Democritus, "The way up is the way down", can be restated as the postulate of complementarity, according to which it is, in everything, necessary to confront opposing views in order to arrive at meanings. We have already seen this in the relationship of fact and value. It appears in the realm of fact in the opposition of the dynamic and static aspects of experience formulated in the odd and even numbered categories.

There is a very difficult but at the same time necessary discipline that consists in regarding every situation as both an affirmation and a denial; every movement as both a rising and a falling; every process as both a

concentration and an expansion. It is this last antithesis that requires our special attention here, and we can see it best by reference to the principle of structure. Structures enter our experience in different ways, according to the perspective of space and time. A structure in space—such as a full-grown tree—is perceived as a whole, and its pattern consists in the arrangement and connection of the different parts: roots, trunk, branches, leaves, and so on. An event—such as the growth from the acorn to the oak—is experienced successively in time, and we have to penetrate beyond immediate sense-experience in order to recognize the event as a unity. There are also unified structures that are not experienced in time and space; as, for instance, a system of classification or organization. The periodic table of the elements and the diatonic musical scale are examples of unified structures that do not depend upon any arrangement in space, nor upon successiveness in time. There are also structures that we experience, but can neither relate to space and time nor bring into any abstract logical scheme. The essential nature of man, with his inherent potentialities, is an eternal structure of this last kind.

Structure is indeed so fundamental that in our experience it is prior even to space and time. That this is so must be recognized if we are not to be misled by the great differences apparent in structures when they are seen from the perspective of temporal actualization. Events in time present various recognizable features. For example, there are conservative events, such as the persistence of a material object; there are cyclic events, such as the swinging of a pendulum; there are movements of expansion, such as the growth of an acorn to a tree, and there are the movements of concentration, such as the coiling of a spring. In each of these examples the same fundamental principle of structure is exemplified, but in different ways. The movements of expansion and concentration require special examination, because of their importance for any understanding of complementarity. Concentration is a process

whereby a higher gradation of energy is selected by a given whole, and lower gradations are rejected. It is the essential pattern of life itself, but it also is present wherever there is the building up of potential energy in either organic or inorganic matter.

If we return to the example of the acorn growing into a tree, we can see that the movement of expansion was preceded by a movement of concentration, whereby the genetic factors of the parent were stored up in the seed. In this process lies the difference between potential and actual. That which has become actual and perceptible has to that extent exhausted its hidden potentialities. Expansion is therefore a movement from the invisible towards the visible, whereas concentration is the return towards the hidden potentialities that are preserved uncorrupted in the eternal source. A simple example of this alternation from invisible potential to visible actual, and vice versa, is to be seen in the swing of a pendulum. Expressed in terms of observability, we can say that all the energy is observable at the moment when the velocity is at maximum—at the bottom of its swing—this is the state of visible energy. At the moment of rest at the top of its swing there is no visible motion, no momentum measurable by the force of impact against another body—the energy is invisible, latent but potent.

Where the process is cyclic, the net outcome is that things remain as they are. Cyclicity alone, however, does not disclose the full significance of the interplay of concentration and expansion. We must therefore look for situations where the two movements can be separated. This separation can be seen in a building up of potential through such an act as heaving a boulder to the top of a hill. The potential built up or concentrated in the boulder can be preserved indefinitely until, for some cause extraneous to itself, it is dislodged and is set rolling to the bottom. In this case, the two processes of concentration and expansion are separated from one another in time. There is no cyclic renewal as with the pendulum, for all the energy of motion is wasted in friction and dissipated in vibrations of heat and sound. Heaving the stone up the hill is an event with its own structure in time. The same structure is reproduced in the opposite direction when the boulder rolls, but with the essential difference that the second process has only to be started and afterwards goes by momentum, whereas the first continues only so long as hard and unremitting work is put into it. This can be expressed by saying that the upward process is reversible but the downward is irreversible.

At first sight it does not appear that every process of concentration conforms to the pattern of 'hard, unremitting work'. Nevertheless, when we look more closely, we can see that concentration is always realized at the expense of the environment. When the oak produces a seed, there is withdrawal of biochemical complexes of high potency from the sap and the surrounding tissues, and these in turn depend upon the extraction of nutrition from air, water, and earth.*

In the process of expansion, causal and statistical laws predominate, The system moves towards its most probable—that is, determined and therefore most stable—state. When in this static condition it has the lowest potential and therefore the least possibility of giving rise to any higher form of order. Concentration, on the other hand, is a movement towards an improbable state—one that is therefore of high potential—in which an unpredictable element enters the situation. Concentration is potent because its trend is against the stream of expansion—or probability—and so 'it can get somewhere'.

According to the principle of complementarity there can be no unbalanced cosmic dyads—that is, pairs of opposites that have a universal character. Expansion and concentration are a typical pair that can be understood only if they are balanced in all processes. The peculiar feature of complementarity is that it is neither observable as a process nor unobservable as a potentiality. Such dyads as the particle and wave dualism of electrons and protons illustrate this peculiarity. Complementarity is the source of coherence by which the balance of existence is preserved. To express this property we shall adopt the term 'hyparxis', which is usually translated as 'subsistence' or 'existence', but which in its original meaning signified the ableness-to-be.+

3.6.9. The Postulate of the Universal Validity of Framework Laws

Knowledge of fact is the first aim of the natural philosopher, but his

[* Many authors have discussed the relation between life and the second law of thermo-dynamics. Schrodinger, in *What is Life?*, described the living organism as] "sucking negative entropy from its environment". Professor Luigi Fantappie, in *Principi di una Teoria Unitaria del Mondo Fisico e Biologico* (Rome, 1945), distinguishes between syntropic and entropic processes and seeks to show that they are to be found equally in the living and the non-living. He recognizes that the two processes do not always occur in succession—producing cycles analogous to that of the pendulum—but that each kind of process can come to and end without starting one of the other kind].

† Aristotle introduced the term *ὑπαρξις* to mean the power to exist as distinct from *οὐσία* for existence itself. Cf. *An. Post.* 98a. 33, *ἐκαστος μὲν ἐπὶ αὐτῷ ὑπαρξῶν*. Also in the *Metaphysics* cf. Edn. W. D. Ross (Oxford 1924), p. 215, 1042a, 9-15, where it is clear that *ὑπαρξις* meant for Aristotle the ableness of a given animal to approach the ideal existence of its species. The Neo-Platonists—Proclus in particular—appear to have used the term with something of the significance that we wish to ascribe to the intermediate determining-condition. See Taylor's *Commentaries on Proclus*: "Everything subsists in its own order according to *hyparxis*."

ultimate goal must be the understanding of meanings. In order to perceive and to communicate meanings, it is necessary to generalize in a manner that is uncalled for in the ascertainment of facts.

In order to generalize, we require to adopt various rules for passing from the known to the unknown. If such rules are to be effectual, they must have universal significance. All such rules can collectively be described as the laws of framework, and, since they serve for the ascertainment and communication of meanings, they must be connected primarily with the will.

Although will cannot be known, it enters every phenomenon as the laws that determine its possible and impossible actualizations. Phenomena correspond to those levels of being where there is little independence

of the environment. Consequently, the laws by which they are governed are, for the most part, not concerned with individual behaviour but with the regularities observed in large numbers or in cyclic situations, which together constitute the laws of nature. Just as function is most easily studied by eliminating as far as possible distinctions of being, so with will we can best discover regularities by starting from the lowest level of being where the inner-togetherness of wholes plays little or no part. In this way, laws are discovered which are independent of the gradation of wholeness and must therefore be applicable throughout the domain of fact. These laws differ from scientific generalizations by reason, of their pervasive character, which can be expressed as the postulate of the universal validity of framework laws. Framework is the form in which we experience phenomena. Phenomena have spatial arrangement and they succeed each other in time. Space and time are framework properties; they are neither behaviour nor existence. There are, however, universal regularities that are not bare configuration and successiveness. Time itself is also conservative and irreversible. Space has determinations of size and direction. These are not the only kinds of universal determinations to which all phenomena are subject. Nevertheless, whatever the restrictions may be, they can all be grouped in classes according to their properties; but when they are so grouped, we find that certain rules must be observed if we are to make statements that correspond to experience. These are the rules of logic, which remain valid irrespective of the kinds of wholes to which they are applied. Finally, there are regularities connected with the co-existence of potentialities; for example, the rule that the higher potentiality implies the lower, but not vice versa* All the regularities of an universal character that do not depend upon any given gradation of wholeness can be called

[* Cf. MacTaggart's 'A-B-C-D Series' elaborated in *The Nature of Existence*.]

'framework determining-conditions'. The chief characteristic of these conditions is that experience never fails to conform to them—at any rate, upon the level of phenomena accessible to our ordinary states of consciousness. Framework determining-conditions are, therefore, unlike scientific generalizations—which have only limited validity within a given stratum of existence; nor do they correspond to the regularities of existence—which are neither more nor less than the grouping of wholes according to the intensity of their inner-togetherness. The four determining-conditions, with their chief phenomenal characteristics, are shown in the following table:

Determining-condition.	Phenomenal Characteristic.
Eternity.	Potentiality and intensity of being.
Time.	Actualization and irreversibility.
Hyparxis.	Ableness-to-be and cyclicity.
Space.	Presence and co-existence.

In the course of thousands of years, mankind has reached a general attitude towards phenomena in which the distinctions of behaviour, existence, and framework are implicitly adopted, although not explicitly recognized. Scientific inquiry and philosophical criticism do no more than give a certain precision to the common-sense interpretation of experience, and sometimes this precision is achieved at the expense of applicability. We are so accustomed to the common-sense view of the world that we cannot readily recognize the steps by which it has been reached. It might help us, therefore, if we were to follow through the stages by which an intelligent observer might come to understand the game of chess, without any prior knowledge of the game, by the study of phenomenal regularities alone.

Let us suppose that a very intelligent being, knowing nothing about human life, notices that it often happens that two human beings take a chequered board with thirty-two black and thirty-two white squares, and a box containing thirty-two pieces of wood half of which are coloured black and the other half white. After placing

the pieces upon the board in a certain manner, the human beings move them at irregular intervals from one square to another. When an observer has watched a sufficiently large number of games, he may reach certain conclusions as to the significance of what is going on. He finds certain regularities. The first he noted almost from the start; that is, that the phenomena are associated with a board of sixty-four squares and pieces of wood which, though differing in shape, colour, and size, fall into six distinct classes, recognizable by similarities of shape and also of the manner in

which they are placed and moved upon the board. The observer is aware of the fundamental characteristics of all experience—namely, wholeness, relatedness, structure, and so on. For this reason, his study of the phenomena will enable him to distinguish between further kinds of regularity—those to be observed in the behaviour of the chessplayers. One of these is the sequence of events; the players sit down, arrange the pieces on the board, decide upon the choice of colour, make their opening moves, pass into the middle game and reach an end-point, when one player is mated or lowers his king. It is a complete process, in which the principle of structure can be discerned. Even though often the cycle is not completed because the game is drawn or stale-mated, yet the underlying pattern can always be recognized. This is the visible aspect of the process that can be known and interpreted in terms of functional regularities.

The other kind of regularity is not visible as a process. It is discerned by the observation of a very large number of games. The laws of chess discovered in this way can be completely established, but the observer—who has no means of communication with the players—can never tell whether he has established the totality of all laws. For example, he may watch thousands of games without meeting a certain situation to which a special rule applies. Nevertheless, if he has once grasped the nature of a game played according to rules, he will understand that they are the framework within which every game must be played or else forfeit the right to be a game of chess. There is thus an almost infinite variety of possible situations, but there is one unvarying factor in all of them; that is, the rules of the game.

When the observer has in this way discovered the laws of chess, he may begin to notice that the games may be classified in terms of a factor that has nothing to do with the sequence of events nor with the rules of the game. This will lead him to discover yet other regularities of a quite new kind; namely, those that derive from the skill and concentration of the players. In order to interpret these new regularities rightly, he would need to understand the properties of attention, memory, and combinative skill that do not show themselves in the outward behaviour of the players. He would, however, establish that the gradations of playing strength form a single ordered series—from tyro to world champion—such that a player belonging to one class would be likely to defeat players in the lower and lose to those in the higher classes. The study of the game of chess would thus have led the very intelligent observer to recognize regularities of three kinds: the first, corresponding to behaviour, is the general pattern of activity of

those interested in chess; the second, corresponding to framework, is the laws of chess to which every game must conform; and the third, corresponding to the stratification of existence, is the grouping of players in classes according to their playing strength.

The analogy is imperfect, but it serves to show how phenomena transcend the distinctions of subject-object. The laws of framework cut across such divisions, but they are only fully exemplified at the lowest level of being, where differentiations of consciousness have little significance in laying the foundations of natural science. We can examine separately the regularities of mechanism, of existence, and of framework; but when we come to apply the results to phenomena—that is, to actual experience—we must restore the perspective under the penalty of distorting the picture.

Chapter Seven POSSIBILITY AND IMPOSSIBILITY

3.7.1. The Meaning of 'Impossibility'

We use the word 'impossible' in various ways. In logical usage it refers to some or other convention regarding the meaning of words. For example, we may say 'it is impossible for a door to be both open and shut at the same time'. This statement is only true if we agree either to exclude from consideration such statements as 'the door is ajar', or to assign conventionally to the word 'ajar' one of the two meanings 'open' or 'shut'. Thus logical impossibility depends solely upon the manner in which we define the meanings of words. This applies also to such paradoxes as Zeno's dictum, 'it is impossible to step into the same river twice'. We may agree that the study of paradoxes such as this is useful as a training in the right use of all language, but we cannot feel that it helps us to a better understanding of experience.

If we say 'it is impossible for two and two to make five', we affirm something that goes beyond the meaning of the words 'two' and 'five'. To see the truth of this assertion, we must have an adequate idea of the significance of numbers; but it does not depend upon definition alone, as was the case in the previous examples, for it also tells us something of the relationship of classes that goes beyond the compass of language. Again, if we say that it is impossible for water to run uphill, we are making an assertion the meaning of which is only clear with considerable knowledge of the physical world; but, when this meaning is grasped, it serves to tell us something of fundamental importance about the nature of time and existence. Nevertheless, a statement is neither meaningful nor true unless it is placed in the right context. For example, water in a siphon will run uphill—but only to a height of some thirty feet—whereas water forced into a pipe-line by a powerful pump will flow uphill to a very great height. In so far as we have knowledge of the physical world, we recognize the meaning of these statements, and also of the limits within which they are true or false. Nevertheless, we rightly use the word 'impossible' in such statements as 'it is impossible on the earth to raise water over thirty-two feet with a suction-pump'.

We are accustomed to make a distinction between 'logical' and 'physical' impossibility. It is held by many that physical impossibility really

means 'improbability so great that the occurrence of the event will not be observed in finite time'. It is, for example, well known from the laws of heat transfer that when a hot and a cold body are placed in contact, heat is invariably observed to flow from the hot body to the cold. Since, however, this flow depends upon random molecular motions, it is always possible for a high-energy molecule to pass from a cold region to a hot one. A positive flow of heat against the temperature gradient is thus 'possible', though never observed in large systems. It would appear, therefore, that the word 'impossible' is wrongly used in formulating the law of heat transfer. Nevertheless, the meaning is clear and unambiguous if we assert that it is 'impossible for the improbable to be probable', in which case 'impossible' must always have the logical meaning conveyed by 'it is impossible for both probable and not-probable to be true'. The assertion about heat transfer can thus be written, 'it is impossible that A is a probable event and A is an improbable event can both be true'. The truth value of a statement cannot be assessed unless we know what the statement means, and therefore all statements about possibilities and impossibilities turn upon meanings, and these in turn arise from the recognition of recurrent elements in experience.

In order to remove all doubts as to the legitimacy of using the word 'impossible' to signify the fact that experience excludes certain events, we may consider the assertion, 'it is impossible that yesterday's sunrise will occur tomorrow'. According to the natural meaning of the words 'yesterday' and 'tomorrow', this statement can be considered as a logical impossibility; but we take it—and rightly so—as a statement about experience that tells us something very significant about temporal actualization. Similarly, if the schoolboy says 'five into four will not go', he is asserting something that is not only logically true—that is, tautologous—but physically significant—as he finds when he attempts to share four marbles among five boys. We shall, therefore, use the term 'impossible' in this discussion to signify 'excluded from experience'.

We must note here the distinction also required between 'possible' and 'potential'. That which is potential exists no less than that which is actual. For example, we speak of potential and kinetic energy, and in doing so we imply both existence and the possibility of actualization. But when we speak of a possible event, we do

not necessarily imply that the existential content required for subsequent actualization is present. We may say 'it is possible to make hay while the sun shines', but this does not tell the hearer whether conditions for hay-making are present or not. On the other hand, if we say that 'the potential hay pro-

duction of England is three million tons', we refer to something that exists even though no one has ever seen or touched it. Thus 'possible' tells us that universal laws—such as those of logic and physics—are not violated; while 'potential' tells us that something exists in a non-actualized form. Moreover, we can readily see that what is potential must be possible, but what is possible is not necessarily potential.

3.7.2. Situations, Occasions, and Actualizations

All that can be known is fact. Not all facts are possible. For example, pouring a quart of liquid out of a pint bottle is an impossible fact. We may make three statements: (a) 'Mount Everest is in this room': (b) 'a red cow is in this room', and (c) 'a chair is in this room'. The first is impossible; the second is possible but not actual; the third is both possible and actual. To distinguish between these and similar cases, we shall use the following definitions:

(i) A situation is a fact taken without reference to its actual or possible arising.

(ii) An occasion is a possible situation, potential or actual, (iii) An actualization is an occasion accessible to sense perception.

Every actualization occupies a definite segment of the spatio-temporal world of our sense-experience, and all phenomena are referred to some centre of consciousness. An occasion that is actual for one consciousness may be not-actual for another. For example, tomorrow's sunrise is not actual for my present consciousness, but it will be actual for a consciousness that observes the phenomenon tomorrow.

The term determining-condition designates the factor by which possible situations are distinguished from impossible. Determining-conditions are independent of actualization, and must therefore have universal validity. On the other hand, they cannot have absolute validity, since they depend upon being which is relative. If the determining-conditions had an absolute character, then statements about fact could be either wholly true or wholly false; but experience teaches us that this is not the case, and that it is always necessary to insert qualifications that give every statement about fact the character of being 'more or less true'.

Many statements of fact can be so nearly true that the 'more or less' can be disregarded, as in the example of the transfer of heat from a cold to a hot body. This close approximation to truth has an important historical consequence, for it means that in the early stages of scientific

discovery the quest for absolute truth often appeared to be both possible and legitimate. Hence, in the seventeenth and eighteenth centuries the aim of science was to discover universal laws that were absolutely true and therefore applicable to all possible situations. It was not until the end of the nineteenth century that the refinement of scientific techniques began to force a far-reaching change of attitude, with the result that in the twentieth century natural scientists have almost entirely abandoned the search for 'absolute laws of nature'.

Once again the relativity of being imposes itself, even where our attention is directed exclusively to the functional element in reality. This is, however, not the only obstacle we encounter in our endeavour to formulate the significance of the rules which govern phenomena. The problem remains obscure if, having taken the relativity of being into account, we still fail to distinguish between function and will. It must be stressed that the regularities of function are of a different character from the conditions that determine the possibility or impossibility of a particular pattern of events.

Let us now consider the statement 'the cow in that field is eating grass'. In an obvious sense the proposition is either true or false according to whether or not a cow 'exists' within the phenomenal situation presented to our common awareness. Here both truth or falsity and possibility or impossibility refer to the presence or absence at a given moment of an object that corresponds to our use of the word 'cow'. There is, in addition, a necessary qualification connected with existence. In making this assertion, we imply that we are referring to a 'real-life' cow. It would not be possible or true if the cow were there but dead, or if it were a china cow standing upon a shelf. If the sentence is to have the meaning we intend, the cow must exist as a living animal. If we were to say: 'There is a right-angled triangle, the sides of which stand in the ratio of 3:4:5', anyone acquainted with the laws of geometry would agree that this not only refers to a possible situation but is also a true proposition. In any discussion of this proposition, truth and falsity, possibility and impossibility, would have a different significance from that which applies to the proposition 'the cow in that field is eating grass'.

Let us now consider the statement: 'There is a round square.' Here the truth or falsity of the proposition does not turn upon any particular phenomenon, for nothing is said about where or when the round square is to be found. We should be inclined to say that the proposition is false and impossible because it is self-contradictory. It is, nevertheless, possible to define a plane figure as follows:

- (a) it has a centre;
- (b) it has four straight sides, equal and perpendicular in pairs; and
- (c) every point in the figure is at an equal distance—called the radius—from the centre.

Such a figure would indeed be a round square, and not only is there no logical contradiction in the definition, but it could exist in Euclidean space, provided that the radius were infinite. If we now try to verify the proposition experimentally by constructing it with ruler and compass, we must fail, since there are no infinite phenomena. We thus reach the conclusion that the proposition 'there is a round square' can never correspond to any fact, and we find also that the impossibility of a round square has nothing to do with existence but only with framework.*

It must be noted further that framework impossibility includes but goes beyond logical impossibility. The statement 'yesterday's sun will rise tomorrow' can be construed as a false proposition by definition of yesterday and tomorrow, but there is certainly something more than a logical contradiction that makes us reject it. On the other hand, its impossibility is only relative to our own form of consciousness. There is nothing logically impossible about a state of consciousness that would be capable of experiencing yesterday's sunrise tomorrow in exactly the same way as it was experienced yesterday.

Discussion of these examples shows that, although given in experience, framework is neither what things do nor what they are, but the form in which—being what they are—they do what they do. That Kant was wrong in thinking that our intuitions of space and time were given a priori became evident with the development of non-Euclidean geometries. Space, time, eternity, and hyparxis are not transcendental—that is, prior to phenomena—for they arise in the no-man's-land between phenomena and fact. Though prior to facts, they are derivative from phenomena, and we discover in experience the universal forms of all possible phenomena. The word 'nature', as commonly used, signifies the world of phenomena, and therefore framework comprises all that we can know of 'the laws of nature'.+

In the twentieth century, philosophy has begun to recognize that the

[* Cf. Marvin Farber, *The Foundations of Phenomenology*, p. 232: "To say that expressions like 'round square' are senseless is to confuse meaninglessness with the a priori impossibility of fulfilling meaning."

Husserl's distinction between 'fulfilling meaning' and 'content as an object' can be understood as the

distinction between framework conditions and existential assertion.

+ Cf. A. N. Whitehead, *The Concept of Nature*, Camb. 1920, p. 187 : "We observe nature as extended in an immediate present which is simultaneous but not instantaneous, and therefore the whole, which is immediately discerned or signified as an interrelated system, forms a stratification of nature which is a physical fact."]

laws of nature cannot be formulated a priori, but are discovered progressively by observation and reflection. Logical consistency, which eighteenth-century philosophers supposed to be the test of truth, proves to have no application at all to fact.

It is always possible to construct alternative sets of rules, any one of which is more or less convenient for reducing phenomena to facts, and yet they may be quite incompatible with one another. Reichenbach's scheme for a philosophy of quantum mechanics illustrates this point. He formulates a set of rules for assessing truth-values of propositions about the existence of waves and particles; and about the mechanism of diffraction, and the emission and absorption of quanta—that differ from those of ordinary logic by restricting the validity of the law of excluded middle. In this way he and other scientific philosophers came close to recognizing the character of the conditions by which possible situations can be distinguished and determined.*

Here it is worth making a verbal distinction, that is also of practical value, between rules that we formulate for ourselves in the light of our present comprehension of the laws for which we are searching. Rules are no more than formulae, the value of which is to be assessed only in terms of their pragmatic effectiveness. Laws are the statement of objective regularities that are presumed to be independent of our search and of its success or failure. The laws of framework prescribe the general conditions which make it possible for situations to enter experience. Rules tell us whether a given situation can be an occasion.

3.7.3. The Search for Universal Laws

A law can be called universal only if we never fail to find it exemplified in any situation to which it could apply. We observe only actual occasions, but we need a test of possibility that can be applied to occasions that do not become actual. For example, a physicist requires to allow for the presence in an atom of non-radiating electrons. In this state the electron does not become actual, and it cannot even be asserted to be present in space and time. We should, nevertheless, say that it is 'impossible' that it should disappear altogether, since we infer its presence from the neutrality of the atom and, possibly, also from its mass. In this way we are able to make confident statements about an occasion that cannot be located in space and time. We do so because we regard the laws of conservation of energy, momentum, and electric charge as having universal validity, whether in a particular instance we can verify them or not.

[* Cf. H. Reichenbach, *The Philosophic Foundations of Quantum Mechanics*, and H. Poincare, *La Valeur de la Science*, pp. 124-33.]

Phenomena are not identical with events in time and space. They have a coherence that we discover when we examine them from the standpoint of universal similarity. This similarity concerns the different ways in which phenomena can be classified, and also the connection that can be found between the classes. The rules that govern these operations have the same kind of significance as those that determine permissible and non-permissible arrangements in space and successiveness in time; they have been formulated by way of logic and arithmetic. In the past, logic was regarded as consisting of rules of thought given a priori—that is, as the form of thought in general—but now is seen to be concerned with a special kind of fact; namely, fact from which existence has been eliminated.*

There is a branch of logic that is concerned with the right use of language, but even this must appeal to experience for its justification. True logic is the search for laws that determine the form of phenomena

without reference to actualization in space and time, and without distinction of actual and potential. The laws of arithmetic have the same kind of significance as those of geometry and dynamics. All consist of propositions that have universal validity for phenomena, and are therefore implied in all statements about fact.

The task of the logician and the mathematician is to bring clarity and coherence into the discoveries that we all make, even without noticing them, about the form of all possible situations; that is, about framework.+ In this respect the determining-conditions of framework differ from the generalizations of natural science. The latter claim neither universal validity nor permanent significance. They are provisional statements of regularities that are found in the mechanisms that operate in the different strata of existence. Great ingenuity is required for the discovery and formulation of these regularities. They have to be dissected out of the seething mass of events that proceed simultaneously upon many different levels. Consequently, consistency and coherence can only be obtained at the expense of comprehensiveness and precision. Thus these generalizations present an ever-changing picture—sometimes

[* Cf. Kant, Critique of Pure Reason, p. 95 : "General logic considers only the logical form in the relation of any knowledge to any other knowledge; that is, it treats of form of thought in general."

+ Husserl came very close to seeing the character of the determining-conditions, but he sought to reduce them all to pure logic. Farber (loc. cit., pp. 144-5) writes: "Space, conceived as the form of order of the world of appearance, is distinguished from space in the sense of a formally defined manifold. ... If by space is meant the categorical form of world-space, then it comes under the genus of pure—categorically determined—manifold."]

gaining in breadth and losing in precision; sometimes coming into focus, but only within a restricted domain.

3.7.4. Universal Laws Governing Possibility

Our grasp of the determining conditions develops in quite a different way. We understand them more readily than we know them. They are obvious and yet so profound that we can never exhaust their meaning. They pervade all experience, moulding it inevitably according to their own laws. Kant rightly saw time as the form in which our inner state is intuited; but he discarded as irrelevant the tricks played upon our experience of time by modifications in our state of consciousness. We are subject both to illusion and hallucination, but these concern existence rather than the form of our experience. A mirage in the desert is actualized successively in time in the same way as the perception of a real oasis. The psychological experience of timelessness—of standing still in the present moment—can be recognized as authentic, although it cannot be measured with a clock. The division of attention in which we can observe our own functions is also an authentic change in our relationship to time. Such considerations confirm the view that we can extend the application of the determining-conditions beyond commonplace phenomena, but are a warning that their significance does not remain constant in passing from one level to another.

Our intuition of the universal framework is in marked contrast with the instability of functional generalization. The very form of our language, the origins of which are lost in the remote past, is already expressive of the framework laws. We think and we speak in the form prescribed by our own intuitions of space and time, and it is not surprising that some philosophers have concluded that these are given to us even before we begin to think. Strictly speaking, this is true—if by 'thought' we mean the process by which phenomena are related to facts, but we must not make the mistake of confusing thoughts about phenomena with phenomena themselves. It is in the latter that the laws of framework are exemplified, and that is why these laws—even if not specifically formulated—are part of the common heritage of all mankind. They are the consequence of our perceiving reality from a certain stratum of consciousness.

The first task of the natural philosopher should be to formulate the laws of framework as clearly and

comprehensively as possible. If he fails to do so and plunges directly into the subsequent stages of searching for regularities of function, he places an almost insurmountable barrier against bringing these secondary regularities into a coherent and complete

structure. We cannot dispense with the discipline of clarification, but our aim will not be achieved if clarity is gained at the expense of applicability. This happens, for example, when formal logic is systemized by separating the study of forms from the study of phenomena. True logic must take into account the element of vagueness that is always present in our experience.*

We have to examine, therefore, the status of such vague propositions as 'the patch was more or less yellow'. We can see that in this case the rule of excluded middle does not apply, since the proposition can only be more or less true. The rule of excluded middle is valid only for propositions about wholes, and it amounts to a convention that whenever a whole is named it will be treated as though it were an individual. If we penetrate more deeply into our experience, we find ourselves ultimately confronted by complex structures with all their uncertainties and incompletenesses. We therefore can answer the question, 'Are there alternative logics ?' by saying that there are as many logics as there are fundamental categories of our experience. There is the two-term logic of wholes and polarity, the three-term logic of the triad, and so on.

Propositions escape from the law of excluded middle, not only by reason of vagueness, but also when they refer to unactualized occasions. If I say 'today it will rain', the truth or falsity of the sentence is projected into the future. Tonight the sentence 'it has rained today' will have become a proposition about an actualization, and therefore will be either true or false. All that can be asserted in the first case is that there is a greater or less probability that tonight the latter proposition will be true or false. Taking the view, as we must, that future occasions are no less part of our experience than present or past occasions, then we must admit probability as part of the framework of phenomena. We thus find how to reconcile the fiducial and confidence theories of probability.

Let us suppose that at a given moment it is a fact that I have just thrown a hundred coins and that fifty-one have turned up heads. I am now in the act of tossing a second hundred, and am again obtaining an approximate equality. I intend to toss a third hundred, and I expect that out of the totality of three hundred very nearly half will be heads. Regularities of this kind have nothing to do with behaviour and existence. An unlimited variety of experiments could be devised in which the laws of probability would be exemplified similarly. In such

[* Cf. F. Waisman, 'Are There Alternative Logics ?' in *Proc. Arts. Soc.* (1946), XLVI, 103. Writing of vague propositions, Waisman remarks that "this sounds as if reality could decide which logic was valid, as though the structure of logic reflected the framework of being". Although Waisman rejects this conclusion, it is the correct one if the words 'reality' and 'being' are taken to mean the content of experience.]

experiments, almost every stratum of existence could be explored and almost every kind of functional activity used. The only condition that would have to be fulfilled would be that a certain pattern of probability should operate—one that is not in time nor in space; for it is independent of actualization or non-actualization. This pattern discloses two sets of conditions: one set determines the potentialities of the situation, and the other the frequency with which a particular potentiality will be actualized. These two sets of conditions are independent of both existence and behaviour and yet both are universal; for no situation is fully determined without reference to its potentialities and their likelihood of occurrence.

3.7.5. Framework as the Condition of Possibility

We have now made a preliminary survey that enables us to give a provisional definition of framework:

Framework is the totality of universal conditions that, applied to any and every situation, determines whether

it is possible or impossible.

The word 'possible' in this definition is used in the sense already discussed of 'not against the rules', and the word 'impossible' as being contrary to rule. For example, in Euclidean space it is impossible to construct a triangle the sum of whose angles is less than two right angles, for much the same reason that it is impossible to start a game of chess by moving the queen. If, however, we choose to vary the rules and say that we have Riemannian instead of Euclidean space—or fairy chess instead of orthodox chess—the situations that are impossible are no longer the same.

If framework determining-conditions are a set of universal laws, according to which the phenomenal world lives, moves, and has its being, then the question naturally arises as to who lays down these laws. Is there a Legislator who imposes them, or are they inherent in the nature of reality? If we consider attentively the steps by which we establish the notion of framework, we see that it is neither the one nor the other. The laws are the limitations placed upon the arbitrariness of phenomena by the form of our own human consciousness. We are not, however, entitled to conclude from this assertion that time, space, logic, probability, and the rest, are merely subjective forms of will. Ultimately, all forms must be manifestations of one and the same will and, hence, framework is no more than a consequence of the self-limitation of that will upon a given level of being. Even for a consciousness liber-

ated from the restrictions of our everyday experience there still must be a distinction of possible and impossible situations, and therefore laws of framework. For lower levels of being, the balance between possibility and impossibility will be shifted in the direction of even greater restrictions than those that apply in our human experience. Thus all possible situations—non-human, human, and superhuman—must take their place in the Great Whole and there must always be a meaning to the question: 'Is this situation possible or not?' In both directions the relativity of being holds sway far beyond the limits of our human experience. We must not forget that this is so, even when, for a given purpose, we confine our inquiry within these limits. As applied to phenomena, the framework determining-conditions are fairly definite, but because of the relativity of being their incidence must vary: what is true on one level may not be true on another and vice versa.

3.7.6. The Four Determining-conditions of Framework

Clarification of the role of the framework determining-conditions can be accomplished by regarding phenomena from four aspects, differing in the significance accorded to existence and mechanism in the study of each. We can study phenomena with special reference to existence, and particularly to the different levels of existence that we find in our experience. The determining-condition that is especially relevant for such study we may call eternity. If we take existence and behaviour together, we can speak of time as the determining-condition that sets existence against the background of behaviour, and of space as that which sets behaviour against the background of existence. The connection between this interpretation and that of Kant can be seen if we remember that existence is experienced as consciousness—that is, 'inner intuition', and behaviour as knowledge—that is, 'outer intuition'. Laws from which both behaviour and existence can be abstracted are those of pure will. They correspond to the conditions already designated by the word *hyparxis*. The laws of *hyparxis* include such abstract forms as classification and logic, but they also include the determination of 'ableness-to-be' that belongs to will.

The grouping of framework laws under the four headings of eternity, time, space, and *hyparxis* is appropriate for phenomena. For higher levels of consciousness, time, *hyparxis*, and eternity become merged, and the separations of space also assume a quite different character from those of our usual experience. Consequently, the partition between the four groups of laws is sharp only in the domain of inanimate objects.

We can therefore best discover the character of the laws by the study of the physical and dynamical sciences. In this connection it must be noted that the words 'eternity', 'time', 'space', and '*hyparxis*' do not signify in the same way as most words of our language. All 'parts of speech' stand for things and attributes and processes.

More rarely, and usually without fully recognizing their character, we use words to indicate levels of being. In the English language suffixes such as -hood, -ity, -ness often give some indication of being; as when we refer to 'thinghood', 'manhood', 'animality', 'deity', 'happiness', 'consciousness', and so on. 'Space' and 'hyparxis' are not words of either kind, for they signify neither what anything is nor what it does.* The former is the outer and the latter is the inner condition of 'being what one is'.

The framework determining-conditions are not known in the way that we know function, and we are not conscious of them in the way we experience being. Nevertheless, all our experience is pervaded by them; their essential character is as familiar to the savage or to the idiot, as it is to the scientist or to the philosopher. The only difference is that the latter seeks to formulate in words his intuition of their nature. By making use of the term 'determining-conditions' we indicate what framework signifies; but a fuller and more definite account can be given by defining framework as the self-limitation of will in respect of the non-arbitrariness of the existing universe. The equivalence of this definition and that given at the head of the section cannot be demonstrated as fact; but it plays an important part in our intuition of values.

The four sets of determining-conditions are inseparable. We cannot think of time apart from space. The two can be separately represented in a mathematical symbolism, but they cannot be discovered as separable constituents of any possible experience. The same is true of hyparxis. Hyparxis is recurrent; there are no non-recurrent occasions, nor can we enumerate except in terms of recurrent situations. We can establish also that eternity is involved in every phenomenon as the source of its potential. It is only for our specialized form of consciousness that the determining-conditions appear to be separate. Since, however, we are concerned here with phenomena—that is, the content of experience on our usual level of consciousness—the four determining-conditions can be clarified with the help of rules which can be summarized and set down more or less independently, as follows:

(i) Space: Rules setting behaviour against the background of existence; that is, the outer relationships of wholes.

[* Cf. A. N. Whitehead, *The Concept of Nature*, Chaps. 2 and 3. See also M. F. Cleugh, *Time*, and Whitehead's notion of 'prehension' in *Process and Reality*.]

(ii) Time: Rules setting existence against the background of behaviour; that is, the inner aspect of function.

(iii) Eternity: Rules having reference to existence and particularly to different levels of existence that we find in our experience. Hence these are largely concerned with consciousness.

(iv) Hyparxis: Rules from which both behaviour and existence can be abstracted—that is, those that determine the manifestations of will possible in a given situation.

The saying of St. Augustine in regard to time—*si non rogas intelligo*—applies to all four determining-conditions.* The framework determining-conditions as applied to universal existence are beyond our understanding. We can study them only as they apply to limited wholes—ourselves included. We enter into situations always with the distinction of inner and outer—of subjective experience and objective experience. Knowledge of the determining conditions enables us to prescribe what is possible and what impossible in such situations, and this implies that there always must be, for our experience, a distinction of inner and outer, corresponding to the different character of the triad time—eternity—hyparxis, as compared with the space-like triad length—breadth—depth. The first refers to the condition of internal possibility and the second to the external possibility of a given actualization. Time, eternity, and hyparxis are conditions of being what one is, whereas space is the condition of not being what one is not. The first three are inner conditions and they are intrinsically similar in character in so far as they do not relate. Space is an outer condition and its chief significance is in relations.

[* Confessions, Book XI, Chap. 4: "But what in discourse do we mention more familiarly and knowingly than time ? And we understand, when we speak of it; we understand also, when we hear it spoken of by another. What then is time ? If no one asks me, I know; if I wish to explain it to one who asketh, I know not."]

Chapter Eight

THE LAWS OF FRAMEWORK

3.8.1. Framework as the Self-limitation of Will

We approached the study of the determining-conditions by seeking for the distinction between possible and impossible situations and by examining the tests that we apply in practice in order to ascertain the status of a fact. Although this appeal to experience is a necessary safeguard, the general character of the determining-conditions can best be established by reference to the fundamental triad. Framework is neither more nor less than the self-limitation of the Will. The cosmic game is in process, and we recognize that the unknown player abides loyally by the rules that he himself has made. Thus the search for these rules not only enables us to follow the game, but may even tell us something of the player. Our immediate task is more humble; namely, to discover in phenomena the universal character of the determining-conditions. We may call them the laws of nature or the laws of framework, but we must not forget that they remain always relative to a state of consciousness and that this relativity is itself evidence that there must be a level of being at which distinctions, that now appear to us irreconcilable, are merged into a single manifestation of Will that is both direct and universal. Since we can never reach a complete understanding of the laws in their ultimate objectivity, we are compelled to make our own subjective rules for dealing with phenomena as they arise.

3.8.2. Time as the Condition of Actualization

Any given actualization is subject to limitations that do not apply to the complete situation from which it derives. These limitations, taken together, are the determining-condition of time.* Actualization, or fixation by selection, is the key to the understanding of time.

The sentence 'It looks like rain' refers to the present occasion as the bearer of indeterminate potentialities in the future. In an hour's time, I may say, 'The sky has cleared and I think it will not rain'. An hour later still, I may say, 'Ah, the rain has come after all'. The various potentialities inherent in the first occasion have undergone a process of selection and in the final outcome the rain has become actual. We are

[* See definitions, Chapter 7, p. 150.]

not entitled to say that the fine weather that was still potential at ten o'clock but did not materialize is less real than the rain that is actually falling. The non-actualized fine weather is just as truly a part of experience as the actualized rain. For a different state of consciousness the sun might be shining at this very moment and the sky clear. I can, for example, think of sunshine, and perhaps, with practice, I could even voluntarily produce in myself all the sensations corresponding to sunshine, and thus, for my own experience, be able to actualize sunshine instead of rain. In yet another state of consciousness, two incompatible events might both be present simultaneously to my awareness.

Actualization is thus a property of phenomena, which themselves are selected from the given totality—that is, from experience—by the form of consciousness to which they are present. Phenomena are inherent in experience in much the same way as surfaces are inherent in material objects. We say, 'this bowl is green' when we mean that our sense-impressions convey to us that the light reflected from its surface has a green colour. Similarly we can say, 'The rain is actually falling', when we really mean that—of the various kinds of possible meteorological phenomena—we have at the particular moment sense-impressions corresponding to rain. Here the use of the term 'sense-impressions' shows the connection between the actualization of rain and

the colour of a surface. From such considerations we are led to conclude that actualization is a determining-condition of phenomena. It is a selection—usually involuntary—which, from among the many potentialities present at a given moment, fixes the one about to enter the field of our awareness. We can influence this selection to some extent by the power that we have over our attention; therefore we must regard actualization as a fixation that is relative only. It is worth mentioning here the interesting suggestion of Ouspensky that it is possible to change the past—a situation that would be impossible if actualization were an absolute condition not admitting of relativity.*

Time is successive, but only partially so; successiveness of time in an absolute sense would mean that only the present moment exists. Our experience, moreover, teaches us that successiveness of time is always combined with renewal, or return. We could have no measure of time were it not for cyclic events; we could have no coherence if there were no recognition of these events. Recognition is the awareness of repetitions+ and, consequently, successiveness and repetition are equally

[* Cf. P. D. Ouspensky, *A New Model of the Universe*, p. 479. The idea of the complete fixity of the past is as unsatisfying as that of the complete determination of the future.

+ Cf. H. Poincare, loc. cit., p. 133. "It is repetition that gives to space its essential characteristics, but repetition presupposes time."]

significant for actualization in time, and so enter into its determining-conditions. By reason of successiveness, the temporal process is an ordered series of moments—one moment disappearing to give place to another. Locke correctly speaks of the "fleeting and perpetual perishing parts of succession that we call duration". He also notices that the measurement of duration depends upon periodicity.*

Repetition is not only significant for the measurement of time, but we owe to it also the very possibility of reducing phenomena to facts, since phenomena themselves are never repeated, and only facts return. If I sit and look at a spot on the wall, and after a few minutes say, 'It is still there,' I mean that I am having a visual sense-impression similar to the sense-impression of a few minutes previously. If, on the other hand, the spot suddenly disappears as I am looking at it, and I say, 'It is no longer there', the assertion has a meaning only because the word 'there' is anchored to the constantly repeated sense-impressions of the surrounding regions of the wall.

Repetition that can be expressed by the sentence 'It is still there' can be called 'conservative'. It is the renewal in time of the whole or wholes that present themselves in the total experience. Conservation is thus a limitation upon the arbitrariness of actualization. Wholes, generally speaking, are independent of states of consciousness—some are more so, some are less. They are also more or less independent of other wholes. From this follows the conservative character of their actualization. On the other hand, the independence is never complete, and there is always, therefore, a non-conservative element in experience. This gives to time the irreversible character by which the past never exactly repeats itself.

The properties of conservation and irreversibility as applied to physical systems are expressed by the two laws of thermo-dynamics. The first of these laws asserts that the changes in an independent system occur without gain or loss in the quantity of energy. The second asserts that the changes that do occur spontaneously tend to be in the direction of greater probability.

We are now in a position to set down a provisional statement of the laws of temporal actualization. Although referred to as 'laws', the following statements serve also to define the meaning of certain words connected with time. They might be more properly described, perhaps, as aphoristic sentences rather than as statements of universal laws. Never-

[* Cf. John Locke, *Essay Concerning Human Understanding*, Book 2, Chap. 14, pars. 2 and 31: "By sensation

observing certain appearances at certain regular and seeming equidistant periods, we get the ideas of certain lengths or measures of duration." And further: "By considering any part of infinite duration, as set out by periodical measures, we come by the idea of what we call time in general."]

theless, they will serve our present purpose, which is to make clear to ourselves what we understand by actualization in time.

(i) Time is the condition of actualization.

(ii) Actualization is an ordered succession.

(iii) The actualization of wholes is a characteristic of all phenomena. (iv) Actualization is conservative and irreversible.

(v) Every whole is actualized conservatively to the extent of its completeness.

(vi) Every whole is actualized irreversibly to the extent of its incompleteness.

(vii) Every whole is subject to the determination of its own proper-time.

(viii) The temporal order is in the direction of increasing probability.

It will be noted that the view of time herein adopted stands between Platonism—for which the actual is merely a copy of the eternal reality present in the idea—and Thomism—for which the actual is fully real because it is the manifestation of the will of God; it probably corresponds to the intention of both philosophers. The characteristics of time can be summarized as successiveness, endurance, continuity, conservation, and irreversibility.

3.8.3. Eternity as the Condition of Potentiality

We define eternity as the condition of potentiality. It is necessary to grasp, however, that potential existence and actual existence are both modes of being. This can readily be seen in the case of mechanical energy, the law of conservation for which asserts that the sum of the potential and kinetic energies of a system of bodies moving without constraint is a constant. The formula, though familiar, has far-reaching implications; for it can have no meaning unless potential energy and kinetic energy are accorded the same existential status. In a pendulum, the energy at the top of the swing exists in potential form—at the bottom, it exists wholly in kinetic form. Between these two extremes, it is distributed between the two. Few people today doubt that energy exists and that 'Visible matter' is only one of its manifestations. There need, therefore, be no hesitation in accepting the view that potential existence and actual existence are equivalent and interchangeable.

Taking this view, we are led to the question, 'Are there, then, laws of potential existence corresponding to the laws of actual existence?' With the definition of eternity as potentiality in mind, we can say that

the laws of eternity should in some way complement the laws of time, so that the two together determine the conditions of existence. If then actualization is the separation of selected occasions, we should expect potentiality to be the co-existence of unselected occasions. From this it follows that potentiality can be multi-valent since all the occasions that are potential in a given situation can exist side by side, although only one can be actualized.

We can readily admit that different occasions can vary in their potentiality, and, moreover, that this variation gives a measure of the degree of freedom that the situation allows. It is also evident that univalent potentiality is determinism. We may here introduce an analogy illustrating several properties of the determining-condition of eternity. It is familiar from the theory of probability and consists in supposing that we have a bagful of balls

which are drawn out one by one. The balls in the bag are invisible, and the drawing is made at random. The result of drawing out one ball from a bagful of exactly similar white balls can be predicted with certainty; it is equally determined whether we draw out one or twenty or all the balls in the bag. In every case the result is completely determined by the fact that all the balls are identical and white. If, on the other hand, the balls were of many different colours and sizes, then an immense variety of combinations could result from drawing them out at random. In this latter case, the potentiality is multi-valent and the actualization highly selective. Out of many millions of potential combinations, only one is fixed as an actualization. Nevertheless, the unactualized potentialities are as much a part of the total situation as the actualization itself. It is the totality that constitutes the eternal aspect of the situation, and it is in this sense that eternity can rightly be called 'the storehouse of potentialities'.

The analogy of the bag of balls fixes attention upon the two modes of existence which we have called potentiality and actualization. It does not, however, adequately represent experience, since there is nothing to correspond to the properties of shape, size, and space-extension that enter into all our experience. Let us therefore consider some type of occasion that we could meet with in our experience. For this we require a whole that offers itself to sense-experience as actually present. This could be an oak-tree growing on the lawn outside the window.

I take for granted that the tree existed a few minutes ago, yesterday, and last year, and that it will probably exist tomorrow and for many years to come. I expect that every time I turn my attention to the tree, I shall find it more or less in the same place, only changing appearance with the seasons and the weather. The actual tree thus resolves into a

series of trees, successively observable by anyone in the vicinity. This temporal series is that part of the existence of the tree which is actualized successively in time. It has certain recognizable features in common with innumerable other such series that we meet with in our experience. We can recognize in such experiences the chief characteristics of time: successiveness, endurance, continuity, conservation, and irreversibility. The temporal series comprises all that we observe, but it is not the whole situation for it does not include the still unactualized potentialities inherent in each successive occasion. The tree that we see at the present moment is in fact a member of a second series that comprises all its potentialities. For example, the tree will produce acorns and some of these may develop into oak-trees, or the tree may be destroyed by some pest. The potentialities are all present at this moment and, taken as a whole, they can be placed in a series according to whether the essential nature of the tree is less or more completely realized. Although we cannot see these potentialities, we can deduce something of their character and extent from our knowledge of biological laws, of the habits of oak-trees, and of the past history of this particular tree.

The difference between the two series and their symmetry can be seen when their characteristics are set down in parallel columns, as follows:

Time	Eternity
Univalent.	Multi-valent.
Successive.	Synchronous.
Irreversible.	Reversible.
Direction of increasing probability.	Direction of increasing potentiality.
Conservative in respect of mass, energy, and momentum.	Conservative in respect of spatial configuration and virtue.

Temporal objects endure, but Eternal objects imperishable, but
perish. not enduring.

Comparing the two series, we can recognize that it is possible to pass from one member of the eternal series to another without change of entropy. On the other hand, the change is neither conservative nor continuous. We have therefore a condition that is in all respects the reverse of what we find in temporal actualization. The temporal series is conservative and irreversible. The eternal series is non-conservative and reversible. If we regard the thermo-dynamical laws as expressing the nature of time, we shall require to reverse them, in order to prescribe the character of eternity.

The concept of virtue is related to the familiar thermo-dynamical concept of entropy*. Virtue can be derived from entropy by reversing the sign and introducing scale factors as, for example,

$$J = \frac{S - S_0}{S_0 - S_1} \dots \dots \dots (8-1)$$

where S_0 is the ambient entropy at absolute zero and S_1 is the entropy corresponding to the maximum availability. Since S is always less than S_0 and greater than S_1 for any actual process of energy exchange, J is a positive quantity, varying from one to nothing. A system with integral virtue has all its potentialities intact; one with zero virtue is in a state of thermo-dynamic equilibrium. By the definition, J varies with time, but for a given system at a given moment of time, J is the same at all levels in eternity.

With the passage of time, existence within an isolated whole neither increases nor diminishes in quantity, but in general it deteriorates in quality. In the direction of eternity, existence diminishes in quantity, but gains in quality; that is, in the richness of its potentialities. At one end of the scale, existence is wholly actualized, and therefore at its maximum in so far as perceptibility is concerned. At the other end of the scale, existence is wholly potential, and therefore at its minimum so far as observability is concerned. At the lowest level in eternity with only one potentiality of actualization, existence is fettered; whereas at the other end, it is free, with all potentialities of actualization open to it.

From the definition of the eternal series, it will be evident that a highly developed being like an oak-tree must possess a greater diversity of potentialities than an undeveloped being, such as a lump of rock. Even the rock, however, has an enormous range of potentialities latent in its chemical composition. We can conceive an ideally simplified mode of existence with no inner differences, and therefore with all its potentialities reduced to the single property of being what it is. The eternal series of such a being would be self-identical throughout, but its potentialities would have to increase, and this is only possible if its energy content can have different values. By definition, such differences cannot arise from within the whole in question, and therefore must be due to its relation with its environment. We are thus led to the notion of a field of force, and of potential energy as an eternal property of wholes due to a relationship with the environment.

[* By an historical accident, the quantitative expression of the irreversibility of time was discovered by Clausius and Carnot in the course of researches into the heat-engine cycle. The term 'virtue' was introduced by M. W. Thring, cf. Jl. Inst. Fuel (April, 1944), 'The Virtue of Energy, its Meaning and Practical Significance'.]

Further up the scale of existence, we meet with beings capable of some degree of independent consciousness. To account for this, we must suppose that different potentialities can be simultaneously present. In other words, that such a being can be conscious in some way of his own eternal series. This corresponds to what MacTaggart has called "the instantaneous field of consciousness which can, at any given moment, be narrower or wider".*

To avoid spatial or temporal connotations, we may adopt the term apokrisis to indicate the separation of distinct sets of potentialities in the eternal series.+ We may say, for example, that the apokrisis of an atom in the excited state is the number of steps through which it can fall to reach the ground-level of energy. The apokrisis of a living organism is that which distinguishes it from a physico-chemical mechanism. The apokrisis of a conscious being is measured by his power to be aware of his own mechanical processes without being identified with them and thereby to preserve his own individuality in the midst of change.

It will be seen from these examples that every whole has its own characteristic apokrisis, and that this is a single-valued property that serves to designate its inherent potentialities. We may therefore speak of the apokritical relationship as one of 'more and less'. The greater the apokrisis, the greater the range of potentialities present within a given whole. The concept of the apokritical displacement is of such importance for our further investigations that it may be useful to indicate its significance with the help of an analogy.

Let us picture a large number of identical sheets of paper, on each of which a story is recounted. The completeness of the story differs from sheet to sheet—in that words, phrases, sentences, and even whole lines may be omitted. Let us suppose further that all the sheets are placed together in such an order that on the sheet at one end of the series the story is complete, with every word and every letter in place; at the other end, the last sheet of paper is left perfectly blank. In reading each page, the missing letters or words can be inserted at the choice of the reader. Where only a few letters are missing there is almost no freedom to alter the sense of the story. It is different when the reader begins to recognize the content and to see what can be changed without depriving the story of meaning. When two pages far enough apart are compared, it may be that one whole incident can be completely changed without

[* Cf. J. E. MacTaggart, *The Nature of Existence*, (Cambridge, 1927), Vol. II, p. 266.

+ This word is taken from the Greek verb *anoxivco* with the meaning of separation into different levels, as when two heroes stand out from the ordinary ranks of men to do battle together. (Cf. *Iliad*, v. 12.)
'*Anoxgiv0nvai* is used to denote the separation of the fine from the coarse.]

contradicting what is already fixed; that is, the words that are printed on the paper. The whole series of sheets is a gradual transition from complete determinism to complete freedom. At the one end, the reader is passive; he has no option but to follow the story word for word as it is written. At the other end, he is active; he himself is the story-teller and the reader at the same time. To complete the analogy, we must note that the whole series refers to identical time and place in all the sheets.

Now let us take two such series, again with identical space coordinates, but now differing by a very small change of time. We assume the two series can be made to correspond, so that every sheet of paper in the second series is the next step of temporal actualization of the situation in the sheet bearing the same number of the first series. We can see that, for conscious experience, there will either be a necessary identity between two corresponding points or else the free possibility of inserting something new.

The analogy suggests that different types of consciousness are associated with different apokritical levels. The first is that in which the potentialities are wholly undiscerned; consciousness is then limited to the immediate present. If such a form of consciousness can be said to have 'experience', the content of the experience is wholly localized in space, time, and eternity. Past events enter only as those traits in the physico-chemical mechanism which may happen to persist, and the sense-impressions received from outside alone have the quality of immediacy. For such an apokrisis, no distinction between necessity and contingency is possible; every event has an equally arbitrary character; both the temporal and the eternal series are closed systems, and neither has any meaning. Such a consciousness may correspond to the experience of the lower animals and perhaps of plants also.

With an apokrisis capable of distinguishing two different levels of eternity, a second type of consciousness is

possible. Here there is a uni-directional connection in the temporal series only. Potentialities are not observed, but can be inferred with the help of memory. With such an apokrisis the past can be known, not merely by its effect upon the configuration of the present, but as an element in the immediate experience. There is, however, no awareness of difference of levels in eternity and therefore no possibility of any direct experience of the difference between necessity and freedom. Nevertheless, complete arbitrariness is removed from the temporal process through the ability to observe regularities and to interpret them in statistical terms. For this type of consciousness, the interpretation of observed regularities will have one characteristic feature; namely, it will always

be forced to introduce arbitrary quantities for the purpose of expressing the potential differences that influence the temporal process and can thus be inferred from sense-perception.

This second type of consciousness—which is that of our ordinary human experience—can never be aware of more than one sheet of paper at a time and cannot know when it has passed from one page of the book to another. The distinction between necessity and freedom degenerates into mere chance; it becomes a question of hazard whether at a given moment something can change or not.

The third type of consciousness is that in which the apokritical interval is sufficient to allow a direct experience of different levels in eternity. It includes—in the analogy—the power to read what is written on more than one of the sheets of paper and to distinguish between them. In the lower levels, the apokritical interval makes itself felt only as a difference of potential energy; whereas for a being with the third type of consciousness, it becomes a pattern or structure in which the mutual influence of the various potentialities can be perceived. It is only for this third type of consciousness that the true connection between time and eternity becomes accessible to direct experience.

Being a measure of potentiality and not of actualization, the apokritical interval is not directly given in sense-experience. This is the meaning of the statement previously made that 'man is eternity-blind'.* Poincare's study of the dependence of our intuitions of space and time upon sense-experience is mainly confined to the visual sense.+ Seeing, being directly related to electro-magnetic radiation—that is, to events upon a subatomic scale—occupies the least possible apokritical interval; hearing has a somewhat greater extension, and the proprioceptive sensation of our own physical existence still more. It is through the study of sensation that we can convince ourselves of the reality of the apokritical interval, for we find that our inner experience of organic processes cannot be referred to a single stratum of potentialities.

The apokritical interval in eternity is analogous to temporal duration. The characteristic interval of a given whole corresponds to the duration of its life. Moreover, both time and eternity are directed series, governed by a single-valued transitive relation. That of time is 'before and after', that of eternity is 'more or less' potentiality. We know nothing of the origin of time, but we can prescribe a zero level in eternity where there are no alternative routes and everything must follow one determined course. Nevertheless, this level can never be reached in any possible

[* Cf. J. G. Bennett, *The Crisis in Human Affairs*, pp. 167, 184, 187. + Cf. H. Poincare", *La Valeur de la Science*, Chaps. 3 and 4.]

experience. As the absolute zero of temperature is approached, entropy also diminishes and, therefore, the decreasing energy becomes increasingly available. We cannot visualize an actualization which is completely without uncertainty. Notwithstanding the inaccessibility of the ground-state, it can be defined as that of a closed system of discrete particles in thermo-dynamic equilibrium. Such a system, though statistically determined, is nevertheless completely chaotic in its detailed process, and therefore nothing can be said of it except that nothing will change.

We can compare the ground-state with that of minimum actualization, where there is not equilibrium, but an

irreversible trend towards equilibrium. In terms of the analogy we can say that here it is always possible to predict the future. From that which is written on any sheet at a given moment, it is possible to predict with greater and greater probability what will be written on the subsequent sheets. The story will change as time goes on, but it will do so in a definite direction—it will suffer a progressive loss of interest through the elimination of the empty spaces, for the dramatic force of the story depends upon the uncertainty of its outcome. This uncertainty—and with it all interest—vanishes when there are no more empty spaces to be filled. The irreversibility of time thus corresponds to the condition that a word once written must remain in all subsequent editions of the book.

With these preliminary discussions, we can set down a provisional statement of the laws of eternity as follows:

- (i) Eternity is the condition of the co-existence of potentialities.
- (ii) Every occasion has its characteristic pattern of potentialities.
- (iii) Apokrisis is the property whereby wholeness manifests its relativity in eternity.
- (iv) The apokritical interval is a measure of the range of potentialities present in a given whole.
- (v) Every whole has a more or less coherent eternal pattern that determines its inner-togetherness and hence its ability to actualize without disintegrating.
- (vi) An entity whose eternal pattern occupies only one level in eternity is fully determined in all its actualizations.
- (vii) Levels in eternity form an ordered series of increasing apokritical interval up to the highest degree of potentiality present in the given occasion.
- (viii) Levels in eternity influence one another in such a manner that the higher level organizes the lower and the lower level disorganizes the higher.

3.8.4. Space as the Condition of Presence

Presence can be defined as the intersection of the potential and actualized states of a given whole,* and is thus the common support of such states. The intensity of presence corresponds to the degree of coherence or a given occasion.

The fundamental character of presence is sometimes incorrectly described as the property whereby bodies 'occupy' space. This—the 'receptacle' view of space—derives from a defective understanding of presence; but it has been uncritically accepted by philosophers since the time of Plato. In the *Timaeus*, space is treated as the receptacle or mother of all that exists. This Pythagorean intuition was discarded by Aristotle, and gradually the idea of presence was abandoned in favour of 'occupancy'. In consequence, Kant thought he could imagine 'unoccupied space'. It is certain that the success of Newton's scheme of absolute space and absolute time in the interpretation of the laws of motion had great influence upon philosophers of the eighteenth and nineteenth centuries. The Eastern philosophies, however, come much closer to experience in their understanding of space as presence—particularly the Hindu, in the concept of Akasha.+ A convincing discussion of the impossibility of conceiving space without presence is due to Poincare. "It is clear that we cannot represent to ourselves either space of four or of three dimensions, because we cannot represent them to ourselves as empty nor can we represent to ourselves an object in space of four or three dimensions."++

Nothing in our experience corresponds to awareness of space without objects. Moreover, presence is not confined within the visible surface of an extended body. Every whole has presence, but not every whole is an object in the sense of a well-defined shape and volume; even those that are bounded by a visible surface are present outside as well as inside it.

Every whole is present to every other whole; a situation that Whitehead recognizes in his concept of 'prehension'. "Every actual entity prehends every other entity." § This requires that every whole should be present everywhere; it is, however, convenient to distinguish this public aspect of presence from the private presence of a given whole. The term 'proper-presence' can be used to signify the sphere of the relationships within which a given whole occupies the dominating position. The presence of a given whole is thus its field of force. For

[* Cf. Whitehead, *The Concept of Nature*. This would correspond to the geometrical definition in which space is taken as stationary for time and eternity. f Cf. *Taittiriya Upanishad*. 1-6. Also *Chhandogya Upanishad*, 7-12. + Cf. H. Poincaré", loc. cit., p. 127. ++ Cf. Whitehead, *Process and Reality*, p. 309.]

example, the solar system can be conceived as a thin plate-like region in the plane of the ecliptic, with a diameter of about eight thousand million miles. Its distance from the nearest fixed star is about five thousand times greater than its diameter, so that a massive body at rest far beyond the outermost planets would begin to fall towards the sun. The proper-presence of the sun is thus an enormous region throughout which its field of force, both gravitational and electro-magnetic, is the dominating influence. A living organism also has a proper-presence that extends beyond the surface of its own body.

Presence is as much a characteristic of phenomena as potentiality and actualization. States of consciousness are no less present than material objects. Alexander argues correctly that mental wholes are subject to the determining-condition of space no less than physical ones: "Turning to space, we find that mind enjoys itself spatially, or is extensive in the same sense as it is successive and endures in enjoyed time."* Wittgenstein also recognizes presence in propositions.+ "Objects contain the possibility of all states of affairs. . . . Space, time and colour are the form of objects. ..." It is clear that it is presence rather than space to which he refers.

By replacing the misleading conception of occupying space by the notion of presence, we avoid the suggestion that space and time belong to fact. Extension and position are factual notions derived from presence. We know the facts about space but not space itself.

These conclusions can once again be summarized as prolegomena to the enunciation of the laws of space, as follows:

(i) Space is the determining-condition of presence. (ii) Every occasion is present. (iii) Presence is independent of potentiality and actualization; that

is, of eternity and time. (iv) Each whole has a 'proper-presence' that is the sum of its outer relationships.

(v) All wholes are present to one another. (vi) The common presence of two wholes determines a unique property, called an 'interval'.

(vii) Every proper-presence is determined by magnitudes that can be grouped in three independent sets. This is called 'configuration'. (viii) Every proper-presence divides space into three parts; one part wholly within and one wholly without it. The third part, which is common to both, is called its 'surface'.

[* Alexander, *Space, Time and Deity*, Vol. I, p. 97. + Wittgenstein, loc. cit., 2.014 2,0251.]

(ix) A proper-presence, regarded without reference to inner distinction, is called a 'point'.

(x) Space is the determining-condition of the co-existence of all proper-presences.

3.8.5. Hyparxis as the Condition of Recurrence

As does space externally, so does hyparxis internally serve to reconcile the mutually exclusive conditions of actuality and potentiality. That which is actual ceases to be potential; that which is potential has no actuality. It is true that, owing to the relativity of being, the balance of the two states may vary, but virtuality is not an intermediate form of existence, but rather a measure of the ratio between the two opposing states. There is a polar opposition and not a relationship. We must, therefore, seek for a triad in which a third independent reconciling force will serve to establish a relationship.

As elements in a triad, potentiality must be the affirming and actualization the denying force. Potentiality is the affirmation of a set of possible events—it is the pattern inherent in a given situation—whereas actualization is rejection of potentialities—the denial of the significance of the pattern as a totality in order to permit one of its facets to become actual. Actualization is a perpetual perishing, and because men have been aware of this they have doubted the ultimate reality of time. On the other hand, potentiality—though indestructible—cannot of itself sustain existence, for eternity is a storehouse to which no one has access until the doors are unlocked. We must therefore look to the third inner determining condition to provide a means of reconciling the antithetical influence of the first two.

The reconciliation of potential and actual results from the property of 'ableness-to-be'. That which is not able to be itself loses its potentialities in the moment of actualization. The more one is oneself, the more one is able to actualize without losing contact with potentiality. Referring to the triad value—fact—meaning, we can appropriately relate value to eternity, fact to time, and meaning to hyparxis. An essential characteristic of a meaning is that it can be recognized. A value experienced once can be none the less valid even though it is not related to any other values. Although facts can be classified and their common features made the subject of scientific generalizations, it nevertheless remains true that each fact is unique and unrepeatable. Values are what they are, once and for all; they do not perish, but they do not return. Facts perish, and they also do not return. Therefore the property of return and recognition must derive from hyparxis. Hence we can say that

in the same way as potentiality is the chief characteristic of eternity and actualization that of time, so is recurrence the chief characteristic of hyparxis. It is through recurrence that we recognize meanings. The science of pure meaning is logic which is independent of both fact and value.

The combination of identity and recurrence gives rise to the series of natural numbers. Through the class concept, a common meaning is attached to similar sets of objects, and hence arithmetic is primarily hyparchic in character. Through hyparxis it is possible to make analytical statements the truth of which is certain, although they cannot be verified by appealing to our knowledge of fact. Strawson gives an example to illustrate the possibility of constructing a purely abstract system in which the meanings are defined without reference to existence. Logical statements can be made in such systems that are evidently true and yet detached from any other interpretation whatsoever.*

In order to penetrate more deeply into the significance of hyparxis, we must see how meanings can never be more than approximate in actual experience. The abstract class concept 'five' has precisely the same meaning in all its applications, but only so long as we confine ourselves to the determining-condition of hyparxis alone. When we have to take facts into account and speak of five events or five possibilities, there can never be more than a common factor recognizable against a background of difference. The possibility of separating meanings from facts and values shows us how hyparxis is an independent determining-condition of possible experience. Its contribution consists in prescribing the extent to which any given whole is able to be itself. A bare actualization is the end of existence, a bare potentiality is its beginning. Between the two in some way

the existence achieves a certain measure of fullness.

The formation of a concept is only incidentally a process in time; in its primary significance it is an hyparchic concentration. The concept of a tree would be very tenuous if we had only one experience of seeing an actual tree. It is the reiteration of experiences having a common content against a background of difference that, little by little, produces in us a recognizable whole that is the idea of a tree.+ Commenting on this process of coming into existence by reiteration, Herbert Spencer refers to the transition from a condition of "indefinite incoherent homogeneity to one of definite coherent heterogeneity". The examples he gives refer to

[* Cf. P. E. Strawson, Introduction to Logical Theory, p. 102.

+ Cf. Campion and Elliot Smith, The Neural Basis of Thought, Chap. 2, 'The organic growth of a concept,'; also pp. 43-5.]

recurrence in time and tend, therefore, to obscure the true character of the determining-condition of hyparxis.

We must turn to Nietzsche, with his conception of eternal recurrence, and especially to Ouspensky's development of this thesis.* Ouspensky rightly grasped that repetition in time alone adds little to the significance of existence, and that it is necessary to postulate the return, not of a similar event in the future but of the same event at the same time.

Let us consider the illustration of drawing lots among a hundred people for the distribution of six prizes. The potentialities in such a simple situation amount to a million million distinct outcomes of the event. When the draw is made, one of the million million potentialities is actualized, and it is necessary to account for the co-existence of the unique event with the immense array of non-events. After the draw is made the tickets are scattered and in time nothing remains. We cannot, therefore, look either to the past or to the future for the preservation of the unactualized potentialities. We are, however, committed to the view that the potential exists equally with the actual, and, moreover, that potentialities must be conserved.

This conservation of potentialities cannot be accounted for in this type of event by the determining-conditions of time and eternity alone. In one sense it can be said that the potentialities, though dispersed, will remain localized in space. The tickets upon which the names of the non-prizewinners are written continue for a time to exist. When they are destroyed, the material of which they are made is nevertheless conserved. The consequences of the event continue to reverberate, influencing all the lives concerned. Although in this manner something of the event is preserved, the potentialities themselves have disappeared. That draw can never be made again. The problem recalls Zeno's paradox of the stream that cannot be entered twice. The paradox is usually ascribed to the misuse of language; for example, the attribution of 'sameness' to the instantaneous event and to the continuing process. Rejecting the paradox as ill-founded does not remove the underlying problem; that is, that of reconciling the two meanings of the word 'sameness'. The moment, with all its potentialities, really exists, but it is unique and unrepeatable. The process merges into the general stream of events: it cannot be uniquely identified. Its sameness is lost in the flux;

[* Cf. P. D. Ouspensky, A New Model of the Universe, Chap XI. There is an unfortunate misuse of language in the term 'eternal recurrence', for this confuses two quite separate elements of existence; namely, eternity as the storehouse of potentialities and hyparxis as the field of recurrence. The latter takes account of the way in which the stored potentialities are distributed among actualizations. Also M. Nicoll, Living Time, Chaps. 7 and 8.]

what we find again is never the same. What is the same can never be found, and yet both 'sameness' and 'againness' are equally valid constituents of our experience.

It is necessary to insist upon these difficulties and to realize that they cannot be resolved in the framework of

eternity, time, and space if we are to understand the significance of hyparxis. The determining-condition of hyparxis is such that the uniqueness of experience is conserved. The significance of this can be appreciated if we reflect that in both time and eternity uniqueness is swallowed up. In time it is lost in the flux of events in which nothing can remain itself. In eternity all potentialities are equal; none is singled out for the unique place. Before the draw is made, the six prizes are everywhere and therefore nowhere. All ticket-holders are potential winners, and therefore none is better off than the rest. At the moment of the draw, there is the unique distribution of six prizes to six people, but this situation quickly breaks down. The money is spent and eventually redistributed and disappears, until once more all the hundred participants are indistinguishable.

It is quite otherwise under the condition of hyparxis, where the event itself is conserved and repeated in such a way that the moment of suspense—when the million million potentialities are suddenly to give place to one actualization—returns again and again. It may be objected that we are familiar with this conservation of the uniqueness of a moment in the memory we have of events in the past, especially where they have the dramatic character described. This objection overlooks the limitations of memory. By far the greater part of what we call memory is only the reproduction of experiences, traced in the nervous system and reinforced by repetition. There is another and a rarer kind of memory in which the event returns and is re-enacted; but when this kind of memory is experienced, we recognize that it does not belong to the temporal actualization to which we are accustomed. It must, moreover, be observed that memory is not conservative. Our power of recall deteriorates and loses its definition. The potentialities that were in the moment itself are absent from the memory and, therefore, we cannot regard actualization, even when aided by the most complete power of recall of the past, as sufficient to ensure that potentialities are not lost. Hence the conservation of potentiality requires recurrence.

Furthermore, hyparxis is not repeated actualization in time; for time itself, as a determining-condition, imposes irreversibility upon each successive actualization. It is in this sense that we cannot step into the same stream twice, and yet it is also true, as Nietzsche and Ouspensky

affirmed, that everything is repeated and that we have at moments the inner conviction that this repetition is a part of our total experience no less authentic than the irreversible succession of events moving towards an end from which there is no return.

It is difficult at this stage to formulate even a first approximation to the laws of hyparxis, the character of which will only become apparent as we see more clearly what is involved in the reconciliation of eternity and time. For the present, the following provisional statement must suffice:

(i) Hyparxis is the condition of ableness-to-be. (ii) Hyparxis is recurrent in time, discrete and numerical. (iii) Hyparxis as recurrence is the reconciling factor between the affirmation of eternity as potentiality and the denial of time as actualization. (iv) The difference in ableness-to-be between two recurrences of

the same entity is called the 'hyparchic interval'. (v) Ableness-to-be depends upon sensitivity which is neither virtual nor actual.

(vi) The vanishing of the hyparchic interval occurs when all recurrences of the given entity are identical.

(vii) Hyparxis is primarily associated with meanings rather than with values or facts.

3.8.6. The Universal Laws of Phenomena

The determining-conditions of framework are directly given in experience. They select possible from impossible phenomena and, at the same time, they ensure the general coherence of experience. For example, the determining-condition of time relates past, present, and future experience, and the determining-condition of space relates the experience of the presence of different wholes. Eternity relates an actual experience to

the potential and hyparxis ensures the consistency and adequacy of the interpretation of experience.

In passing from phenomena to facts, we have to translate the determining-conditions into universal laws, which, taken together, constitute the framework of fact. These laws can be grouped by reference to the determining-conditions.

(a) Statistical Laws: These concern the rules for selection and combination that limit the possibilities inherent in any given

situation and turn upon the character of the determining-condition of eternity.

(b) Conservation Laws: These are of two types: those that prescribe possible motions and can be reduced to Hamilton's law of varying action; and those that concern transformations of energy and include the first law of thermo-dynamics and the laws of conservation of momentum, electrical charge, and spin.

(c) Laws of Irreversibility: These are connected with the nature of time and prescribe the conditions in which a system does or does not proceed towards its most probable state.

(d) Laws of Co-existence: These derive from the determining-condition of space. They prescribe the extent and limitation of the presences of different types of whole.

(e) Laws of Classification: These are the foundation of logic and arithmetic.

(f) Laws of Correspondence: These concern the connection between beliefs, knowledge, and truth.

The common characteristic of all such general laws is their universal applicability. Because they do not refer to function, they are independent of any specific manifestation. They are applicable to all gradations of being, though differently. For example, all being is subject to actualization in time; but actualization may be determined, voluntary, multi-valent, or creative, according to the gradation of being and, hence, the level in eternity to which it applies. Similarly, every whole has a presence, but the nature of that presence depends upon its level of being.

Our ability to describe facts is restricted mainly by the difficulty of reducing phenomena to knowledge, due to the defects that are inherent both in our sense-perceptions and in our forms of language. The difficulties of formulating the determining-conditions are not of the same kind. Formulations evade us chiefly because the conditions are too simple to be expressed in words without introducing misleading complications. It is true that the deep conviction—shared by most scientists and philosophers—that nature is simple, appears to be contradicted by the complexity of the functional element in phenomena. We find that the scientific method that consists in disregarding the distinctions of being is a two-edged weapon that serves at first, but later turns against its user. All the difficulties and confusions, however, can be kept within manageable limits, provided that we keep our attention upon the determining-conditions of framework. It is the

simple and ultimate character of these conditions that justifies our belief in the unity and uniformity of nature. If we can succeed in formulating the framework laws as far as possible without reference either to function or to being, we can use them later both as a means of avoiding error and also of unifying the results obtained in very diverse fields of investigation.

If the framework is right, every element of possible experience must find its place. Consequently, the adequacy and coherence of our systematics is the test of the correctness of our formulation of the framework laws.

Part Four - Systematics

Chapter Nine EXISTENTIAL HYPOTHESES

4.9.1. The Field of Scientific Inquiry

The natural philosopher has the task of showing how phenomena, with all their varying subjective qualities, can be reduced to a common basis of fact, susceptible of expression and communication by words and signs. The scientist, taking note of the procedures by which the reduction is accomplished, uses them to guide him in his own work of discovering regularities in phenomena which he, in his turn, will exhibit as facts. As a matter of convenience—perhaps even of practical necessity—the scientist limits the field of his inquiry to specifiable groups of phenomena. Since, however, phenomena are relative to a particular form of consciousness, the whole field—comprising all groups—is not precisely defined and it is therefore a matter of convention to prescribe its limits.

We must not lose sight of this conventional and arbitrary character of the delimitation of the field of scientific inquiry. Religious experience, for example, is usually regarded as a subject unsuited to scientific investigation. The reason given is that it cannot be approached through the methods of controlled experiment, measurement, statistical analysis, and so on. The significant point is that religious experience, in so far as it is authentic, is not 'phenomenal' in the restricted sense in which this word is employed in the present book. The same comment applies to artistic experience and, more generally, to all value judgments. We have equally to exclude from the domain of phenomena the various forms of hallucination and psychosis that can arise in either subnormal or abnormal psychological states.

Phenomena are thus the experience of the ordinary man in his ordinary states of consciousness. Using the conclusions reached in the last chapter, we can say that the phenomenal world is present in space, successive in time, potential in eternity, and held together by its hyparchic recurrence. We extend our knowledge of this world by reducing phenomena to facts. Combining this knowledge with our intuition of existential levels and forms of will, we can arrive at more or less adequate schemes for the exploration of our ordinary experience.

Phenomena are relative to our ordinary level of consciousness, and

they have therefore no fixed status. A landscape painter and a meteorologist, looking at the same sunset, perceive different phenomena; a taxonomic botanist and a farmer looking at the same field will notice different plants growing in it.

In the domain of phenomena, knowledge as the ordering of function can have no more than a technical significance, in the sense of more or less successful adaptation. If we wish to go beyond knowledge and to understand the world in which we live, we must give full weight to the discriminations of being upon which all values depend. In earlier centuries, men tried to harmonize fact and value by forcing all knowledge into a pattern that conformed to some preconceived view of the universal order. In Western Europe, for example, it was believed for more than a thousand years that any true concept of nature must conform to a Christian scriptural revelation. There is a twofold error in such a belief. On the one hand, our knowledge of fact is reached by eliminating the distinctions of being from phenomena; for, since phenomena are themselves subject to a particular form of subjective experience, knowledge of fact can never be more than an approximate representation of our ordinary experience and must, in addition, be subject to uncertainties that we cannot hope to remove. On the other hand, scriptural revelation—which, by hypothesis, originates from the experience of higher levels of consciousness—is transmitted to us through the medium of language. Language itself, however, is relative to being, and we have seen that the highest truths can be expressed only in the unique language of gesture. When these truths are, step by step, translated into the medium of common speech, it is inevitable that conventional and artificial ideas should be introduced that have the effect of obscuring the deeper meanings. Hence it is not possible to reduce revelation and knowledge of fact to any common denominator, either in experience or in language. Therefore, if an harmonious, unified structure is ever to emerge, we must endeavour to penetrate to the total experience of function, being, and will. Within

this given totality, we may set ourselves to examine, with the aid of the categories, the procedures of natural philosophy and the nature of revelation.*

We cannot carry either task to a successful conclusion in terms of function alone, and so must defer the search for a unified interpretation of all value-experience. We shall, therefore, now address ourselves to a re-examination of the foundations of natural philosophy, making use of the methods of legitimate abstraction and universal similarity,

[* The twelve categories do not include values, and in Vol. II we shall study those that are beyond Autocracy.]

and also of the conclusions we have reached as to the framework of the phenomenal world.

The first step is to search for the means of grouping wholes according to their level of existence; that is, according to the intensity of their inner-togetherness. The concept of eternity gives us the means of representing to ourselves the stratification of existence, each level being occupied by different types of whole. By definition, inner-togetherness has the unique inner relationship of 'more and less'; hence it is an intensive magnitude. We can perhaps learn something about it by analogy with one of the intensive magnitudes of physical science, such as temperature.* In its relativity and our dependence upon intuition rather than upon description for apprehending it, 'temperature' has many correspondences with 'existence'. This is not surprising, since temperature and existence both depend upon the energy present in a given whole. The difference is that existence comprises many different forms of energy, whereas temperature takes account of only one; namely, that of motions upon the molecular scale. The comparison of existence with temperature may help us to see what is meant by the assertion that level of existence is an intensive magnitude, independent of function. Air and water may be at the same temperature, although the functional distribution of energy in the molecules may be quite different. Similarly, two wholes may be on the same level of existence, although their functions may show no apparent resemblance.

4.9.2. The Relativity of Existence

The relativity of existence is observable throughout all phenomena. It applies equally to the living and to the non-living and it is common ground for any interpretation of physical or biological data. Scientists who favour mechanistic explanations recognize different levels of existence no less than do those who regard life as irreducible to physico-chemical terms. The doctrine of evolution, in whatever form it may be held, affirms that in the transformation of species life passes from one level of existence to another. Most writers on this subject agree that the intrinsic properties of the organism are enhanced in the course of evolution and that it acquires a greater degree of independence of its environment.+ These are the functional consequences of a greater degree of inner-togetherness; that is, of a displacement from one level

[* Cf. MacTaggart, *The Nature of Existence*, p. 242.

+ Cf. J. S. Haldane, *The Philosophical Basis of Biology* (1931), p. 132. J. Huxley, *Evolution* (1942), p. 564. J. B. S. Haldane, *The Causes of Evolution* (1932), p. 153. J. Needham, *Integrative Levels: A Revaluation of the Idea of Progress* (1937). J. H. Woodger, *Biological Principles* (1929), p. 426.]

in eternity to another. We cannot, however, take for granted that any functional description can suffice to tell us in which direction in eternity the displacement is made. It is well-known that there are non-adaptive forms that appear to have lost rather than gained in potentialities in the course of geological time.*

The relativity of existence is indeed so obvious that at all periods it has been recognized—though in different forms. No evolutionary conceptions are required to see that beings stand upon different levels. Aristotle laid the foundations of the natural sciences as we know them today, for he showed that each level of being calls

for its own appropriate methods of investigation. He also saw that it was necessary to establish a single scale of existence, beginning with inanimate objects and ending with man. He realized, moreover, that differentiations of form and function were of a secondary importance.

Shortly before Darwin popularized the idea of automatic evolution with his doctrine of natural selection, Geoffroy St. Hilaire set up a morphological scheme, based upon the idea that one single structure underlies all the diversities of form. The materialist biologists have sought to interpret the levels of existence in terms of function only. Whereas evolutionary biologists have been mainly concerned with problems of form and function, the philosophers of the various evolutionary schools have recognized the deeper questions raised by the gradual transition from lower to higher levels of existence.

A modern version of the scale of being is given by S. Alexander, who writes: "Roughly speaking, the different levels of existence which are more obviously describable are: motions, matter as physical, matter with secondary qualities, life, mind." He also refers to the 'natural piety' with which we should accept the relativity of existence.+

The levels of existence do not primarily concern the functional mechanism; that is, neither the form of its presence in space, nor the history of its actualization in time. The determining-conditions themselves do not import into phenomena the required relationship of more and less. ++ Existence is determined by the conditions of framework,

[* Cf. Huxley, loc. cit., Chapter 9, Section 4, 'Non-adaptive Trends and Orthogenesis'.

+ S. Alexander, *Space, Time and Deity* (London, 1920), Vol. II, p. 52. Alexander recognizes that "there would be nothing extravagant in supposing that electricity or light, for instance, were a substance anterior to matter in the proper sense". Here and elsewhere he anticipates some of the ideas developed in the present book.

++ Such a statement as this last apparently conflicts with the common usage according to which we speak of 'more or less time' or 'more or less space', but this is merely a careless use of words. If we wish to be correct, we should say 'a longer or shorter duration' and 'a greater or smaller volume'. Accurately, one duration is not 'more' than another any more than one circle is 'more circular' than another.]

but these are not responsible for its gradations. The relationship of 'more and less' is applicable both to extensive and to intensive magnitudes. We can say concretely 'there is more coal in this heap than in that one', and we can also say abstractly 'a ton is more than a hundredweight'. We only need to be sure that the comparisons are of such a nature that they can be reduced to statements of fact. If, for instance, we were to say, 'in this house there is more money than happiness', we should be using a form of speech that would have meaning only if the hearer could recognize the distinction of values implied. The extensive relativity of existence offers no difficulties of interpretation, since it can readily be expressed in terms of fact, and is given in our sense-experience of conservative actualization. The intensive mode, however, gives us some trouble, because it is not directly given in our sense-experience. In elucidating the character of eternity as a framework determining-condition, it was assumed that any given being could, without ambiguity, be assigned to a given level. We have now to examine this assumption and see how far our experience justifies it. The intensity of inner-togetherness is a single-valued property that should be assignable to a being in the same way as temperature is a single-valued property assignable to any body irrespective of its state or composition.

4.9.3. The Scale of Being

If there are different levels of existence, these either form one single ordered series, or else there must be parallel or branching hierarchies. On a superficial view, the second alternative seems to correspond best to the data of experience. Nevertheless, all attempts to set up a morphological *échelle des êtres* have failed. The

transcendental morphologists, from Buffon and Goethe onwards, came near to understanding the principle of structure, but they confused the unity of structure with the unity of existence and, hence, formed a wrong conception of the *échelle des êtres*—an error that is clearly noticeable in the great work of St. Hilaire.* Nevertheless, the insight of Goethe might well have led his followers to a new understanding of the principle of structure had the attention of the biologists not been diverted from morphology by the publication of Darwin's *Origin of Species*. The ubiquity of structure was lost to view and the conception of a 'form of all forms' gradually disappeared from biological thinking. Nevertheless, it is precisely in non-morphological, or unseen, living unity that the differences of level are hidden. We have therefore to consider the different kinds of [* Cf. G. de St. Hilaire, *Philosophie Anatomique* (1818-23).]

intensive magnitude that might serve to define different hierarchies of existence. We might, for instance, assess the status of material objects in terms of size, mechanical strength, density, temperature, and electrical and magnetic properties. With living organisms, we should be more likely to consider duration of life and stability of the internal environment; size, adaptability, and independence in respect of the external environment.* Human beings would be assessed in terms of bodily health, intelligence, character, experience, and so forth.

Upon a superficial view, these data seem to belong to quite different hierarchies and, even in any particular series, to divide into branches that diverge and lose any common feature that at first they might appear to possess. Aristotle places all animals in a single ascending series, from fishes and birds, through oviparous quadrupeds and viviparous mammals to man. According to him there is no branching in the series: "the race of plants succeeds immediately that of inanimate objects". Biologists who succeeded Aristotle have for the most part failed to penetrate his intuitions of being, and have been misled by similarities of function. Probably Goethe did not make this mistake; but, against other attempts to establish a scale of being, Cuvier rightly objected that "the pretended scale of being is only an erroneous application to the totality of creation of partial observations which have validity only when confined to the space within which they were made".+| We find, however, that all criticisms of a morphological scale of being are, for us, beside the point; for morphology is the functional aspect of structure, whereas we are searching for the invisible property by which existence is held together.

The characteristic modes of existence of such diverse wholes as a pulse of electro-magnetic radiation, a stone, the water in a lake, a living plant or animal, a state of consciousness or a memory, appear to be so different the one from the other that no single property would seem available to serve for their assessment. Notwithstanding all differences, these various wholes have in common the property of being more or less coherent entities towards which we can stand in a definite recognizable relationship.

4.9.4. Potency as the Criterion of Level

If we compare a stone with an animal, we can see that they both endure in time, but in quite different ways. One stone may be harder

[* Cf. the discussion of size in J. S. Huxley's *Problems of Relative Growth* (London, 1932)-

+ Cf. G. Cuvier, *Règne Animal distribué d'après son organisation* (Paris, 2nd edn., 1829), Vol. I.]

and more durable than another; one animal more adaptable and more viable than another. Both stone and animal are in a sense independent of the environment, but the word 'independent' has quite a different meaning in the two cases. Failure to take such shades of meaning into account, when using words referring to existence, has been the cause of many of the confusions into which biological and physical scientists have fallen.

Concerning any whole, whatever may be its functional structure, we can always ask the question: How far is

it itself? We can ask: How far can this whole be recognized by reason of what it is in and for itself and not by reference to the environment in which it is situated? A stone is recognizable by reason of its shape, size, colour, and so on; but if it is chipped or cracked we may say it is still the same stone, though somewhat changed. If it is split in two, we say that there are now two stones instead of one and the individuation of the original stone is lost; each fragment is now separately individuated. Furthermore, the long duration of a stone's existence must not disguise from us the fact that, like all other material objects, it is steadily and inevitably wearing away. Fixity of shape and long duration, however, give the stone a greater degree of individuation than that of a lump of clay, or of a heap of sand.

The individuation of an animal is of an order quite different from that of a thing. It can be characterized by its inner structure, which must not vary beyond certain limits if the animal is to preserve its normal state of existence. We can prescribe far more definitely what it means for an animal to 'be itself' than is possible in the case of the stone. Although we are forced to use verbal descriptions in order to indicate differences of being—thereby diverting attention from existence to behaviour—nevertheless, even when this is allowed for, there remains a non-verbal intuition that corresponds to the assertion 'the animal exists more than the stone'. This element in phenomena that cannot be reduced to fact proves, nevertheless, to be the very means by which fact can be discovered. There is nothing mysterious about this non-factual element in experience. We need no help from geologists and biologists to know that rocks and animals should be studied separately and by different methods. Nevertheless, for a geologist a rock is an individuated whole, endowed with its own mode of existence, no less than is a plant for a botanist, an animal for a zoologist or a man for an anthropologist. In every case, the whole thus individuated is something more than its function, and bears its meaning in itself.*

[* Cf. William Blake, *Proverbs of Hell*: "Everything that lives has meaning and needs neither suckling nor weaning."]

To exist is not 'to be' in general; but to be a particular representative of a species actualizing in an alien environment. Existence thus has a threefold character—hypernomic, autonomic, and hyponomic. The hypernomic character of existence consists in the potentialities with which a whole is endowed by reason of membership of a species. Thus a rose exists as a rose: that is, as a member of the genus *rosa*. Its potentialities are all derived from the genetic pattern common to all plants of the genus. The genus contains many species and a most complicated distribution of inherited characters, so that the pattern of potentialities comprises many varieties. We shall use the term *potency* to denote the maximum degree of individuation accessible to the members of a given class of wholes.

Potency is the assembly of potentialities within a given whole. It represents the limits of possible self-realization that are prescribed by a given class of wholeness. The richer and more significant the pattern of potentialities, the higher the level of being the given whole can attain. It must be emphasized that potency is not mandatory but permissive. No law requires that a given whole should realize its potentialities. Self-realization depends, not upon potency but upon ableness-to-be; that is upon an *hyparchic*, rather than an eternal, characteristic.

We are thus led to regard potency as the true basis of classification, by which entities are assigned to a given level of existence. Potency is not to be identified with being; it is, however, one element of being, namely that which affirms the pattern of existence. It thus stands in opposition to the actuality which, though the visible expression of the pattern, is nevertheless a denial in so far as it arises by the rejection of unfulfilled potentialities. The individuality of a given whole depends upon the manner in which that particular whole succeeds in reconciling the conflict of time and eternity. Individuation cannot serve as a basis of classification; for two given wholes—identical in their basic pattern—may have quite different degrees of individuation. For example, all acorns are equipotent; but their degree of individuation depends upon their ableness to fulfil the destiny of becoming an oak-tree. Potency, not individuation, is thus the sole criterion of level and we shall adopt it as the foundation of our systematics.

By reason of potency, all experience is stratified and the potency of the phenomena can be disclosed by abstraction of non-essential details. The method of legitimate abstraction is thus applicable to all phenomena. That this is so does not mean that we have any direct perception of the potency by which different gradations of wholeness are characterized. We observe a certain pattern of external behaviour,

and from this we infer that a corresponding whole is present. The inference could not be made from knowledge of behaviour alone, but requires a certain intuition of being. This is not a mystical intuition, but a sensitivity to potency such as that which brings the rocks to life for a good geologist. We have not only to recognize distinct behaviour-patterns but must also strive to relate them to our own intuitions of being and will. This striving is the process of hypothesis-formation, by which the natural scientist extends the frontiers of his knowledge.

4.9.5. Working Hypotheses

The schemes that the scientist constructs in order to bring his observations into harmony with his general beliefs regarding the order of nature, can be called 'working hypotheses'. They are essentially methodological and practical, and therein differ from philosophical systems. Moreover, they are generally limited in scope to a particular field of scientific inquiry. Nevertheless, the working hypothesis differs from a summarized statement in that it makes an assumption relating to being.* The distinction is by no means obvious, for we are not accustomed to regard the potency which lies behind the observed behaviour. A few examples will serve to illustrate this point.

Kepler's laws of planetary motion summarize a series of accurate observations and measurements made in the belief that the universe was constructed according to a pattern of periodicities that determine events upon every scale. He believed in astrology and sought for the music of the spheres. The Copernican hypothesis brought no immediate addition to the observed regularities, but it reinstated Aristarchus' intuition as to the being of the solar system. Our respect for Copernicus is derived more from the new sense of qualitative potency that, due to him, we now have in contemplating the solar system than from the quantitative interpretation that he gave to the planetary motions. This new awareness can be seen in the attitude of Galileo and Newton, who both recognized that Copernicus' laws were more than generalizations of fact, and therefore sought for the potency from which they derive.

In 1845, Faraday observed that a magnetic field would rotate the plane of polarization of a beam of light, but it was not until 1873 that these and many subsequent observations of experimental physicists were given existential status by Clerk Maxwell's hypothesis that radiation

[* Cf. Husserl, Criticism of Marty's Logical Studies (Second Logical Survey), quoted by Marvin Farber in Foundation of Phenomenology, p. 12: "The mathematician does not assert a universal proposition without first establishing the objects postulationally at the beginning of the deductive system, by means of existential assumptions."]

consists of electro-magnetic waves. His famous prediction of radiation outside the range of visibility led to Hertz's discovery of radio waves. Another deduction from this hypothesis—the existence of radiation-pressure—was not finally verified experimentally until the work of Bell and Green in 1933. Both these latter discoveries were made possible because of the existential character of Clerk Maxwell's hypothesis, that, for the first time, recognized that light and electro-magnetism are equipotent. This is true, notwithstanding the doubt thrown by subsequent experiments upon the 'existence' of the luminiferous ether, the vibrations of which were presumed to constitute the electro-magnetic waves. The history of electro-magnetic radiation theories is of great importance for our present theme, in so far as it serves to illustrate the 'unknowableness of being', and also the truth that the intuition of being is not to be expressed in words. We are thereby led to realize how the scientist, having made a discovery, searches for a functional interpretation and, in doing so, may mislead both himself and others. Nevertheless, any fruitful hypothesis, even though its form may

eventually be modified, remains valid in so far as it draws attention to a level of potency.

In 1885, Balmer observed that the spectrum of hydrogen contained lines that could be expressed by a numerical formula, the meaning of which, at that time, no one suspected. It was thirty years before Nils Bohr enunciated his working hypothesis of atomic structure and invested the purely empirical formula with an intuition of being.* Since the work of Bohr and Rutherford, the 'inner-togetherness' of the atom has acquired a significance that the observed regularities of the spectrum could never have evoked had they remained only in the form of empirical generalizations. Bohr's hypothesis led to far-reaching advances such as the electronic theory of valency. The force of Bohr's theory lay in the existential hypothesis that treated the atom as if it were a miniature solar system. Although this conception has since been abandoned, it nevertheless laid the foundations of modern atomic theory and led to Rutherford's conception of the atomic nucleus, with all its prodigious consequences for the life of man.

In the field of biology, Mendel's observations on heredity were summarized in his two laws—aggregation and independent assortment. Although these laws gave an accurate account of the transmission of inherited characteristics, it was not until they were interpreted in the light of Weismann's genetic hypothesis that the significance of the being of the reproductive cell began to be grasped. It is owing to this hypo-[* Cf. Phil. Mag. (1913), 26, and subsequent papers.]

thesis that we now have an intuition of the inner-togetherness of the sexual cells that goes far beyond their functional mechanism as disclosed in Mendel's laws. The genetic theory is pre-eminently one that establishes potency as the active principle that determines the pattern of development. An hypothesis is thus seen to be not solely, or even primarily, descriptive. Because it includes an intuition of being, it refers directly to phenomena and therefore can be the source for the discovery of new facts. In each of the examples cited above, the formulation of an hypothesis led to new observations. Another illustration of this characteristic can be seen in the discovery of meiosis, or the reduction-division of the chromosomes—made in the female cells of the ascaria in 1887 by Van Beneden and Boveri, and in the male cells by Platner some two years later*—phenomena which had already been predicted by Weismann from his own hypothesis. Similarly, the discoveries which Rutherford and others predicted—and subsequently made—after formulating the hypothesis as to the existence of the atomic nucleus, are evidence that something more than the functional regularities were involved. According to the interpretation we have given here, every working hypothesis relates to existence as well as to mechanism. It has no value as a mere catalogue of phenomena, and its real significance lies in directing our attention towards a specific pattern of potency.

4.9.6. Hypotheses and Determining Conditions

It must be noted that for an hypothesis to be of value, it needs to conform to the determining-conditions of framework. Because of the framework conditions, the hypothesis is confronted by the necessity of being brought into correspondence with the fundamental laws of nature. For example, the discovery of radiation-pressure brought Maxwell's hypothesis into harmony with the first law of thermo-dynamics. Moreover, the determining-condition of hyparxis prescribes the requirements of logical consistency that any useful hypothesis must satisfy. Henry Margenau specifies six requirements that a scientific hypothesis must satisfy in order to be acceptable both to science and to common-sense. These are enumerated as follows:

- (a) Fertility,
- (b) Multiple connections;
- (c) Permanence and stability;
- (d) Extensibility of constructs;

(e) Causality; and

(f) Simplicity and elegance.

[* Cf. E. B. Wilson, *The Cell in Development and Inheritance* (1900), Chap. 5.]

Margenau calls these requirements metaphysical, but they are very diverse in character.* Other no less convincing criteria have been formulated, and there is still argument among philosophers as to whether hypotheses are more, or less, than statements of fact. One school holds that an hypothesis is no more than a convenient way of describing a variety of facts, while another regards it as a statement about reality. The term 'construct', introduced by Karl Pearson,+ is often used in this connection with much the same intention as we have used the word 'fact'.

The meaning of a fact is the operation by which it is ascertained; that is, the steps by which we pass from phenomena to orderly knowledge. Of this transition from phenomena to facts, Margenau writes: ". . . experience, in becoming complete and integrated, moves from the sensory and spontaneous to the rational and reflective. By this transition, the elements of the given take on orderly traits and allow reason to take hold of them. Among the peculiarities of bare sense-data is a certain logical haze, a tangled connectedness which defies classification of mere data as individuals. For this reason, it is not possible to define datal experience in a manner other than denotive or extensive. The passage to orderly knowledge involves the positing of constructs, which are the rational elements to which datal experience is made to correspond. An external object is the simplest construct which we habitually set over against most kinds of sensory awareness."++

Margenau also prescribes rules for deciding whether a construct "is only scientifically acceptable or that it is part of reality". Confusion is then introduced from the start, because constructs are admittedly abstract. He says on the one hand that "abstraction is an elementary form of construction", and on the other that "construction is a creative as well as a synthetic act".§

Nowhere does he consider the distinct status of a working hypothesis, which is in his language a 'creative construct', whereas fact is an 'abstractive construct'. The creative construct is in our terminology a sign for a 'pattern of potency'.

The merit of facts is that they can be known; their defect is that they are not complete experience, for they lack the elements of both being and will. The working hypothesis stands closer to experience than fact because it comprises at least some reference to the element of being. In

[* Cf. Margenau, *The Nature of Physical Reality* (New York, 1950), Chap. 5. + Cf. Karl Pearson, *The Grammar of Science* (3rd edn.) p. 41. ++ Cf. Margenau, loc. cit., p. 72. § Cf. *ibid.*, p. 71.]

an hypothesis, there is always an intuitional element that is absent from a mere catalogue of facts. Moreover, an hypothesis says something about the form of events, thus referring not only to the determining-conditions of framework, but also to distinctions that we associate with will. It can therefore be said that upon the level of our ordinary human experience the formulation of an hypothesis is a foretaste of the work of objective reason, since it demands a combination of knowledge, consciousness and understanding.*

Hypothesis-formation is a moment of consciousness, wherein new understanding enters to transform knowledge. The scientist apprehends something that the facts alone do not disclose. Any doubt on this point must be dispelled by the accounts given by scientists themselves of the agonizing period during which the conflict between the new fact and the old hypothesis cannot be reconciled, and the relief when the new hypothesis reveals itself.+

Not only is hypothesis-formation distinct from the acquisition of knowledge, but it is also different in the manner of its communication. To 'understand' a new hypothesis requires, in general, a different kind of effort

of attention—and hence a different state of consciousness—from that which is sufficient to cognize a group of facts, even if this latter is quite complicated. To be sensitive to experience one must not be quite lost in fact.

4.9.7. The Existential Hypotheses

Working hypotheses are generally provisional in character, and can be modified, or even abandoned, without disturbing the general scientific activity within a given field. There is, however, a class of hypotheses which define the field itself—namely, those which assign a level of existence to entities of a particular range of potencies. These may be termed existential hypotheses and they are the basis of a systematic classification of the sciences. ++ In this connection we shall use the word entity to designate a particular whole referred to a specific potency. An entity is thus to be regarded as a member of a class of wholes that satisfy an existential hypothesis.

[* Cf. Henri Poincare, *La Science et l'Hypothese* and *La Valeur de la Science*.

+ A telling description of this process was given by Sir Lawrence Bragg in a broadcast made in 1946. See also J. G. Bennett, *Nature* (1944), Vol. 153, p. 130.

++ We should here note that Levy in his doctrine of 'isolates' recognizes that it is the inner potency and not the outer form that distinguishes one level from another. He writes: "An isolate has at once an internal structure with internal relations between the elements of which it is composed, and it has external relations in virtue of the fact that it is itself an element in a larger isolate" (p. 35). (*A Philosophy for a Modern Man*, pp. 34-42.)]

The existential hypotheses are the most powerful instruments of scientific investigation, for they enable each level of science to be defined with precision and at the same time serve to unify the various working hypotheses and to test their validity. Only when he can form a clear conception of the level of the entities he is studying can the scientific investigator direct his observations and experiments into fruitful channels. So, as we have seen, a defective existential hypothesis is better than none at all.

4.9.8. The Basic Hypotheses

We may start to systematize our conclusions by dividing existence into three great domains of sub-animate, animate, and supra-animate existence; we can search in each of these for a series of entities that have an equipotent structure. The result of this search is to demonstrate that there are twelve principal levels of existence, each characterized by a specific relationship of the three fundamental modes.

The systematic classification we introduce uses words of Greek derivation for the basic modes—hypernomic, autonomic, and hyponomic—and words of Latin origin for the twelve levels from uni-potence to duodecimpotence. Within each of the twelve levels there are gradations distinguished by the degree of completeness with which the characteristic properties of the level are exemplified.

The primary division turns upon the relative dominance of one of the three modes as against the others.

A. HYPONOMIC DOMINANT

The Basic Hypothesis of Physical Existence There is a class of entities dominated by the hyponomic mode, and therefore essentially passive in all their relationships both inner and outer.

B. AUTONOMIC DOMINANT

The Basic Hypothesis of Animate Existence There is a class of entities dominated by the autonomic mode and

therefore able to maintain a balance of reconciliation between their inner and outer relationships.

C. HYPERNOMIC DOMINANT

The Basic Hypothesis of Cosmic Existence There is a class of entities dominated by the hypernomic mode and therefore able to act as originating active sources for external relationships.

Within each of the three primary divisions there are four families distinguished by the level of hyparchic existence possible for them. Each level is equipotent.

A 1. Unipotent Entities Existential Indifference A 2. Bipotent Entities Invariant Being A 3. Tripotent Entities Identical Recurrence A 4 Quadripotent Entities Composite Wholeness

First Transitional Hypothesis Active Surface B 5. Quinquempotent Existence Self-renewing Wholeness B 6. Sexipotent Existence Reproductive Wholeness B 7. Septempotent Existence Self-regulating Wholeness B 8. Octopotent Existence Self-directing Wholeness

Second Transitional Hypothesis Biospheric Wholeness C 9. Novempotent Existence Sub-creative Wholeness C 10. Decempotent Existence Creative Wholeness C 11. Undecimpotent Existence Super-creative Wholeness C 12. Duodecimpotent Existence Autocratic Wholeness

We have now established a formal systematic for all branches of natural philosophy, and our final task in the present book is to relate the formal scheme to the data of observation and experiment.

Chapter Ten THE CLASSIFICATION OF THE SCIENCES

A. SUB-ANIMATE EXISTENCE—HYPONOMIC ENTITIES

4.10.1. The Character of Hyponomic Existence

According to the principle of relatedness, every event must be the resultant of three independent forces. We should, therefore, expect to find that all existence will disclose three independent components standing to one another as the affirming, denying, and reconciling elements of a triad. These we find in the hypernomic, autonomic, and hyponomic worlds. Hyponomic existence is a common ground of denial or passivity with many shades and gradations.

We observe in our experience entities that have neither the power to initiate activity nor the means of regulating it. They thus remain passive in all their actualizations. Hyponomic existence comprises not only entities passive in their very nature, but also the passive element in entities that have the potency for a reconciling or active role. We shall in the present chapter consider only those entities whose nature satisfies the basic hypothesis of hyponomic existence; that is, entities which are through and through passive by nature. These can be grouped in four principal classes according to their potency for individuation, and to the extent to which they possess an intrinsic or natural pattern. The most primitive mode of existence—the unipotent entity—can never be more than the mirror of its environment, to which it brings nothing but the bare fact of its presence. Even that presence is irrelevant ; for any other entity, irrespective of its nature, would serve exactly the same purpose. Bipotent and tripotent entities—even though hyponomic—can participate and be of service in the environment by way of force and relationship, but it is only the quadripotent entity that wholly exemplifies the nature of the physical world. This nature is 'thing-like' and every entity to whatever degree of potency it may rise continues to participate in the universal 'thinghood' by reason of the hyponomic elements in its constitution.

The systematic of the physical sciences turns upon the stages by which determinate thinghood is attained by progression from the indeterminate ground-state. The first stage is the entry of the hyle

into existence by its association with the framework determining-conditions. The primary sciences are thus those in which the laws of framework are studied without reference to any distinctions of being. We shall now elaborate the various existential hypotheses, but without any attempt at rigorous treatment. Their significance will emerge in the detailed studies to be undertaken in Book II.

4.10.2. The Hypothesis of Existential Indifference

The most drastic simplification of the problem of existence is to put it aside entirely and to study situations by reference only to unspecified entities having unipotent existence. By such an operation, we abstract from phenomena all distinctions of existence and also all differentiations of function, and are left with the irreducible determining-conditions of framework. The assumption that this is a legitimate procedure enables us to formulate the hypothesis of existential indifference thus:

There is a class of occasions, the laws of which are independent of the nature of the existents that participate in them. Only entities standing upon the first, or unipotent, level can participate in such occasions.

The study of phenomena without reference to existential distinctions helps us to formulate the framework laws in their most general form. The framework sciences are constituted by all the regularities discovered in phenomena that are independent of the existence of any particular kind of whole.

A few examples will serve to illustrate the subject-matter of these sciences.

(a) The sciences of generalized geometry specifying the conditions of all possible relationships of presence without restriction as to the manner in which the content is experienced. Metrical geometry is excluded, although this presupposes the existence of rigid bodies to which the hypothesis of existential indifference does not apply. These sciences refer mainly to space.

(b) The sciences of classical dynamics and pure—or Gibbsian—thermo-dynamics. These are also framework sciences in so far as no restrictions are placed upon the energy distributed in the systems studied and refer mainly to time.

(c) The statistical sciences—including the theory of probability and generalized field theory—are framework sciences that refer to eternity.

(d) Semantic analysis, arithmetic, logic, and the theory of cyclicity are framework sciences that refer mainly to hyparxis.

The common characteristic of the framework sciences is that they are applicable to all levels of existence and to every class of whole, but this does not mean that they could be discovered without the experience of phenomena. They are not, in the Kantian sense, a priori synthetic knowledge. Existential indifference does not imply no existence at all, and the framework sciences are as much derived from the data of experience as any others. They are discovered by selecting from phenomena those elements that are unipotent and therefore indifferent to distinctions of kind. The unipotent elements in experience can be reduced to facts by experiment, observation, and analysis. Reflection upon the facts thus established leads to the formulation of the laws of framework. The rules of the framework sciences are rigorously applicable only to unipotent entities. For this reason, their applicability is greatest in the lower strata of existence. The earliest evidences that man had gained insight into the form of framework laws are older than history. Men had learned to count and to measure even before they acquired the use of writing. A considerable mathematical equipment was possessed by the pre-dynastic Egyptian and the earliest Andean civilizations, both of which observed the stars and constructed calendars. Egyptian architects used the method of triangulation based upon the 3—4—5 rule at least four thousand years ago, and it is probable that they were already aware of the 'theorem of Pythagoras' upon which this rule is based. Certainly the Chaldean mathematicians of the second millennium

B.C. also knew of this theorem and had their own form of proof. The ancient Sumerians played games of chance and discovered the laws of probability. The framework science of probability, based upon these laws, gradually took final shape with the work of mathematicians from Laplace and Hayes to Pearson, Jeffreys, and Keynes. Although the status of probability as a framework science is not even now fully realized, it is yet seen to differ from other sciences by its indifference to the material to which it is applied.

The framework sciences are simple and primitive. They are built upon the common-sense generalizations that mankind has always made in the process of reducing phenomena to knowledge. An example commonly cited is found in the laws of thermo-dynamics, which, as Eddington remarked, teach us the nature of time. These laws, of conservation and irreversibility, are familiar in our common experience in the form of endurance and decay. Every recognizable whole exhibits to the world a certain 'sameness' against a background of 'other'. This

sameness must persist and, in persisting, it enables us to discern the character of phenomena. Endurance, or persistence in time, is thus seen to be an overriding condition inherent in all actualization, without which no occasion could be known at all. No less, however, does our experience assure us that what endures also decays and perishes. The accurate measurements and observations of physical science have provided us with an immense array of facts concerning endurance and decay, both of which can be expressed in terms of cyclic phenomena. Universal periodicity, which we express in the mathematical symbolism of the differential equation of the second order, is also a framework property by which all phenomena are characterized. It should also be clear that statistical laws are applicable to phenomena only when reduced to unipotent terms.

4.10.3. The Hypothesis of Invariant Being

Short of wholly disregarding the relativity of existence, the simplest existential hypothesis that can be framed is to assume that all wholes are bipotent. Since bipotence means 'either-or' existence devoid of inner distinctions, this would appear to be equivalent to assuming that every whole could be treated as a thing. This common-sense view, however, conceals serious possibilities of error. Things endure only for a limited time; their presence changes in passing from within to without their bounding-surface; they are in different states of aggregation and, consequently, they have varying degrees of rigidity; their internal energy differs and, therefore, they stand upon different levels of existence. In order to avoid error and to treat consistently of wholes without reference to such differences we set up as our second hypothesis that of invariant being. This can be formulated in the following terms:

There is a class of occasions in which entities behave as if they were exempt from mutual interaction and were self-identical and invariant with respect to all four determining-conditions.

This formulation assumes that there is a level of existence upon which all wholes can be treated as if they were present throughout space, actualized in all time, and self-identical on every level in eternity. Such wholes are devoid of all internal differentiation. For them, the relativity of wholeness consists in either existing or not-existing. Every such whole must be able to exist without suffering limitation from, or encroaching upon, the presence of other wholes.

As formulated, the hypothesis of invariant being seems to be completely

at variance with our experience of phenomena. We neither encounter, nor can we picture to ourselves, a finite extended body that could occupy all space—nor could two such bodies occupy the same space. This objection, however, turns upon the erroneous view of space as a 'receptacle', a view that we have rejected in studying the determining-conditions. Space is a form of relatedness, and there is no reason why we should not assume the existence of wholes that have single-valued relatedness, and therefore are present in all space. The same applies to the notion of invariant actualization in time. In our experience we do not observe objects that are exempt from change in time, but if we examine the subject-matter of dynamical science, we note that

the 'bodies' whose motions are studied are assumed to remain self-identical throughout their actualization. In dynamics it is assumed that measurements can be made that are possible only if rulers and clocks remain self-identical wherever they are used—an assumption that holds good for entities of invariant being. Although we recognize that the assumption can never be specified in absolute terms, we can approximate to invariance as closely as we wish by suitable experimental precautions.*

The justification for adopting the hypothesis is that in making the assumption that the objects of its study are self-identical throughout, dynamical science has achieved a very high degree of completeness, consistency, and precision. Many fictitious difficulties in the interpretation of dynamical data arise through the failure to recognize the basic assumption by which the scope of dynamical science is defined. There is, for example, the dispute between those who believe that all action must be contact-action and those who believe that there can be action-at-a-distance. Wholes of invariant being are present everywhere, and therefore they are always in contact. On the other hand, their contact can never bring about internal changes because, by hypothesis, they have no potency for change.

Invariant entities are self-identical under all the framework conditions. They are consequently insensitive to the direction of temporal actualization. Thus it is that we find that the laws of motion do not change their form when the sign of time is reversed. When carefully examined, it can be seen that the 'law of least action' is equivalent to the hypothesis of invariant being. We can therefore say that all phenomena to which the laws of classical dynamics and electro-magnetics apply belong to the bipotent level of existence defined by this hypothesis. It is indeed remarkable that so restricted a mode of existence should be found to

[* Cf. Henri Poincare, *La Valeur de la Science*. Chaps. 2 and 3. See also *Le Mesure du Temps* and *La Notion de l'Espace*.]

correspond to such an important group of phenomena as the motions of the celestial bodies and classical electro-magnetism.

Entities of invariant being cannot act upon one another. Their inner state is everywhere and always self-identical and they cannot enter into any exchange processes. Nevertheless, they do appear to exert a force by reason of their mutual presence—a condition that is assumed in our study of planetary motions. We know that the sun and the planets participate in intense and complex energy exchanges; the very fact of observation requires an exchange of energy through light signals. Yet, over the period of time during which we observe them, the proportion of their total mass involved in these exchanges is negligibly small and, for this reason, they behave as if the hypothesis of invariant being were satisfied.

Bipotency can also be called 'polar existence', and it is therefore the level most directly associated with the division of energy into two forms—potential and actual. The sciences of invariant being are mainly concerned with the behaviour of bodies in a field of force.

4.10.4. The Hypothesis of Identical Recurrence

In extending our field of inquiry to include phenomena of spatial location and temporal change, we have to adopt a third existential hypothesis, that of identical recurrence, in which the restriction of invariance is relaxed. It may be formulated as follows:

There is a class of occasions in which entities behave as if they were exempt from any but reversible interactions and were subject only to cyclic changes in their inner constitution.

We can assume the existence of entities that do not change, but can be present or absent in a reference system determined by other bodies. Such an existence is possible only if the determining-conditions of time and eternity are exactly balanced in such a way as to enable the potential in eternity to compensate the rate of

temporal decay, or to annul it. An entity of this kind is a perpetuum mobile, renewing itself exactly and capable of being annihilated, but not perishing by the usual processes of decay. The existence of such wholes can be understood in general terms if we think of time as using up potentialities and of eternity as creating them. If these two tendencies were exactly balanced for a given entity, this latter would re-occur indefinitely in the two directions of time and eternity; the forces acting upon it from within would exactly balance those acting upon it from the environment, so that it would be free from all internal strain. In other words, we should have an ideal closed

system, having its own inner structure, but such that nothing would either enter or leave its presence.

Once again we seem to have denned a mode of existence that does not correspond to anything in our phenomenal world and is therefore not 'observable'.* It so happens, however, that in physical science situations are encountered that satisfy to a high degree of approximation the hypothesis of identical recurrence. Tripotency corresponds to the gradation of existence occupied by the unit particles of physics—the nucleons, out of which all the actualized masses of the universe are built up. These exist in such a manner that there is no change of thermo-dynamic potential between one moment of observation and another, and this applies equally to the particle and to the wave-aspect of such entities. It is not the case, however, that all events in the world of the ultimate particles and electro-magnetic radiation are tripotent and limited by the hypothesis of identical recurrence. On the contrary, we can, and do, observe exchanges of energy and inter-conversions, and also transitions from one level of potential energy to another. These are, however, 'all-or-nothing' changes, and they do not invalidate the basic hypothesis that we are entitled to regard these entities as normally exempt from any gradual or partial modification of their nature. This is illustrated in a type of occasion that is believed to occur in almost all states of matter; • namely, that in which the non-radiating electron, occupying a specific energy-level, recurs indefinitely until an 'all-or-nothing' transaction occurs that will cause it to disappear from its existing actualization.

Identical recurrence corresponds to the level of existence where entities can be related without interaction. In the kinetic theory of gases, the constituent molecules are assumed to have no existential status other than that of stable vibrational systems, and hence they satisfy the hypothesis. In statistical mechanics and also in applied thermo-dynamics, we meet with situations in which the hypothesis of identical recurrence is implied, even if not specifically recognized. We thus have a group of sciences which study phenomena that are exactly recurrent and repeat themselves cyclically in time. These studies include not only the electro-magnetic theory of light, but the greater part of statistical mechanics and also the quantum theory. The importance of tripotency derives from the fact that it characterizes that level of existence at which we find the omnipresent, recurrent phenomenon of electro-

[* Cf. A. S. Eddington, *The Nature of the Physical World*, p. 239. In discussing the relaxation of postulates to enable systems to be defined, Eddington asks: "But how can a theory of steady conditions provide anything for observation to get a grip on? Those influences from the external world which reach our senses are due to change and transition."]

magnetic radiation. When projected into eternity, an entity of identical recurrence occupies three distinct states:

- (a) that which contains all its potentialities,
- (b) that which contains the lines of its actualization, and (c) that which contains its recurrence.

4.10.5. The Hypothesis of Composite Wholeness

Hitherto we have completely disregarded the inner character of the entities that participate in the occasions studied. The step now to be made will enable us to describe situations in which the essentially composite

nature of all entities that we encounter in our common experience can be taken into account. It is, however, necessary to restrict the hypothesis to include only the one feature needed. This feature is the presence within a single whole of the twofold property of endurance in time and decay in time. Such a property cannot be ascribed to any whole whose existence has the 'all-or-nothing' character hitherto considered. Only a composite whole can remain itself while at the same time wearing away, and so we can formulate, as the fourth existential hypothesis, that of composite wholeness, as follows:

There is a class of occasions in which entities enduring in time behave as if subject to both interaction and change and yet remain wholly passive in their inner and outer relationships.

Composite wholes rely for their existence upon a superabundance of potentialities that enable them to undergo modifications that are relatively small compared with their total existence. The potentialities of even the simplest molecular structure far outnumber the possibilities of actualization. To exist by drawing upon large reserves is characteristic of composite wholeness which, for this reason, can also be called 'enduring wholeness'. There is a very wide range of entities that satisfy the hypothesis. When commensurate with the scale of our own existence, composite wholes are the familiar 'things' of our common experience.

In general, composite wholes have a limited extension in space and a limited endurance in time, but a very large store of potentialities in eternity. In consequence of the restricted nature of their possible actualizations, their potentialities can be conserved only by almost identical recurrence in hyparxis. Nevertheless, being quadripotent, they have scope for a limited degree of adjustment between eternity and time.

There is, nevertheless, a mediative change in passing from the third to the fourth existential hypothesis; that consists in the entry of one of

the characteristics of all existence; namely, the superfluity of means for the attainment of ends. As the complexity of an entity increases, potentialities multiply out of all proportion to their possible actualization, and this makes possible the paradoxical combination of passivity and adaptability that we observe in the physical world. A 'thing' is not a 'being' and yet it has an unmistakable ableness-to-be. This ableness-to-be is quite different from the fixed self-identity of an electron, which cannot change without ceasing to be itself.

Composite wholeness ranges from the helium nucleus to the greatest cosmic structures. Atomic nuclei are degenerate quadripotent entities in so far as they lack spatial presence. True composite wholes begin with molecular complexes such as we find in the crystallite or micellar structure of solids. From this narrow base they spread out to include all kinds of material objects, in so far as these are studied from the point of view of primary stability and secondary change. Quadripotence is the characteristic mode of hyponomic existence in which an entity can actualize by reason of its own constitution, but cannot draw upon its environment to restore its own togetherness. All branches of physical science that are concerned with the properties of matter fall within the general domain of this hypothesis.

4.10.6. The Transitional Hypothesis of Active Surface

In the ascent of the hyle, life is reached by a transition that marks one of the great moments of existence. It is at the fifth level of potency that entities can become active or reconciling in relation to their environment. By definition, the nature of hyponomic entities is to be essentially and always inert. They cannot react selectively to their environment, for the whole of their actualization takes place within an apokritical interval that does not admit of selection. Living organisms, on the contrary, can—and do—react selectively to their environment. Between inertness and selective reaction there is a step that serves to link the non-living and the living worlds. In this region we encounter situations in which there is interchange of hyle, but no free potency. Interchange is something more than the migration of hyle from one region to another; it is the transfer of ordered groupings in such a manner that the energy and entropy balance is shifted in favour of one region at the expense of another. For this to occur there has to be a bounding-region across which the interchange takes

place. Where there is no such boundary there can be change, but not interchange. Since at this stage there is a characteristic mode of existence, we shall here adopt the transitional existential hypothesis of active surface:

There is a class of occasions in which entities behave as if their wholeness were maintained by a pattern of potentialities that enables exchanges of hyle to take place across their boundary surface without loss of identity.

The hypothesis affirms the existence of entities whose very nature consists in undergoing exchange of hyle without loss of identity. Such entities should properly be regarded as a special class of composite wholes, for they still have not the fifth level of potency that gives an entity the power to be more active than the medium in which it exists. The chief difference between entities of active surface and the preceding class of composite wholes, lies in the presence of a potential energy gradient observable in space.

All the material objects of our common experience are, strictly speaking, two-phase systems, for they are imperfect solids with porous cracks and fissures, at the inner surface of which gases or liquids are always present. This is not their characteristic feature, however, for the absorbed fluids play only a minor part in their behaviour. The co-existence of two or more phases becomes significant only when there is an active surface and hence exchanges of energy take place. The possession of an active surface is commonly associated with the colloid state, and colloids are entities that typically satisfy the hypothesis. In a colloidal system, the surface properties have a greater significance than the property of composite wholeness. The stability of the colloid depends upon the structure of the atomic lattice. The step in the hierarchy of existence made in passing from composite wholeness to active surface turns mainly upon the new and enhanced significance given to energy by its partition between different constituent parts of the system. A non-uniform distribution of energy, however, is not sufficient to characterize the new type of occasion. For example, an iron bar heated at one end and cooled at the other is not a system of interchange but a state of transflux equilibrium, since for true interchange to occur there must be a surface at which there is an actual discontinuity in the distribution of energy.

A colloid comprises two phases—one continuous and one disperse. It is a system that has the property of possessing an enormous internal surface compared with its mass or volume. This surface is the partition between the two phases and may be very large where the state of subdivision is very fine. It is misleading, however, to speak of 'colloidal particles', for the mere fact of subdivision does not make a colloid. The crystallites—recognizable as units in a crystalline structure—may have

the same order of magnitude as colloidal micelles and yet constitute a quite different state of matter.

Size is of especial significance in a colloidal system. The minimum size of an independent colloid system is many hundreds of times greater than the smallest molecule that satisfies the hypothesis of composite wholeness. The colloidal region is a range of sizes from one millionth to one thousandth of a millimetre—a size-range that applies to the particle size of the disperse phase and is the region that—less than fifty years ago—was called by Ostwald 'the world of disregarded sizes'.*

The hypothesis of active surface is satisfied by entities, such as the proteins and nucleic acids, that have an eternal pattern so rich in potentialities as to enable them to exert an organizing influence upon their environment. Such entities, though not living, are nevertheless different in nature from the wholly passive composite wholes. They are invariably colloidal in character and exemplify the immense significance of active surfaces in the transition from the hyponomic to the autonomic world.

4.10.7. The Bifurcation of Existence

The colloidal micelle is a unit of existence that can be extended in two different directions. The first leads towards greater size, duration and complexity of function and the other towards greater inner-togetherness.

The visible world about us is mainly built up from the aggregation of colloidal particles—crystalline structures are far less important than colloids. The complex physical and chemical reactions upon which the life of nature depends—in the inorganic no less than the organic world—are made possible by the presence everywhere of active surfaces. Organic life on earth in its entirety is an active surface phenomenon and even in the galaxies we can observe active surfaces at the plane of intersection of star populations of different kinds. The totality of such manifestations—whatever may be their scale of size and duration—remain within the limits of hyponomic existence. They constitute the universal linking-ground by which the active and passive forces are brought into fruitful contact. Notwithstanding their cosmic importance, they do not constitute a special class of entities requiring a new existential hypothesis.

It is otherwise with the inner way where the active surface becomes associated with the new forms of inner organization that make life possible. The transition from hyponomic to autonomic existence is made through the proteins and acids from which protoplasm is built.

[* Cf. Wolfgang Ostwald, *Die Welt der vornachlassigten Dimensionen* (Leipzig, 1909).]

The combination of protein and nucleic acids that gives biochemical activity leads to the enzymes that stand at the threshold of life. The ways that open at the first great bifurcation of the hyle leads in one direction to the universal hyponomic existence and in the other to the universal autonomic existence.

Chapter Eleven THE CLASSIFICATION OF THE SCIENCES

B. ANIMATE EXISTENCE—AUTONOMIC ENTITIES

4.11.1. The Character of Autonomic Existence

Everything that lives participates in the power of reconciling existence with non-existence. This power is autonomic: it is relatively individuated and independent. In order to reconcile any two opposing impulses it is necessary to participate in the nature of both and yet not to be subordinated to either. Throughout all its manifestations, life has this twofold character. Notwithstanding the great differences of level that separate the lowest and the highest forms of life, all forms have to some extent the paradoxical property of being themselves only by the help of what is not themselves. Nutrition, reproduction, self-preservation, and other recognized characteristics of life depend upon the power to extract from an indifferent or hostile environment the very materials and the very conditions required for an autonomic existence. It is the ableness to use the environment that distinguishes living from nonliving wholes.

Autonomic existence is subject to all the physical laws of hyponomic existence, yet it is able to adjust itself to these laws in such a way as to serve a law higher than itself. For example, by fixing carbon from the atmosphere, green vegetation produces a result that could not occur spontaneously under terrestrial conditions and, in doing so, serves to maintain the existence of all life on the earth. The enzymes that regulate nearly all the chemical reactions of living tissue are themselves hyponomic; yet, contrary to the laws of hyponomic existence, they can so change the speed of transformations in the living environment as to enable a higher potency to be derived from a lower. Such transformations are essential for maintaining the higher forms of existence.

The power of life to use hyponomic existence for its own and higher purposes turns upon the fact that it penetrates into the quinqué-potential region where the barrier that separates time from eternity begins to be overcome. Until this level is reached we do not find entities whose potency can be manifested in time. No ordinary composite whole—that is, no 'thing'—can influence by its own pattern the actualizations

that proceed within and around it. In this consists its passivity. Autonomic existence—even at the lowest level—acts upon its environment and disturbs the orderly process of energy transformation in the interests of

its own individuation. We shall find throughout our study of animate entities that there is evidence that potency upon the fifth level changes the course and the speed of visible transformations.

4.11.2. The Hypothesis of Self-renewing Wholeness

The potential energy of colloidal matter is not organized. A recognizable step in the emergence of life is made when different layers in eternity begin to develop an organized interaction. Here we pass from active surface to active volume; that is, to the kind of entity that is able to preserve its own identity in a changing environment. The significance of this step consists in the power of such entities to maintain their existence, not merely in spite of the environment but at its expense. This is the first and most primitive characteristic of biological wholeness, and we can formulate the hypothesis of self-renewing wholeness that:

There is a class of occasions in which the duration of existence in time is prolonged by the renewal of potential energy at the expense of the environment.

The self-renewing entity has an autonomic organization that regulates its behaviour. For this property to be manifested, the entity must have a minimum extension in space. The average size that is sufficient for colloidal stability is approximately the same as that which is to be found at the threshold of self-renewing existence. All entities that use their environment are endowed with life, but we must remember that life—as a being-property—must be relative. It is not an attribute uniquely defined, which can be either wholly present or wholly absent in a given actualization. We commonly speak of an 'organism' as being either alive or dead, and a 'thing' is regarded always as non-living, but the distinction so made refers rather to function than to being. We tend to say that an organism is 'alive' when it behaves in a certain way, and that it is 'dead' when that behaviour ceases. Nevertheless, we cannot avoid the feeling that such a description misses some essential point. Mechanisms have been constructed that reproduce much of the behaviour-pattern of living organisms, and we can conceive of others that would go still further in this direction, yet we should not feel that even the most astonishing cybernetic mechanism could properly be called alive.

These misgivings arise from our intuition that life is not a kind of behaviour. There is a structure of potencies and, according to the

principle of structure, there must be discontinuities in the transition from one quality to another. The first appearance of autonomic existence must occur at one such point of discontinuity. Nevertheless, this must not be taken to imply that the hyle in its ascent jumps over an open gap; it is rather that a new qualitative factor enters. There can be no sharp line of demarcation below which all is lifeless and above which all is living. Biological science has indeed demonstrated that the various characteristics of a living organism make their appearance at different levels of organization. The hypothesis of self-renewal asserts that there are entities that exchange energy and matter with their environment in such a way as to maintain their potentiality in the midst of change.* In this sense, life is something unique that stands apart from other modes of wholeness. Since, however, there can never be exact correspondence between the inner needs of the given whole and the resources available to it in the environment, self-renewal cannot continue indefinitely as an automatic process.

The property of self-renewal is of special importance from the standpoint of the inner-togetherness of an occasion. It indicates a potency that can do more than balance the inherent tendency of every system to fall towards its most probable state. The self-renewing organism does more than maintain itself in equilibrium with its environment: it can select active constituents from without, and reject passive constituents from within, its own surface. This type of exchange-process starts at the border-line between protein-chemistry and bio-chemistry. The sub-cell virus which exhibits this property is very little larger or more complex than the largest protein molecule—or even such an intermediate form as the enzyme—nor has it any visible structure that would account for its autocatalytic powers. It must, therefore, have an apokritical interval in eternity, far greater than that of any of the most complex chemical substances such as protein, thus admitting a structure

of five equi-potential layers, able to interact and so to make self-renewal possible. We see here exemplified the fifth law of eternity, according to which the higher level organizes the lower but suffers a disorganizing influence in its turn. Self-renewal prolongs existence but cannot perpetuate it, for sooner or later the power of assimilation and transformation breaks down and the living tissue dies—renewal delays, but does not overcome death'. The characteristic quinquopotent entities are the enzymes and viruses, which constitute a whole range of levels and yet share in the common property of self-renewal. It will be recognized that self-renewal is a mode of linkage between eternity and time.

[* Cf. E. Schrodinger, *What is Life?*, p. 72.]

4.11.3. The Hypothesis of Reproductive Wholeness

Another decisive step in the scale of existence is made when we pass to occasions in which entities reproduce their own existence outside themselves and thus establish the continuity of life itself. Self-reproduction is commonly classed with nutrition as a characteristic feature of living organisms, but it is a property of a higher order in the scale of being than nutrition and it implies an altogether higher mode of inner-togetherness in the entities that exemplify it. Reproduction is associated with certain basic properties, such as irritability, conductivity, assimilation and excretion, respiration and secretion—all of which are present in the more primitive wholes that are capable only of self-renewal. The properties of growth and regeneration associated with reproduction imply a pattern of potentialities of a higher order. We can therefore adopt as our sixth hypothesis that of reproductive wholeness as follows:

There is a class of occasions in which self-renewing entities can reproduce outside their own surface other entities similar to themselves.

This requires a sexipotent existence and we can recognize the connection between reproduction and the sixth category of recurrence.

The simplest living whole that can reproduce its own existence is the cell, for viruses cannot do so when isolated from a cellular host. Living cells, found either in the form of unicellular organisms or as the cellular constituents of plants or metazoa, are wholes with this power of reproduction. It is sometimes said that the cell is the basis of life, for every form of life—even that of the sub-cell viruses and phages—depends upon cells for its existence. A cell is a whole contained within an active surface. This mode of existence permits a higher degree of organization than is possible at any earlier stage, but it is not sufficient for self-regulation.

One of the great problems of the biologist is to account for the development, distribution, and power of adaptation of the functional mechanism in a living whole without invoking some non-material agency that maintains itself unchanged through all the dramatic changes that the organism undergoes. It is at this point that the need to admit an invisible, though material, structure becomes inescapable. The living cell comprises a series of six layers, each standing from the next at an apokritical interval sufficient to maintain the potential energy required to balance the disturbing effect of the environment and the inner tendency towards degeneration. These six layers, taken together, constitute the eternal structure of the cell and endow it with the power not only to renew its own substance, but to reproduce its kind. This process is seen in mitosis,

where the cell divides to produce two new units, the structure of each of which is almost identical with its own. This overriding unity is seen also in the fusion of unicellular organisms, whereby the potency for reproduction is restored.

The cell has not only two-dimensional surface properties, but also a three-dimensional inner structure; that is, an active volume. The existence that proceeds within a cell has its own complex organization. The cytoplasm always has numerous granules of various kinds floating in it. The golgi bodies and the mitochondria are self-renewing granules belonging to the lower order of existence that comprises also the viruses and enzymes.

Furthermore, the smallest cell is near the upper limit of size of the sub-cellular, self-renewing structures, just as these in their turn begin near the upper limit of size of the colloidal micelles.

Generally speaking, the cell world is subordinate to the world of organism. Both in plants and in animals the cells depend upon the specific environment of the tissue in which they are placed and without which they could not manifest their characteristic activity. This would suggest that the apokritical range of the cell is only sufficient to give a potential that can maintain itself in an environment that contains the requisite nutritive material. Such dependence, however, is only relative, for in the protozoa we encounter self-reproducing entities that do not depend upon the support of specific tissues. Even so, the protozoa can exist only in an environment that has about the same stability as the body fluids of an animal or plant, and therefore there is no reason for supposing that the protozoan animal requires an apokritical structure very different from that of tissue cells.

The character common to all cells is a stability of pattern that certainly cannot be accounted for in terms of the physico-chemical structure alone. This pattern of cell-life transcends the existence of the individual, and impresses itself upon innumerable generations. It is this stability that points unmistakably to an invisible organization. By the principle of relatedness, we should infer the presence of three distinct levels of organization. Between the unchanging pattern and the visible cell actualizing in space and time, there must be an intermediate level that serves as a link, or reconciling factor. The mutual adjustment of these three levels is the eternal organization of the particular form of cell-life concerned. The apokritical interval between the highest and lowest level must be sufficient to produce a potential energy not less than that required for regeneration of the whole. The cell can be called the 'atom of life', for it occupies a position in the autonomic series roughly corresponding to that of the atoms in the hyponomic series.

4.11.4. The Hypothesis of Self-regulating Wholeness

Self-regulation requires two distinct sources of order. One is the specific plan or pattern towards which the whole existence of the organism strives to conform; the other is the immediate balance that enables it to adjust itself to environmental patterns. Consequently, the self-regulating entity must have an apokritical range comprising an additional layer to that which suffices for reproductive wholeness. Certainly all organisms must exhibit renewal and reproduction, but they also show essential features of structure and behaviour by which they can always be distinguished from lower forms of life. The metazoan animal is characterized by a stable differentiation of tissue that allows a corresponding differentiation of function, allowing not only self-renewal and reproduction, but self-regulation. Self-regulation is the property by which the organism differs essentially from the cell, since it requires an organization of a higher order than those of self-renewal and reproduction.* We now require an hypothesis exemplifying the complete seven-fold structure of potency, septempotence, and shall formulate the hypothesis of self-regulating wholeness as follows : There is a class of occasions comprising entities able to maintain and

regulate a functional balance within their own enclosed surface or skin.

Every living organism is a complex colloidal system of gas, liquid, and solid phases, distributed through a cellular complex. Its component cells are differentiated in groups into characteristic tissues, each with its functional significance for the life of the whole. The functions of a living organism are all subordinated to a fundamental cycle of birth, growth, maturity, senescence, and death. Nothing fully corresponding to this cycle is to be found upon any lower level or organization.

It is not necessary to elaborate these arguments to establish the appropriateness of the general hypothesis of self-regulating wholes as a mark to distinguish one of the chief divisions in the scale of existence as it is known to us. We should, moreover, note that by reference to the determining-conditions of framework, we find that the organism has a presence fundamentally different from that of lower forms of existence. Its actualization is concerned not only with its own self-renewal, but with an action upon the environment that

connects the past with the future.

Individuation properly speaking begins with self-regulation. Even the freely moving protozoan animal is not individuated. Though the

[* Claude Bernard expresses this property in his dictum: "The fixity of the inner medium is the condition of free life." In this connection Maurice Vernet has emphasized the narrow limits of regulation that each species maintains.]

members are often scattered over great distances and not connected by any functional organization, the species is nevertheless the whole upon which the protozoan animal depends. This can be seen particularly in its mode of reproduction, which lacks the mechanism of hereditary partition, without which the individual organism cannot have the unique genetic constitution that characterizes both plants and animals.*

All these characteristics, taken together, justify us in regarding the hypothesis of self-regulating entities as determining one of the fundamental divisions in the scale of existence. Within this division there are not only separate levels, but also different manifestations of organic structure such as the vegetable and animal kingdoms. The living organism occupies the central position in the scale of existence, and it is here that individuation acquires the rudiments of independence; for its presence can be said to be independent of its environment in so far as it is able to extract from it, and assimilate, the substances it requires for maintaining its own inner potential without blending with that environment.

Every living organism has a structure in which several different levels in eternity participate. The respective contributions made by different levels to the structure of a given species lead to broad classification, but however great the differences between one organism and another may be, the members of the species taken all together form a group with characteristic laws that we do not discover either upon lower or upon higher levels.

It is most important to note here that sexual reproduction begins with the septempotent entity. The completeness of its structure enables it not only to individuate, but also to participate. By reason of sexual reproduction, there is a sharing of organizing potency throughout a species. This gives both stability and flexibility to a degree not possible at any lower level of existence.

Although the living organism as a septempotent structure can individuate, it is, however, automatically regulated by the specific structure derived from heredity and the environmental conditions of its conception, birth, and development. It is no more than a wonderfully adjusted machine, very often able to adapt itself to a wide range of conditions, but it remains a mechanism with no possibility of changing its own status. It is incapable of completeness, for this requires an eightfold structure that goes beyond self-regulation.

[* The argument here refers to three levels of existence characterized by the properties of self-renewal, self-reproduction, and self-regulation respectively. Viruses, cells, and metazoa are typical occupants of the three levels. There are, however, exceptions. Some unicellular organisms exhibit both isogamy and heterogamy, whereas there are also highly developed organisms that have a narrowly fixed reproductive cycle.]

4.11.5. The Hypothesis of Self-directing Wholeness

Upon the sub-animate levels of existence the determining-conditions of framework have fairly clear and distinct significance. The time-like properties of matter are quite separate from those that derive from its eternal self-apartness. In living organisms there is the close and unceasing influence of the eternal pattern upon the temporal actualization. Time and eternity begin to merge, but the characteristic relationship between eternity and consciousness has hitherto remained in the background. At the eighth stage, we reach the

decisive moment where that which has hitherto been essentially mechanical begins to acquire the characteristics of self-determination, independence, and freedom. These qualities emerge when entities arise that have the power to relate, in their own consciousness, more than two separate lines of actualization. This power enables them to pass from automatic self-regulation to conscious self-direction and we can formulate our eighth existential hypothesis of self-directing wholeness as follows:

There is a class of occasions characterized by the presence of self-directing entities able consciously to choose between alternative lines of actualization in time.

We meet here for the first time the eighth category of individuality that carries us beyond the limitations of structural laws. Where there is an octopotent existence, one level is already liberated from the action of the mechanistic laws that govern the hyponomic world. In this consists the merging of time and eternity already referred to.

A self-directing entity possesses a presence that differs from that of the simple organism, particularly in its relation to past and future occasions. A self-directing entity can foresee and influence such occasions, whereas the simple organism adapts itself only to stimuli immediately present. Self-directing existence includes such properties as memory of the past and expectation of the future, and the ability to adjust behaviour accordingly. These attributes have a profound effect upon the mode of actualization in time, for they make it possible for a given entity to change the level upon which its own presence is actualized. Our natural megalanthropic preoccupation must not lead us into the error of supposing that all men and women are self-directing in the sense of the present hypothesis; nor must self-direction be confused with conscious individuality—which latter stands upon a far higher level in the scale of existence than the sentient self-directing entity. A great part of human life proceeds with the same mechanicalness as animal life and with no greater intensity of presence. On the other hand, among the

higher animals—not so much in species as in individuals subjected to special environmental conditions—we can encounter manifestations of self-directing existence, even if only of a primitive kind. There are certainly different levels within the broad divisions of self-directing existence, but all have in common a basic characteristic—that of the ability to choose between two possibilities present in the given occasion. The possibility of free choice represents the highest achievement of autonomic existence. It is this that enables a being such as man to understand and to fulfil the role—assigned to all life—of reconciling the affirming and denying forces in the universe. With the eighth gradation of potency, existence acquires true autonomy and can be free from both of the universal trends of evolution and involution. The octo-potent entity can be itself. It must not, however, be forgotten that we remain within the realm of fact—free individuality is not in and for itself a value nor is octopotence a value category.

4.11.6. The Transitional Hypothesis of Biospheric Wholeness

The whole organic life of the earth can be regarded as a sensitive film called the biosphere, stretched over the solid surface.* This, with the lithosphere—the solid earth; the hydrosphere—the oceans; and the atmosphere—the gaseous envelope, constitutes one of the four main distinguishable regions of the physical globe.

The view that the biosphere should be regarded as a living entity, having its own mode of organization and, hence, its own inner-togetherness, has been advanced by many biologists and geologists since Suss first formulated the theory that was later developed by Vernadsky.+ Such a view is a challenge to our conception of existence as stratified into layers of increasing consciousness and more closely integrated inner-togetherness; for it would mean that man is not the highest order of being whose existence is given to us in sense-perception. If the biosphere is a living whole, then we men and women are parts of its physical organism and, indeed, parts so small as to stand in much the

[* The name 'biosphere' appears to have been introduced by H. R. Mill, *International Geography* (1899), p. 4. The idea was further developed by Suss in the fourth part of *Die Antlitz der Erde*—see the translation by H. B. C. Sollas (1909), p. 637.

+ Cf. P. Vernadsky, *La Biosphere* (Paris, 1933). This theory is quite different from that of H. Jaworsky, who in *Le Geon* (Paris, 1928) puts forward the view that the earth itself is to be regarded as a living being—an idea already elaborated by Fechner in *Ueber die Seelenfrage* (1861), and *Die Tagesansicht gegenüber der Nachtansicht*, for a discussion of which, see Lecture IV, William James, *The Pluralistic Universe* (London, 1912).]

same ratio of size and number as does the single cell to the living body of man. If we regard mankind as the brain-cells of the biosphere, the numerical coincidence is indeed striking. It is estimated that in the human brain there are three thousand million cells, which is equal to the expected human population of the earth in 2000 a.d. Moreover, there are some 10,000,000,000,000 ordinary cells in the body, which figure agrees with a reasonable estimate of the number of metazoan animals on the surface of the earth.

It is hardly surprising that in former times both scientists and philosophers have hesitated to regard the biosphere as a living entity higher in the scale of existence than man himself. Nevertheless, our increasing knowledge of the way in which organic life on the earth is a closely integrated system of energy-exchanges obliges us to take into account the possibility that it is one of a class of entities satisfying what can be called the hypothesis of biospheric wholeness, namely:

There is a class of occasions in each of which one total living whole is associated with the active surface of a planet.

According to this hypothesis, organic life on the earth would be but one of a class of biospheres associated with planets throughout the universe. The adoption of the hypothesis would introduce biospherology as a new branch of science hitherto not considered separately from biology and astronomy, namely, a science that would study the potentialities of life on the earth and other planets, regarded as independent entities. The direct evidence for the belief that the biospheric hypothesis applies on other planets is very slender, amounting almost only to a few indications of life on the planet Mars. Nevertheless, we should not be deterred by this from accepting the consequences of the hypothesis, since, after all, some that we have studied—such as those of self-renewing and self-reproducing wholeness—are based upon observations only recently made. It is only within the last century that the nature of the atomic and cellular worlds has begun to be appreciated, and it is still more recently that the study of astro-physics has provided us with the means of ascertaining conditions at the surface of heavenly bodies other than that of the earth.

The biospheric hypothesis is to be studied in the first instance in relation to organic life on the earth. It begins with the observation that the terrestrial symbiosis depends for its stability upon relationships between the various organic species that are, in the main, co-operative rather than destructive. Ecological science tends to show how positive are the mutual relationships between species and how the disturbance of

the existence of any one form of life adversely affects the whole of life within a given region. There is scarcely any example on record of benefit to other species arising through the intentional or accidental destruction of any one species, however harmful or useless this latter may appear. There is, furthermore, an unmistakable rhythm of life, by which the whole earth is pervaded, that is manifested in the diurnal and seasonal changes and in the greater climatic cycles. These rhythms are evidence of an underlying unity of structure. Moreover, in our contact with organic life we may become aware of a presence that is greater than that of any separate organism or even of whole species.*

We should note that with the biospheric hypothesis we encounter a new kind of problem in the reduction of phenomena to facts. By reason of the small size of our own organism, our direct experience of organic life on

the earth is, of necessity, restricted to very small regions, and the intellectual effort required to apprehend it as a whole is one of expansion rather than of reduction. Nevertheless, in either case there is no essential difference in the process. Our task is to produce, out of an immense diversity of phenomena, a single fact that others can recognize. To perceive life on the earth as a single whole calls for the ability to think on a different scale of time from that to which we are accustomed. We measure the rhythms of the biosphere in days and years, and those of our own organism in seconds and minutes. Man's breath pulsates at a rate of some fifteen to twenty respirations per minute; his heart beats at seventy to eighty per minute. In comparison with this, the first great rhythm of organic life is the diurnal change of night and day. This cycle and that of the tides are some thirty thousand times slower than our breathing and heartbeats respectively. The great biological orders that represent the functional organs of the biosphere, develop, flourish, and disappear over periods of many millions of years.

Organic life itself has existed on the earth for not less than five hundred million years. It may be that biospheres have come and gone, one dominant form of life holding sway on the earth for several million years before being replaced by another. It has been suggested by Ouspensky that the biosphere has a life of two and a half million years; that is, thirty thousand times the life of man.+ Such speculations are

[* Cf. Jaworski, loc. cit.: " . . . the earth is a cell, composed of a nucleus, a nuclear membrane and a protoplasm. We are particles collected round the nucleus which participates in the great rhythm of its life. We are the mitochondria of the earth-cells." This kind of analogy is hazardous and in the present case misleading, for it confuses the biosphere with the planetary existence.

+ Cf. P. D. Ouspensky, *In Search of the Miraculous*. Cf. also Rodney Collin, *The Theory of Celestial Influences* (Cape Town, 1954).]

hazardous in the absence of any direct evidence of the longer rhythms. Nevertheless, they teach us to be cautious about interpreting the life of the biosphere in terms of our immediate experience. The data of palaeontology and palaeo-botany suggest very strongly that the whole of organic life on the earth has passed through successive periods of activity and quiescence, and of degeneration and rebirth, that are reminiscent of the life cycle of separate organisms.

The biosphere should, according to our calculations, have an eightfold structure, and, therefore, complete a cycle of existence. It is indeed the end-point of life as we know it. Nevertheless, in man these levels are also present in the shape of his two higher centres of function. Consequently, man when fully developed should be able to participate in the consciousness of the biosphere and understand its cosmic significance.*

[* For a description of the higher centres in man, see P. D. Ouspensky, *In Search of the Miraculous* (pp. 142, 194-5, 197, 259, and 279).]

Chapter Twelve THE CLASSIFICATION OF THE SCIENCES

C. SUPRA-ANIMATE EXISTENCE—HYPERNOMIC ENTITIES

4.12.1. The Character of Hypernomic Existence

We now pass from autonomic to hypernomic existence; from entities which, though self-directing, have a degree of potency not yet sufficient for true affirmation and creativeness to those which have, by their very nature, the required cosmic potency.

There are two distinct paths by which existence ascends the scale to pass beyond organic life. Along one, hyle moves to produce within the autonomic being the creative power that belongs to the hypernomic world; following the other it moves towards those entities which are by nature hypernomic and creative. In the present chapter we shall consider only the classification of hypernomic entities of the second kind; that is,

entities whose hypernomic existence arises by way of involution from above.*

The cosmic affirmation is transmitted through entities that are by their nature hypernomic; that is, predominantly affirmative. A cosmology that regards the heavenly bodies as the channels of affirmation necessarily runs counter to the belief that the history of the stars can be studied adequately from their observed behaviour alone. For the most part, astronomers study the stars as if they were 'things' having no higher existential status than the material objects of our everyday experience. There is certainly a justifiable approach to the study of any level of existence that treats all wholes as material objects and attempts to reconstruct their life-history solely in terms of energy-exchanges. In the case of living organisms, this procedure is followed by biophysics; but just as this latter can make at best only a very limited contribution to our knowledge of the living organism, so also must astrophysics be regarded as an instrument altogether too restricted in its scope to tell us much of the true character of the heavenly bodies.

[* Study of the first kind of entities—that is, of those whose hypernomic existence arises by evolution from below—leads to the central problem of the significance of free individuals in the universe. It is this mode of existence that directly concerns us as human beings, but its study belongs to the domain of values, rather than that of fact, and therefore does not fall within the scope of this present volume.]

We must, moreover, be on our guard against the uncritical transfer to the astronomical world of conceptions that apply to terrestrial living organisms. The biosphere must always be distinguished from the planet upon which it exists. It may be regarded as the final and highest manifestation of organic life, but it is at the same time the transition to a higher form of existence that is beyond life altogether.

We have, therefore, to attempt to frame existential hypotheses, which going beyond life as we know it in the biosphere, will serve to distinguish among the heavenly bodies different levels analogous to those we found in the physical and organic worlds. Here astronomical science can certainly help us, for within the present century it has established beyond doubt the existence of species of entities that together can be described as the 'cosmic group' as distinct from the physical and organic groups. There are four such species within the cosmic group—comprising planets, stars, galaxies, and the visible universe. Each of these species marks a level as definite as those that we have found in the study of the lower orders. Moreover, we can readily comprehend that the form of existence encountered at each level must call for an enhanced potency. Even with the conception of the biosphere as a living whole, we have gone far beyond the scale of any individual human experience. The unity of the planetary world and of the greater astronomical units, however, may be inferred by reduction; but it cannot be experienced in any state of consciousness ordinarily possible for man. Therefore at this stage we must content ourselves with indicating the possibility that there are levels of existence definable in terms of the inner-togetherness of the great astronomical systems. The notable work of D. E. Harding is based upon the assumption that there is a hierarchy of existence. In this he includes humanity, life, earth, sun, galaxy, and the whole universe. He also recognizes that when we contemplate existence beyond life on the earth, we have to take what he calls 'the distant view'. This means that we cannot reduce the observed data without combining them with the intuition of wholeness. This is the chief reason why astronomical science has so far not realized that its discoveries cannot be rightly interpreted without admitting the presence of units having an intensity of inner-togetherness that is far higher and more significant than our human existence.*

The higher existential hypotheses presuppose an attitude of mind
that differs fundamentally from either current scientific conceptions of
the universe or the theological and theosophical notions that have

[* Cf. D. E. Harding, *The Hierarchy of Heaven and Earth* (London, 1952), pp. 75-132]

prevailed in the past. We are in front of facts, namely, the realization of the truth that the universe is organized upon a vast scale and, in addition, that this organization shows no sign of being a mere extension of the organization of life as we know it upon our planet. The hypothesis of hypernomic existence requires, therefore, the conception of supra-animate consciousness; that is, a mode of togetherness that does not depend upon the vital characteristics of self-renewal, reproduction, self-regulation, or even self-direction.

As we place life upon a higher level in the hierarchy of existence than thinghood, so we must be prepared to concede to cosmic existence a higher order of consciousness than is possible for any form of life. However scanty may be our material for the study of hypernomic existence, we shall at least do better to let ourselves be guided by the cosmic hypothesis than to attempt to reduce all astronomical facts in terms of thinghood.

4.12.2. The Hypothesis of Sub-creative Wholeness

The planet earth is vast, and almost immortal compared with our own bodies. We speak of 'Mother Earth', and it is not a meaningless phrase, for both the materials of our existence and also its essential pattern are derived from the earth. Autonomic existence on the earth is neither self-created nor the result of blind chance; it has arisen under the action of an affirmative, creative power that resides in the earth itself. Nevertheless, neither the arising of organic life nor its maintenance would be possible without the multiform energies it receives from the sun. The earth is thus a sub-creative whole—creative, but still dependent and subordinate.

When we seek to place our observations of the earth's nature in the scheme of classification, we note that it has one degree of freedom beyond what is required for autonomic existence. It is a novempotent entity and stands, therefore, below the level of true creative existence which requires at least two degrees of potency beyond the autonomic. We can formulate the hypothesis of planetary existence as follows:

There is a class of occasions in which entities can exert an affirming force towards life without being themselves independent wholes.

Planets have inner qualities of stability and permanence that enable them to support the transformations of autonomic existence in the biospheres. Nevertheless, they require in their turn to be reinforced by the energy, exterior to themselves, derived from the sun and stars. The drama of life also requires an immense span of time to work out

its potentialities, and for this requirement no entity less permanent than a planet will suffice.

The assertion that planetary existence stands above the level of life is difficult to grasp and hard to accept. We can scarcely conceive consciousness otherwise than associated with a living organism in some respects analogous to our own—to suppose that there can be an even greater intensity of consciousness associated with a body like the earth seems quite implausible. The existential character of the planets is further obscured by the well-meaning attempts of those who have sought to show that the planet is a living being with organs like those of an animal.* There is something much closer to our conception of planetary consciousness in Harding's view of the earth as being 'consciously dead'. He asks how it is that we can consent to look upon the earth as a "mirthless mud-pie flung into space, a stone, a revolving pellet of filth and fire". He replies that: "The easy answer is that only a creature that is less than human could forget that it is alive; the true answer is that only a creature that is more than human could remember that it is dead—lesser beings are apt to overlook this. Many-sided death is the condition of her (the earth's) vitality.+ It is very difficult to avoid using the word 'life' to express the condition of conscious experience; but we must not forget that living and dying are limitations of existence and that for a mode of existence transcending our separation of time and eternity both life and death cease to have any of the meanings ascribed to them on the basis of our human knowledge. The apokritical pattern of the planet must be fuller than that of the biosphere, and must, therefore, comprise not less than nine distinct levels. The ninth category expresses our intuition of the universal pattern, but not

freedom of creation. With the planetary existence, we enter a world that is beyond finite wholeness and has at least one layer beyond the point at which time and eternity are reunited. Whereas the biosphere completes the first cycle, which at its zenith is free from the separations of space, time, and eternity, the planet itself begins the ascent towards universal existence as the starting-point of the emergence of values.

4.12.3. The Hypothesis of Creative Wholeness We have found an analogy between the atoms and the cells, each the

[* The suggestion made by Fechner that the earth is an 'angel', and such studies as Jaworski's Geon—based chiefly on analogy—treat the earth as if it were an immense unicellular animal.

+ Cf. D. E. Harding, loc. cit., pp. 98-9.]

second member of their respective tetrads. We have now reached the second member of the hypernomic tetrad, and we are tempted to extend the analogy and seek in the stars the 'atoms of the universe'. A further reflection shows the aptness of the analogy. The atoms of hyponomic existence are the ultimate particles. The atoms of autonomic existence are the cells. The atoms of hypernomic existence are the stars. The analogy is valid, however, only in so far as each of the three kinds of 'atom' is taken without reference to its cosmic role. The hypothesis of invariant being applies rigorously only to particles devoid of interaction and quite passive. Similarly, the sun shows its atomic nature only when we study it in its role as an independent creative power.

The visible structure of the solar system has been discovered only after centuries of patient observation and inference. Our present picture of the solar system shows us the sun, the planets, the numerous satellites and innumerable asteroids, the interplanetary dust, the incessant stream of radiant and particulate energy, and the gravitational and electromagnetic force-fields. In this most complex structure, the sun is dominant—99-85 per cent. of the whole mass of the solar system being concentrated in it. Of the free thermal energy available for producing changes in the surface of the planets, nearly all is derived from solar radiation. Moreover, of the small fraction of mass lying outside the sun, nearly all is concentrated in the two planets Jupiter and Saturn, so far away from the centre as to constitute almost a world of their own.

The dependence that we have noted in the planets gives way to independence and isolation when we turn towards solar existence. We cannot doubt that here we are meeting existence upon a different level and that the study of suns is a different science from the study of planets. It is only the accident of a common set of techniques that has hitherto combined them in the single science of astronomy. There is, however, no more one astronomy than there is one biology. We should separate heliology and planetology, as we separate zoology and botany. Because this is not done, we miss the extraordinary problem that confronts us in trying to understand a level of being in which life as we know it could play no part and yet which, by reason of its greatness and its power over our own and all planetary existence, must be regarded as standing upon a higher level than our human consciousness can reach.

The hypothesis of creative wholeness can be formulated as follows:

There exist a class of occasions in which entities atomic in nature exercise a free creative power within their own presence.

The tenth category of existence is represented here by the decem-potent structure of the sun. The sun is to be regarded as the highest manifestation of individualized existence, and at the same time it can be seen as an atom of the universe. The isolation of the sun and the stars is the outstanding characteristic that distinguishes them from all other entities irrespective of size and level of existence. The distance of our sun from the nearest fixed star is so great that their mutual influence in respect of any energy-exchanges of which we have knowledge is negligible. The probability of accidental collisions between the stars is so small that Jeans calculated that among the hundred thousand million stars of our galaxy, only a few odd collisions due to

random motions can have occurred in the past thousand million years. Such extreme independence cannot be encountered anywhere else in the universe—from the atoms to the galaxies—and it must have a deep cosmic significance. It is the primary datum which any interpretation of the hypothesis of creative existence must take into account.

4.12.4. The Hypothesis of Super-creative Wholeness

We have found an analogy between corresponding members of the three tetrads of existence. We may therefore find some help in the otherwise impossible task of prescribing the nature of galactic existence if we compare it with the corresponding levels of hyponomic and autonomic existence. In each case the characteristic feature is relatedness and transcendence : the self-renewing entity has a triadic constitution that enables it to be itself notwithstanding changes of energy: the reproductive entity renews its existence outside itself. We should expect to find in the galaxies a similar power of relatedness and transcendence. The form in which this power is manifested must be affirmative and yet not directly creative. The galaxies, in effect, transmit a cosmic pattern that finds its expression in the creative activity of their component stars. We may therefore speak of the galaxies as super-creators. They are beyond individuality and each is itself an universe comprising tens of thousands of millions of stars. Nevertheless, we must recognize that the galaxies are limited in size and duration, and that their affirmative role is fulfilled as units in the greater whole. The galaxies have, *ex hypothesi*, eleven levels of potency. This should give them an intrinsic triadic relationship in their hypernomic levels. The galaxy can be regarded as the supreme manifestation of the triad, but it remains dependent for its existence upon the hypernomic tetrad.

We can therefore formulate as follows the hypothesis of super-creative wholeness:

There exists a class of occasions in which entities—not themselves autocratic—are nevertheless manifestations of the supreme affirming power.

4.12.5. The Hypothesis of Autocratic Wholeness

To the limits of possible observation, the universe of galaxies stretches with a more or less uniform distribution throughout space. All available evidence, however, appears to show that none of the particular galaxies has existed for more than a few thousand million years; that is, a time-period comparable with the life of the individual suns, and even of the planets. It seems likely, therefore, that we do not at present possess the means of penetrating towards the origin of time beyond a certain interval, just as our telescopes are interdicted from searching for light-signals beyond a distance at which the slowing down of light prevents it from ever reaching the earth.

We must therefore regard the universe as intrinsically unfathomable for us, and this applies to the determining-conditions of eternity and *hyparxis* no less than to those of space and time. The universe, as we know it, cannot be infinite, but this does not mean that there is no existence beyond any attainable limits of human knowledge. We cannot, for example, either assert or deny that time had a beginning, but we can say that the universe as we know it may, at some time in the past, have been very different from what it is now.* We can therefore define a mode of existence ultimate as regards possible human knowledge, but not necessarily so for some entity existing upon an entirely different level of consciousness and understanding.

The fourth degree of hypernomic existence is the all-embracing fact and it completes the natural order. Whether knowable or not, there must be a whole of wholes that is hypernomic for all its subordinate parts. This whole is the universal affirmation and corresponds to the twelfth category of autocracy by which the categories of fact are completed. It is the source of all involutory processes by which the affirmation is transmitted through the different levels of existence. The potency of the Great Whole is taken to be duodecimal, for this is the number that corresponds to the combination of triad and tetrad by which will and existence are reconciled. We must, however, not fail to remark that these

[* Cf. the essays on the question, 'What is the Logical and Scientific Status of the Concept of the Temporal Origin and Age of the Universe?' published in the Brit. Journ. for the Phil. of Science, Vol. V, No. 19, Nov. 1954. The prize essay by Michael Scriven concludes, "No verifiable claim can be made either that the Universe has a finite age or that it has not" (loc. cit., p. 190).]

ascriptions are, for the time being, made solely for the purpose of setting up a system of classification.

4.12.6. The Universal Systematics of Natural

Philosophy

We have completed the first stage of our undertaking—that of bringing all possible knowledge into a system founded upon the primary data of experience. We must, however, recall the provisional character of the categories and the view that they constitute an indefinite progression of which only the first few terms are accessible to human understanding. The claim to have established an universal systematics is tempered with the recognition of a profound ignorance of the higher orders of significance.

We do not know anything in advance of the struggle we make to understand our experience and to find our place in the universe. The way we have taken is not the only possible way. We have used the categories as seemed convenient at each step, and other interpretations might have given other results. Nevertheless, we are now in possession of a working scheme, that will have at least heuristic value in our attempt to bring the data of natural science into a single coherent structure.

It will be convenient before embarking upon the next stage of our undertaking, to summarize the systematic classification showing the branches of natural science comprised within each of the fourteen existential hypotheses. The corresponding categories are shown on the left of the table.

A. HYPONOMIC DOMINANT

The Physical World—Things

A.1. Unipotent Entities. Category Hypothesis of The framework sciences. Wholeness Existential Indifference. Geometry. Arithmetic. Logic. Kinetics of uniform motions. Four-dimensional physics.

A.2. Bipotent Entities. Hypothesis of The polar sciences. Polarity Invariant Being. Force-fields. Dynamics. Electro-magnetism. Corpuscles. Light. Five-dimensional physics.

A.3. Tripotent Entities. Category.

Hypothesis of The physical world. Relatedness Identical Recurrence. Behaviour of rigid and elastic bodies. Ultimate particles. Six-dimensional physics.

A.4. Quadripotent Entities.

Hypothesis of Atomic nuclei. Subsistence Composite Wholeness. Properties of matter. Exchange processes. Chemistry and mechanics. Thinghood.

The First Transition

Hypothesis of Colloid sciences. Active Surface. Polyphase systems. Interaction of levels. Proteins and nucleic acids. Enzymes and catalysts.

B. AUTONOMIC DOMINANT The Animate World—Life

B.1. Quinquopotent Entities.

Hypothesis of Sub-cellular life. Potentiality Self-renewing Wholeness. Viral science. Biochemistry.

B.2. Sexipotent Entities.

Hypothesis of The cell world. Repetition Reproductive Wholeness. Cytology. Protozoology. Embryology.

B.3. Septempotent Entities.

Hypothesis of The metazoa. Structure Self-regulating Wholeness. Biological sciences. Development and growth. The phenomena of birth and death.

B.4. Octopotent Entities. Category.

Hypothesis of Individuation. Individuality Self-directing Wholeness. Psychology. Herd behaviour. Organic Species.

The Second Transition

Hypothesis of The biosphere. Biospheric Wholeness. Ecology and genetics. Origin of species.

C. HYPERNOMIC DOMINANT

The Supra-animate World—Celestial Existence

C.1. Novempotent Entities.

The Hypothesis of Existence beyond life. Pattern Sub-creative Wholeness. The planets.

C.2. Decempotent Entities.

The Hypothesis of The sun and the stars. Creativity Creative Wholeness. Functional freedom. Creativity. The solar systems. Cosmic individuality.

C.3. Undecimpotent Entities.

The Hypothesis of The galaxies. Domination Super-creative Wholeness. The universal transformation.

C.4. Duodecimpotent Entities.

The Hypothesis of The knowable universe. Autocracy Autocratic Wholeness. The universal order. Cosmology.

In setting up this universal scheme, we must not forget that we remain within the limitations of the phenomenal world. The three modes of existence have been defined in factual terms; no discriminations of value have been introduced. In the progression of the categories

from wholeness to autocracy, we have not gone beyond the intuition of what existence comprises—we have to go further in order to seek an answer to the questions why and whither. In the next book we shall apply the results so far obtained to a systematic survey of all the data of natural science—that is, of the World as Fact.

Second Book - The Natural Sciences

Part Five - The Dynamical World

Chapter Thirteen

THE REPRESENTATION OF THE NATURAL

ORDER

5.13.1. The Natural Order

For a hundred generations, since the times of the Chaldean Magi, of Confucius, Gautama Buddha, and the early Greek philosophers, man's search for a solution of the riddle of the universe has been guided by one fundamental axiom—namely, the affirmation of a natural order as a common ground of the experience in which we all share. If the Chaldees can be called the spiritual ancestors of the modern world, it is because they were among the first to assert the non-arbitrariness of phenomena and to attempt the formulation of universal laws.

It is commonly overlooked that without the affirmation of a natural order the words 'possible' and 'impossible' can have no meaning. Our aim as natural philosophers is not to explain events but to formulate the rules that enable the possible to be distinguished from the impossible. Only when this has been done can we relate, in a recognizably consistent manner, the present moment—with its fleeting and seemingly capricious actualization—to other moments of experience remote in time and place.

We have defined reality as the totality of all possible experiences and phenomena as the awareness of reality as it arises in finite centres of consciousness. Phenomena may appear to us as arbitrary and even meaningless, but this occurs only in so far as we do not see them in the context of a larger order. The belief that phenomena are not arbitrary derives from confidence in the universality of the natural order. The belief in universal laws and the expectation of finding them has grown in strength for a hundred generations. Man, looking for order in the universe, has not been disappointed. There is, nevertheless, a limit beyond which the affirmation of a natural order, as absolute and ineluctable, cannot go; for in a perfect scheme—ordered in every detail and hence of necessity predetermined—neither freedom nor responsibility could have any meaning.

In a world governed solely by self-consistent and inexorable laws, the simplest question could not be answered, nor even asked. Questions arise precisely because order is not all, but they can be answered only

in so far as order is omnipresent. We certainly do ask questions and we do expect to find answers. Therefore all our philosophic activity rests upon the conviction that order and disorder are somehow interwoven in the stuff of reality. If the universe were divided into two parts—one orderly and one disorderly—the two parts could have no connection, and neither could be the dwelling-place of man. We must therefore conclude that order and disorder are inseparable. The task of natural philosophy is to search for the regularities while recognizing that order in the form of universal laws could not hold sway, to the absolute exclusion of all disorder, without destroying freedom and responsibility. The discrimination of order from disorder is achieved by a process of clarification of experience, which, when it is accomplished, discloses the determining-conditions of existence in the form of universal laws. The results of this separation constitute the framework sciences. Framework is the totality of the conditions that preserve the universe from chaos without reducing it to sterility. The laws of framework are discovered through the study of the functional aspect of phenomena, that is behaviour. This study, however, would overstrain our power of thought if it could not be simplified by taking account of the relativity of existence. The stratification of existence enables us to eliminate some of the difficulties that ensue from the differences in level of being of the entities concerned, and to establish a foundation built solidly upon the framework laws. Nevertheless, when we wish to apply these laws to any given phenomenon, we shall again have to take cognizance of the different levels of being, for the words

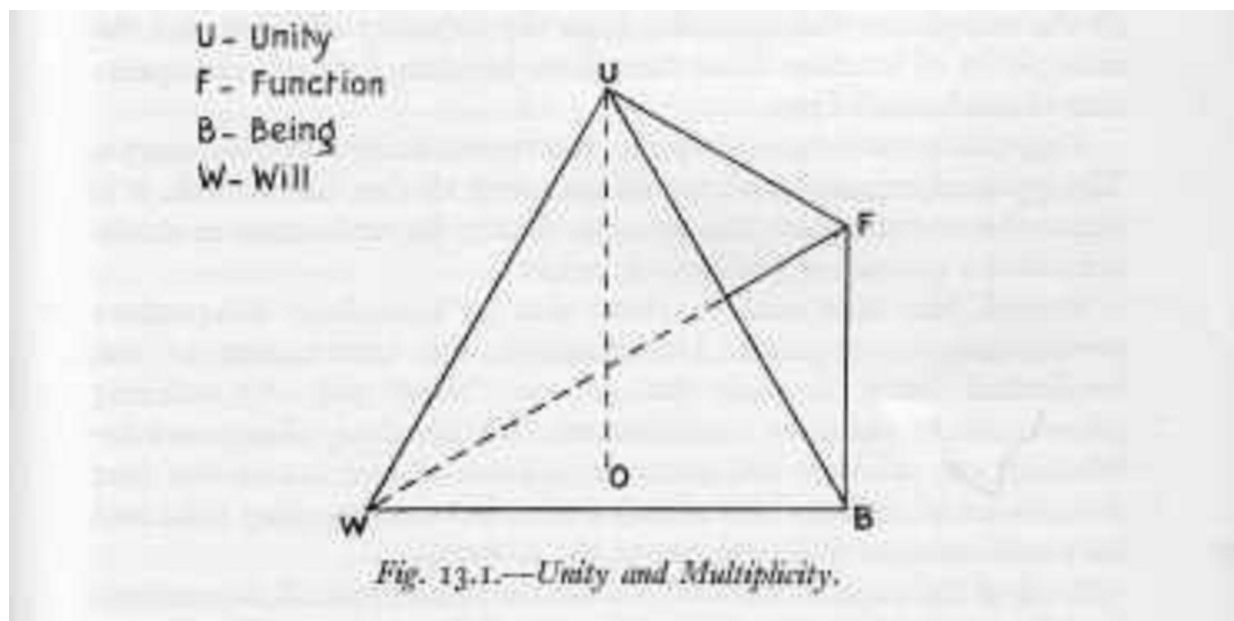
'possible' and 'impossible' change in their meaning according to the level of consciousness to which they refer.

5.13.2. The Inexhaustibility of Phenomena

It has been the perennial and unvarying experience of man that every question he succeeds in answering leads to other questions that he cannot answer. Phenomena present themselves to us flowing from a cornucopia that however much man succeeds in extracting from it still remains brimming over with unsolved problems. This suggests the geometrical analogy of shaving two-dimensional surfaces from a three-dimensional solid that remains undiminished in thickness however many such surfaces may be removed. Reality has more dimensions than thought, and we must learn to adapt our thinking to the recognition of its own inadequacy.

Philosophers have disputed as to the relationship between appearance and reality—the idealists condemning all that is temporal as 'mere

appearance' and regarding only the timeless, eternal Absolute as 'real'. This kind of idealism does not satisfy us, but the realism that treats phenomena as objective reality does not convince. We cannot believe that reality is wholly subjective, but equally we cannot admit that it is wholly objective. There can be no division of reality into two realms, one subjective and the other objective, one all experience and the other altogether devoid of experience. All that we have discovered in the first part of our studies must convince us that any such dichotomy is spurious. The dualism that seeks to retain both views without also seeking to reconcile them is unfruitful, and the pluralism that regards multiplicity as ultimate is a confession of failure. Even the triad consciousness-function-will, taken alone, does not account for the different degrees to which the three elements are fused in various kinds of situations. The universe, as it subsists, extends throughout many such degrees or levels, so that all experience can be represented by a triangular pyramid, with unity at its apex and multiplicity at its base.



At the three lower corners of the diagram, function, being, and will, are shown separately as if they were mutually exclusive components. Each point O in the triangular base represents a combination in which the three are brought together in a certain proportion. Realism could then be defined as the doctrine that nothing exists except the base of the pyramid. Conversely, idealism—leading as it inevitably must to monism—asserts that only the apex is real and all the rest is mere appearance. Allowing either doctrine to be true, a final answer could be

given to any and every question. Experience contradicts both, however, and teaches us that there is

multiplicity in every unity and unity in every multiplicity; reality in all appearance and appearance in all reality. The proportions of appearance and reality differ from one experience to another, according to the state of consciousness present. Furthermore, the balance of function, consciousness, and will is itself unique in each occasion. In other words, the whole pyramid, with its threefold infinity of points, is required for the representation of experience, whereas our exclusively mental processes can serve at best to build up a two-dimensional, or flat, representation.

In the pyramid, points on the vertical axis O U indicate the balance between determinism and freedom. The axis passing through the point F on to the plane U B W similarly measures the ratio between abstraction and concreteness. That which passes through the point B indicates the level of being, that through W perpendicular to the plane U B F gives the 'simplicity ratio'. At the apex W there is but one law, that is, freedom; whereas on the plane F B U the will is manifested in all the complexity that can arise from the relativity of being and the multiplicity of function. Here there is no freedom, but only the operation of mechanistic laws.

This scheme can be adapted to the representation of phenomena. The pyramid represents all possibilities and all that falls outside it is impossible and therefore non-existent. Reality beyond existence stands outside the domain of philosophic studies.

Enough has been said to show that at least four independent co-ordinates are required. Unfortunately, the construction of our intellectual brain is such that we can 'think' only by reducing phenomena to two-term combinations. We are thus, always and inevitably, cut off from the direct experience of two out of the four dimensions of reality. This remains true, however we may twist and turn and strive to find evidence to the contrary.

Each of the major disciplines studies the same pyramid, but regards a different point as the apex. Natural philosophy searches for an exhaustive knowledge of function, and therefore places the pyramid in the position shown in Fig. 13.2.

At the apex there is the perfect order of the universe conceived as a single functional mechanism. The base with its three vertices, being, unity, and will, represents the whole wealth of immediate experience with its inextricable complexity and its disorder, both real and apparent. The three points at the base now direct attention to the three fundamental postulates of natural philosophy; namely,

(i) Unity—that is, the self-consistency of the natural order (U). (ii) Framework—that is, the omnipresence of universal laws (W). (iii) The stratification of existence—that is, the existential postulates (B).

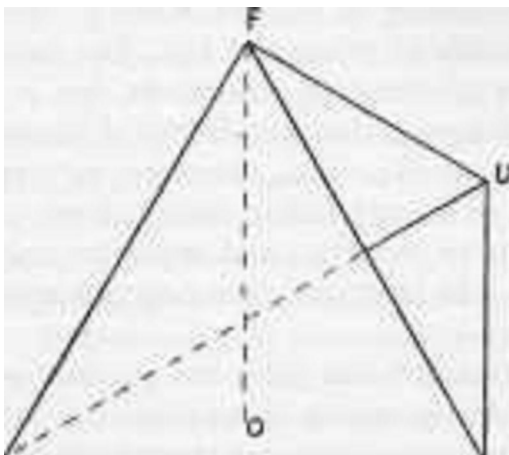


Fig. 13.2.—Natural Philosophy.

The ideal situation that the natural philosopher seeks to achieve is represented by the point F at which all possible experience appears as the operation of simple, universal, self-consistent and functional 'Laws of Nature.' Only at this point are all the uncertainties of will and consciousness eliminated from the world-picture.

Man with his limited perceptions can explore only a small part of the pyramid and—as we have seen—cannot adequately represent even that which he finds. We must suppose, however, that at each apex there is a total experience ideally possible, and some idea of its character can be deduced by eliminating the other three components from all possible experience. Will, divorced from being and function and from the fundamental postulate of unity, is no more than framework, and we can expect to learn much by studying this corner as one of three foundations of natural philosophy.

5.13.3. Mathematics

Since the restraint of disorder by framework is a pure operation of will, we can neither know it nor be conscious of it, and yet it can be understood. We never discover space, time, eternity, or hyparxis in consciousness, but only events governed by these determining-conditions. If we seek to treat the determining-conditions as objects of knowledge, we falsify them and are led astray by the fallacy of misplaced

concreteness. For example, all discussions as to the nature of time are useless, for time, as such, has no nature and no properties. We can, however, know facts, and those regularities that we discover to be common to all facts can be expressed as laws.

Our possible understanding of the determining-conditions is very different from our possible knowledge of fact. The former has grown through the experience of countless generations, but we can no more describe in functional language these conditions of our existence than a fish could describe water. We need, therefore, to employ a special language that is to be, as far as possible, exempt from the relativity of being and the diversity of function, and expresses only the abstract operations of the will. The language possessing this abstract quality is mathematics.

It has often been remarked that there is a peculiar and subtle correspondence between the operations of mathematics—which appear to be purely conceptual and subjective—and the processes of the universe—which appear to be objective and irreducible to conceptual form. This is the more remarkable in that mathematical analysis cannot unravel the complexity of even the simplest occasion that arises in our experience. The language of mathematics has little or no value for the description of fact, and yet we recognize in it the remarkable power of relating and unifying subjective experience and objective reality.

This paradox can be resolved only if we realize that mathematical symbols do not denote functional operations but acts of will. The symbol df/ds is used in determining the path traced by any body moving conservatively in a field of force, but it does not tell us either what the body is, or what motion is—nor does it describe any event. Consideration of such symbols must convince us that mathematics is concerned solely with distinguishing possible and impossible operations and processes. The connection may not always be self-evident, but it can always be discovered if we seek to understand the meaning of the symbol or operation without reference to any specific fact. The power of mathematical symbolism lies precisely in the property of enabling operations different in functional character to be prescribed by the same symbol. Moreover, the affirmations of mathematics always concern the possibility or impossibility of occasions, without reference to the question whether or not any particular occasion has been, or will be, actualized. Since remote antiquity, men have been impressed by the correspondence between mathematical operations, which are purely mental and apparently under our conscious control, and physical events, which are outside our minds and independent of our will. The

mathematicalness of the objective world is a datum with which we have to reckon. This does not mean that every functional problem will yield to mathematical treatment. On the contrary, it is only with great difficulty that a few highly specialized occasions can be adequately expressed in mathematical symbolism. Nevertheless, we remain convinced that mathematics can give us an insight into the physical world that we cannot attain by sense-experience alone. Moreover, we firmly believe that underlying all the complexity and 'non-mathematicalness' of our immediate experience there is an orderly array of particles and force-fields obeying strict mathematical laws. As our thoughts wander freely and at random in idle association, they remain connected in an unbreakable relationship with the physical processes in our brain, which latter we believe could be expressed in terms of the symbolism of mathematical physics. It is necessary to emphasize—and even to over-emphasize—the paradox of the universal applicability of mathematical symbolism and the non-mathematicalness of sense-experience, in order to bring home to ourselves the importance of distinguishing between the symbols of mathematics as the language of will and verbal descriptions as the language of function.

Remembering that the will-language is characterized by the use of gestures, each of which has an unique significance at a given moment, we should expect to find that mathematics also has a gestural quality. This proves to be the case. Every mathematical symbol is related to some gesture. For example, the trigonometric symbols sine, cosine, tangent have the effect of drawing our attention both to the universal relationships of right-angle triangles and the properties of infinite series. It would be difficult, if not impossible, to convey by means of words or signs, all that a mathematician recognizes in the symbol pi. It stands for a number that is itself unique, but it is far from being a 'mere' number, since it expresses all our notions of circularity and recurrence, and does so with the force of a gesture that was as full of meaning to the builders of the pyramids as it is to a mathematician or engineer of the present day. We are thus accustomed to treat pi as an operator rather than as a number, but we often overlook this when we seek to define its meaning.

The equation:

$$d^2 \psi / ds^2 + k^2 \psi = 0 \quad (13.1)$$

tells us the form of all possible vibrations, that is, all events in which a disturbing and a restoring force are in rhythmical equilibrium. There is an endless variety of occasions to which the equation applies. and their

functional content has nothing to do with the validity of the equation. The mathematician understands its meaning without interpreting it in terms of either function or being. Herein lies the special character of the mathematical symbolism; namely, that it is the language of pure will and not, as is the case with the 'practical language',* the language of will superimposed upon the full expression of function and being. Hence, mathematics is in a true sense the language of framework, and is fully valid only for that corner of the pyramid of experience labelled W in the diagram. Cf. Fig. 13.1.

In the strict sense, mathematics cannot be 'known' and failure to appreciate this is the cause of many of the difficulties that people encounter in mathematical studies. Mathematics is not in any way concerned with the qualitative content of experience. It can prescribe what is possible or impossible in a given kind of situation, but it can tell us nothing about what 'ought' or 'ought not' to be done therein. Likewise, it cannot tell us what things are, nor into what occasions they will enter, but only whether—things being what they are—a given situation is possible or impossible. For this reason mathematics can be regarded as the characteristic language of the natural order.

5.13.4. The Representation Manifold

Every act of will establishes a relationship, and will has therefore a special connection with the triad. This suggests that mathematical symbolism cannot be complete so long as it is restricted to two-term combinations. Although the primary components of mathematics are terms and operations, its object is attained only when

these are exhibited in a valid relationship.

For example the equation :

$$S = 2 \pi R$$

connects in a valid relationship the operator pi with the two terms S and R that represent the length of the circumference and radius of a circle in a Euclidean plane. The affirmation lies in the equation, the denial in the incommensurability of the terms and the reconciliation in the universal recurrent operator pi.

The expression of every relationship between two terms requires a reference that is independent of the terms themselves and the operations performed upon them, otherwise we should not be able to say anything about what has been done. This independent system of reference need

[* Cf. Chapter 4, 'Language', Section 8.]

not be explicit; but, if it is to serve beyond the needs of a single occasion, it must in some way correspond to the laws of will. In setting up a scheme of natural philosophy, therefore, the first task is to provide ourselves with a means of representation that shall have, as far as possible, universal validity and significance. There is no other way in which we can escape from functional description, valid only ad hoc.

Let us pause to consider what we mean by 'a means of representation'. Let us suppose that I wish to specify the position of a number of objects in the room in which I am sitting. In front of me and a little above the level of my head is a clock upon the mantelpiece; to my right, ten feet away, is a table standing against a wall; below my chair, stretching across the floor, is a carpet. In such a manner I could enumerate and locate as many objects as I pleased. Indeed, the procedure is so familiar, and appears to be so simple, that we overlook the difficulty of giving it a precise meaning. We assume, for example, that the words 'in front', 'above', 'to the right', 'below', all have a meaning that is the same for us and for those who will attend to our descriptions, and yet we know that if I were to turn my chair and face the window, the same description would require an interchange of the words. If, however, I were to start not from myself but from the fireplace, the words 'before', 'above', 'right', and 'left' would have the same meaning in whatever position I myself might be sitting. Thus it is that in practice we can always find and represent a fixed reference-framework for describing positions. Similarly, the words 'yesterday' and 'tomorrow' change their meaning in the passage from one day to another but 'before or after the 11th of November' means the same today as it meant yesterday and will mean tomorrow.

A means of describing both the place and the time of events is called the representation manifold.* Experience teaches us that such a scheme goes beyond description and tells us also something about what is possible or impossible. It is possible that 'before' can change into 'after' as I sit quietly in my chair; but it is impossible that 'in front' will change into 'behind' unless I turn round. It is possible for me to change 'here' into 'there' and 'there' back into 'here' by moving my body, but it is impossible for me to change 'now' into 'then' or 'then' into 'now' by any means of which I am aware. Likewise, geometry tells me various things that are either possible or impossible for me to do with rulers and

[* Here the word manifold expresses the fact that a numerical order can be assigned to each independent set of measurements. In the previous example, we can construct a scheme in which we measure in feet and minutes starting from the moment when the observation begins.]

pieces of string; and, in the same way, kinematics tells me what observations are possible or impossible to make with clocks and moving bodies. Such considerations enable us to make a distinction between description and representation. We can now define the word 'representation' as denoting the act whereby we show the relationship of function to will in a given situation. Since we are now concerned only with will

manifested in the form of order, we can give a more precise definition of representation as an act of will relating behaviour to framework. Representation is thus seen as a special form of language that lends itself to mathematical treatment. It makes use of symbolism in order to preserve the generality of the framework laws, but it allows of application to particular cases, provided that the level of existence can be ascertained.

5.13.5. The Geometric Symbols

Geometry is commonly regarded as the science by which we discover and study the laws of space. In a more general sense, it can be regarded as the science of representation, without any restriction to space-like relationships only. It is, for example, now customary to speak of a four-dimensional geometry of space-time, and even of N-dimensional geometries of unspecified character. We may therefore adopt the term geometry to designate the study of representation.

The mathematical language requires the use of numbers, and the question arises as to the degree of independence that is necessary between different sets of numbers in order to give an adequate representation of an event. An independent set of numbers is called a dimension, and a collection of such sets is what we have called a manifold. One of the tasks of the framework sciences is to determine the most appropriate manifold for the representation of all hyponomic entities. Every whole is—in respect of its simple wholeness—a unit indistinguishable from any other unit and, therefore, can be represented by the number one. Since, however, it is knowable in other respects, an array of numbers will be required to represent the various situations into which it can enter.

In accordance with the progression of the categories, representation should begin with wholeness. We use the term point to designate a whole without reference either to being or function. The primary gesture—the act of representation—is that of 'pointing' which amounts to fixing one whole A as distinct from all other wholes not-A. The gesture that fixes a point as whole is complete in itself. It ignores all but the point designated, and therefore does not reach the category of polarity. Therefore a point has no force and no magnitude. Every whole conceived only as a whole can be represented by a point.

The category of polarity can be exemplified only when there are two independent points. We shall use the term interval to designate that unique property which is defined by two points A and B without reference to any other wholes. Because of this last condition, the interval has no direction. In the geometry of three dimensions of space, the interval is a length and nothing more. In the dimension of time, it is a duration and nothing more. The determining-conditions of eternity and hyparxis must also have their intervals and, where it is required to be specific, we use the terms 'apokritical interval' and 'hyparchic interval'. The gesture that designates an interval is one of separation, and therefore suggests force. The interval between two geometrical points carries no force in the physical sense and yet it conveys the notion of polarity. It is, however, simple polarity in which there is no relatedness. To designate the interval between any two points A and B, irrespective of their nature, we shall use the symbol $\backslash AB \backslash$. The word 'interval' must be taken as having the same meaning whether it is applied to lengths and durations that we can measure, or to apokrisis and hyparxis that escape our observation.

To denote a relationship we introduce a third symbol; namely, the **vector**. A vector cannot be defined in terms of interval alone; it has direction and magnitude, both of which can be ascertained only by a reference that is independent of the two points A and B by which the vector interval is prescribed. The gesture that connects A and B has no meaning unless it includes the force that separates them. A vector is therefore the representation of an act of overcoming resistance. The transition from A to B connects A with B and B with A , but it does so in such a manner as to distinguish between the two directions. When A and B are supposed to be known entities, we represent the vector that connects them by the symbol $\overrightarrow{AB}$. When we wish to designate the vectorial gesture without reference to two particular entities, we use the symbol V . A number of different vectors are designated by symbols, all of the same form, V, W, U , etc.

Let us suppose that N independent sets of numbers are required to represent any possible occasion. Then a point is defined as the combination of N numbers taken one each from all the different sets.*

It is necessary also to define a fourth symbol $[N]$ —an N -fold—that stands for a **manifold** at which every point is uniquely determined by N independent numbers. A single point is $[0]$, a line is $[1]$, a surface $[2]$

* In one aspect, therefore, the word 'point' satisfies Euclid's definition as that which is 'without parts or magnitude'. His definition fails, however, to convey the uniqueness of the occasion represented by a point. Cf. Heath, Greek Mathematics.

and so on. An $[N]$ is then said to have N dimensions. Any two points A and B in an $[N]$ uniquely determine an interval, represented by the symbol $|AB|$. There can also be vectors $\overrightarrow{AB}$ that have both magnitude and direction, but are not necessarily unique since the qualities transferred from A to B may differ. Vectors alone will not serve to represent such multi-valued transfers; but, as will be shown later, a geometry can be set up in which families of vectors can be so defined as to give the necessary properties. These will be called **pencils** and their application to physical problems is one of the principal innovations in the mathematical treatment adopted in the present work.

In addition to these five primary symbols, the operations we need can be represented by the usual mathematical symbols for summation, differentiation, and the combination of matrices and tensors. Such other concepts as those of identity, congruence, equality, and inequality can be given their customary meanings, though it will later become apparent that some of these will have to be made subject to the relativity of meaning that accompanies all propositions about being and existence.

5.13.6. Geometry

Geometry is the science that studies the representation of framework without reference to existence. The

representation manifold must possess as many degrees of freedom as there are independent magnitudes to be specified. For example, actualization is single-valued, successive, and non-transitive. It can therefore be represented by a [I] in which vectors do not differ in direction but only in magnitude, and therefore cannot be distinguished from intervals. Potentiality is single-valued and transitive. It can be represented by a [I] in which vectors can be distinguished by the inequality 'greater than'-'less than', which is inherent in all eternal intervals. Hyparxis is multi-valued, is neither successive nor subject to potential difference. Though recurrent and therefore essentially quantized, it can be represented by a continuous manifold of H dimensions. Time, eternity, and hyparxis together constitute the internal determining-conditions of any given whole P, and, when combined, they give a [N] where the value of N depends upon the dimensional character of hyparxis—at present unknown to us.

All the external relationships of A with not-A can be represented by an array of numbers that correspond to our familiar notion of space. We know from experience that space can be represented by a [3]. It is, however, not isotropic; that is, equivalent in all directions. For example, there is always, for any given whole, a unique direction that connects

one moment of actualization with another. 'The instantaneous direction of motion' is the manner in which we experience this unique space-like direction of each and every whole, A. We shall designate this by the symbol X and the numerical value of X will be a measure of the manner in which the actualization of P affects other wholes.

There is also a direction in which all the forces acting upon A in consequence of its own eternal potential have their resultant. This is, in general, independent of X, and can be represented by the symbol Y. Finally, there is a direction in which the body is 'able to be itself. This is, in the simplest case, a neutral direction in which there is neither motion nor force. In the case of the planets, we can recognize this third direction in their axis of rotation. It will be designated by the symbol Z.

There are thus three external directions corresponding to the three inner determining-conditions. The former presents the conditions of the outer world of A, and the latter those of its inner world. According to this analysis, we should expect the representation of A to require not less than six sets of numbers and, therefore, a representation manifold of six or more dimensions. It will be shown later that, given the character of the inner determining-conditions and the requirement that these should be fully linked to the outer world of A, a representation manifold of six dimensions is both necessary and sufficient.

The ableness-to-be of a given whole, A, can be assessed only when it is confronted with other wholes B, C, D, etc., with which it may interact. In so far as all its interactions can be disregarded, a whole can be treated as if it were stationary in hyparxis—and the geometry then reduces to the five-dimensional scheme of time, eternity, and space.

5.13.7. Eternity as a Fifth Dimension

The geometry devised by Minkowski for representing Einstein's restricted theory of relativity distinguishes between the inner and outer determining-conditions of each whole, but confines the former to successiveness in time. This gives a [4]. It is necessary here to represent the fact that the inner world must fit the outer, and this requires that intervals and vectors vanish at every point of contact between the two worlds. Minkowski satisfied this requirement by treating the velocity of light as a universal constant that relates time-like to space-like intervals. In these circumstances, the use of an indefinite metric is clearly appropriate when constructing a representation manifold through which the inner and outer worlds of every whole can be compared and related. We shall extend Minkowski's device for constructing

a homogeneous manifold, in which he uses the finite velocity of light as a conversion factor, by introducing a corresponding factor for connecting apokritical intervals to lengths. We can then write down the metric of the representation manifold in a differential form, as follows:

$$ds^2 = dx^2 + dy^2 + dz^2 - c^2 dt^2 - \lambda^2 da^2 . \quad (13.2)$$

Here the internal ds depends only upon the values of the position coordinates taken separately. If all the terms on the right-hand side of (13.2) had been positive, the manifold would be called Euclidean. To indicate the special character of the metric, it will be referred to as 'flat but indeterminate' or pseudo-Euclidean. Had there been cross terms of the form $dx dy$ the manifold would have been of the Riemannian type adopted by Einstein in his treatment of general relativity.

In this equation, durations and apokritical intervals are treated as imaginary, and lengths as real, so that cosmic intervals can be positive, null, or negative. Where ds^2 is positive, the interval is called space-like ; where it is negative, time-like; and where it is zero we shall speak of ds as a null-interval.

If we now take two vectors OA and OB , such that A and B are in the outer world of O , by integrating (13.2)—the manifold, being pseudo-Euclidean, allows this—we can obtain the magnitude AB in terms of the components of the vectors OA and OB . It follows from this that OA and OB can both be finite vectors, and yet the magnitude of AB can be zero. When this is the case, AB is called a null-vector. Since the value of AB is also a measure of the magnitude of the angle between the two vectors OA and OB , this angle can be called a null-angle. It differs from a zero angle in that the two arms do not coincide and yet they do not diverge. No such situation can arise either wholly within the inner or wholly in the outer world of O . It represents a relationship that connects the two worlds. It is because of this property that the special kind of geometry with an indefinite metric can serve for the representation of physical events.

The importance of this property has been insufficiently considered in the development of geometry suitable for representing physical events. Nevertheless, the idea of a five-dimensional representation manifold is not new and, indeed, the physical significance of multidimensional geometries is already widely recognized.

The need for a six-dimensional geometry can be grasped if we relate it to three conservative properties common to hyponomic situations in general. The first of these is the constancy of the velocity of light in

the absence of matter, irrespective of the motion of its source. This, as Minkowski showed, requires a four-dimensional representation manifold. There is, secondly, the conservation of energy, mass, and charge, that requires a five-dimensional scheme to allow for accelerated motions. Thirdly, there is the conservation of angular momentum, or spin, that is independent of the other conservative properties and requires six dimensions for its complete representation.*

5.13.8. The Existential Tract and the Cosmodesic

We shall now introduce and define a few characteristic properties of the representation scheme. In so far as a given whole A exists in and for itself without exchange of hyle with other wholes, it is said to exist conservatively. Its existence depends solely upon its own potential pattern in eternity and, hence, the eternal pattern must be self-identical for all actualizations, since there is nothing within A itself that could change its own pattern. The existence of A at any given moment can therefore be uniquely defined by two sets of numbers—one of which fixes its state of actualization and the other its potential level. Both these numbers belong to the inner world of A , and, in fact, exhaust the content of that world. We shall therefore call the [2] in which all possible conservative inner states of A can be represented, the existential tract. All vectors in the existential tract are time-like and they can tell us nothing of the relationship of A to wholes other than itself.

Intervals in the existential tract represent possible transitions from one state of A to another. Conversely, any interval that falls outside the existential tract must represent a transition that is prohibited unless A itself changes.

Let us further consider a point P in the representation manifold that prescribes the actual state of a given whole P at a moment of time t_0 . Various actualizations are possible if there could be interchange between the inner and the outer worlds of P. There can, however, be only one conservative actualization; that is, one free from interaction. This conservative treatment can be followed over an infinitesimal interval ds that represents the actualization of P from the point P at the time t_0 to the point P' at the time $t_0 + dt$. If, from the second point P', P is again actualized conservatively, there will be another unique interval identical with the former. We have thus a series of intervals that represent all those actualizations of P starting from the point P

[* In the Appendix to this chapter (p. 490) a brief account is given of the various five-dimensional theories that have been put forward since 1920. See also the Appendix to Chapter 15 for a fuller discussion of the requirements of an adequate scheme of representation.]

that satisfy the condition that there should be no interaction with any-other whole. This set of intervals can be called the unconstrained actualization of P. For the corresponding [I] we shall use the special term cosmodesic*

We can use the conception of unconstraint in the same manner as Newton to define a 'straight' path. The only difference—and it is a most important one—is that the path does not necessarily lie in the same time-space manifold as that of an observer O who is unconnected with P. Whereas according to special relativity the paths of O and P may diverge in time; they remain in the same space-time—that is, in the 'absolute world' of Minkowski. Our scheme of representation has no absolute world of space and time, for there may be any number of ways in which space-time can be related to eternity. The path of P can be said to be 'inwardly and outwardly' straight; that is, there are no changes either in the form of P's actualization or in its relationship to other wholes. There can therefore be one and only one cosmodesic passing through two points and the cosmodesic is 'absolutely' the shortest path. In other words, the cosmodesic must be a straight line in the pseudo-Euclidean representation manifold. Since the direction of the cosmodesic cannot depend upon anything but P itself, it must always bear a fixed relationship to the existential tract of O and compose with it a [3], of which two dimensions are in the inner and one in the outer world of P.

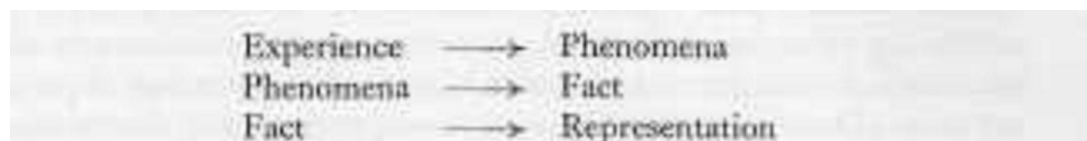
In so far as the actualization of P is regarded as a motion in space and time, the cosmodesic can be called the 'true path', and the motion can be called conservative. This formula is, however, too restrictive, for the straightness of the cosmodesic and the uniqueness of the existential do not depend upon actualization alone. Nevertheless, their true character could be apparent only for an hypothetical universal observer able timelessly to regard the whole situation and to treat time and eternity as equivalent homogeneous directions. When referred to the perceptions associated with any finite whole O actualizing in space and time, the observed body P may appear to move in a curved track. The representation manifold allows for this possibility by reason of its indefinite metric, which permits a straight line to have curved projections into the outer world of a given observer O.

We must not leave the subject of representation without emphasizing

[* The term cosmodesic is used to express the conception of a generalized geodesic in N-dimensions. Cf. J. Podalanski, Proc. Roy. Soc. (1950), p. 201A, pp. 234-61, 'Unified Field Theory in Six Dimensions'. Podalanski regards the null-geodesic as the true link between geometry and physics.]

that only facts can be represented in the manner discussed. There can be no representation of phenomena. The natural order presents itself to us in our experience concretely as will actualizing in function through the mediation of being. This is the experience of phenomena; we witness them and we seek to know them. The

reduction of phenomenon to fact and the representation of fact by the aid of mathematical language and geometrical constructions is undertaken in quest of knowledge. The order we thus discover, as we improve our instruments of observation and means of representation, is the projection of regularities that we believe to be independent of the three stages of reduction, that is,



Because of this independence, the source of which lies in the homogeneity and self-consistency of the natural order, the knowledge we acquire can lead to fresh functional adaptations in our relationship to our own world. These adaptations complete the cycle and serve to verify the soundness of the path we have taken.

5.13.9. Eternity-blindness

The purpose of the representation manifold is to enable us to use the mathematical language for giving expression to our subjective and objective experience of the events we study. This would present no difficulties if man's organs of sense-perception could respond to the gestures that express the relation between potential and actual states. Since, however, his sense-perceptions are sensitive only to actualizations and not to potentialities, the data with which they furnish us can give only an indirect assessment of the eternal aspect of the observed whole.

The apokritical interval is perceived only as the transition from one state of consciousness to another and not as an exchange of energy. Consequently it escapes from any possible observation through the senses. The human observer who cannot make measurements of the apokritical interval tends to divide up his world in a manner that does not correspond to the full inner significance of events. His outer world appears to him as in process of actualization in time alone, whereas in his inner world he can and does have perceptions of potentiality. The limitation of human sense-perceptions can be called eternity-blindness. By this, man, although recognizing the three-dimensionality of his outer world, is led to treat his inner world as if it were one-dimensional.

Consequently, all events are projected into his inner world as if they constituted a single actualization. This occurs even when the event itself includes apokritical displacements; that is, the transfer of experience from one level in eternity to another.

The simplest illustration of man's eternity-blindness can be drawn from the fact that we do not perceive potential energy through the senses, but infer its existence only from the law of energy conservation. Another consequence of eternity-blindness is that man fails to recognize the significance of null-vectors. He cannot directly make the measurements required to assign to any given whole a position in the cosmic manifold that will fully represent its relationship to other wholes. It must be emphasized here that eternity-blindness is not inherent in human nature as an order of being, but arises only through our habit of restricting attention to sense-impressions and disregarding the distinctions of consciousness that are constantly occurring in our inner world.

5.13.10. The Universal Observer Q

The human observer cannot set up for himself a five-dimensional reference framework, since everything that he does appears to him to be confined to the four dimensions of his own sense-experience. We can, however, postulate a universal observer, free from the limitations of eternity-blindness. We shall use the symbol Q for the universal observer and O for the human observer, while P stands for the body under observation. The significance of Q is not confined to his ability to make measurements in the existential tract, but at present we need not explore all the meanings the symbol may bear.

We suppose that Q carries out the same kind of operations as the human observer; that is, he can set up and use apparatus to measure lengths, angles, durations, and masses. He can, in addition, by means of apparatus of a kind that we cannot picture to ourselves, measure apokritical intervals and explore the existential tracts and cosmodesics of bodies. He lives in a five-dimensional world, with one advantage over O that consists in being free to observe translations in the direction of eternity. Apart from this, Q actualizes in time as does O and records his observations as functions of time as the independent variable. In order to bring his observations into a form suitable for mathematical analysis, Q requires to set up his own scheme of representation.

In order to construct his own representation manifold, Q has to determine directions and make measurements without being restricted by distinctions of actual and potential for a given state. Having discovered

the constancy of the velocity of light, O is able to make a direct comparison between lengths and durations. The universal observer Q can go further and can make a direct comparison between lengths, durations, and apokrisis. This enables him to set up his own metrical equation in a homogeneous form in which all intervals are reduced to a common measure. He is thus able to do for the five dimensions what Minkowski accomplished for space and time. Whereas the consciousness of O is confined to a local system, Q can be regarded as a consciousness associated with the general mass-system of the universe. This latter must have one overriding actualization that determines a unique direction of time. Q must also have a unique direction of eternity, namely, that for which the whole universe is in a non-actualized state: it can be called 'the universal potential gradient'. These two fundamental cosmic directions must always be independent and therefore can be represented as orthogonal axes in the representation manifold. Moreover Q, being conscious of all the potentialities present in every spatial configuration, must be able to construct the three dimensions of space orthogonal to his existential tract. In other words, Q can make a direct use of the cosmic manifold as a means of representing all his observations of occasions in time and eternity. Thus it is Q who is able to set up the equation for the interval given in eqn. (13.2). O cannot make the required observations directly but can infer the validity of (13.2) from a combination of his own measurements and his existential hypotheses.

It should here be noted that throughout we have been assuming that the determining-conditions can be regarded as altogether independent. We know that this is true only for occasions of existential indifference, that is, the base of the pyramid referred to at the beginning of this chapter, near to which O is situated. Q can be regarded as standing at the apex of the pyramid, where the determining-conditions become merged into a single separation of all possible from all impossible occasions. In this we can find a justification for treating the representation manifold as flat. Q can assign all events throughout the pyramid to the cosmic manifold by treating the relativity of existence as an independent factor.

Chapter Fourteen MOTION

5.14.1. Non-interacting Relatedness

Our experience of entities including our own bodies begins with the perception of motions. The relative movement of bodies is not only a primary datum, but also the foundation of all our knowledge of an external world. Motion brings us face to face with the need to reconcile permanence and change. The body that moves changes its position but remains itself. This is the simplest observation of the natural order and, by fixing our attention upon it, we arrive at the notion of 'invariant being' that enters into the second existential hypothesis. A body that moves and yet remains itself is bipotent. From this bipotentiality arises the relativity of motion, for it separates, as polar opposites, the observer and the body observed as in motion. In so far as any exchange of hyle between the two can be neglected, the combined system is also bipotent and can be represented by the five-dimensional framework of space, time, and eternity. Only two inner dimensions are needed, since the condition of hyparxis is significant only when time and eternity are cross-connected in the existence of an entity and therefore require mutual adjustment. Between the temporal and the eternal content of any occasion there is bipotent separation of forces, but this alone does not bring about an exchange of hyle.

So long as the dimension of hyparxis is left out of account, there is no opening, or 'hole' wherein an entity can become other than itself, nor can we represent the transfer of energy from one whole to another without a means of expressing the property of 'emptiness'.

Since experience as we know it invariably comprises some elements of interaction, the five-dimensional framework can represent only partially even the most elementary experience. There are, however, many events in which interaction plays a negligibly small part, and for these the five-dimensional geometry is adequate. Moreover, it allows a straightforward and yet comprehensive mathematical treatment, the results of which can, with suitable precautions, be transferred to those more complicated occasions where interaction plays a decisive role and must therefore be taken into account.

In the present chapter we shall confine our investigation to the time-

eternity world of five dimensions; but in doing so we must remember that the inner determining-condition of hyparxis does not cease to be operative. We shall assume, however, that its effect is always the same and that it consists in ensuring that every entity shall throughout be self-identical, irrespective of the occasions into which it may enter. The basic hypothesis of hyponomic existence selects for study those occasions in which all the entities concerned are assumed to remain wholly passive in their inner as well as in their outer relationships. In the simplest case such entities neither receive energy from their environment nor give energy to it. Each is therefore an ideal perpetuum mobile, and, as such, theoretically inaccessible to sense-observation which depends upon energy-exchanges. The experimental physicist can never study such occasions in an absolute or ideal form, but he can find approximations in which interaction plays so small a part that results can be predicted to a very high order of accuracy. The most important examples of these approximations are found in the motions of massive and charged bodies.

Non-interacting relatedness can be of two kinds, constrained and unconstrained. The former occurs when two wholes are linked together in their actualization without, however, exchanging energy—as when two massive bodies are held together by a rigid bar, so that whatever be their motion they are constrained to remain at a fixed distance one from the other. An unconstrained relationship is one in which the actualization of each of the several participants in the occasion is unaffected by the presence of the remainder. This occurs, for example, when a small body is falling in the gravitational field of a large massive body and when the atmospheric resistance can be neglected. Using a misleading terminology, we are accustomed to say that the large body 'attracts' the small one and thereby give the impression that the greater acts upon the lesser. Although this form of description is customary, it runs counter to the conviction that there can be no influence without connection; that is, action at a distance. It would be preferable to say that there is no interaction at all, and this is the assumption that we shall make in the study of unconstrained motions.

Kinematical science is the study of unconstrained relationships. The unconstrained relationship is unique. Strictly speaking, it can arise only between bipotent wholes that satisfy the hypothesis of invariant being, for only they are entirely exempt from interaction with other wholes. The converse is also true—that all wholes that satisfy the hypothesis of invariant being can have one, and only one, outer relationship; namely, that of unconstrained motion relative to other bodies and the general mass system of the universe. In contrast to this, constrained relation-

ships can be of different kinds according to the degree of freedom in their mutual interaction. A small massive body, rigidly fixed to the surface of the earth, can actualize only as part of the earth's history. More precisely, any material element of a rigidly connected system is constrained to actualize as part of the whole system. There can also be a non-rigid linkage of two bodies by a flexible string that allows mutual motion in any direction, provided that the space-like interval between them does not exceed the length of the string. Constrained interaction also occurs if there is a flow of energy, as when one end of a rigid body is kept at a different temperature from the other.

A special and important example of constrained motion is the cyclic or wave form. A pendulum swinging under gravity is a massive whole; its motion is constrained by the length of the string and retarded by the viscosity of the medium. In the case of a frictionless pendulum the constraint is of such a nature that the entire occasion is renewed indefinitely. Even when frictional retarding forces are present, the renewal is observed though with diminishing amplitude.

It can be seen that constraints fall roughly into three classes:

- (a) rigid connectedness or full constraint,
- (b) flexible connectedness or partial constraint,
- (c) friction or drag.

It will be noted that constraints of the third class cannot arise for wholes that satisfy the hypothesis of invariant being, for friction is quadripotent in nature and always operates through exchanges of energy and so, properly speaking, can apply only to semi-permanent wholes that satisfy the hypothesis of composite wholeness.

We can, therefore, set down the preliminary conclusion that wholes of invariant being can be related only in one of three modes of connectedness:

(i) ideal rigid connectedness, (ii) flexible connectedness or ideal plasticity, (iii) ideal non-connectedness or total absence of mutual constraint. The science of dynamics studies the occasions in which there are these three different kinds of connectedness and no others.

5.14.2. Relative Rigidity and Quasi-rigidity

The facts of dynamical science are derived through the observation of bodies that satisfy as closely as possible the hypothesis of invariant being. In making such observations, we always have the task of reducing the phenomena to facts in such a manner as to eliminate the effects of

interaction. The phenomena coming under observation may be of considerable complexity, and observation is impossible without some exchange between the observer and the observed body, so that in any case interaction is an inescapable factor. In order to minimize the effects of such interaction in relation to occasions of invariant being, we shall specify in advance the characteristics of the entities and instruments that are necessary for the experiments we have to make. We require, for example, to measure lengths. For his measurements of lengths, O employs a ruler—a rigid body visibly marked in such a way as to give a series of lengths that are assumed to correspond wherever they are brought into close proximity with another material object or groups of such objects.

The concept of rigidity seems familiar enough, but when we seek to define it in a manner that will enable it to be related to occasions of invariant being, we encounter many difficulties. Rigidity in the phenomenal world means 'keeping the same shape notwithstanding external stress'. In the representation manifold, rigidity means parallelism of the time lines of all the points in a given spatial configuration. We can verify phenomenal rigidity only by observing that some bodies keep their shape better than others, and by assuming that there could be an ideal condition in which a body would keep its shape in all possible external conditions. A body defined in such a way will be called 'an ideal rigid body', and can serve as a standard of comparison by which the rigidity of other bodies can be verified. Scientists assume that the international standard metre—consisting of a platinum iridium bar, the markings of which are from time to time verified in different ways—has remained constant in shape and size since 1889 when it was first deposited at Sevres. The elaborate experimental precautions that enable the length of the standard metre to be defined within one part in ten million may give the impression that rigidity can thereby be so closely approximated as to make all anxiety as

to the meaning of 'length' or of a 'space-like interval' superfluous. Nevertheless, at almost the same time as the International Commission was defining the standard metre, Michelson and Morley were conducting experiments that led Fitzgerald to the conclusion that a moving body must contract in the direction of motion. The contraction was explained by Einstein and Min-kowski, without disturbing the basic conception of physical rigidity.

Hermann Weyl raised fresh problems by suggesting that the metrical structure of the world itself might vary from place to place, and that this variation might be the source of electro-magnetic phenomena. If this were so, it would follow that measuring rods—although in the

physical sense approximating as closely as could be desired to the requirements of perfect rigidity—might, nevertheless, change both size and shape when transferred from one place to another. The property whereby the body that is rigid by all physical tests may change in length in moving from place to place was called by Weyl "the relativity of magnitude". He suggested that "the same certainty that characterizes the relativity of motion accompanies the principle of the relativity of magnitude", and added: "We must not let our courage fail in maintaining this principle, according to which the size of a body at one moment does not determine its size at another, in spite of the existence of rigid bodies. But, unless we are to come into violent conflict with fundamental facts, this principle cannot be maintained without retaining the conception of infinitesimal congruent transformations; that is, we shall have to assign to the world besides its measure-determination at every point also a metric relationship. Now this is not to be regarded as revealing a 'geometrical' property which belongs to the world as a form of phenomena, but as being a phase-field having physical reality. Hence, the fact of the propagation of action and of the existence of rigid bodies leads us to found the affine relationship on the metrical character of the world which lies a grade lower."*

In this interesting passage, Weyl comes close to recognizing the significance of the existential hypotheses. Had he not been—like most other physicists—dazzled by the success of Einstein's theory in predicting the 'bending of light' observed at the eclipse of 1917, Weyl might well have come to the conclusion that the relativity of magnitude could not be represented in a four-dimensional manifold and, in consequence, have been led to formulate the five-dimensional field-theory. Had he done so, he would have avoided introducing the defect which later was discovered in his own theory—that it led to a violation of the principle of conservation of energy. In consequence of this defect, Weyl was led to abandon his conception of quasi-rigid bodies; a conception that is very close to that reached herein.

It is not surprising to find that the term 'rigidity' has now acquired for us a relative meaning; for rigidity must be a property of being, and its meaning must vary according to the existential hypothesis adopted in any particular context. It is only in the case of existential indifference —when events can be completely represented by the world-geometry alone—that a 'rigid body' is identical with a Euclidean solid; that is, self-congruent for all possible transformations of the space-time coordinates. We shall use the term 'quasi-rigidity' to denote the property

[* Hermann Weyl, *Raum, Zeit und Materie* (Eng. trans., Oxford, 1922), p. 283.]

of material objects which makes them appear to an eternity-blind observer as remaining unchanged in shape and size, whether the motions with respect to the observer and to one another be constant or accelerated. A quasi-rigid body is functionally rigid but existentially plastic. It can transmit a force, but it cannot sustain a relationship. It is thus bipotent and therefore falls short by two gradations of the requirements of true subsistence which must be at least quadripotent. Although the quasi-rigid body is only a 'shadow of a fiction', it is, nevertheless, a most useful concept in the development of dynamical theory. It has the great advantage of having a well-defined existential status that is independent of the accident of observation.

5.14.3. The Entities of Dynamical Science

We shall need to set up a special group of such conventional entities, all of which must be assumed to be bipotent. This means that only one-to-one correspondences are to be taken into account and all interaction is to be neglected. Not only the human observer O and the observed body P, but all instruments of observation and measurement must be treated as bipotent. Even Q the universal observer is taken to make his measurements solely in space, time, and eternity, without influencing the relationships he studies.

Both O and Q observe coincidences, directions, lengths, and durations, and thereby collect data from which they discover the regularities of unconstrained motion. We can picture O not only as a Kepler or a Tycho Brahe, but also as a Copernicus or a Newton, both observing phenomena and formulating general laws of motion. Q also observes and generalizes, but, being free from eternity-blindness, obtains results that are inaccessible to O. Our task will consist in correcting the laws of motion deduced by O in such a manner as to make them conform to the 'true' observations of Q. The latter experiences the linkage of the determining-conditions directly as a set of relationships between the different entities. The spatial presence of a body can thus be defined by Q by means of intervals that take account of the influence of the conditions of eternity as well as time, and therefore fix the relationship of all inner elements. It is by this linkage of the inner and the outer determining-conditions that a bipotent whole can be distinguished from a collection of physical particles or a manifold of mathematical points.

We can define the term triangulation as the totality of operations by which the spatial presence of a collection of material objects is explored and the results transferred to the representation manifold. The basic

event in triangulation is the observation of coincidences. This depends upon the sensitivity of the organs of perception, and especially of the eye of the observer O. Although this sensitivity is the mark of a high existential level, the observation itself is bipotent—it can be expressed as a simple 'yes' or 'no'.

We can now clarify the conception of quasi-rigidity by recognizing it as the property whereby the results found by O on triangulating a given object always prove to be the same, irrespective of the time and space co-ordinates and of the order in which O's measurements are made. The quasi-rigid body defined in this manner is free from deformation by any forces operating in the space-time world of the observer O. On the other hand, Q is aware that changes in level of eternity bring with them modifications of the distribution of potential energy. A change in potential energy that affects one part of a body differently from another must result in a stress and, hence, in a deformation which can be avoided only by introducing some compensating changes in the inner relationships of the body itself.

Let us suppose, for example, that a bipotent entity in the form of a massive body M has a potential energy that varies in passing from one point to another within its own presence. In general, the apokritical intervals at two separate points A and B will differ. As A and B are rigidly connected and there can be no transfer of hyle from one to another, a strain will result that can be observed as force. This agrees with the view that bipotency is the mode of existence that gives rise to forces and, moreover, it is the only such mode. With higher potencies, there would be room for exchanges of hyle; and interaction, rather than strain, would ensue. Since M is bipotent, the force acting between A and B cannot result in a distortion or change of shape and hence the differences of potential energy must be compensated by an invisible constraint. Such constraints are termed 'invisible' to indicate that they cannot be detected by any measurements that O may make; for his measuring instruments, when brought to the same points A and B, will be subject to the same potential energy differences, and therefore to the same constraints.

In consequence of his eternity-blindness, O 'incorrectly' deduces from his observation that his rulers are always self-identical, irrespective of their position and relative motion. He therefore has no means of observing the constraints or of taking them into account. For example, the two ends of a ruler—though always an identical distance one from the other by any test that O may apply—will nevertheless be subject to constraint when there is a change in their relative apokritical dis-

placement. Therefore all measurements made by O of space-like intervals will be subject to the influence of constraints wherever there is an apokritical displacement. This is one of the ways in which the eternity-blindness of O influences his observations.

The second instrument required by O is a clock. Theoretically, a clock is an instrument that returns to the same spatial configuration at fixed intervals of time. The practical measurement of time consists in the observation of coincidences between the returns of a clock to a given state. If a clock is subject to apokritical displacement, there may be a change in its periodicity owing to the change in potential energy but, once again, this change would be unobservable by O since all instruments used to verify it would be subject to the same effect. There is, however, an important difference between the measurement of time and the measurement of space. Measurements of length require quasi-rigid constructions outside the presence of the observer O and his rigid support M. If the ruler R extends beyond the common presence of O and M, it must be subject to constraints of the kind already noted. On the other hand, the measurement of time, being internal to the given body, must always be made at the same apokritical level as the body itself. It is further possible to employ for the measurement of time objects so small that any inner displacement can be neglected and therefore, the measurement of time intervals made in their immediate vicinity can be regarded as free from apokritical ambiguity. We have at our disposal such objects in the form of atoms, and we can take as our fundamental time-interval the period of a monochromatic light.

We have to take into account the presence of a massive extended body without which our bodily existence could not be maintained. Our human observations and experiments are made at, or near, the earth's surface. Our measuring instruments and our clocks are fixed with relation to the earth, or at any rate move in an ascertainable manner at or near its surface. We may therefore assume that in all our observations there is present a massive space-extended body M that is assumed to constitute a quasi-rigid system in the sense above defined. The observer O, together with his rulers and clocks—that is, his instruments of measurement—constitute a subordinate system R that is assumed to be quasi-rigidly fixed with respect to the massive body M. We shall designate the system O-M-R by the term the observation system.

We have further to specify the object of observation. At the present stage, without loss of generality, we can simplify our task by assuming an observed body P that is actualized in the simplest possible manner

in a single line of time and at a single point in space. P is commonly referred to as a 'point-mass' and, where necessary, electric charge can be ascribed to it.

O-M-R and P are subordinate wholes within the totality of all existence—that is, the universe—which we shall denote by the symbol U. The universe U is a space-extended massive system actualizing in time, and we may assume that it exists throughout all levels in eternity. The total existence of U extends in three independent directions. There is universal time, t_u , which is the direction of actualization that is independent of any of the separate parts of the whole and therefore independent also of O-M-R. There must also be one universal direction of eternity, a_u , which at any given moment contains all the possibilities of the universe. The actualization of the universe and its potentialities must be independent at all points and, therefore, a_u must be orthogonal to t_u . We require to add a third direction, h_u , which is the direction of hyparxis that contains all the degrees of freedom or frequencies of occurrence of all the different states of U. At the present stage of our investigation, h_u is left out of account on the assumption that all the bodies that we shall now study have identical recurrences. We have now defined a sufficiently comprehensive set of bipotent entities to enable us to study the relationships of constraint and un-constraint that are consistent with invariant being. These entities are:

(i) the universe U, (ii) the universal observer Q, (iii) the human observer O, (iv) the massive space-extended rigid body M, (v) the measuring system of O—that is, his rulers and clocks—

with his organs of sense-perception O-M-R, and (vi) the unconstrained observed body P.

All these six entities are artificial constructs, obtained by eliminating all degrees of potency above the second. In the process of elimination, we lose most of the rich content of our common experience; but it is noteworthy that the entities are by no means so strange as we might have expected from the manner of their definition. This observation confirms the general soundness of the procedure by which the existential hypotheses have been formulated. We have succeeded in isolating a stratum of experience by taking into account only the category of polarity with which bipotency is primarily associated. This has the further advantage that we are thereby enabled to set aside the interpenetration of the determining-conditions that develops increasingly in passing to higher

potential orders. Absence of constraint is a condition of the independence of the determining-conditions and so, by studying the occasions in which interaction between entities can be disregarded, we may hope to clarify not only the laws of motion, but also the relationship between the determining-conditions and existence itself.

5.14.4. The Laws of Motion

The experiment to be made by O consists in releasing the unconstrained body P which thereafter falls freely quite unaffected by the presence of O-M-R. From this point O begins to make, by means of rulers and clocks, his observations of the subsequent positions of P and the times at which these positions are occupied. O then transfers to a representation framework, rigidly fixed with respect to O-M-R, the results of these observations and traces what he calls the 'observed path' of the freely falling body P. We may designate the moment of release as occurring at a moment of time t_0 and at a position (x_0, y_0, z_0) , all these being measured in the representation framework. The subscript letter 0 indicates the zero of time and place for the observation in question. We know from experience that P will appear to move with acceleration. This is commonly ascribed to the 'attraction of the earth's mass'. We must remember, however, that this attraction is not observed nor can we conceive that the action of the earth could be transmitted to the freely falling body P without some link between the two. We must therefore start our examination of the situation without supposing that there is any action between M and P, and by considering only the manner in which measurements of space and time made by O will differ from those of the universal observer Q.

Disregarding at present the direction of hyparxis, h_u , we have two fundamental directions, t_u and a_u , that are determined by the actualization and the potentiality of the universe, always and everywhere. These directions must be unique, since the universe itself as the totality of all existing worlds is unique. They are, by hypothesis, always ascertain-able by the universal observer Q. The unconstrained relationships of the universe must be capable of representation in terms of t_u and a_u and of the three orthogonal outer directions x_u , y_u , and z_u that Q can set up in the framework of the universal mass system to which he belongs. It is quite otherwise with the directions of time t_m and eternity a_m for the massive quasi-rigid system O-M-R. These will coincide with t_u and a_u only if M is at rest relative to the universe and has a distribution of potential energy identical with that of U. Since we assume that O-M-R is but an exceedingly small part of the totality U, neither condition

can ever be satisfied except accidentally for a brief moment. On the other hand, if we take M to be our own planet, we can see that the velocity of the earth relative to the mass-system of the universe cannot be great—for example, it cannot approach that of light—otherwise its kinetic energy would be enormous and its disruption inevitable. Our observations show that, compared with this limiting velocity, all the masses of the universe move extremely slowly, and we can therefore conclude that the direction of time of O-M-R—that is, t_m —must nearly coincide with t_u . It must be noted that we assume that all the entities have only one line of actualization in time. For all hyponomic entities this assumption is justified, since there is no 'multiple actualization' below the level of life. At all levels in eternity, hyponomic entities are 'doing the same thing'. Bipotent entities not only do the same but are the same at all levels.

The direction of eternity for O-M-R can be deduced from the following considerations:

- (a) The whole universe has been defined as a duodecimpotent system, within which all possibilities are comprised. There must be, therefore, an unique direction au that, at every point in space and time, gives the apokritical axis of everything that exists.
- (b) The system O-M-R is bipotent and is therefore incapable of sustaining an independent relationship. Its potentialities cannot diverge from those of the universe.
- (c) Hence, the eternity axis am of the rigid system O-M-R cannot diverge from an.

Since we are dealing only with conservative actualizations in which there is no exchange of substances between one whole and another, we can always choose a point to represent a whole of invariant being, and this point will be called its centre of gravity. All actualizations satisfying these conditions can be uniquely represented in the cosmic manifold represented by Q , by means of a pseudo-Euclidean manifold as described above in Chapter 13.

The indefinite metric of this manifold implies that the square of the interval between two points A and B may be positive, zero or negative, and the interval itself can therefore be expressed as a real, a zero or an imaginary number. This type of manifold is familiar from the geometry employed by Minkowski for representing the situations of special relativity.*

[* H. Minkowski's paper Space and Time, 80th Congress of German Natural Scientists and Physicians, 1908.]

It is evidently not possible to set up a similar universal representation manifold for the system Q-M-R, because we do not know the effect of the constraints by which the several parts of this rigid system are held together. It is, however, always possible for us to take the position of the human observer O and to establish directions related as closely as we can to those of the cosmic manifold. Now x_m , y_m , and z are the space-like directions of measurements of O , and t_m and a_m the directions of time and eternity. By definition, the rigid system O-M-R actualizes without change of its spatial configuration or of its eternal potentiality. We can therefore treat the tracks t_m , passing through all the points of the system O-M-R, as parallels. For O , the lines t_m are the same distance apart, but for Q they may be curved and not the same distance apart.

We may now pass from the constrained system O-M-R to consider the unconstrained body P that is under observation by O . Since P is free from constraint, it cannot be a quasi-rigid body as previously defined, and may be regarded either as truly plastic—in the sense that there is no constraint between its several parts—or, more simply, as a point mass. For the time being, we shall make the latter assumption. There is evidently nothing to prevent us from assigning to P co-ordinates in the universal reference-manifold of Q .

It is evident that the differences between the observations of O and those of Q may be due either to a difference in direction of the space co-ordinates, or in the manner in which the inner dimensions t_m and a_m are related. Differences affecting only the space and time co-ordinates will give O-M-R a constant velocity with respect to the general mass system of the universe, and any differences in the measurements can be corrected by the well-known relationship of special relativity. We can therefore to a first approximation assume, as above, that the only difference between O-M-R and Q is in the relationship between t_m and t_u or that between a_m and a_u . There are in general only two ways in which the measuring system of O can diverge from the universal framework of Q in a manner that cannot be allowed for by the special relativity corrections. One is a non-coincidence of the two [4] worlds of temporal actualization and the other is a non-coincidence in the directions of eternal potentiality as between O and P .

It will further be noted that the non-coincidences that we have to consider are both imperceptible for the sense-observations of O , since they lie outside of his particular world of space and time. Since these non-coincidences are assumed to be the conditions of O 's own experiences, they must lie in his existential

tract. The existential tract common

to Q, O, and the observed body P can be made to coincide by a suitable choice of the origin of co-ordinates and subsequently making relativity corrections. In the existential tract, we can have non-coincidence as between t_m and t_u or as between a_m and a_u . Any combined non-coincidence can be resolved into these two by the usual methods of vector analysis. Then non-coincidence of t_m t_u may be considered in relation to the orthogonal to O's four-world (x_m , y_m , z_m , t_m).

. In both cases the non-coincidence with a_u leads us to ascribe potential energy to P. It follows, therefore, that in the study of these divergences we may expect to find the source of accelerated motions in general and the means of establishing a comprehensive field-theory.

The property of non-coincidence can be given a full quantitative interpretation only with the aid of a detailed mathematical analysis; but its qualitative nature can be grasped if we reflect that force-fields are only recognizable by the observation of accelerated motions. The source of acceleration is easily understood when we see work visibly done as when a locomotive moves a train. It appears mysterious when, as in the case of gravitation and electrical forces, no visible work is being done. We can, however, picture acceleration as the addition of increments of velocity derived from the conversion of potential into actual energy. Therefore, provided that we can picture the source of potential energy in a form analogous to that of uniform motions, the mystery disappears. Minkowski showed how non-coincidence of time axes gives uniform relative motion. Similarly accelerations are due to non-coincidence of eternity axes. Such non-coincidences can arise in one of two ways as we have seen above. These can be described broadly as:

(a) Non-coincidence of the direction of eternity given by the orthogonal to the common space-time [4] of O and P with the direction of eternity for Q. Here the 'private' eternity common to O and P differs from the 'public' eternity of Q. This gives rise to gravitational fields.

(b) Non-coincidence of the directions of eternity of P and O. This leads to electro-static fields and when combined with non-coincidence of time-axes to electro-magnetic forces.

This shows why there can be only two kinds of centrally directed force-field and why also they have the precise properties associated with gravitation and electricity.*

[* A simplified mathematical proof of the laws of motion in gravitational and electrostatic fields is given in the Appendix II to this chapter (p. 499).]

Part 6 - The World of Energy - Chapter Fifteen

THE UNIVERSAL GEOMETRY

6.15.1. The Representation of Relatedness

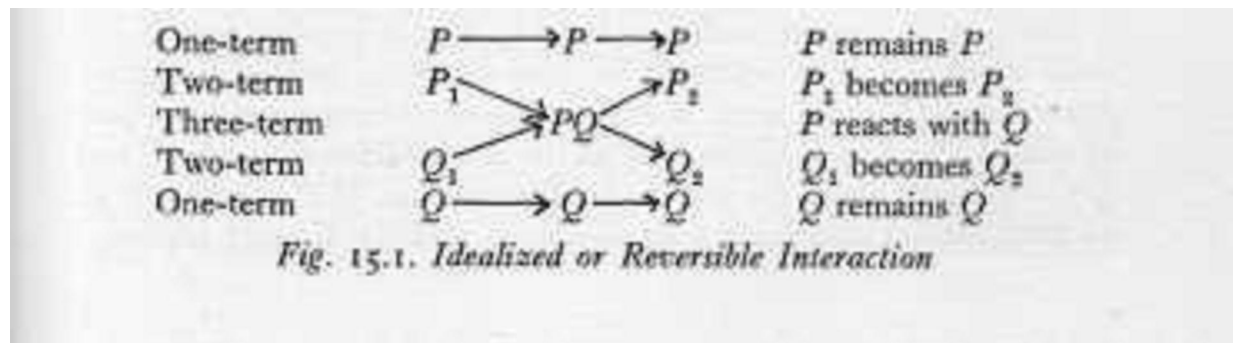
The five-dimensional geometry of the last two chapters suffices for the representation of bipotency because eternity and time can be regarded as the positive and negative poles of a dyad. Eternity affirms potentiality while time denies it. Such polar opposites, when unrelated by a reconciling factor independent of both, can give rise only to forces, and so we find that the study of bipotency does not lead us beyond the theory of fields of force in which bodies move without interacting. We have used the term 'non-interacting relatedness', but we must now recognize that it is a misleading expression since there is no true relationship. It is justified only by the fact—verifiable by observation—that the framework itself provides the link by which the overall unity of systems in relative motion is assured.

Where there is no linkage of the determining-conditions, time and eternity consist in the simple antithesis of what is and what might be— each excluding the other. This gives the distinction between actual and potential

states of the hyle, and hence between kinetic and potential energy. The transition from bipotent to tripotent entities requires that we should take account of a third state of hyle; namely, that of being shared. The representation of exchange or coupling requires an independent set of parameters and scalar magnitudes that are distinct from both mass and charge. We have to set up a geometry that will be capable of expressing the threefold character of an exchange between two entities P and Q, namely:

- (a) that P and Q interact without ceasing to be what they are,
- (b) that they undergo modification by the exchange of hyle, and (c) that they are related to one another by the exchange.

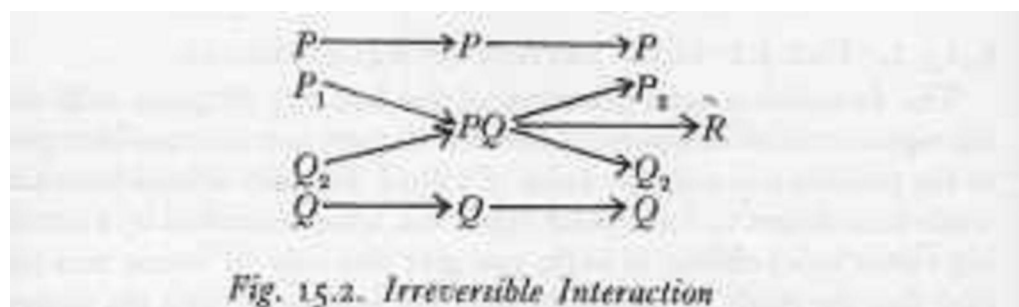
This can be set out symbolically in the following scheme:



Here P₁ and P₂, Q₁ and Q₂ are the states of P and Q before and after the interaction and PQ is the relationship established between them.

The interaction of P and Q can take two forms according to whether or not there arises a third entity R distinct from either. We have thus

to consider the alternative scheme:



The difference between the two kinds of interaction lies in the fact that the first can be taken in either direction of time and can therefore be reversible. The second diagram can be read in one direction only and therefore expresses an irreversible reaction.

The requirement that P and Q should remain what they are notwithstanding the arising of R can be satisfied only if P and Q are composite, for simple wholes must either exist integrally self-identical or cease to exist at all. We can therefore assign reversible reactions to tripotency and irreversibility to quadripotency.

An event that is cyclic in time, like the motion of a frictionless pendulum, continues to actualize successively in time until disturbed from without. The hyparchic recurrence is not successive but simultaneous—since the direction of hyparxis is by definition orthogonal to that of time. Therefore identical recurrence can be regarded as the property of being unable to change. Whereas perfect reversibility in time is impossible in a

world of exchanges and interaction, exact recurrence in hyparxis is possible. We may therefore expect to learn much about the transition from the undifferentiated ground-state of existence to the corpuscular and composite states, by setting up a geometry in which interaction can be represented both for simple and also for composite wholes.

The type of interaction depicted in Fig. 15. is possible only if PQ itself is either uni- or bipotent; for otherwise some residue R distinct from P and Q would arise. If PQ is uniquely defined for a given pair of wholes P and Q, it follows that all the potentialities shared by P and Q can consist only in the one mode of interaction. If P and Q exist in an environment containing a quasi-infinite number of other wholes—

many or all of which could interact with them, the unique event PQ has the effect of polarizing the existence of P and Q by fixing certain directions of both potentiality and actualization. It becomes, as it were, a pivot about which the joint existence of P and Q turns. We can regard PQ as absorbing some part of the existence of P and Q in such a manner that the total existence remains unchanged. We can thus formulate a general law of interaction as follows:

When two entities P and Q interact, energy, potentiality, and existence are all conserved, but redistributed between P, Q, and the combination PQ.

Viewed from the standpoint of P and Q separately, the actualization of their interaction is a loss of potentialities; for their non-interaction is now excluded. But PQ is a new entity having its own inherent potency and this is equal to the potency lost by P and Q. In so far as this lost potency is single-valued, PQ must also be single-valued and hence identically recurrent.

6.15.2. Types of Relatedness

Tripotent entities provide us with the simplest material for the study of relatedness. They are unencumbered with the burden of existence and yet can support the relationship of three independent factors. We have to find a means of transferring this linkage into our representation manifold. In the present case, the connecting link is provided by the notion of a 'simple material whole' that satisfies the postulate of identical recurrence. The designation 'simple' does not here mean 'indivisible' but rather 'self-identical in all its occasions'. An entity that has only one pattern of behaviour is simple. This is compatible with tripotency, since one and the same pattern of behaviour may enter into a very large number of occasions.

Each permissible occasion is an element in the potency of the entity. A composite entity is a whole containing or consisting of two or more simple parts and it may have any degree of potency, but we shall at present confine our attention to quadripotent compound entities to which no inner structure is ascribed, except that of being compounded of simple entities.

Let us consider a composite whole P formed of a number of distinct simple parts, a, b, c, d, etc. To indicate the composite character of P we shall use the symbol $p(P)$ which reads 'the totality of simple entities of which P is composed'. We require also the symbol $p(\sim P)$ which means

'the totality of simple entities existing in the universe which are not part of P'.

In the following discussion $p(P)$ will be called internal to P and $p(\sim P)$ external to P. A relationship of the form 'the existence of A implies the existence of B' will be called conjunctive and a relationship of the form 'the existence of A implies the non-existence of C' will be called disjunctive.

We can now define four types of relationship significant for P.

(i) Relationships Internal to P and Conjunctive These all take the form:

P and a co-exist. P, a and b co-exist. P, a, b, c, etc. co-exist.

Taken together, all such relationships constitute the potency of P and are regulated by the determining-condition of eternity.

(ii) Disjunctive Relationships Internal to P

This takes the form:

The existence of a excludes the

existence of b, c, d, etc.

or the existence of a, b, c, etc., excludes

that of d, e, f, etc., where a, b, c, etc. are all events forming part

of the total existence of P.

These are selective relationships that cannot apply to potency and must therefore be regulated by the determining-condition of time.

(iii) Relationships External to P, but Conjunctive These take the form:

$p(P)$ is related by I to $p_k(\sim P)$

The symbol I here means the interaction of P with a group of entities p_k which are not part of P itself. Interaction is possible only if at least one simple constituent passes between $p(P)$ and $p_k(\sim P)$. Thus the occasions of invariant being studied in the last chapter are not interactions, because nothing passes between P and the observer O. Interaction is a relationship intermediate between potentiality and actualization, and is governed by the determining-condition of hyparxis.

(iv) The Disjunctive, External Relationships of P These take the general form:

There is a $p(P)$ the existence of which

is incompatible with the existence of a $p(\sim P)$.

Here the tripotency of P prescribes a limit to the actualizations of $\sim P$. Since all the relationships we are now considering are by definition external to P, they cannot be regulated by the inner determining-conditions of time, eternity, and hyparxis. They require a threefold system of disjunctions governed by the determining-condition of space. In the primitive case of tripotency, all the relationships of space are reversible and monotonous; that is, they are of the form either:

$p(P)$ allows $p_k(\sim P)$ or: $p(P)$ does not allow $p_k(\sim P)$

The first expresses the fact that bodies can co-exist in different places, the second expresses the fact that two bodies cannot occupy the same place. These relationships hold only for space and not for the inner determining-conditions. The distinctions between the two kinds of relationships can be expressed by the mathematical symbolism of real and imaginary numbers that has the required properties. We can therefore write x, y, and z for the outer dimensions of space; and it, ia, iu, etc., for the inner dimensions, and so construct a pseudo-Euclidean manifold similar to that used in the previous chapter.

6.15.3. The N-dimensional Geometry

In setting up a scheme of representation, we postulate the homogeneity of all hyponomic relationships required to enable one and the same scheme to represent the existences of different entities P, Q, R, etc. To maintain the distinction between the four types of relationship, we might expect to require four reference manifolds, each with a sufficient number of independent sets of numbers to enable all the required magnitudes to be expressed. Since both internal and conjunctive relationships are concerned with the inner nature of the entities concerned, these can be combined into one set, while all disjunctive relationships external to P form a second independent set. This suggests, as a geometrical postulate, that two independent manifolds should suffice for representing all the relationships of all entities up to and including the gradation of quadripotent existence. Adopting this postulate we can set up a reference manifold of N-dimensions, divided into two indepen-

dent sub-manifolds, K of k and J of j dimensions respectively, where $k + j = n$.

We make the assumption that the j independent number systems of J are adequate for representing all the relationships of time, eternity, and hyparxis. The k independent numbers of the second sub-manifold K are to represent all the relationships of space. K and J together must be adequate to represent all four types of relationship of every hyponomic entity existing in the universe.

Since the three determining-conditions of time, eternity, and hyparxis impose distinct and characteristic limitations upon existence, the geometry must also allow for distinct and characteristic modes of representation. The course of actualization must be distinguishable from the potential-energy gradient and both must be separable from the intensity of existence. Each must be capable of being expressed by a set of numbers; but it is not sufficient to construct sets of independent manifolds. We require in addition to specify the permissible transformations by which one kind of magnitude can be related to another. We also need to be able to represent the transfer of hyle from one entity to another in such a manner as to agree with the facts of observation. The [N] can be partitioned into sub-manifolds, and we can take the mode of partition as one of the characteristics of the existences present. This is already familiar from the geometry of Minkowski, where each independent body divides the 'absolute world' into its own proper time and space manifolds. In our universal geometry we shall look for four kinds of intervals corresponding to time, eternity, hyparxis, and space, but we shall expect to be able to transform one kind of interval into another, as is done in the geometry of special relativity by regarding the velocity of light as a conversion factor.

6.15.4. Skew Parallelism

In dealing with tripotent entities we have a problem that does not arise with invariant being; namely, that of reconciling potential and actual states by means of an interaction that partakes of the nature of both. To represent this, we require a special kind of vector that has to be in some way of the same kind as the vectors that we use to represent mass and electric charge, and yet must be independent of them. As we have seen, the indefinite metric allows for null-intervals, null-vectors, and null-angles. We shall, therefore, again adopt the device of treating the two parts of the [N] as sets of real and imaginary numbers respectively. The metric of the [N] is thus pseudo-Euclidean, and the expres-

sion for an interval will have k positive and j negative terms. We call the [K] 'real' and the [J] 'imaginary'.

In Minkowski's four-dimensional geometry a null-vector connecting the point A of emission of a ray of light with the point B of its absorption expresses one of the fundamental data of bipotent entities; namely, the constancy of the velocity of light. When time is measured along the interval from A to B, the interval vanishes and we have the already noted 'zero proper-time' of light. This means that although a finite space-interval separates the points A and B, and a finite time-interval separates the moment of emission from that of absorption, the two when combined to constitute an interaction give a null-vector. The absolute or locus of null-vectors serves to link the space-like and the time-like intervals because it brings together the inner and the outer relationships of the two entities; namely, the atom A and the atom B. The absolute or null-cone of

the N-dimensional geometry corresponding to any tripotential entity P provides the link between the inner or time-like and the outer or space-like relationships of P with all other existing wholes.

In order to distinguish between the four kinds of basic relationship, we can make use of the property of null-vectors. Any vector can serve to represent the transfer of a magnitude from one point to another. A space-like vector can represent the displacement of an entity P from one position to another position without implying motion and therefore change of time. Similarly, a time-like vector can represent the fact that any existing entity P transfers its mass from one moment of time t_1 to another moment t_2 without change of place. A mixed vector can represent the momentum with which a certain mass appears to move relative to an external system of reference. Turning our attention now to null-vectors, we can see that if one has a non-vanishing component in space—for example, a displacement—then it must also have a non-vanishing component in a time-like direction of such magnitude and direction as to bring the resultant into the null-cone. On account of this property, null-vectors can be used to represent the connections and relations of the separate elements that go to make up the existence of a given whole.

Let us suppose that V is a unit-vector that represents one of the simple entities composing a composite whole P, and that U is a null-vector also associated with P. The nullity of U is apparent in the [N] and is therefore independent of the choice of P. On the other hand, the resolution of U into non-vanishing components can be made only by reference to P or some other existing entity. If we regard imaginary values as internal and real values as external, then we may take V as falling either inside

or outside the null-cone. It cannot lie on the cone or it would itself be a null-vector. We can now choose U so that it is orthogonal to V . This enables us to define a vector W where

$$W = V + \Theta U \quad (15.4)$$

This will be called a skew-parallel of V since $WV = 1$.

The divergence Θ is a scalar and if its value is not zero, the components of W and of V in all directions are not identical. If V is an interior vector—on the J side of the null-cone—then W is also an interior vector.

All the skew-parallels obtained by giving Θ all possible values will be called a **pencil of skew-parallels of V** . By giving Θ as many values as are required to specify all possible inner or outer relationships of P as the case may be, we obtain a means by which we can represent by a single symbol both the actual and the potential state of P . The null-vector U can be associated with some definite property so that the pencil of skew-parallels then serves to link through the vector V with a component of P .

A family of skew-parallels is definite in respect of its guide-vector V , but indefinite in respect of the associated null-vectors. This property corresponds to the fundamental difference between actual and potential states of the hylē. Thus skew-parallelism, which at first glance appears to be no more than a geometrical curiosity, proves to have the greatest significance for the representation of physical events. We shall therefore attempt to formulate in non-mathematical terms the character of the relationship that exists between a vector and its skew-parallels.

Let us consider two events (A) and (B) separated in space and time but connected by the fact that a given whole P participates in both of them. The events might be, for example, the moment when a man starts upon a journey and that at which he arrives at his destination. The events are connected by a line which is the direction of time of the man P . If this line is a cosmodesic, the points A and B will determine a time-like vector of finite magnitude. If the journey lasts exactly one year, we can call it a unit-vector in the scale of years. Now let us suppose that during the journey the man deviates from the intended itinerary, but makes up the time that he loses by travelling faster, so that in the end he arrives at the destination at the same moment as if he had followed the intended path. There can be an infinite number of such diversions and all of them will leave the beginning and starting points unchanged, provided that the lengthening of the path in space is accompanied by an increasing speed, exactly calculated so as to leave unchanged the overall time taken. The situation so described can be represented by

This gives rise first to two main kinds of pencil according to whether V is free or fixed. If V is not unique, then the pencil is called **transitive**: if it is unique, the family is called **non-transitive**.

In what follows it is often convenient to take the U 's as fixed, introducing enough of them to enable their variety to be expressed by variable divergences $\emptyset$. Thus we have transitive families of skew-parallelisms given by the equation:

$$W = V + \sum_1^m \emptyset_p U_p \quad \dots \quad (15.6)$$

Here the null-vectors U_p are mutually orthogonal and each is orthogonal to the guide-vector V . In this equation the divergences $\emptyset_p$ are real non-zero parameters. The degrees of freedom are m and may be shown to be at most j if $k > j$, or $j - 1$ if $k = j$. Every member of the family is a skew-parallel of every other member. The guide-vector V can be chosen as any member of the family and hence is not unique.

In a non-transitive family every W is a skew-parallel of V , but not in general of the other W 's. The degrees of freedom may be shown to be at most $n - 2$, where $n = j + k$.

(i) *The Alpha-pencil*

We shall use the term α -pencil to denote the system of skew-parallelisms of a guide-vector developed with the condition that there is a single null-vector U which is fixed, and the divergence $\emptyset$ varies. The singly infinite range of values that can be ascribed to $\emptyset$ can be regarded as conferring on an α -pencil one degree of freedom. Every member W of the pencil is a skew-parallel of every other member. Thus an α -pencil is a transitive family having one degree of freedom. Since U is fixed, the pencil has the quality of directiveness.

The single degree of freedom resulting from the variability of $\emptyset$ gives to W a singly ordered series of magnitudes. The α -pencil neither excludes nor selects, nor does it depend upon the choice of the guide-vector, V , since any one of the W 's could serve as a guide-vector. It follows that the α -pencil has exactly the properties required for the representation of potentialities in which the basic relation is a simple 'more or less'. These considerations lead us to identify the α -pencil with the determining-condition of eternity and to assign to the latter one dimension. There is thus no departure from the interpretation adopted in the five-dimensional geometry. The scalar $\emptyset$ serves to fix the degree of coupling between the guide-vector and the property represented by U . $\emptyset$ appears to be connected with the potential difference separating two inner states of the whole to which it refers.

(ii) *The Beta-pencil*

When U is not fixed, the pencil has an indeterminate apportionment of internal and external vectors. If no other restriction is placed upon U than the requirement that it is to be normal to V , the pencil has $n - 2$

degrees of freedom. We no longer have the property that every W is a skew-parallel of every other W and the guide-vector V is therefore unique. The pencil is non-transitive and can be used to represent a property inherent to the existence of an entity.

The significance of the B-pencil and its suitability for representing the time-like property of mass can be seen from the following consideration. All the lines of time of the objects we look at are skew-parallel to our own line of time, but they are not in general skew-parallel to one another. The apparent simultaneity that we constantly experience with our own bodies is a direct property of this skew-parallelism. The totality of visual impressions constitutes a pencil of lines of time that are skew-parallel to the direction of actualization of the observer O .

If this latter is taken to determine the guide-vector V , the null-vector U can have any direction compatible with the requirements of special relativity.

In five dimensions with $k = 3$ and $j = 2$ the B-pencil has three degrees of freedom corresponding to the null-vectors of the light-signals which may be added to the basic vector V along which O is actualized. In this case the pencil of null-vectors is 'the whole field of vision of O '.

The guide-vector itself is clearly to be associated with actualization in time. It can serve to represent that aspect of existence that is conserved in the process of actualization; that is, the inertial mass. Thus the vectorial representation of inertial mass used in special relativity and in our own generalized field theory, proves to be a special case of the more general conception of mass as the guide-vector of a family of skew-parallel lines that, taken together, represent the 'total temporal experience possible for the entity P '.

Although the a - and B-pencils thus have properties that make them suitable for representing eternity and time, we have still to verify the identification by examining the manner in which the two sub-manifolds K and J are related to one another. In other words, the properties of the a - and B-pencils must be brought into harmony both externally as well as internally with the character of tripotent and quadripotent entities.

(iii) The Gamma-pencil

Let us consider a transitive pencil with the maximum degree of freedom consistent with the condition that every member of the pencil

is to be a skew-parallel of every other member. A pencil so defined will be called a γ -pencil.

This is obtained by adding m independent, mutually orthogonal null-vectors to the guide-vector V . The m mutually orthogonal null-vectors may be defined by taking for each null-vector one inner and one outer vector from m orthogonal unit-inner-vectors in the sub-manifold J and m orthogonal unit-outer-vectors in the sub-manifold K . If $k = j$, and therefore $m = j - 1$, the unit-vectors in J span a prime in J . In order to span the whole of J and link it through the null-vectors of γ -pencils with the whole of K , k pencils are necessary and sufficient. If $k > j$, and therefore $m = j$, we need k γ -pencils to span the whole of K and link it with J .

Thus k γ -pencils provide a transitive total linkage of K and J , and permit the outer relationships of every whole P to be linked with the inner properties of P . We therefore associate the γ -pencil with the determining-condition of space, and note that it requires k such pencils for total linkage. Below we shall find, as expected, that $k = 3$; that is, that the space so defined is three-dimensional.

It can be recognized that a γ -pencil is very similar in character to the α -pencil. Both are transitive families and neither has a fixed guide-vector. The α -pencil differs only from the γ -pencil by the fact that:

- (a) it is composed of inner, not outer, guide-vectors,
- and (b) it has $m - 1$ fewer degrees of freedom.

In a sense, the α -pencil is a degenerate γ -pencil.

(iv) *The Delta-pencil*

We should expect to find a degenerate non-transitive pencil bearing the similar relationship to the β -pencil as does the α to the γ . We can evidently define a δ -pencil as a degenerate non-transitive family having only one degree of freedom with Θ fixed and U varying. The direction U , having only one degree of freedom, must be such that the equal inner and outer vectors into which U can be resolved rotate upon two-dimensional surfaces in J and K respectively. The rotation then corresponds to the single degree of freedom, and the independent parameter can conveniently be taken as the angle of rotation.

6.15.6. THE FOUR TYPES OF PENCIL AND THE FOUR DETERMINING-CONDITIONS

We must now look more closely into the properties of the four types of pencil, in order to satisfy ourselves that they can serve to represent

every kind of hyponomic fact. The first requirement is that every entity P should be able to be identified and distinguished from all other entities in the universe. Secondly, there must be a general order, or configuration, of all entities in which not only every actualized event but also all potentialities and all relationships can be represented.

Since we regard every quadri-potent whole as an aggregate of simple entities, we can assign a number to every such component and obtain a singly infinite set to comprise all its potentialities. For such a representation the a-pencil is suitable, and we have therefore provisionally assigned it to the dimension of eternity. Similarly, the B-pencil, with several degrees of freedom, is assigned to the dimension of time, wherein it is necessary to compensate for the highly selective effect by which each entity actualizes only one of its potentialities. Only a linkage that could hold together the resulting distribution of directions of actualization could give coherence to the universe. In the representation scheme, a system of skew-parallels having a high degree of freedom will be required to ensure that the actualization of P should remain linked to all other actualizations proceeding in the universe both simultaneously and non-simultaneously.

Herein lies one significant difference between the two dimensions of time and eternity. We are accustomed to think of potentiality as representing freedom and actualization as fixation. This is perfectly correct in so far as concerns the inner-world experience of a given entity. For man, freedom is in eternity and fixation is in time; but whereas eternity places no restrictions upon the co-existence of different entities, time with its strong exclusions requires a correspondingly strong linkage to preserve the unity of actualization.

The y-pencil is that which places P in a set of relationships with all other existing entities. The y- and the a-pencils have in common the transitive property that makes them non-exclusive. The difference between them is that the a-pencil allows for the co-existence of potentialities, whereas the y-pencil allows for the co-existence of the entities themselves. Examining the properties of the y-pencil, we can see that it has the requisite degrees of freedom to enable it to serve as a linkage between the outer dimensions of space and the three inner dimensions.

The characteristic property of the o-pencil is that it is self-linked and does not require any other linkage. Unlike the B-pencil that can hold one actualization in relationship with another, the o-pencil can be said to preserve the entity P from the consequences of the existence of other entities. We can liken this to the condition of hyparxis, which we have defined as regulating the 'ableness-to-be of any given whole'. The

suitability of the (o-pencil for representing ableness-to-be suggests that it may be used to represent the dimension of hyparxis. We have, however, to consider also the characteristic hyparchic property of recurrence.

For this we must examine more closely the physical interpretation of the (5-pencil. According to the principle of relatedness we should expect the inner world of a given whole to comprise three independent elements standing to one another as affirming, denying, and reconciling, factors. Taking into account its main characteristic of sensitivity, we ascribe to hyparxis the property of reconciling the affirmations of eternity with the denials of time. The reconciliation is accomplished not by the action of some universal law, but by the ableness-to-be of every existing whole. This is a varying quantity depending upon the existential status of each entity concerned. For hyponomic entities there can be no self-regulation or inner adaptation to adjust the process of actualization to an eternal pattern; their ableness-to-be is therefore no more than the quantitative expression of their mode of recurrence. Even the simplest ableness-to-be goes beyond the identity of the whole itself and confronts it with all the rest of existence. We must remember that ableness-to-be is distinct from the intensity of inner-togetherness that determines the level of being of a given whole. In the dimension of eternity the intensity of inner-togetherness varies according to the state of consciousness so that, for example, a given whole may behave sometimes as if it were an inanimate object, and sometimes as if it were a conscious being. Throughout these fluctuations, however, the ableness-to-be itself remains a stable factor that measures on the one hand the range of variations possible in the dimension of eternity and, on the other, the extent to which the given whole is able to retain its identity in the process of its actualization in time. Ableness-to-be oneself is significant especially in the sense of 'ableness-to-be oneself when confronted with others.'

In our earlier discussions about the character of hyparxis, we have associated it on the one hand with the logic

of classes and, on the other, with the frequency or probability of recurrence. We can now bring these various characteristics into the form of a single specification. Everything that is completely actualized ceases to exist as an independent entity and is reabsorbed into the ground state of the hyle. The possibilities that remain unactualizable are no safeguard against this inevitable dissolution. If, however, every actualization repeats itself, then the totality of all existence, and also of all potentialities, remains stable. Nevertheless, such repetition or recurrence cannot find a place either in time or in eternity; for in the one case it would fail to preserve potentialities while

in the other it would be lacking in actualization. Unless the property of recurrence is such as to leave scope for variability, it would be trivial. Nothing would be added to existence by the mere fact that every whole is destroyed over and over again instead of being destroyed once only. Consequently we have to ascribe to hyparxis the power that enables everything that exists to repeat itself, but only to a limited extent, and this limited extent is measured by its ableness-to-be. From these considerations, it follows that ableness-to-be is a quantity and therefore must be susceptible of measurement. Furthermore, the measurement cannot be infinitely divisible; since repetition or a recurrence can only apply to wholes; that is, to events or parts of events that can themselves be recognized as having an independent existence. In this respect hyparxis differs fundamentally from time and eternity which have no inherent quantization.

We can consider here the analogy of a simple harmonic oscillator, subject both to damping and renewal. The intrinsic character of the oscillator as an alternation of actual and potential states belongs to time and eternity; but if we add that there shall be only a finite number of renewals, then we introduce the determining-condition of hyparxis also. For example, we may think of a watch, the mainspring of which can only be wound a limited number of times before it is worn out and has to be replaced. Here the wearing-out has to be regarded as distinct from the running-down of the watch as the spring unwinds. Similarly, we may think of a living organism having a definite life-cycle measurable in years and a potentiality of adaptation assessable in terms of its apokritical level. The two taken together tell us what might happen in general and what does happen in one particular life, but it does not tell us how the particular and the general are reconciled. For this we require a third determining-condition to prescribe not only the number of repetitions of the given cycle of life, but also the distribution of potentialities as between the various actualizations. It is this latter feature that corresponds to the 'frequency' conception of hyparxis.

Now we have seen that the o-pencil, though not fixed in direction, has nevertheless only one degree of freedom. This can most simply be pictured as the rotation of a vector in a plane. The angle of rotation from a chosen direction can then be taken as the variable parameter. The chosen direction itself can then be regarded as the 'initial and final' state of a recurrent cycle. The cycle is neither 'in' time nor 'out of it. It is a kind of verification or presentation of all the potentialities associated with the entity P, the intensity of which is measured by the 'length' of V and the extent of which is given by the number of recurrences.

6.15.7. Characteristics of the Universal Geometry

A multi-dimensional geometry can always be constructed for the representation of any set of relationships that can be defined by sets of numbers; but when the characteristics of the geometry are selected solely to fulfil a specific set of conditions and no attempt is made to generalize it beyond these conditions, the geometry can be called one of 'conventional representation'. We do not require that such geometry should be susceptible of direct interpretation in terms of our own sense-experience and inner intuitions. It has no justification or use except those of mathematical convenience. When, however, the geometry is directly related to sense-experience—as Poincare attempted to do in regard to space and time—then it must serve to represent all facts without exception and it has no value unless this condition is fulfilled.

According to Poincare, the three-dimensionality of space is to be explained through a study of the human organs of perception, and the same applies also to the successiveness and irreversibility of time. Geometries constructed in this manner are by their very nature applicable to a wide variety of phenomena, but they break

down when we seek to represent relationships that are not directly given in sense-experience.

The geometry that we have sought to establish differs from those just discussed inasmuch as it is derived from an examination of the fundamental conditions which are common to all phenomena, and takes into account also the stratification of existence. We require of it that it should prove adequate for the representation of all hyponomic entities and all the relationships that can arise between them. We shall not expect that it will prove suitable for giving a complete representation of all autonomic or hypernomic existence. Even with this restriction, the demand that we make upon the geometry is very severe, and it could not be satisfied unless there were an authentic correspondence between the geometry itself and the phenomena of the hyponomic world.

A few of the requirements of the geometry can be stated as follows:

(i) Every hyponomic whole must be capable of representation as

an aggregate of simple entities, (ii) Relational entities when simple are tripotent. (iii) Composite wholes are quadripotent. (iv) Bipotent entities have no interaction. (v) Tripotent entities can interact reversibly. (vi) Quadripotent entities have both inner and outer relationships

and can participate in irreversible interactions.

(vii) Every relationship has three characteristics:

(a) its direction,

(b) its magnitude, and (c) its diversity.

(viii) A distinction has to be made between conjunctive and disjunctive relationships.

(ix) Relationships may be transitive or non-transitive and the geometry must enable this distinction to be represented. (x) Quadripotent entities, being massive space-extended aggregates of hyle, it is necessary to represent by means of the geometry the properties of mass, electric charge, momentum, and angular momentum, that are associated with such entities. (xi) The geometry must give an account of the distinction between

virtual and actual states of matter. (xii) It must also give an account of exchange forces. (xiii) The thermodynamic laws of conservation and entropy must be capable of geometrical representation.

Some of these properties have already emerged in the treatment of dynamics and others will be demonstrated in the course of our further investigations.

6.15.8. The Six-dimensionality of the Hyponomic World

The N-dimensional manifold considered in the present chapter has an indefinite pseudo-Euclidean metric. This enables us to represent the conservative properties of hyponomic existence by means of straight lines for which straightness must have an absolute significance, independent of the entities concerned and of the manner in which they are observed.

The N-dimensional manifold is divided into two parts, K and J respectively, with k and j dimensions, where $k + j = n$. Every hyponomic entity has a small number of distinct characteristics such as inertial mass, electric charge, linear and angular momentum. These we know from observation are conservative for the temporal actualization of any closed system. There are other unobservable characteristics such as potentiality and ableness-to-be that we infer from phenomena and which also must be conservative for some eternal or

hyparchic transformation. The 'geometrical postulate' requires that all these characteristics should be capable of representation by means of co-ordinate numbers and vector directions in the cosmic manifold.

If the sets of numbers assigned to a number of entities, P, Q, R, etc., are to be consistent, the number of dimensions $k + j$ must neither be so

large as to lead to 'over specification' nor so small as to make full specification impossible without auxiliary quantities. The number $k + j$ should therefore be ascertainable from the basic requirements of 'fitness of the manifold'. It should also be possible to deduce it from the geometry alone, by considering the fundamental requirement that there should be no break of continuity between the inner and the outer worlds of P, Q, R, etc. This is given by the property of the y-pencils that enables them to link space with time, eternity, and hyparxis. Moreover, there has to be a sufficient number of degrees of freedom associated with each kind of pencil to enable the number of independent variables present in P, Q, etc., to be fully represented. It may be shown from purely geometrical considerations that the construction is possible only when $k = 3$ and $j =$ either 2 or 3*. In the former case there is no o-pencil and the resulting geometry is the five-dimensional scheme adopted in Chapters 13 and 14. When $j = 3$ we obtain the six-dimensional geometry with three y-pencils representing space, one a-pencil representing eternity, one B-pencil representing time, and one o-pencil representing hyparxis. It can further be shown that the values $k = 3$ and $j = 3$ enable any number of tripotent entities P, Q, R, S . . . to be represented with all their relationships in one and the same manifold. The proof of the foregoing theorems shows that the geometry we set up is in a true sense 'universal'. The six-dimensional geometry has three dimensions having inner, and three dimensions having outer, characteristics. Four of these dimensions belong to our common experience of space and time. The two remaining represent the determining-conditions of eternity and hyparxis. Actualization, potentiality, and recurrence characterize the three inner determining-conditions, and they stand in the relationship of denying, affirming, and reconciling forces of the inner triad of the given whole. The three outer relationships correspond to three directions of space that are fixed when a given whole P begins to enter into relationships with its external world. P has three characteristics : firstly, its own instantaneous direction of motion; secondly, its direction of acceleration or the gradient of the force field in which it is moving; and, thirdly, a direction determined by its axis of rotation or an equivalent property associated with hyparxis. These three directions are intrinsically independent; they are the outer determining-conditions that correspond to the inner determining-conditions of time, eternity, and hyparxis, respectively. Thus we see that the isotropy of space is

[* A simplified proof of the basic theorem concerning the six-dimensionality of the representation manifold is given in the Appendix to this chapter (p. 506). Reference should also be made to Podalanski's treatment (loc. cit.).]

only a geometrical fiction. In every physical occasion that we observe in our phenomenal world, space is directed, for there is always motion; there is always a field of force independent of the motion, and there is always a relationship between a given whole and other wholes that depends upon its own ableness-to-be. All the six dimensions are thus required for the representation of any situation in which the existence of a whole is effectively committed. We should therefore expect to be able, by use of the universal geometry, to represent all the occasions of the physical world; that is, all relationships of hyponomic entities.

Chapter Sixteen SIMPLE OCCASIONS

6.16.1. Simple Interactions

Passive entities fall into one of the four hyponomic grades according to the degree of potency associated with their existence. In this chapter we shall direct our attention mainly to tripotent entities lacking the elements of 'compositeness' and 'subsistence'. These entities are 'simple' in the sense that all their actualizations are of an 'all-or-nothing' character. This enables us to regard them as undivided, but also as non-individualized, wholes. The simple entity cannot change—for change means a rearrangement of parts. Where there is no change, the

direction of time has no significance and thus we find that all simple interactions are by nature reversible. According to our interpretation of the determining-conditions, a simple entity is cyclic in the dimension of hyparxis. It thus satisfies the hypothesis of identical recurrence, no one of its potentialities standing upon a different level from any other.

A picture of such simple wholeness can be given in the existence of a perfectly elastic massive sphere, P. Such an entity exemplifies the hypothesis of identical recurrence. Let us consider two such spheres P and Q. Any collision between the two must result in an energy transfer that could be exactly reversed. For example, if the universe consisted solely of two such equal elastic massive spheres, each of which falls initially upon the other from a finite distance, then the whole of the subsequent history of the universe would consist of a cyclic exact repetition in which the spheres would fall together, rebound, return to their original positions and fall back again. This example may serve to bring home to us the limitations of the hypothesis of identical recurrence, for evidently, in our everyday experience, we seldom encounter anything even remotely resembling such perpetual motion. We shall see, nevertheless, that the study of identical recurrence enables us to deduce certain fundamental laws that apply especially in the domain of the ultimate particles and atoms.

6.16.2. Reversibility

In the example just considered, the two spheres are at rest at two points in each cycle; one is the moment of maximum compression, when they

are in contact with one another just before the rebound, and the other is when they are at the greatest distance; that is, in their original positions.

In both extreme situations the whole energy of the system is potential. There are two other moments when there is no potential energy; one is the moment of impact and the other that of separation. Between these four points the energy is present in three different states; one is the kinetic energy of motion, another is the strain energy of compression, and the third is the energy of the gravitational potential. The three forms of energy require for their representation three different pencils of skew-parallel. The potential energy of the gravitational field is independent of time, and can be specified by means of an α -pencil, in which the divergence Θ is the only variable and characterizes the field. The kinetic energy requires a β -pencil, for it is necessary to specify both the inertial mass and the velocity in order to fix the energy, and for this the four degrees of freedom of the β -pencil are required. The strain energy of the compression, being independent of both time and eternity, must be represented by an hyparchic magnitude; namely, a δ -pencil. The amount of strain required to absorb the appropriate energy depends upon the nature of the material of which the sphere is made, and hence upon its ableness-to-be. There is in the whole system, however, one overriding characteristic, namely, the complete determination of all its history, both inner and outer. The potential energy has only one possibility of actualizing. We describe such a tripotent system as 'fully degenerate in eternity', for it only has two possibilities—of existence or non-existence. The system PQ remains permanently in a state of constant entropy; it never has more than one possibility at a given moment of time and the recurrence of PQ is precisely the sum of the recurrences of P and Q taken separately.

Not all cases of identical recurrence are fully determined in this manner. Let us suppose that the two spheres, P and Q , instead of being isolated in a private universe consisting of themselves alone, are in the presence of an indeterminate number of other similar spheres, each introduced at random after its own cycle of recurrence has begun. The perturbations in their motions, caused by the other bodies, will very soon preclude an exact return and collisions will soon become very rare; yet their combined energy will remain constant, though now influenced by the complex gravitational field set up by the totality of spheres present. The individual actualizations will cease to be reversible, although the system remains conservative and all entities still satisfy the hypothesis of identical recurrence. There will, however, be a progressive diminution of potentialities as the system tends towards a state in which some of the spheres

will be lying at rest in contact with one another, with their energy stored up in a state of compression, while the remainder will be moving outwards through space beyond the range of the gravitational attractive force of the central mass.

If this account is translated in terms of the hyle of which the spheres are composed, we can see that a finite, though small, proportion of the mass present will at all times be in the form of potential energy. Herein lies the difference between the present example and the former one, in which only P and Q were concerned. The system now has a progressive actualization in time, and also a certain apokritical range that measures the potentialities of the whole. The chief difference, however, will lie in the dimension of hyparxis, for here exact

recurrence will apply initially only to the individual spheres, although there will slowly emerge an intrinsic 'ableness-to-be' of the system taken as a whole.

The hyparchic axis of the whole is not ascertainable from those of the individual spheres, but it does depend upon the potential and actual energies distributed in space at each successive moment of time. The final equilibrium is reached only after an immensely long interval of time compared with the initial frequency of collisions. The reason for this is that even with perfectly elastic spheres not all the energy of collision is restored as kinetic energy. It is only when there is the rare occurrence of a simultaneous collision of three or more spheres that the system begins to slow down effectively. At any moment of observation sufficiently far removed from the final state, the potentialities of the system are enormous. These potentialities constitute a reserve of energy; but, because it is potential, this part of the total quantity of hyle present is lost to observation and re-entry into its temporal actualization thereafter becomes increasingly improbable.*

Entities existing in such circumstances acquire a character that cannot be described in terms of potentiality alone. This is due to the fact that a part of hyle is withdrawn from actualization. This cannot return into space and time except at the end of an immensely long and very improbable sequence of events. It will further be noted that the potential energy stored up in this way carries with it the virtual pattern of all possible actualizations.

In the case of the reversible interactions between entities of identical recurrence, the virtual pattern occupies only one level in eternity, and there can be no intervening links. Such entities have no eternal differentiation; that is, no apokritical structure. Consequently, their eternal

[* See, however, Chapter 22 for a suggestion that energy 'wasted' by non-absorption in matter may be the source of new atoms arising in the cosmic spaces.]

pattern repeats itself exactly from one level to another, starting from the level of determinism—where the visible motions are in progress—to reach to the limit of togetherness—where all matter is in the virtual state. We can thus visualize a system of elastic spheres as reproduced with its eternal pattern at regular apokritical intervals that correspond to its level of existence.

In this sense alone is it legitimate to speak of eternity as recurrent; but even here the term is misleading; for there is no repetition of events, but rather the kind of effect that is seen in a room with parallel mirrors, where the actual events proceeding in the room seem to repeat themselves over and over again in the mirrors, yet adding nothing to the amount of existence of the room or its contents.

6.16.3. The Quantum of Action

According to the principle of polarity, the determining-conditions of eternity and time can—in the absence of the appropriate reconciling factor—only produce a state of tension or a force. This force arises through the opposition between the many potentialities of an entity and its single actualization. When this conception is applied to a simple entity, it corresponds to the division of energy between potential energy and the energy of motion. The difference between these two can be regarded as a measure of the degree of tension that exists owing to the opposition between potential and actual states. Now the difference between the potential and the kinetic energy of a system has a special significance for dynamical science. It was called by Helmholtz the "kinetic potential of the system". When the sign is reversed so that the potential energy appears as negative, the function is that—commonly called the 'Lagrangian'—which serves to characterize conservative motions. By the use of Lagrange's function, mathematicians of the eighteenth century achieved a wonderful simplification of dynamical problems, which has been retained in all its significance in the development of modern theoretical physics.*

It is important here to examine the status of some of the concepts that we associate with the existence of

matter. We are accustomed, for example, to regard energy and mass as enduring properties of a material system; but we tend to overlook the fact that mass only 'exists' by being subject to the condition of time. A more significant assessment of existence is therefore obtained when energy is combined with a duration of time.

[* Cf. the use by Podalanski of the six-dimensional curvature scalar as the Lagrangian for the purpose of relating his 'hyper-dimensions'—equivalent to our eternity and hyperaxis—to space-time. Cf. J. Podalanski, 'Unified Field Theory in Six Dimensions', Proc. Roy. Soc. (1950) 201A, p. 247.]

In order to take account of potential as well as kinetic energy, the Lagrangian function is integrated over a time-interval. The quantity so obtained is called the 'action of the system'. Because both time and eternity are combined in this conception, action is a measure of existence more fundamental than mass alone.

Many great mathematicians of the past have recognized the deep significance of action. The concept itself was first expressly formulated by Maupertuis and subsequently developed into a powerful instrument of analysis by Sir William Hamilton. Hamilton, referring to the importance of Maupertuis's conception, writes that "he conceived that the more space has been traversed and the less time it has been traversed in, the more action may be considered to have been expended".* It will be evident that action defined in this manner must be related to hyperaxis, for it is a measure of ableness-to-be.

The property of action depends primarily upon the relative movement of bodies. A rigid body rotating about a fixed axis or a number of separate bodies revolving about a common centre of gravity have a rotary action; that is the angular momentum which has the dimensions of action.+ This does not vary with time, but is an intrinsic property of every conservative system. We are given in this way a remarkable insight into the nature of existence. Philosophers in the past have discussed the significance of shape and colour, and have posed the question whether these are accidents or true qualities of existence; but they have not at all considered the property of angular momentum which proves to be an intrinsic element in the very existence of an independent system. The angular momentum of the solar system is, for example, one of the most difficult of all its properties to account for. It is this property that maintains a reconciliation between the potential energy and the kinetic energy of the sun and the planets. It never occurred to Kant that his speculations as to the origin of the planetary world would break down chiefly through failure to account for the enormous quantity of angular momentum stored up in the great planets.

The importance of action becomes further evident when we examine the effect upon a system of interactions between its several parts. Sir William Hamilton showed that the principle of least action, by which non-interacting dynamical systems are governed, should be replaced by a principle of varying action that enables the degree of interaction to be assessed. The best known applications of this principle are found in the transmission of light through a dense medium.

[* Sir William Hamilton, Collected Papers, Vol. 1, p. 384.

+ i.e. ML^2/T which is equivalent to energy multiplied by time.]

The concept of action enables us to distinguish between the different types of hyponomic entity. Where there is unipotent existential indifference there is no action. With bipotent entities that satisfy the hypothesis of invariant being all systems actualize according to the principle of stationary action. With tripotent entities of identical recurrence the law of least action applies, and every change is reversible. Tripotent entities have quasi-reversible reactions, and in so far as they can undergo total changes, they can be said to have 'intermittent least action'. Wherever there is a true irreversible interaction—possible only with quadripotent entities—the action of the system and of its several parts prescribes the way in which changes can occur.

In order to give a more exact expression to the significance of action for the transformations of quadripotent

composite wholes, we must return to a geometrical representation in which an o-pencil is associated with the dimension of hyparxis. The a- and B-pencils can be associated with electric charge and inertial mass; but neither of these characterizes the entity in terms of its own power of existence, or ableness-to-be. The o-pencil is non-transitive—that is, it has a guide-vector that is distinguishable from all the skew-parallels of the pencil. This guide-vector can serve to represent the action of an entity, and the family of skew-parallels can then serve to connect the one actualization of P with all its potentialities. For this purpose the o-pencil with its single degree of freedom is adequate.

There is, therefore, nothing in the geometry that is inconsistent with the association of o-pencils with action. We should, however, look further and examine whether there is any positive reason for making this connection. The geometry of the 5-pencil shows that the degree of freedom is of the type given by the rotation of a vector in a plane. It is thus intrinsically recurrent and agrees with the interpretation of hyparxis as the reconciliation, by way of repetition, of the multiplicity of potentialities with the singularity of actualization. Whereas, geometrically speaking, the dimensions of time, eternity, and space are true continua, the dimension of hyparxis has an inherent quantization. The geometrical representation of a simple entity as a single vector differently linked to the six cosmic directions is consistent with the physical picture of a corpuscle as a unit quantity of hyle without size or duration. Bipotent entities are simple, and can only be so in the strict sense if they are corpuscles; that is, the smallest units capable of participating in observable events. All the entities of physical science, with the exception of the corpuscles and particles, are composite wholes; that is, quadripotent. All physical existence is founded upon the basic

atomicity of the corpuscular state. The reconciliation of the singularity and conservative character of actualization in time with the multi-valent character of potentiality is obtained through the recurrence of every entity over as many cycles as are required to ensure the overall conservation of existence. Where an entity is composite it recurs as a whole and also in its several parts. The unification of recurrences required for this effect will be called coupling.

We must picture to ourselves coupling as a property that is neither actual nor potential and yet is related to both. One way to do this is to think of the moment of release when a heavy body is set free to fall in a gravitational field of force. The transition from rest to motion occupies no time and has no potentiality; nevertheless, it is as much a part of the event as the prior rest state and the subsequent motion state. We can, by an effort of thought, eliminate the notions of 'before' and 'after' and look upon transitions as timeless elements in all experience. Even the word 'transition' is misleading, for it cannot be thought of except as a succession in time. The words we have so far applied to the elucidation of the concept of hyparxis may here be brought into juxtaposition:

Hyparxis—the condition of ableness-to-be. Recurrence—the reconciliation of potentiality and actualization. Transition—the link between rest and motion. Coupling—the combination of sharing and exchange. Sensitivity—the relational state of hyle. Action—the observable aspect of recurrence.

o-pencils—the geometrical representation of transition, action, and recurrence.

The close association of action with spin—that is, angular momentum—and the rotational property of the o-pencil suggest the tentative identification of spin with the null-vector U of a o-pencil. The guide-vector V would then correspond to the inner property of 'ableness-to-be', which at present we have no means of measuring or even defining. We may, moreover, note that 'intensity of inner-togetherness'—which defines in eternity the level of being—appears as electric charge when projected into time. We should, therefore, not find it strange that ableness-to-be also gives rise to a well-defined and exactly quantized magnitude—namely, action—when similarly projected.

The importance of action now becomes apparent. It is a property of existence even more fundamental than mass and charge; for it is the common binding-force by which all entities are held together and all interactions

are regulated. The twofold character of hyparxis as the

regulator of coupling and exchange is represented in the δ -pencil by the guide-vector and the null-vectors. We shall use the symbol Δ to distinguish the δ -pencil associated with an entity, and $n\hbar$ to stand for the quantum of action associated with n recurrences. The Δ -pencil of an entity P has:

- (a) a guide-vector V of fixed magnitude. This can be regarded as the measure of P 's ableness-to-be;
- (b) a fixed divergence $\emptyset$ that holds the existence of P to its actualization in time;
- and (c) a set of null-vectors U that are free to rotate in a plane. Each of the null-vectors is orthogonal to V .

Whatever may be the potentialities of P it is always possible to select an eternity-vector for each separate relationship of P and to find the corresponding space-vector required to give a null-vector belonging to the Δ -pencil. We can therefore adopt the following hypothesis regarding the existence of every entity capable of interactions:

Every tripotent entity requires for its representation vector corresponding to mass and charge and also a Δ -pencil that expresses both its ableness-to-be and also the conditions of its possible interactions.

The measurement of the guide-vector is made in terms of an unit that we identify with Planck's 'quantum of action'. The hyparchic guide-vector is related to the Hamilton characteristic function that expresses the total action of a system of related entities. The characteristic function then takes its natural place as the link between the determining-conditions. Action can be regarded as a basic property of existence acquired by the hylē in emerging from the primitive ground-state.

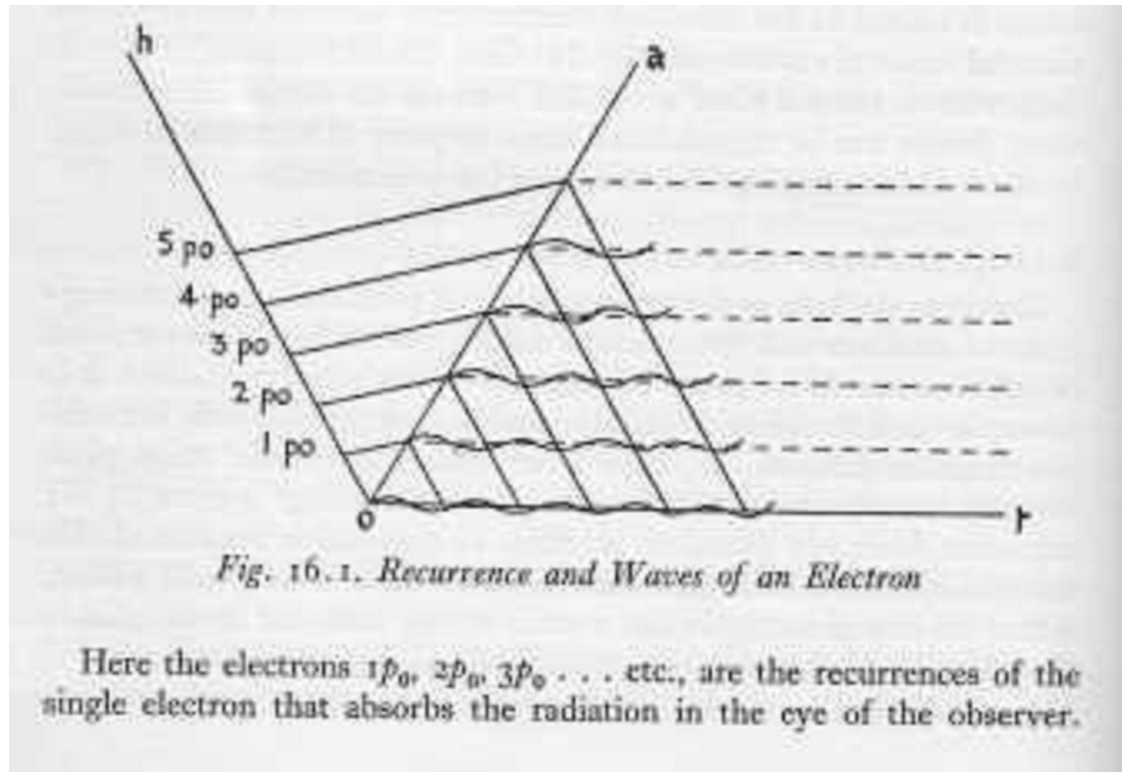
6.16.4. Electro-magnetic Radiation

Energy in the form of electro-magnetic radiation is at once the starting-point of existence and the universal medium of exchange. Every pulse of light is a transfer of potential energy from one entity to another. It is a simple—and therefore reversible—interaction, possible only between two tripotent entities. In nearly every case, the transfer takes place between two atoms and the change in potential energy is given by the transition from one 'level' to another. A remarkable feature of this interaction, that makes it quite different from those of composite wholes, is that the loss of energy in one atom is exactly balanced by the gain in the other. In other words, the interaction is of the simplest type, that of Fig. 15.1. It has no residue and therefore all recurrences are identical.

Each cycle of recurrence is an exact replica of each other cycle. The total existence of an electron in time and eternity, corresponding to a single cycle in hyparxis, will be called a counterpart. The terms of the counterpart series of a simple entity such as an electron differ only in respect of potential energy measured in terms of action multiplied by the time duration of each cycle. Each counterpart is a complete electron in time, space, and eternity; but only a fraction of an electron in hyparxis. The electron has no individuation and so its ableness-to-be is spread over a quasi-infinite number of counterparts, any one of which has only an infinitesimal subsistence. Nevertheless, for the purpose of interaction, any one counterpart can be the carrier

of the quantum of action associated with the electron.

We should be able to deduce the observed properties of electromagnetic radiation by considering the manner in which the counterpart series of an electron will appear in the space-time of an observer who is both eternity- and hyparxis-blind. Each recurrence has exactly the same balance of potentiality and actualization. There is, however, a definite amount of energy E associated with the event. This quantity can be regarded as the amount of energy lost by atom A or the amount gained by atom B, or thirdly, as the energy associated with the light pulse itself. When observed in space and time, all the recurrences must appear as if transferred to a single world or level of time and space. This step can be visualized with the help of a diagram.



Each horizontal line represents one space-time actualization. The curves are drawn to indicate the light vibrations as they appear when referred to the time line of the emitting electron.

Q will always observe the light vibrations from all recurrences to be in phase in eternity. Without this the identity of the recurrences would be lost. It does not, however, follow that this phase-identity need be apparent to O, for whom the recurrences of the electron are not directly observable and who sees only their projections into space and time. The cycles of recurrence will appear to O as if they were spread out in time. The entire event can be represented as a cycle of rotation of the [triangle]-pencil of P. The recurrent series can be transferred into space-time by way of Hamilton's characteristic function. In this we need to consider only the term Wdt where W is the energy concerned in the interaction. W does not contain the time explicitly, and the occasion as a whole is isentropic—that is, the thermo-dynamic potential of the total event is the same in the initial and final states. It follows from this that the cyclic character of the o-pencil must appear to O as if it were due to a cyclic renewal of the action of the system. For this the intervals must be given by $Wt = h$, where t is measured in the proper time of the observer.

We are dealing here with tripotent entities, the actualizations of which are reversible, so that in passing from one cycle to the next, there is neither change of entropy nor loss of energy. This doubly conservative character of the counterpart of the waves can only be maintained if all counterparts are in phase. Any mutual interference of the waves would result in a rotation in the existential tract and loss of energy would ensue.

We can now see how the system of representation enables us to give a complete and consistent account of the relationship between action and frequency observed in electro-magnetic radiation. When a simple entity such as an electron undergoes a change of state involving the emission of a pulse of light, the energy transferred must be equal to the frequency multiplied by the quantum of action. It is recognized by all physicists that Planck's quantum is a constant of nature as fundamental as, say, the electronic charge or the velocity of light. It does not appear, however, to be, like these, associated with particular forms of existence. Hyparxis and the third dimension of space are specially linked through the property of recurrence which gives action and also angular momentum. It is thus a most important feature of our theory that the quantum of action should find its natural place as a primary constant of nature independent of entities.

In the same way as the recurrent series in hyparxis determines the

relation between energy and frequency, so does it account also for the momentum of light in the direction of propagation. This is a very important result, because it removes a difficulty that would otherwise arise in the interpretation of the hypothesis of identical recurrence. We have ascribed this to tripotent entities that lack the property of subsistence, and therefore can have no inherent mass. Both the energy and the momentum of light result from the summation of a quasi-infinite number of counterparts in the recurrent series. It is a similar effect that gives the electron a rest-mass that is not true subsistence-mass, but the relational mass of a moving electric charge.

6.16.5. Geometrical Mechanics

In 1924, L. de Broglie drew attention to the symmetry of particles and waves in the observed behaviour of electro-magnetic radiation and electrons. This led to the foundation of modern wave mechanics, and the realization that the distinction between a particle and a wave resides in the manner of observation rather than in the entity itself.

In interference experiments the electron behaves as if there were a 'guide-wave' that carries with it the 'presence' of the particle. It is well known that the decisive argument in favour of the undulatory theory of light was the demonstration of interference which appears to be quite unaccountable in terms of the corpuscular theory. When, however, it was found that electrons, which undoubtedly behave as corpuscles in the greater part of their manifestations, could also show interference phenomena, it became evident that de Broglie's waves must have some concrete significance.

By 'wave' we understand the periodic oscillation of some function propagated through space. The form of this function was established by Schrodinger in 1926, but no function having the required characteristics could be associated with an electron conceived as a material particle. M. Born suggested that the wave-function was equivalent to the probability of the electron being present at a given instant of space-time, and that it was the oscillation of this probability that constitutes the wave. This interpretation—with improvements subsequently introduced—gives a fairly satisfactory account of the behaviour of small particles; but it must be confessed that the function can in no way be given a physical significance in terms of space and time alone. The wave-function would seem to require that only a part of the electron is present in any given space-time volume, and it is just this concept of 'partial presence' that has no physical meaning. On account of this difficulty many writers, from Kaluza and Klein to Flint and Rosenfeldt, have

suggested a five-dimensional framework in which the wave-function becomes a periodic oscillation of potential. There is, however, the difficulty that potential energy cannot be quantized unless directions in space are also quantized, which seems quite inconsistent with experience. Although Klein rightly saw that the fifth dimension should be associated with potential energy* he did not appreciate all the difficulties of introducing a wave-like character as well. These difficulties were overcome by Podalanski in his six-dimensional treatment; but? the interpretation of the wave-function remained obscure.+

The sixth-dimensional representation gives a framework that is inherently quantized owing to the rotational character of the o-pencil. On the other hand, the treatment of existence in terms of tri- and quadripotency also introduces an inherent atomicity, by regarding every composite whole as built up from simple components. The simple bipotent entity has no individuation and cannot subsist except by reason of its quasi-infinite set of recurrences. It is now necessary to examine the consequences of recurrence for the virtual existence of the electron in the dimension of eternity.

6.16.6. The Concept of Virtuality

Making use of the illustration of the elastic spheres we can write down a definition of virtuality as follows:

Virtuality is the condition or state of the hyle when withdrawn from actualization in the form of an eternal potentiality.

We have reached this definition through the study of a system of bipotent entities that satisfy the hypothesis of invariant being and have primary actualizations only. By reason of its freedom from exclusion rules, virtuality allows for a far more complex structure than can be found in any actualization; for it can, and must, carry all the potentialities of a system from its inception to its final state.

A bipotent entity such as an electron has the possibility of entering into a quasi-infinite number of actualizations. Being entirely without individuation, electrons are indistinguishable except at the moment of interaction. Their identity is then fixed, not by what they are in themselves, but by their participation in the existence of some quadripotent whole.

We have used the term virtuality to denote that state of the hyle in which entities exist without determination. Hyle in the virtual state is

[* Cf. Appendix I to Chapter 13, p. 490.

+ Loc. cit., p. 258. Podalanski explicitly refers to his treatment as being incomplete.]

unobservable, not because it ceases to exist, nor even because it is 'round the corner', but because it does not actualize and for this reason it is imperishable.* We must, however, interpret the concept of virtuality in terms of the relativity of existence and postulate a transition from complete actuality or fixation to complete virtuality or non-fixation. To obtain a numerical representation we can treat complete virtuality as unity and all fractional states as designating an entity that is partly actualized. All bipotent entities whose virtuality is unity are identical. This applies not only to all electrons, but to the particles called neutrinos and to interacting corpuscles, such as the photon.

The state of complete virtuality is thus a reservoir of existence from which hyle can be drawn for the purpose of actualization. We must note that the virtual state of the hyle as a reservoir of potentiality is distinct from the pre-existential or sub-corpuscular unipotent state.

A bipotent entity is only relatively existent. It has the properties of matter only by reason of its framework orientation. Thus an electron has inertial mass only by reason of its electric charge, a neutrino has momentum only by reason of its limiting velocity. Geometrically the corpuscles exist only in the null-cone except at moments of interaction. The general mass system of the universe is composed almost exclusively of tripotent entities. The bipotent corpuscles cannot build—in nearly all their manifestations they remain single units. But even these manifestations are dependent. An electron only becomes a determinate entity when it participates in an interaction. In the vast majority of cases, the reaction is supported by the presence of a quadripotent entity, such as an atomic nucleus. The interaction of two corpuscles without immediate massive support is so rare an event that it has only been observed to occur a few dozen times during twenty-five years of world-wide experimentation.+ The fixation of an electron is a determinate event and requires the

immobilization of all the potentialities for other actualizations. The conservation of potentialities in the case of a simple entity must remain within the entity itself, and therefore the reconciliation of the eternal and the temporal aspects of its existence can be achieved only if all its recurrences are identical.

[* It should be remarked here that the term 'unobservable' is used in many ways in scientific and philosophical discussion and most of them are ambiguous, e.g. Jeans, *The New Background of Science* (London, 1947), p. 128, has a strangely ill-assorted list of unobservables that includes "distant events, objects, ether, absolute space, absolute time".

+ The creation of an electron pair by high energy γ -irradiation occurs almost always in the immediate field of an atomic nucleus. The conservation of energy and momentum require the presence of a quadripotent entity.]

The simple reactions of a bipotent entity comprise :

- (a) a single actualization in time,
- (b) a single potential energy transition in eternity,
- (c) a quasi-infinite residue of unactualized potentialities,
- (d) a quasi-infinite series of recurrences in hyparxis,
- and (e) a single collision or fusion with another entity in space.

Let us examine how the conservation of potentialities is achieved in a simple, corpuscular entity. All corpuscles have identical potentialities and therefore there must be an apokritical interval common to all corpuscles that represents the level in eternity at which these potentialities exist.

We must note here that we have still to find a physical definition of the corpuscular state. Existentially the corpuscle is simple and bipotent. Geometrically it is identically recurrent. The physical entities that appear to have these properties are varied in their nature. Some, like the electrons, are universal constituents of all hyponomic existence. Others, like the photon, participate in nearly all the energy exchanges of the hyponomic world. Others again, like the positron, are found only very rarely and seem to be incapable of existing in the presence of other entities. The neutrinos are scarcely discernible and certain mesons that seem to be bipotent and simple have nevertheless a considerable rest-mass that seems to indicate tripotency. It is not surprising that physicists have been doubtful as to the propriety of regarding all these entities as manifestations of one and the same corpuscular state.

We can, however, give an account of the differences, without involving any inner structure, by considering only the effect of linkage with respect to framework. We represent the existence of a corpuscle by a combination of three pencils, one of which determines its actualization, one its potentiality, and one its ableness-to-be. We may take one only as fixing the intrinsic character of the entity. When this pencil is associated with the direction of eternity, the corpuscle will have either positive or negative unit electric charge. When associated with time it will have duration and apparent mass, but no identity. When associated with the direction of hyparxis, it will have neither mass nor charge, but only a quantum of action. In this way we can have one and the same basic corpuscle appearing as an electron or a positron, as a photon or energy corpuscle, or as a neutrino or action corpuscle.

We may now fix our attention upon an electron and consider how its potentialities are related to its actualization. This relationship cannot be directly observed by the observer O, whose observations and measure-

ments can only tell him whether or not a given event has occurred at a given moment. The electron itself has

no structure and therefore its recurrences can only be identical cycles, each connecting one of its potentialities with its lost actualization. In this way hyparchis overcomes the sharp dualism of virtuality and actuality. The resulting intermediate condition must be in some manner perceptible for O. A single recurrence of P is characterized as experiments tell us by a unit of action equal to Planck's constant and is associated with one of the potentialities inherent in the electron by reason of its virtuality; when this is transferred into the space-time world of O, the fraction of the total existence of P is infinitesimal compared with what it would be if P were wholly present in O's world.

O must therefore observe not one, but the totality of P's recurrences, and must do so, moreover, in such a manner that none of the existential content disappears into virtuality. This point is so important that it is worth restating in terms of P itself. Let us suppose that P in some sense is conscious of its own existence, but only at a single moment of space and time. It will see itself as actualizing in a perfectly definite and unambiguous manner and, if it were able to assess its own possibilities, would ascribe them to a future actualization rather than to its own eternal potentiality. If now we take O to be—though eternity-blind—able to recognize the limitation in P's way of regarding its own existence, we can see that O would look beyond an immediate recurrence and see how the potentialities of P lie not in the future or any other points of space, but in the totality of its own recurrences. It is just through the inability of O to make this objective assessment that his observations of P take the peculiar form that we are about to examine.

6.16.7. THE VIRTUALITY FUNCTION

Our present task is to see how the regulation of interaction by the recurrent hyparchic series affects the temporal behaviour of a body and the manner of its observation. We shall consider a body *P*, assumed to be so small compared with the observer *O* and his measuring system *O-M-R* that the whole recurrent series of *P* must participate in order that *P* should be 'observable'. We start then with a quasi-infinite number of identical recurrences of *P*, the hyparchic interval of which is an integral multiple $n\hbar$ of the basic unit of action $\hbar$. The hyparchic interval is periodic, as can be seen from

$$\Delta = n\hbar (is, i \cos \theta, i \sin \theta, 1) \quad \dots \quad (16.1)$$

For a simple bipotent entity n is unity. *P* is assumed to move in the space-time world of *O* in the direction *OX*.

If *P* is a simple bipotent entity, its potentialities have neither structure nor differentiation; they all consist in *P*'s continuing to be what it is, unless and until it disappears in an annihilating collision with an entity bearing a positive electric charge. The apparent changes of energy that *P* may undergo through motion in electrostatic or gravitational force fields are relative and exist only for the quasi-rigid observer—not for *P* itself. Hence we must conclude that all the potentialities of *P* consist exclusively in the shifting balance between actual and virtual existence. We can suppose the latter to vary between unity and zero. Virtual existence for *P* means that it is indistinguishable from any other bipotent, entity. Actual existence means that it is fully present in the process of actualization in time. The electron is only actual when it is 'observed'. On the other hand, the alternating transition from actual to potential and vice versa is not an 'event'; that is, it is not an interaction. It follows from these considerations that the existence of the electron is a linkage of the inner determining-conditions by way of a reconciliation of the affirmative virtual state and the negative actual state. Each recurrence is thus an image or projection of the total recurrent set; in the way, for example, that one man is an image or projection of all men.

In order to give a quantitative expression to the 'unity in multiplicity' of the recurrences of *P*, we should start

by examining the manner in which the potentiality of P oscillates between virtuality and actuality and thereby ensures that all the possibilities of actualization are preserved without mutual interference.

The recurrent series is composed of a quasi-infinite number of identical complete events. There is no partial recurrence. The eternal series is a wave-form or harmonic oscillation between states of virtuality and actuality. The potentialities open and close so that each cycle corresponds to one possible actualization.

So far we have built up our representation in terms of our knowledge of the four determining-conditions and of well-established experimental data. In Chapter 15 we distinguished the four types of skew-parallel pencils and showed how each of these could be assigned with some confidence to one of the determining-conditions. This led to the result that the representation manifold for physical occasions has six dimensions. The α -pencil is associated with eternity and with the gravitational and electro-magnetic fields of force. We should expect similarly that the wave-equations would follow from the properties of the δ -pencil. That this is likely to be the case is simply demonstrable.

Consider the hyparctic vector with components $(0, 0, 0, 0, 0, 1)$ and the null-vector orthogonal to it $(ikl, ikm, ikn, k \cos \theta, k \sin \theta, 0)$ where

$$l^2 + m^2 + n^2 = 1 \quad (16.2)$$

and l, m, n , are functions of θ .

The null-vector has one degree of freedom if k is fixed. Hence the vector $(ikl, ikm, ikn, k \cos \theta, k \sin \theta, 1)$ is, for varying θ , a δ -pencil.

In the observation of an event the inherent ableness-to-be is manifested in space-time. We can take either:

- (i) The δ -pencil belongs to the particle and is projected along the sixth dimension so that the particle is not observed,
- or (ii) The ableness-to-be of the particle is represented by a vector along the sixth dimension, in which case its observation entails projection along a δ -pencil.

In either case there enters into the representation of the observation in five dimensions—excluding now hyparxis—a term of the form $(ikl, ikm, ikn, k \cos \theta, k \sin \theta, 0)$. This term contains a circle in the time-eternity plane of radius k , associated, in the simple case where n is zero, with a circle in a space plane, also of radius k .

On making a second projection along the eternity axis into space-time, the circle in time-eternity becomes an harmonic oscillator in the time-dimension with which is associated a circular recurrence in a space plane. If the second projection is made along, say, an α -pencil associated with eternity, the oscillator and the space circle combine to give a figure having wave properties.

If wave properties are thus inherent in the δ -pencil, it should therefore be possible to show that association of the δ -pencil with hyparxis leads naturally to the recurrent character of ableness-to-be and offers a satisfying representation of the wave-particle dualism.

6.16.8. The Solitary Electron in the Hyle-field

As Eddington has pointed out,* the condition of a single charged particle in the absence of an independent field is quite artificial. We have seen that notwithstanding the definite and identical recurrence of such a particle in the sixth dimension, its location in space and time is completely indeterminate. Although the electron is assumed to be the only actualized entity, there is nevertheless present always and everywhere the substratum of pre-existent hyle. This can be regarded as existence of vanishingly small intensity. The potential energy of the electron against this background is, within any finite region of space-time, vanishingly small.

We can thus conceive a field of potential energy distributed through-

[* A. Eddington, *The Relativity Theory of Protons and Electrons*, pp. 80 and 260.]

out all space and time but of infinitesimal intensity. This can be called the hyle-field. It is probable that such a field is present at the threshold of existence and is connected with the potential barrier that will be considered later. We can have no means of detecting such a field; for in the presence of material objects, potential energies of higher orders of magnitude are always present. Moreover, being unlocalized, the hyle-field can never be experienced as a difference. Nevertheless, the picture is useful and gives meaning to Eddington's concept of a 'solitary electron universe', in which space is closed about the sole entity present. We should go further and recognize that the presence of an entity in process of actualization also polarizes space. Indeed, our view of space requires that there should be a direction X of actualization, notwithstanding the fact that the direction itself is, in the absence of other entities, completely indeterminate. A solution of the wave-equation can then be found that proves to be the conventional de Broglie relations in the fully relativistic form. Thus we have, as is well-known, the result that the particle appears to be present to an equal degree at every point of space and time. Each separate recurrence is for the universal observer Q perfectly determinate in its own space-time. The corresponding elements of time for each cycle of recurrence appear to the O-observer as a set of multiple actualizations at each level in eternity where the virtue function passes through the value of unity.

6.16.9. The Potential Energy Barrier

A potential energy barrier is one of those notions in current physical theory which are easy to deal with analytically, but very difficult to associate with any concrete picture. We start by noting that the potential energy barrier is encountered in experimental physics with bipotent entities. We can then see at once that its character can be very simply derived from the properties of the virtue-wave in eternity. The virtue-wave—which is the analytical expression for the apokritical series—presents, in terms of the temporal virtue of the particle, an arithmetic series for the characteristic function H, of Hamiltonian dynamics.

This function determines the character of the occasions into which the ingression of the particle is possible. If there is a critical value of H beyond which the occasion acquires a different configuration, it becomes possible to have at one and the same time and place an entity, some of whose recurrences have a total energy less than, and others a total energy greater than, the critical value. The division between the two configurations is the critical value of the potential energy; that is, it is a potential energy barrier. We thus have the situation where a bipotent

corpuscle can at one and the same time and place lie both inside and outside a given potential energy barrier. The eternity-blind observer can only interpret the result as though the electron itself in some way or another were partly inside and partly outside the barrier in space.

Let us consider a beam of electrons passing through two slits, S1 and S2, close together and intercepted at the target screen T. At certain regions of T, no electrons appear. At points between these regions, there is a fourfold intensity as compared with that of a single slit. It is well known that such electron diffraction

experiments raise in its acutest form the problem of particle-wave dualism. When the electron is conceived as a single small particle, which must pass either through the one slit or the other, no account of the diffraction can be given. If, on the other hand, the electron is regarded as a wave in space and time, its behaviour on striking the screen is equally hard to describe in concrete terms. When, however, we take into account the hyparchic aspect of the electron, we can see how it must behave as a wave in respect of its recurrences, and as a particle in respect of its actual presence in any one [4]-world. The wave-particle dualism, in fact, appears only in the act of observation or, more generally, in the interaction of one entity with another. The prehension of the particle, whether by an observer or by another particle or body, necessarily involves a potential energy field. The effect of the field upon the recurrent series of the prehended entity is inherent in the very possibility of knowledge of its existence. This effect influences all the recurrences equally. Consequently, the space-like wave aspect of P is seen to be the consequence of the fact of observation.

In the case of interference experiments, the apparent shape of the electron waves depends upon the field as distributed in the world of the observer O fixed with respect to the slits. The field produced by the two slits acts as a potential energy barrier of infinite height, thus determining the existence of the recurrent series exclusively within certain regions. There is, therefore, a wave associated with the behaviour of the recurrences, as they are projected into O's observation world. The whole of this belongs to the single electron, and there is only one wave. Consequently, the parts which correspond to equal and opposite values of the apokritical vector must annul one another. In such regions there is no actualization and hence there is zero probability that any atom on the screen in such regions will be found by the electron.

The examples we have been considering are familiar and can readily be described in wave-mechanical terms. The significance of our approach

lies, not so much in giving a concrete physical account of the wave function itself, as in relating the wave-equation to the very conditions of existence. The concept of recurrence as the link between sameness and otherness is fundamental for the whole cosmology we are in the process of working out. The material wave of de Broglie and Schrodinger is a special case of universal recurrence that applies only to the tripotent aspect of phenomena. It is the simple entity without inner transformations that has an identical recurrent series and therefore an associated wave-function that can be expressed in terms of Schrodinger's equations in their conventional form. Although strictly applicable only to bipotent entities, 'simple interactions' of the kind studied in the present chapter are the elementary events from which the entire common cosmic exchange of energies is built up.

Part Seven - The World of Things

Chapter Seventeen

CORPUSCLES AND PARTICLES

7.17.1. Unipotence—The Emergence of Materiality

We have been dealing so far with abstractions. Unconstrained motions and force fields can be described in terms of entities that are artificial and conventional, for such are the quasi-rigid body and point mass, or the human observer regarded as an automaton for noting coincidences and assumed to exist unchanged throughout time and space. We have developed the theory of interaction in terms of unspecified particles—assumed to satisfy the hypothesis of identical recurrence—that could not occur as such in nature. These and other unnatural procedures that we have adopted can be justified by the methodological rule of legitimate abstraction that enables us to isolate from the whole gamut of experience a single layer in which all entities are regarded as equipotent.* Every entity, irrespective of its intensity of inner togetherness, has its place in all such layers up to its own maximum potency. A man can without ambiguity be treated as bipotent when we have to define the eternity-blind observer O. In this case bipotency consists in the ability to say yes or no to

the question whether or not two points or two directions coincide; but to say and do nothing besides.

Having established the general laws of dynamical and physical science, we must now return to the scale of existence and study the actual content of the hyponomic world as we discover it in our experience. Not content with describing what the various entities do, we must set ourselves the task of defining what they are, and our study of language has shown us that this is possible only by means of a numerical scale. The scale that we have established consists in the first twelve numbers, each of which designates an order of potency. In the hyponomic world we have only the first four gradations which together comprise all passive entities of every possible kind. The four main orders are broad groupings within which a range of subordinate possibilities can arise. We should expect, for example, the highest manifestation of tripotency to resemble in many ways the lowest level of quadripotency, but we should also

[* This procedure may be compared with that adopted by Whitehead in *Process and Reality*. He writes, for example, of "electronic occasions" to designate the type of process in which only the distribution of energy is significant.]

expect to find some qualitative difference that enables the one to be distinguished unambiguously from the other.

We shall, in the present section, trace the main steps by which existence emerges from non-existence, and afterwards examine in detail some of the intermediate levels in order to make connection with the observed data of physical science. We start from the concept of non-existence as pure being, beyond the limits of all possible experience. Out of non-existence, by a step that we cannot fathom, arises the undifferentiated prime-source-cosmic-substance, hyle. This exists but it has no properties. It exemplifies the bare fact of existence—quantitative but not quantized, qualitative but without qualities. It is the bearer of all potentialities, and the sufferer of all actualizations, and yet in itself it is neither potential nor actual. It is omnipresent and yet it is not extended. It has neither shape, size, nor position. It has no history, and yet, because it exists, it is subject to the determining-conditions. It is eternal without potentiality; temporal without actualizations; spatial without extension. In order to acquire the attributes by which we recognize and distinguish the manifestations of existence, hyle must accept individuation; that is, the separation of existence and non-existence. To exist means to stand out of the unconditioned. In this 'standing out', hyle becomes determined as matter.

Materiality is relative, and each existential hypothesis prescribes a stage in the transition of hyle from the formless ground towards the ineffable integrated consciousness of the hypernomic world. In its primitive state hyle is an unfathomable reservoir whence is drawn the material out of which all possible events are made. There cannot, however, be a continuous unrestrained flow of hyle from the unconditioned world into the conditioned world. If such a flow were possible, there could be no determination, for every entity could wax and wane unpredictably, and all would be merged into a formless flux. Moreover, this indeterminism would be unlimited and pervasive. Not only would atomic existence be impossible, but every entity would be subject to unaccountable transformations. It would contradict the well-established laws of conservation and leave nothing but the play of a meaningless caprice.

The concept of hyle as unconditioned existence requires, therefore, that it should be separated from the actual world by a boundary that can be crossed only under prescribed conditions. We need to form at least some provisional notion of the manner in which the materialization of the hyle occurs. In the last chapter, we met with the conception of the hyle-field, wherein a source of potential energy of an infinitesimal

intensity is distributed throughout infinite space and time, and suggested that this would correspond to the pre-existent state that acts as a counterpoise to all actualizations. There is no reason, in such a conception, for regarding the hyle-field as perfectly homogeneous. It can be conceived as subject to subliminal fluctuations that are the precursors of materialized existence.

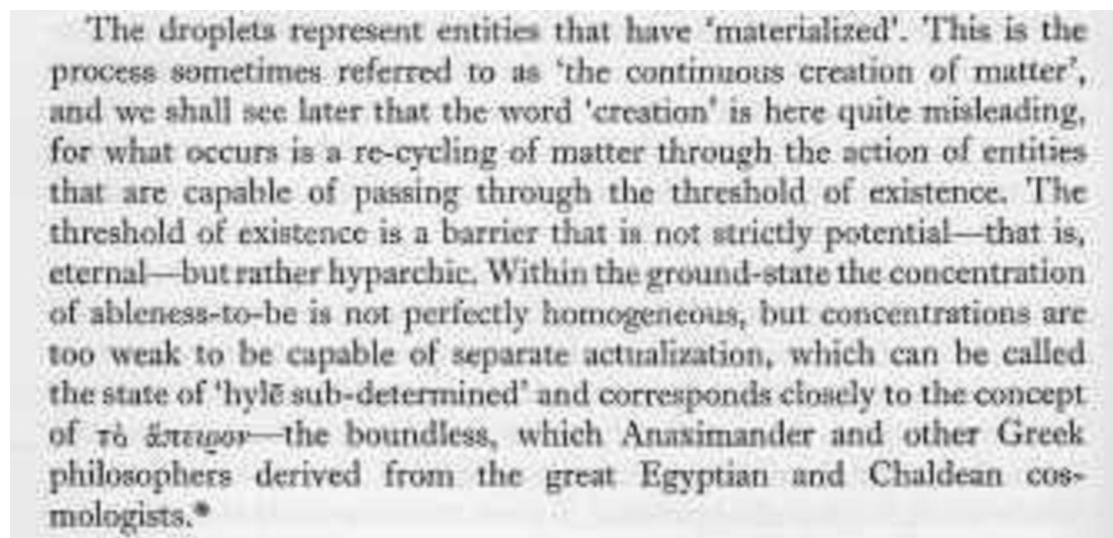
The determining conditions are given by the pure geometry studied in the preceding chapters. There are in the geometrical world no actual entities by which the properties of the determining conditions can be ascertained, and yet it is only in the complete absence of any determinate matter that space, time, and eternity are completely distinct and exactly defined. In the formless ground is exemplified that complementarity which characterizes all experience, for we must conclude that the complete indeterminism of existence allows a complete determinism of framework. At the opposite extreme, where existence is fully self-realized, the distinctions of the determining-conditions are merged in the freedom of unconditioned will.

The unipotence of hyle consists in its one possibility of materialization. It is the 'universal donor' from which all existence draws its sustenance, but it could not give itself freely without destroying the very significance of existence itself. The free flow of the hyle which we have rejected as impossible would be not unipotent but omnipotent.

To reduce the unconditioned to unipotence there must be a barrier that prevents its penetration except at one precisely defined state.

In order to form a clearer picture, we may represent the undifferentiated ground state of hyle as a finite but limitless ocean. Being undetermined, it neither changes nor yet does it remain the same. Time, eternity, and hyparxis can be likened respectively to the shores, the bottom, and the surface of the ocean, and space to its extent, but the ocean itself knows nothing of shore or surface. It lies peaceful in its immensity, swaying unceasingly yet timelessly in the rhythm of some cosmic tide that ebbs and flows through the fathomless being that is beyond existence itself.

The surface of the ocean has not the same unchanging peace as the depths. It is stirred by the winds of experience, so that ripples and waves from time to time pass over it. Having compared the surface to the determining condition of hyparxis, we can regard these ripples and waves as momentary concentrations of ableness-to-be. By such concentration, time and eternity are brought together, and there may be agitations intense enough to initiate an historical process that can be likened to clouds of spray thrown up into the atmosphere.



The droplets represent entities that have 'materialized'. This is the process sometimes referred to as 'the continuous creation of matter', and we shall see later that the word 'creation' is here quite misleading, for what occurs is a re-cycling of matter through the action of entities that are capable of passing through the threshold of existence. The threshold of existence is a barrier that is not strictly potential—that is, eternal—but rather hyparchic. Within the ground-state the concentration of ableness-to-be is not perfectly homogeneous, but concentrations are too weak to be capable of separate actualization, which can be called the state of 'hylē sub-determined' and corresponds closely to the concept of τὸ ἀπειρον—the boundless, which Anaximander and other Greek philosophers derived from the great Egyptian and Chaldean cosmologists.*

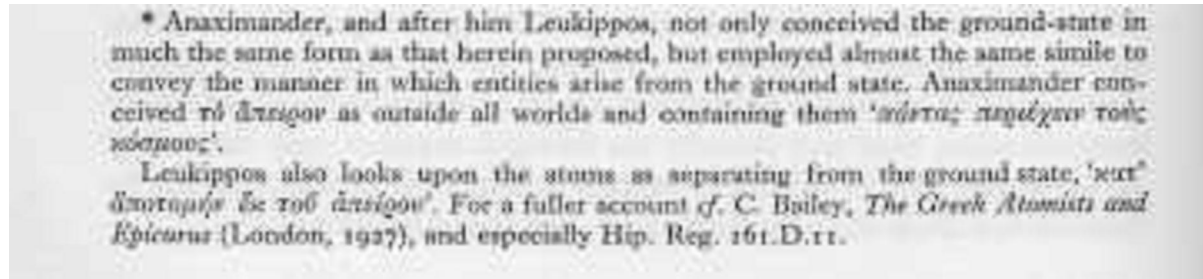
7.17.2. The Corpuscular State—Bipotence

Hyle passes over the threshold of existence by the dichotomy of 'this and not that', whereby it acquires bipotence. This is the corpuscular state, and we shall define a corpuscle as hyle determined but not individuated. The corpuscular state comprises all those forms of existence in which entities participate in reversible processes exclusively and have no individuation. We have already seen from our dynamic studies that bipotency does not participate in the irreversible character of time. Bipotent entities have no

'temperature' and therefore no entropy. The reversibility of their processes is possible because they have no inertial rest mass, and therefore no proper direction in time.

It can be seen that bipotent entities exist in nature in the form of electro-magnetic radiation, electrons, positrons, and neutrinos. These occupy the first layer of existence at the threshold of undifferentiation, and moreover everything that exists, without exception, has its place in this layer which can be called the 'electronic world'.

Before considering the different species of bipotent entity, we must first examine the property of 'atomicity' by which all are characterized. By definition, an atom is the smallest and simplest entity within which a given property can be fully exemplified. For example, a man is an atom of humanity, for, if he were cut in two, the separate halves would



cease to manifest characteristic human traits. The corpuscle is similarly the atom of interaction. Our experience teaches us that all interaction is quantized and we have seen the reason for this in the determining-condition of hyparxis. It must, however, be understood that the corpuscles participate in interactions only in their external process. By hypothesis, they are devoid of inner differentiations of sufficient intensity to enable them to undergo change in the usual sense of the word.

Quantization is moreover inherent in the step by which the corpuscle emerges from the hyle, for the quantum of action is the minimum ableness-to-be that permits the step to be made that separates 'this' from 'not-this'. If we prescribe the simplest kind of atom that can exist subject to the determining-conditions, we should require it to be self-identical at all times, in all places, and in all its recurrences. There is, however, no such mark upon a corpuscle by which it can be identified, for this would make it tripotent, and therefore capable of entering into the relationship of the triad. Hence all corpuscles must be indistinguishable.

Any two electrons in the universe could exchange places, and there would be no means, even hypothetical, by which this exchange could be observed. It can thus be said that all corpuscles are 'unlabelled'.

It should here be noted that the property of being unlabelled is not the same as that associated with the special statistics of corpuscles and particles. The distinction between fermions and bosons will be discussed later in connection with spin.

The principal function of corpuscles in the universal actualization is that of providing the medium for all kinds of interaction and exchange. The corpuscular state varies according to orientation with respect to the determining-conditions. There are corpuscles that exist naturally in time, eternity, and hyparxis—these are the neutrinos, electrons, and photons. There are others that exist only in the null-regions connecting two or three of the determining-conditions. These include G the atom of gravitational action, the Bohr magnetons, and also the unstable meson states known as muons and pions that link the corpuscles with the massive particles. We shall consider here only a few of the principal forms of corpuscular existence.

These represent stages in the emergence of bipotency from the unipotent ground state. We need here only to remark that although the different types of corpuscle are qualitatively distinct and form a progressive series, they all are the same in respect of bipotency. This means that they can have no independent existence but

occur solely as the instruments of interaction between entities of a higher order.

(a) *The Neutrino*

The first basic state is that of a bipotent corpuscle without any intrinsic qualities that derives its ableness to participate in events only from the framework determining-condition. We shall identify this state with the **neutrino**. Such an entity has neither size nor shape, neither mass nor electric charge, and yet it can have momentum and spin—a possibility which can readily be understood from the universal geometry. The neutrino actualizes in the null-region, and must therefore appear to any finite observer to be moving with the velocity of light. It is this that enables it to have an indeterminate momentum, notwithstanding its lack of mass or electric charge. Since, moreover, it links hyparxis and space, it must have spin. It is, however, not a fully-established bipotent entity, for it has no potentialities for further actualization.

The δ -pencil is $(ix, s \cos \theta, s \sin \theta, 1)$ where s is fixed and θ varies, and the properties of the neutrino are given when $s = 0$. This agrees with the fact that the neutrino is a particle that is never observed directly. Its existence, however, was postulated to account for anomalies in the distribution of energy, momentum, and spin, in various atomic transformations. We can regard it as a degenerate corpuscle, in that it is devoid of potentialities. This means that it is fully actualized from the moment it comes into existence, and cannot therefore participate in further events. By reason of its very passivity, however, the neutrino has the power to penetrate through the barrier that separates existence from the ground state. There is, indeed, no other destiny open to a neutrino except to return into the hylē, but in doing so it carries its own actualization that must have the effect of provoking in the hylē an equivalent state of potentiality. It is this return of the neutrinos that makes possible the emergence of fresh material from the ground-state. We shall see later that this cycle has immense cosmological significance and explains the arising of new stars and new galaxies required to maintain the concentration of actualized matter in the growing universe. Thus the neutrino is pre-eminently the time-like state of the corpuscle.

(b) *The Electron and Positron*

The non-degenerate bipotent corpuscle should have two equal and opposite states. Although it cannot have relationships, it must be subject to polar forces. It follows that the simplest non-degenerate bipotent entity must be orientated in eternity, where there are two equal and opposite directions of potency. We should therefore expect the bipotent corpuscle to be associated with a property eternal in nature and capable

of taking equal and opposite forms. This can be represented in $(ix, s \cos \theta, s \sin \theta, 1)$ by writing $\theta = \pm \pi/2$ and $s \neq 0$.

We can readily see that this suggests identifying non-degenerate bipotence with electric charge. Since bipotence does not admit of relativity, the electric charge of the corpuscle must be a fixed quantity that corresponds exactly to the potency required for emergence from the ground-state. We may see in this the reason why all electric charges are multiples of one basic unit, and why partial charges are never encountered. The characteristic non-degenerate bipotent entity is the **electron** with unit charge represented by an apokritical vector bearing a negative sign. The positron with the opposite charge cannot enter stable combinations and has only a short free life.

Like the neutrino, the electron, when not radiating, exists in the null-region, and has half-integral spin and no inertial rest-mass. We should here remark that the positive and negative forms of the non-degenerate bipotent corpuscle have by no means identical significance in nature. The negatively charged electron whose apokritical vector is negative, *i.e.* directed towards actualization, participates in almost all events in the universe; whereas the positively charged **positron** whose apokritical vector is positive, *i.e.* directed towards freedom, is chiefly significant for the conservation of pattern in eternity. Positrons are rare and fleeting visitors to the world of space and time, and they take the first opportunity to return into the state of virtuality. Both electrons and positrons are eternity-like states of the corpuscle.

(c) *The Photon*

In the last chapter we studied electro-magnetic radiation as the universal recurrent phenomenon. Unlike any other known form of existence, radiation is literally omnipresent. In a not entirely figurative sense, it can be described as the 'Will' of the hyponomic world. The energy exchanges of the universe are effected mainly through the medium of electro-magnetic radiation. Its predominantly hyparchic character gives radiation a property—that can be called quasi-relational—of connecting entities and permitting their interactions though widely separated in space and time.

The photon having no 'inner world' we write in $(ix, s \cos \theta, s \sin \theta, 1)$ where $s = 0$ and $\theta = 0$. The close connection between charged corpuscles is well brought out in the three values of θ , $+\pi/2$ for electron, $-\pi/2$ for positron and 0 for photon.

We have therefore to inquire into the existential status of light. That it does 'exist' cannot be doubted. Not only does it produce observable

results, but it has momentum and even mass. A not inconsiderable fraction of the total energy of the universe is, at the present time, existing in the form of radiation. Nevertheless, it is only comparatively recently that data for establishing the existential status of light has become available. Newton, with his astonishing intuition, regarded light as corpuscular, but this view has been obscured for centuries by the evidence that light travels through dense transparent media like a wave. In the present century, it has seemed necessary to

accept Rohr's principle of complementarity, according to which the wave and corpuscle views, though apparently contradictory, are equally valid and necessary to one another. We have seen how this apparent dualism of wave and particle results from the eternity-blindness of the observer. Intrinsically, a pulse of electro-magnetic radiation is an entity as well-defined as an electron or a neutrino. It has the same existential status, but it has the additional quality of connectedness, and therefore is a fuller exemplification of bipotent existence. An electron is not complete in itself. Its action appears only in relation to other charges, positive or negative. A photon is an entity that carries its own actualization. Its cosmodesic always lies in the null-region, and the bipotency of light can be recognized in the manner in which it holds together space and time. The velocity of light, the charge of the electron, and the spin of the neutrino, are the three fundamental units of hyle on the level where it emerges from unipotence into bipotence. It should be remarked here that although the energy of a photon can vary enormously, its action has a fixed value. It has no individuality, and we have no means at all of prescribing the manner in which it exists between the moments of emission and absorption.

tion.

(d) The Corpuscular Mesons

Photons of very high energy and electrons moving with very high velocity can be transformed into entities that seem to belong to a higher level of existence, in so far as they have a considerable rest-mass. These are the u-mesons that can have positive or negative electric charge and in many respects behave like electrons and positrons. They very probably consist of a triad of distinct states of the corpuscle. Having no true subsistence, they are held together by relatedness only and rapidly decay into (a) an electron or positron, (b) a neutrino, and (c) a photon. The u-mesons have no individuation, and there can be little doubt that these are bipotent entities that belong to the corpuscular level notwithstanding their large rest-mass as compared with the other known corpuscles. From what we have seen of the geometry of energy and

action, we should expect μ -mesons to be corpuscles that have acquired sufficient energy to occupy the transition region that stands between bipotence and tripotence.

Remembering that, by the principle of structure, the transition from the third to the fourth stage of any process is discontinuous and requires an external shock, we should associate μ -mesons with the possibility of transition to a higher level of existence. The transition is not one that can be made spontaneously by the corpuscle that arises from the hylē with small residual energy. The appearance of μ -mesons is invariably associated with exceptionally high states of energy, whether in the form of cosmic radiation or of accelerating devices produced in a terrestrial laboratory. On this interpretation the μ -meson is a stage in the materialization of the hylē that is perhaps the most elementary example that we can hope to find of the working of the principle of structure.

The following table gives some of the properties of the various modes of corpuscular existence.

<i>Usual Designation</i>	<i>s</i>	<i>θ</i>	<i>Dominant Dimension</i>	<i>Electric Charge</i>
Neutrino	zero	indeterminate	time motion x	zero
Electron	const.	$+\pi/2$	eternity field y	-1
Positron	const.	$-\pi/2$	eternity field y	$+1$
Photon	const.	zero	hyparxis spin z	variable
μ -Meson	const.	indeterminate	intermediate field	± 1

Table 17.1. The Principal States of the Corpuscle.

Here s and θ refer to the parameters of the δ -pencil (s , $s \cos \theta$, $s \sin \theta$, 1) and the directions are determined respectively by the velocity, acceleration, and spin of the entities concerned.

It will be noted that pions (charged and uncharged π -mesons) are not included in this list. These are to be regarded as degenerate particles rather than as high-energy corpuscles. In this connection, it is very significant that whereas transitions from π -mesons to μ -mesons occur spontaneously, there is no indication that the reverse process can take place even under conditions where energy of sufficient intensity (> 66 electron masses) is available in the form of hard gamma-rays. The involutionary movement is spontaneous, but the evolutionary transition from the corpuscular state requires the intervention of an organizing factor of a higher order.

Summarizing, we may say that the corpuscular state is a well-defined and necessary element in the total scheme of existence. It occupies one of the twelve major gradations. It represents the totality of non-

individuated entities, upon which the whole structure of the universe rests.

We can recognize in the corpuscular state a threefold cycle. The first is that in which neutrinos arise and

return to the ground-state of the hyle. The second is that in which electro-magnetic radiation provides the universal bond of all existing wholes. The third is the cycle whereby, through the electrons, positrons, and u-mesons, hyle acquires the potency for building up into higher gradations of existence, and also of returning to the corpuscular state.

It should finally be remarked that in the corpuscular state there is a sharp division between virtuality and actuality. An electron, for example, can only occupy two states; one is the non-radiating state in which the electron is wholly virtual, and the other the moment of radiation at which it is wholly actual. The photon is wholly virtual in its wave-like aspect, and wholly actual in its particulate aspect. The neutrino is wholly actual at the moment of its appearance, and wholly virtual as it re-enters the ground-state of the hyle. This sharp dualism is characteristic of bipotency. Moreover, the very absence of any intermediate condition is that which deprives the corpuscles of individuation; that is, the ableness-to-be themselves. Every corpuscle is a member of a quasi-infinite class indistinguishable from any other.

7.17.3. The Particulate State—Tripotence

By particle we mean a simple tripotent entity having no parts. The characteristic particles are the neutron, the proton, and the particle of unit mass that enters into the constitution of atomic nuclei. The latter is commonly called a nucleon, but usually regarded as being identical with the free proton or free neutron, which is not the case. The particles also include a variety of mesons characterized by tripotency and the possession of approximately unit mass.

Tripotence is relational. To be related one must also be able to be unrelated. The tripotent entity is thus properly speaking the beginning of existence, since it is the first appearance of individuality in its most passive manifestation. When studied experimentally the corpuscles and particles appear to be very similar and yet, as their nature comes to be better understood, the distinction is seen to have a basic character. The particles are able to be what they are. Among other qualities, this includes the possession of their own potentialities and their own actualization. These properties are associated with inertial mass. To exist in the physical sense is to be massive, extended in space, and enduring in time. These are characteristics that cannot be properly ascribed to the cor-

puscles. There is a radical difference between an entity that can be weighed directly and one whose weight can only be inferred. For example, the mass of an electron cannot be determined except by calculation from two measurable quantities, one of which is the ratio of charge to mass, e/m , and the other is the electronic charge e . No one has ever weighed directly any corpuscle, or even any quantity of corpuscles. When traced in a photographic emulsion, the momentum of an electron can be calculated directly from its collision with a massive particle. It is not the mass but the velocity of the electron that we deduce. The mass of a proton can be obtained directly by weighing unit volume of hydrogen gas and dividing the result by Avogadro's number.

These distinctions are important because they help us to grasp the step that is made in passing from bipotence to tripotence. The step is indeed a mighty one, for it brings into existence the universal property of inertial mass. This means actualized energy that does not depend upon framework relationships. It is a property that is quite absent in the corpuscular state. When mass is distinguished in this way from free energy, we can say that all the masses of the universe are built up entirely from tripotent entities in the particulate state.

We must remark here the significance of the term 'built up' for it serves to distinguish tripotence from quadripotence. The particles do not 'subsist'. They require, in order to subsist, to combine with an electron to give a neutral hydrogen atom, or to merge with other particles to give an atomic nucleus. Relatedness is the prior condition of subsistence, but it does not itself constitute subsistence. A particle is the 'atom' or unit of all relatedness, but the unit of all subsistence is the quadripotent nuclide, the simplest example of which is the alpha-particle or helium nucleus.

Owing to its tripotence, the particle can have no inner distinctions. Hence all particles must consist of identical units of hyle. This agrees with the view generally held that the proton is the building unit of the material universe. The particles occupy the third grade or level of existence. They are omnipresent and they are always the same. Each particle is an individual unit of hyle, but the individuation is of the simplest possible kind. The only distinctions that can exist between particles arise from their association with the even simpler corpuscles. The neutron that spontaneously decays into a proton, electron, and neutrino, appears to contradict this view. It is, however, now generally held that electrons cannot exist as such in the interior of atomic nuclei, and therefore the electrical neutrality of the neutron is not due to cancellation of two charges, but to the way in which the inner and outer

vectors are linked. When the neutron decays, the positive charge takes its natural alignment in the direction of virtuality, and at the same time a new electron is actualized. We may picture the neutron as maintaining its separate existence until it has swept out of the ground-state a sufficient quantity of hyle to produce an electron and a neutrino, which then separate, leaving the particle in its natural state as a positively charged proton.

It should be remarked that an electrically charged particle can have only a vanishingly low probability of passing through a potential energy barrier. It has as it were to turn itself sideways in order to slip past the restraining influence of the electrical field. Of all the many ways in which an atomic nucleus can disintegrate, that which consists in the direct loss of a proton is never observed. The particles that emerge from the nucleus never bear an odd number of electric charges and are usually either neutrons or neutrinos—charge 0—or α -particles—charge 2. This makes it possible for the particle to pass into a state of virtuality in which it can slip through the potential energy barrier. B-ray emission, that consists of electrons, is not an exception to this rule, for the electron does not 'come out' of the nucleus but is formed from the hyle together with a neutrino. Thus B-radiation is the arising of new corpuscles from the hyle. Hence the apparent anomalies regarding the conservation laws.

Important though the role of the neutron is in atomic disintegrations, it is of even greater cosmic significance in the arising of matter from the ground-state of the hyle. Clearly, protons as such could not emerge from the ground-state in which there could be no electric charges, for these imply polarity—and hence bipotence—which is inconsistent with the unipotent state of the prime source. It is only as neutrons that hyle can materialize. This is possible because the determining-conditions are completely separated in the unipotent state of existence, so that there can be existence without any force, either electrical, gravitational, or coupling. It is the force-free neutron that can emerge from the hyle in response to a stimulus from a returning neutrino. Although the neutrino has no self-energy, it moves with the velocity of light, and therefore can have a momentum sufficient to cause a disturbance in the hyle. Only the exact quantum of hyle that can pass through the barrier is materialized, and this is a neutron at rest with respect to the gravitational and electrical fields at the point of its arising. It remains thus for a brief moment unperceived and imperceptible, floating passively on the surface of the hyllic substratum. Then—having produced, as it were, a neutrino and an electron in its wake—it emerges transformed into a proton and

the universe is enriched with a new particle of matter and two new corpuscles. Once formed, the proton is almost indestructible. It retains its identity, whether present in the vacuous regions of inter-galactic space or in the force-fields of inconceivable intensity that obtain within an exploding star.

Having ascended to this stage in the level of existence, the hyle does not return, but its subsequent transformations depend upon the entry of new forces that cannot arise within the limits of tripotence.

It should, however, be remarked that the particle can itself occupy intermediate states in which part of its mass is rotated out of time, to give unstable conditions with and without electric charge. These states of the particle go under the name of heavy mesons, with masses usually ranging from 800 to nearly 2,000 electron masses. There is, however, one very important particle that lies so close to the corpuscular state as to justify

the view that it occupies a point of transition. This is the η -meson, the mass of which—approximately 273 electron units—is only slightly greater than the μ -meson, that is undoubtedly a corpuscle. Most physicists are agreed that the π -meson is the particle whose existence was predicted by Yukawa's hypothesis for explaining nuclear forces. This alone is strong evidence for regarding it as a particle rather than a corpuscle, notwithstanding the fact that it spontaneously degenerates into a μ -meson and a pion. The three distinct forms taken by the pions distinguish them from muons, as does the great difference in their coupling with particles and atomic nuclei. It is as though a barrier exists between the corpuscular and panicle states that can be bridged only in very exceptional circumstances that have little cosmic significance.

The various states of the particle are set out in the following table:

Particle Dominant Condition Characteristics

Anti-proton Eternity Mass Unity. Charge Unity. Unstable. Proton Eternity Mass Unity. Charge Unity. Stable. Neutron Time Mass Unity. Charge Zero. Unstable. Nucleon Hyparxis Mass Unity. Charge oscillating between unity and zero. Semi-stable. Heavy Mesons Intermediate Mass greater or less than unity. Charge unity or zero. Unstable. Table 17.2. States of the Particle

7.17.4. SPIN AND STATISTICS

Every corpuscle has angular momentum and magnetic dipole moment and therefore appears to be rotating about an axis in space. In 1925, Uhlenbeck and Goudsmit showed how the concept of 'spin' enables the fine structure of optical spectra to be accounted for to a high degree of accuracy. The spin angular momentum of the electrons in atomic orbits can be measured and is found to be $\hbar/2\pi$ where $\hbar$ is the quantum of action. Dirac showed that this electron-spin is accounted for in the wave-mechanical theory of the electron. There remains, however, the problem of explaining the fact that electron-spin is only half a quantum and that the photon has spin unity. It is further necessary to connect spin with the statistics of corpuscles and particles. Pauli showed that all entities of half integral spin obey Fermi-Dirac statistics. This means that their occupancy of states is controlled by the presence of other entities whereas entities of zero or integral spin can, in an assembly of identical units, occupy the same state. We have already remarked that the statistical properties do not follow the division between corpuscles and particles. They are not connected with either mass or charge. For example protons, electrons, and neutrinos are all fermions; whereas pions and muons, though otherwise closely similar, are respectively bosons (spin zero) and fermions (spin one-half).

The observed data can readily be accounted for if we remember that action is a property of hyparxis and that action and recurrence combine to give spin. The null-vectors associated with a δ -pencil that serve to represent its sensitive or coupling properties can be formed with the aid of either time-like or eternity-like inner components. With the former, the angular momentum is either observable in space and time or vanishes identically. Entities thus orientated are **bosons**. By far the most important of these is the photon, which occupies, as we now can see, the segment of the null-cone where space, time, and hyparxis meet. The corpuscles and particles that can have potentiality are all orientated in the segment that unites eternity and hyparxis. Only one half of their action is observable in space and time. These are the **fermions**, the most important of which are electrons, protons, and neutrons. By vector addition it is possible to form composite wholes having spin $(2n + 1)\hbar/2\pi$. These constitute the atomic nuclei to be studied in the next chapter.

Before leaving the subject of spin as it affects the corpuscles and particles, we should note the very important relationship between pions and muons. The charged pion has a relatively long life for an unstable simple entity, namely 2.6×10^{-8} seconds. It then decays into a muon and

a neutrino with the loss of a large amount of energy equal to 66 electron masses. This transition, according to our views, is from a particle to a corpuscle and it is also a change from a boson to a fermion. The uncharged pion has a far shorter life, about 10^{-14} seconds and then decays into a pair of high-energy photons. These reactions give us a means of estimating the energy that is stored up in the hyparchic component of a particle.

We have two schemes:—

$$\left. \begin{array}{l} \pi^{\pm} \rightarrow \mu^{\pm} \rightarrow e^{\pm} + 2\nu \\ \text{and} \\ \pi^0 \rightarrow 2\gamma \end{array} \right\} \quad (17.1)$$

The first reaction tells us that hyparchic action can be transformed into energy and mass. The second supports the supposition that the bosons exist in the region between hyparxis and time. There should therefore be a true electro-magnetic wave associated with the pion.

Finally these considerations suggest that gravitation—the corpuscle of which is a boson (spin 2)—should be in the null-cone and therefore appear to be propagated with the velocity of light.

7.17.5. The Threefold Character of Time

In the particulate world, the determining-conditions are linked by the presence of inertial masses and electric charges. The well-defined geometric scheme of Chapter 15 can therefore serve only approximately for the description of particulate events. Particles, being tripotent, are always related, and thereby the orientation of the representation manifold ceases to be arbitrary. Whereas for the corpuscles time is pure actualization and eternity pure potency, particles exist in a more complex manner. Every further stage towards consciousness brings with it a closer linkage of the determining-conditions until finally all merge into one, namely, the cosmic distinction of possibility and impossibility.

One consequence of the linkage of the determining-conditions is that each acquires certain of the properties of the others. Time, which for existential indifference—that is, unipotence—is simple successiveness, acquires with the corpuscles the characteristic of conservation that belongs properly to eternity. With the particles the further character of irreversibility arises, and this can be defined strictly only by reference to hyparxis. As we have seen, all the interactions on the corpuscular level are reversible and time has no direction. The directiveness of time is a result of the appearance in the universe of inertial masses; that is, of tripotent entities.

We need, therefore, to examine the manner in which the linking of the determining-conditions produces these secondary characteristics. Since we are obliged to describe phenomena as events in time, it is of special importance that we should understand the secondary characteristics of time, and hence the present section will be devoted to the study of "the threefold character of time". Tracing the steps by which the linkage of the determining-conditions proceeds, we may start by examining the character of actualization of bipotent corpuscles. These appear to have an unlimited stability. We have almost direct evidence that a photon can remain unchanged for several thousand millions of years in travelling from a very distant nebula to a photographic plate in a terrestrial telescope. All speculations as to the condition of the universe—for example, the supposed recession of the nebulae, deduced from the red shift of spectral lines—are based upon the assumption that the photon will not suffer the smallest change in energy content during its prodigious journey through space, unless it passes through force-fields of varying intensity or through regions occupied by atoms and dust.

The stability of the electron is equally well-established, though on quite different evidence. The electrons are the most thoroughly studied of all the sub-atomic particles, and there is no evidence that in any circumstances does an electron change except by way of interaction with matter. It neither decays nor does it undergo any spontaneous inner change.

The neutrino, though almost entirely unknown and unknowable, appears to have the same complete and inviolable stability.

The corpuscles do not exist in their own right, but they are fixed by the determining-conditions in such a manner that they can only change by completing the conversion from one form into another, as for example when a high-energy photon gives rise to an electron-positron pair through collision with a heavy particle.

The particles are intrinsically as stable as corpuscles, but they have an incomparably greater variety of possible actualizations. Not only can protons be built up into hundreds of different nuclear species, but they form composite wholes in the form of chemical molecules, and these in turn can be built up into material objects. All these possibilities arise because the proton is tripotent and can therefore enter into a triadic relationship which itself has unlimited possibilities of further combination. The capacity of the particles for entering into combinations gives them the property of individuation that we regard as the chief existential characteristic of the tripotent level. The distinction between

particles and corpuscles can clearly be seen in the hydrogen atom, where according to the Heitler-London model the two protons remain distinct entities, whereas the two electrons are indistinguishable and partly merged. In all its manifestations the proton is stable, but the manifestations themselves are irreversible and therefore unstable. By examining this situation, we may hope to understand something of the manner in which time acquires its secondary characteristics.

There are two distinct ways of measuring the passage of time. The first is that to which we are accustomed. It makes use of cyclic phenomena such as the succession of day and night, the swinging of a pendulum, or the periodicity of an atom. We can, however, also measure time by irreversible processes, on the assumption that the entropy of an isolated system increases at a constant rate.* In both cases, we measure time by a property that is not directly time-like. Successiveness as such cannot be used for measurement, for the fleeting instants cannot yield coincidences that can be observed.

Similarly, we measure space by a property that is not space-like; that is the recurrent character of intervals and the endurance of rigid bodies. Thus we are brought to recognize that in our experience the determining-conditions are always linked by their secondary characteristics. We can describe events more or less adequately in terms of space and time alone, for the very reason that we import into them qualities that properly belong to eternity and hyparxis. Nevertheless the procedure has only limited application and breaks down entirely when we need to distinguish the existential factors associated with entities of a given potency. For this we must see which conditions arise from pure or geometric time, and which come from the existential linkage with eternity and hyparxis.

In consequence of the linkage, each of the three inner determining-conditions has a certain characteristic that we are accustomed to associate with time alone. In this sense we can regard time as having a threefold nature in the form of actual time, virtual time, and recurrent time. The true characteristic of actual time is successiveness, that of virtual time is conservation, and that of recurrent time is irreversibility. It can be said that conservation is the projection of eternity into time and that irreversibility is the projection of hyparxis. Hyparchic time is thermo-

[* This distinction was made by Dingle, cf. *Through Science to Philosophy*, Oxford, pp. 299-301. Dingle, in his Lowell lectures of 1936, showed that irreversibility and cyclicity lead to two independent conceptions of time that require two independent parameters for their full representation. In this way Dingle came close to

making the distinction between time and hyparxis, geometrically represented by the B and (o-pencils of skew-parallel vectors.])

dynamic time measured by the rate of increase of entropy of a closed system near to thermo-dynamic equilibrium. True time—that is, successive time—is experienced but cannot be measured. Successive actualization is the self-realization of the universe—one of the four conditions that makes existence possible.

If we examine our experience closely, we can see that the immediate delivery of our senses is the successive perishing of each moment. It is probable that the primitive perceptions of invertebrate animals have

no other temporal content than that of the fleeting moment. Our experience of conservation depends entirely upon our state of consciousness. In sleep, the perception of conservation almost entirely disappears; conversely, the higher the level of consciousness, the more do we become aware of the imperishableness of true being. The imperishable is not static but endlessly renewed. The imperishable is not exempt from death, but its death is an endless resurrection. Where conservation and destruction are thus perfectly harmonized, a conscious being can become aware of successiveness as a perpetual non-perishing.

We are confronted now with the simplest version of the ancient problem of reconciling the permanent and the impermanent elements of our experience. The stable, simple tripotent entity must be endowed with a balance of potentiality and actualization that enables time and eternity to be harmonized. This is achieved in so far as entropy and virtue compensate for one another in a cyclic manner, and thereby enable the entity to remain what it is, notwithstanding the irreversibility of its actualization.

7.17.6. The Regenerative Ratio

Successiveness is common to all three conceptions of time. To separate them, we have to examine their relationship to the determining-conditions of eternity and space. No massive body can acquire a momentum equal to its mass multiplied by the velocity of light in vacuo. The neutrino, for example, can have a finite momentum associated with the velocity of light only because it is a massless corpuscle and not a particle.

Just as there is a limit that material successiveness cannot exceed, so also there must be a limit that prescribes the most favourable balance of virtuality and actuality. When a system has no virtuality, it is in thermo-dynamic equilibrium both inwardly and outwardly, and this means that it has no potentiality for participating in future events. Such a system can be said to be 'wholly materialized'. When virtuality is complete, the entity is exempt from decay and able to move freely

in the dimension of eternity. In other words, it becomes 'wholly conscious'. Between these two extremes, there must be a direction in which there is neither gain nor loss of potentialities. When an entity exists along this line, it is exempt from decay, but it is fixed at a definite level from which it cannot be displaced without loss of identity. Such an entity can be said to have 'accidental identity of recurrence' as distinct from the 'inherent identity of recurrence' of the bipotent corpuscle.

Having distinguished one primary and two derivative aspects of time, we may now fix our attention exclusively upon the derivative characteristic of irreversibility. The coherence of the universe requires that there should be a limiting rate of entropy-increase common to all systems in thermo-dynamic equilibrium. Every system that is 'running down' without receiving supplies of high-grade energy from outside must do so at a constant rate that can be called the 'Universal Decay Constant'. We can go further and suppose that even when the 'running down' is restrained in some way—for example, by supplying heat—the rate of running down is given by dividing the decay constant by the rate of heat input.*

Proceeding in this way we can picture a system in which the supply of energy of the requisite quality—thermo-dynamic intensity—exactly balances the rate of entropy-increase so that there is neither gain nor

loss of the power of actualization. A simple example is to be found in the common pendulum arranged with a weight to maintain the amplitude by compensating for the increase of entropy resulting from friction. Here the potential energy of the weight can be regarded as the eternity component of a vector in the existential tract.

We can now generalize these conceptions to include any system, including simple entities, and may postulate a direction along which entities are free from decay. We can use this to define an important constant of nature; namely, the ratio of potentiality and actualization of any entity that remains self-identical in time. We shall call this constant the 'Exact Regenerative Ratio'. It is also given by the tangent of the angle made by the existential of a stable entity with its own direction of actualization in time. We have here two distinct conceptions;

[* Cf. Principle of Minimum Entropy Production, by M. J. Klein and P. H. E. Meijer, Physical Review, Vol. 96, 1954, p. 250. "The steady state is that state in which the rate of entropy production has the minimum value consistent with the external constraints which prevent the system from reaching equilibrium. . . . When constraints, such as an externally maintained temperature difference between parts of the system, prevent the system from reaching equilibrium, the system does the next best thing; it goes to a state in which the thermodynamic variables do not change with time and in which the smallest possible amount of entropy is created per unit time."]

namely, that of the cosmodesic or path of actualization, and that of the existential or direction of existence. The cosmodesic characterizes the energy in its external relationships—it is a line in space-time, and is connected with observability. The existential characterizes the inner state of the entity and is a direction in the plane containing the time and eternity axes of the entity.

Two entities with divergent cosmodesics may have the same orientation in eternity and hence constant relative velocity or different orientation and hence mutual acceleration. The direction of the cosmodesic tells us nothing of the inner stability of an entity. For this we must look for the thermo-dynamic balance that is given by the direction of the existential. The existential is not space-like; but a direction in the plane of eternity and time. *It can be regarded as the divergence of inner time and outer time.* An entity whose inner and outer times coincide is in thermo-dynamic equilibrium with its environment and must be regarded as 'dead'. An entity whose inner time diverges at the exact regenerative ratio can maintain its independent existence indefinitely, without an external supply of energy.

The exact regenerative ratio is a universal constant which we shall designate by the symbol $\mathcal{R}$. Any whole undergoing irreversible change will have a regenerative ratio R less than $\mathcal{R}$, whereas one that is increasing its potentialities at the expense of its actualization will have a regenerative ratio greater than $\mathcal{R}$. The former condition applies to all hyponomic entities of our experience, and the latter only to hypernomic entities. Where the regenerative ratio R is zero, the entropy of the system increases at the rate prescribed by the universal decay constant.

In order to determine the value of $\mathcal{R}$ we should require to know:

- (a) The numerical value of the universal decay-constant expressed in terms of known units.
- (b) The numerical value of the potentiality of a perfectly stable entity expressed in the same units.

Both these magnitudes are unknown and we must therefore proceed indirectly. For this we have to make a working hypothesis that will afterwards require to be tested against observational data. This hypothesis is already suggested by the discussion of the three aspects of time and can be formulated as the **Hypothesis of Temporal Equivalence** as follows:

The exact regenerative ratio is the same as the ratio between the dynamical and thermo-dynamical measures of time.

It will be recognized that $\mathcal{R}$ is not only a physical constant of nature,

but also a framework magnitude in that it serves to connect eternal and time-like intervals. We may note, moreover, that the plausibility of the hypothesis is increased by its analogy with the well-known formula:

The velocity of light in vacuo is the same as the ratio between the electro-dynamic and the electro-magnetic

measures of electricity.

In order to give numerical expression to the hypothesis of temporal equivalence, we can compare two cyclic processes, one of which derives from the recurrence transferred from hyparxis to eternity, and the other from regeneration in time. Clearly, these are two different ways of specifying one and the same phenomenon—namely, the property of exact regeneration—and therefore if we can formulate the two in terms of known constants of nature, we should succeed in establishing the value of the regenerative ratio.

Let us consider a particle K, the recurrence of which is characterized by equal increments of action. Referring back to the geometrical interpretation, we recall that the property of the o-pencil is such as to introduce a cyclic character into hyparxis, and for the simple entity which does not undergo inner modifications, the period of this cycle is equal to Planck's quantum of action h .

If now we turn to the recurrent series of K, we can write K_0 for the member of the series that corresponds to the particular actualization upon which we are fixing our attention. All the other members of the series are identical except in regard to the action which they carry. We can assign an arbitrary value, say zero, to the action of K_0 and then the n th member of the series will have action equal to nh .

We have to prescribe, on the one hand, the thermo-dynamic, and, on the other, the dynamic character of the existence of K. We can envisage the existence of the entity in terms of its three basic properties of action, charge, and mass. There are three fundamental relationships that make for stability of existence. The first consists in the framework connection between the units of time and eternity. This gives an universal constant of nature α analogous to the constant c that connects the units of time and length. The second ratio connects the existential properties of electric charge and inertial mass. The third relationship arises from the unitary character of all the interactions of tripotent entities and connects the units of time and mass with the quantum of action. In these three relationships there are three unknown quantities, one of which is the universal regenerative ratio for which we are seeking. The remaining quantities are the well-known and accurately-determined universal constants of physics; namely, the velocity of light in vacuo, the charge of

the electron, and the quantum of action. The regenerative ratio R can be expressed as the tangent of the angle Λ made by the existential of a stable entity with its own line of time. Since the existential contains both the inner factors of stability—namely, the effect of charge on mass and the balance of eternity and time, we have a sufficient number of relationships to eliminate the unknown and unmeasurable quantities that lie in the dimensions of eternity and hyparxis. It is necessary to make the natural assumption that the two cycles of existence in time and eternity are both inherent in the nature of the tripotent entity and therefore stand in the same relationship for all stable particles. It is then found that the perfect regenerative ratio is a pure number given by:

$$R = \tan \Lambda \quad (17.2)$$

$$\text{where } \tan \Lambda = e^2/hc = \alpha/2\pi \quad (17.3)$$

α is the fine-structure constant of atomic spectra. This is a very remarkable and encouraging result in so far as it brings the property of regeneration into direct connection with hyparxis.

When R is evaluated numerically in terms of the known values of e , h , and c , we have:

$$R = \sqrt{\alpha/2\pi} = 0.0340793 \quad (17.4)$$

The angle Λ is a small angle of slightly less than two degrees of arc. Though small, the angle is by no means negligible. The magnitude of the angle Λ does not depend upon the choice of units for the expression of the various intervals of the basic magnitudes. It is a number without qualitative distinctions. As can be seen from its recurrent character and the absence of fixed directions, hyparxis—in the absence of matter—is arithmetical rather than geometrical. We find, therefore, a justification for our procedure in the reflection that the regenerative ratio is in its intrinsic significance **a measure of ableness-to-be**. Although we represent it geometrically as a direction in the existential tract, this is only for convenience of relating it to the observed properties of matter. The pure number 0.0340793 is the expression of one of the basic relationships of the universe, in this case of the balance of potentiality and actuality by which all existence is maintained.

It has been suggested by Eddington* that the fine-structure constant of atomic spectra can be deduced as the pure number 1/37 from considerations of the possible modes of relatedness of corpuscles taken in pairs. The observed value of the constant differs significantly from the whole number 1/37, and Eddington's speculations, though inspiring, have for

* A. Eddington, *The Relativity Theory of Protons and Electrons*.

the time being been set aside by most physicists. We have now found a closely related number for the universal regenerative ratio and this raises the question whether this number can be deduced from considerations of relatedness alone or whether it may not depend upon the state of the existing universe. On the whole, the latter alternative seems more probable, in which case R should be connected with the thermo-dynamic age of the universe; that is, with the proportion of its ultimate potentialities that have at the present time been actualized. If this view is correct, the value of R should slowly be increasing and this is only possible if at least one of the three quantities, e , h , and c , is also changing with time. There seems to be some, though small, evidence that the velocity of light may be changing. If so, all speculations as to the size, age, and future of the universe must be subject to revision until such time as the true significance of the universal regenerative ratio is better understood and a decision reached as to its constancy with time. If, on the other hand, the universe itself is in a state of everlasting equilibrium due to the regeneration of hyle, then the universal regenerative ratio is a permanent characteristic of all existence and as such could be deduced from simple considerations of the forms of stable relatedness on the lines of Eddington's investigations. In any case, there is much to be learned from the further study of this quantity.

Chapter Eighteen COMPOSITE WHOLENESS

7.18.1. Quadripotent Entities

It is sometimes necessary, in order to avoid associations that may be misleading, to call familiar objects by unfamiliar names. We have to complete our examination of the hyponomic world by considering the nature of thinghood; but unfortunately the word 'thing' has too many and too vague meanings to be suitable for our purpose without more exact definition. Of all the various definitions of 'thing', that which reads: 'an entity consisting of matter and extended in space' is the nearest to our requirement, and we could use the equivalent 'material object' if this did not also convey implications of size, coherence, visibility, and impenetrability that are too restrictive. We shall, therefore, retain the term 'composite whole', but fix upper and lower limits to its applicability. The lower limit of composite wholeness is the combination of not fewer than two tripotent entities into a single whole. The upper limit is given by the definition of hyponomic existence as that which is passive towards its environment. The characteristic relationship is that of part and whole, and we shall confine ourselves to such entities as exhibit this relationship, but no higher form of inner-togetherness. To make this point clear, we must see exactly what we mean by the quality of 'partness' in reference to a 'whole'. By emphasizing this quality, we are enabled to distinguish between relationship and subsistence. A part subsists in the whole, and the whole subsists by virtue of the qualities it derives from the relationships of its parts. It is here necessary to distinguish subsistence from the higher categories needed for discussing questions of life and consciousness. The connection between a whole and its parts is categorically different from that between the organism and its organs. It is also categorically different from the connection between two

interacting tripotent wholes. In order to make this latter point clear, we can examine the manner in which wholeness emerges step by step as we pass out of the undifferentiated hyle towards the higher gradations of existence.

A whole in which the identity of the constituents is completely submerged belongs to the corpuscular state of the hyle; that is, bipotence. Such, for example, is a definite quantity of electron gas, which can be regarded as the lowest gradation of wholeness that can be recognized

and thought of. When we pass to tripotent entities, we find that the simplicity of the corpuscle has already been transcended, but that there is still no relationship of whole and part, for the constituent elements have no possibility of independent manifestation, being entirely subordinated to the requirements of stable existence. Thus in the transformations of a neutron or proton, corpuscles are emitted or absorbed, but they cannot be regarded as parts of the entity in the way that the legs or the back are parts of a chair. When a neutron is transformed into a proton, its identity wholly disappears, and a new particle arises, the actualization of which has no inner dependence upon the state of the neutron prior to its disintegration. It would be quite misleading, therefore, to say that the neutron 'changes' into a proton. Existence on this level has the all or nothing character which requires that an entity must either be itself or not be at all.

Any comprehension of the transition to composite wholeness requires that a clear meaning should be assigned to the sentence 'the entity A has changed but has not ceased to be itself'. This phrase can have a meaning only if A is composed of a number of parts, p_1, p_2, p_3 , etc., connected by a set of relationships $r(p_m, p_n)$ or r_{mn} , where r_{mn} can within limits take different values without the identity of A being thereby destroyed. This leads us to an improved definition of composite wholeness as 'the gradation of existence whereat an entity can undergo changes of its inner constitution without losing its identity'. As worded, this definition applies only to existence in time, but a non-temporal formulation can also be given. We can write in almost pure existential terms:

An entity A is a composite whole if:

- (i) There are two or more tripotent entities $p_1, p_2 \dots$, each of which is assignable to A rather than not- A ,
 - (ii) There is more than one set of permissible relationships between the p 's,
- and (iii) At least one of the relationships is such that at least one p can be assigned to not- A .

The clumsiness of this definition indicates that we are attempting to describe the indescribable. The mutual significance of part and whole is categorial, ultimate and irreducible to simpler terms. It belongs to the category of subsistence. Subsistence in time is to endure. Subsistence in space is to be composite. Subsistence in eternity is to have a diversity of potentialities. Subsistence in hyparxis is to have a recognizable identity. These various properties can be relative in their manifestations, and within the range of existence defined as composite wholeness, there

are many degrees of inner-togetherness. All have in common the basic existential characteristic of quadripotence. We have thus a group of conceptions expressed by such words as 'composite whole', 'material object', 'molecule', 'compound', 'thing', 'enduring entity', 'subsistent whole'; all of which derive from the existential hypothesis of composite wholeness. To these various concepts, we can add that of a proper history

and also that of a pattern of potentialities as an intrinsic characteristic. Up to the level of quadripotence, phenomena are non-historical, for all processes that concern only corpuscles and particles are inherently reversible. Tripotence has no pattern but only a number of permissible combinations. On the level of tripotence, we can speak only of a collection of entities p_1 , p_2 , etc., but a quadripotent entity of which the p 's are parts is more than a collection. On the other hand, its parts are not entirely subordinated to the whole. Each of them retains some measure of independent potentiality and separate actualization. Without this relative independence of the parts, no meaning could be ascribed to the phrase "A changes, but endures".

Using the notation previously employed, we can say that in A itself there is an affirmation of wholeness; in the parts p , wholeness is denied, while in the relationships r there is the reconciliation between the parts and the whole. Clearly the triad formed in this manner does not produce a composite whole unless the r 's have a specific character that will enable them effectively to sustain their dual role. It is in this specific character that subsistence differs from simple relatedness. The mere fact that there are links between a set of p 's is not sufficient to ensure subsistence of the set regarded as a whole. For example, the molecules of a diatomic gas are composed of atoms linked in pairs, but this does not suffice to endow a given quantity of such gas with the status of composite wholeness. This status is not achieved even if we add further relationships such as the requirement that the energy should be equally distributed between the independent degrees of freedom of vibration, rotation, and translation. The gas remains a mere collection of tripotent entities until it is enclosed in a vessel in such a manner as to give meaning to the assertion that the same gas is there at different times and under different conditions. This example suggests that a composite whole arises only by way of some constraint placed upon the actualization of its component parts. This constraint is the price of subsistence. The constraint that must here be taken into account differs from those placed upon all physical systems by the framework conditions. For example, the laws of least or varying action have no reference to our present problem, nor is it concerned with the laws of thermo-dynamics that apply equally

whether the p 's subsist in a common whole or not. To understand quadripotence, we have to go beyond both the successiveness of time and the potentiality of eternity.

7.18.2. Intensive, Extensive, and Coupling Magnitudes Following the discussions of the early chapters, it will not appear strange to assert that function is extensive, being is intensive, and will is conjunctive. Referring to the inner determining-conditions, we would expect intensive magnitudes to be associated with the dimension of eternity, and extensive magnitudes with that of time. We should now add to these a third kind of quantity, that we shall call coupling magnitudes, to be associated with the dimension of hyparxis. To assist our intuition of the three kinds of magnitude, we may conceive a man as subject to assessment in terms of three independent quantities; namely, the extensiveness of his functional activity, the intensity of his consciousness of potentialities, and the force of his own ableness-to-be. Only the combination of all three can lead to a true assessment of a man's value, independent of the accidental circumstances of his temporal actualization, or the fluctuations of his states of consciousness. The same conception can be transferred into the physical world if we recognize that many observable quantities can be expressed as the product of three independent magnitudes. The heat-content of a body can be expressed as the product of temperature difference above an assigned zero, the heat capacity, and the mass. Magnetic energy is the product of field strength to the second power, permeability, and volume. In each case there is an intensive magnitude that is active, an extensive magnitude that is passive, and a coupling magnitude that is neither active nor passive, but yet participates sufficiently in the nature of both to serve as the reconciling element.

If we consider the example of magnetic energy, we can see that the coupling magnitude is concerned with the way in which the material is put together. Iron, silver, and bismuth behave quite differently in a magnetic field and we know that the differences in behaviour turn upon the atomic structure; that is, a property belonging to lower existential levels. The same applies to heat-content. These observations can be generalized in the form of the Coupling Theorem for Composite Wholeness; namely:

All coupling magnitudes on a quadripotent level derive from the ableness-to-be upon the tripotent level.

One consequence of the coupling theorem is that it is only very rarely

that coupling magnitudes can be calculated. They are quantities that the physicist has to measure. For example, the chemical constant of a gas cannot be calculated from the gas laws alone, but only with the help of the quantum theory, that is, from considerations of tripotency. The magnetic susceptibility must be accepted as a fact of observation until the scale is transferred to that of the atomic particles where the tripotent Bohr magneton is found to be the basis of calculations. Even so, there remain anomalies that show how far the large-scale phenomenon depends upon the inner structure by which the randomness of the atomic moments is reconciled with the orderliness of the large-scale actualization. In Goudsmit and Uhlenbeck's postulate of electronic magnetic moment and spin, we are provided with means of calculating not only magnetic, but many other properties of composite wholes; but the significance of spin itself remains as obscure as when it was first put forward.*

The chief obstacle in the interpretation of this and many other hypothetical properties of hyle in the quadripotent state is removed by recognizing that every composite whole is the product of three factors; one extensive, prescribing the mass, momentum, and other temporal properties of hyle; one intensive, that measures the potentialities of the constituent elements; and the third, a coupling magnitude by which the whole and part relationship of quadripotence is established.

We can now add to our previous notions of composite wholeness the conception of a triad passing into a tetrad by the interlocking of whole and part. Quadripotence thus means adding to the potentialities of the triad a fourth independent potency of 'being oneself in the midst of change'. We thus return to our first definition of thinghood, having linked it to the existential hypothesis of composite wholeness. A thing can be 'more or less' itself and this 'more or less' is a property that is entirely lacking in the lower gradations where existence is invariably 'all or nothing'.

7.18.3. The Coupling of Recurrences

Let us consider a set of tripotent entities, each actualizing in its own cosmodesic path and recurring self-identically in an existential of perfect

[* The difficulty of interpreting coupling magnitudes without knowledge of the inner structure of matter is well exemplified in the conception of spin; that is, the ascription of mechanical angular momentum not only to particles, but even to corpuscles such as light, quanta, and neutrinos. Cf. G. Joos, *Theoretical Physics* (1951), p. 661: "No deeper meaning is to be attached to such a detailed picture of the structure of the electron, since it cannot be verified in anyway." Cf. also S. Goudsmit and G. Uhlenbeck (1926), *Zeit. der Phys.*, Vol. 35.]

regeneration. No inner change can occur to disturb the eternal calm that reigns in each particle of hyle. Each is a windowless monad closed to all outward influences. The totality is a collection and not a whole. In order to become a whole there has to be a merging of existence. Although this merging must occur within the entities concerned, it cannot be represented in time or eternity; for in either case it would be inconsistent with the tripotency of the parts. Hence we conclude that composite wholeness arises from the coupling of recurrences in such a manner that each of the entities surrenders some part of its freedom in order to allow a corresponding amount of freedom to the whole.

The quantitative expression of recurrent coupling can be found by considering the vector pencils required for specifying each of the p's. So long as the p's are independent tripotent entities, six internal degrees of freedom are available. Four of these are absorbed in defining the character of the entities, leaving two unspecified conditions that allow unrestricted choice of cosmodesic and existential. The potentialities of each entity is specified by a number that determines its apokritical level.

We have now to find a means of specifying the fact that all the p's are parts of the whole A. The spatial connectedness is readily described by means of the y-pencils and need not concern us here. The existential problem can be resolved only by assigning to A an hyparchic vector that defines its own recurrence. Here the quadripotence of A allows us to assign only one degree of freedom to the recurrence. This means that the recurrences of A are self-identical, that is, A has no possibility of changing its own level of existence. This is, of course", characteristic of all hyponomic existence, which is by hypothesis passive in all its transformations.

To produce the condition of composite wholeness, each of the parts of A must have a common inner component of their null-vectors. This component must lie in the two-dimensional region that connects eternity and hyparxis. In consequence of the sharing, a fraction of the action available for maintaining each of the p's independently is released, with the result that the energy of A is less than the sum of the energies of the p's in their independent state.

We have thus discovered a quantity, measurable in time, that is directly proportional to the intensity of coupling. The magnitude depends upon the intrinsic character of the quadripotent entity A and not upon the properties of the tripotent entities $p_1, p_2, p_3 \dots$ etc. If, for example, the entities are nucleons, then the coupling magnitude will be the same for neutron-neutron, neutron-proton, or proton-proton. Through the coupling of recurrences, there will be a diminution of the

potentialities of the p's taken separately, but the overall potentiality will be conserved through the arising of a fresh potential associated with the composite whole A. This conservation of potentiality absorbs the only degree of freedom available in the region connecting eternity and hyparxis. In other words, when a composite whole is formed, the independence of all its constituent parts is subject to a restriction. Turning from potentiality to actualization, we have a somewhat different situation, in that the lines of time and hyparxis are of the same kind; that is, both non-transitive. It is this that allows a transfer of a part of the action from hyparxis into time. This takes the form of the binding energy of the composite whole A. Since binding energy is a measure of stability, it is a negative magnitude that must be added to the temporal actualization in order to disrupt A and restore to its primary components their independent actualization.

By the cyclic property of hyparxis already considered, there are two components, $\cos \theta$ and $\sin \theta$, that give rise to the virtuality and material waves of the several p's. When the recurrences are combined, there will be a common o-pencil with its own virtuality and material wave. It must, however, be noted that this applies only when the constituent particles are all of the same kind; only then can there be superimposition of the recurrences so as to fit the fine structure of hyparxis. In this, the space components of the recurrence remain free and the combined particle behaves as a single unit of hyle. In all other cases there requires to be a space-like structure as well as an inner coupling. This leaves us to distinguish two fundamentally different kinds of composite whole; namely, those whose coupling is altogether internal, and those whose coupling has a space component. Composite wholes of the first kind are the atomic nuclei; those of the second are the molecular species and space-extended wholes generally.

The atomic nuclei can be regarded as degenerate quadripotent; that is, as entities that are quadripotent in constitution and tripotent in their manifestations. We can observe how closely similar is the behaviour of the hydrogen and helium nuclei, notwithstanding the fundamental difference in their existential status. This is to be expected in view of the relativity of being which requires that there should be transitional levels between each of the major gradations.

7.18.4. The Stability of Composite Wholes

The coupling of recurrences does not of itself suffice to produce a whole that is stable in its temporal actualization. We have to distinguish between coupling and stability. As we have seen, each separate particle

has two unspecified degrees of freedom. Only one of these is absorbed in coupling, and therefore, when more than two particles are involved, combinations can arise that can be more, or less, favourable either in respect of the merging of potentialities or the probable course of actualization in time. This applies even though the constituent particles are assumed to be identical and interchangeable. It is known, for example, that a combination of great stability arises when two neutrons and two protons are associated to form an α -particle or helium nucleus. The coupling of the entities is ideally perfect and there is a maximum binding-energy available, amounting to more than seven million electron volts for each unit of hylē. Now the slope of the existential must be exactly the same for any multiple of four units of hylē. In the beryllium nucleus of mass eight—designated by the symbol ${}^8_4\text{Be}$ —the binding-energy for each unit of hylē is only very slightly less than that for helium. We should therefore expect ${}^8_4\text{Be}$ to show great stability, whereas in fact it is so unstable that its existence has never been observed and, if formed, it probably disintegrates into two α -particles in less than a thousand million millionth of a second.

The well-known explanation of this apparent anomaly is that the tetrahedral arrangement of the four units of hylē in the α -particle forms an independent whole that is denser than that of any other arrangement. Consequently the ${}^8_4\text{Be}$ nucleus disintegrates spontaneously into two α -particles. It must, moreover, be noted that the fourfold structure of the α -particle corresponds to the basic requirement of subsistence; namely, the conjunction of four independent elements. Whereas ${}^4_2\text{He}$ can be only relational, ${}^8_4\text{Be}$ can be subsistent.

In assessing the stability of a composite whole, all possible modes of disaggregation have to be taken into account. The irreversibility of actualization consists in the trend towards situations of maximum stability, but the path towards stability will depend upon a variety of factors of which the coupling of recurrences, though very important, is not decisive.

The factors that determine stability can be placed in three groups:

- (i) Potentiality, and especially the maximum potential determined by the highest level in eternity that the whole in question can occupy.
- (ii) The variety and range of actualizations open to the whole in question due to:
 - (a) its inner structure, and
 - (b) its outer relationships.
- (iii) A coupling of recurrences that depends in its turn upon the variety and character of the aggregates formed from the component tripotent entities.

In the simplest possible situation, no subordinate inner aggregates are formed, and the whole is homogeneously composed of hylē in the form of corpuscles and particles without place, order, or sequence. A tripotent entity can be in equilibrium with three bipotent entities, thus $P(a, b, c)$, where P is a particle and $a, b,$

and c are corpuscles. The corpuscles a, b, and c can only be in certain states. Some of the energy must be available for inner stability, while the remainder may be in the form of a negative electric charge or both positive and negative. The inner corpuscles may become neutrinos or photons and, if the former, have right- or left-hand spin. We can then readily construct the arrangement of maximum stability which is given when the pairing of corpuscles is symmetrical and complete. This is achieved in the helium nucleus, or a-particle, which can therefore be regarded as the basic pattern of quadripotence. We may observe here that the overwhelmingly greater part of all the existing masses of the universe are in one of the three primary forms:

- (i) Corpuscles—mainly as electrons and photons. (ii) Particles—mainly as protons or hydrogen nuclei.
- (iii) a-particles—mainly as helium nuclei.

Taking into consideration only the 'free' states, in which there is no building together into composite wholes of greater complexity than the helium nucleus, these three modes of existence account for 98 per cent, of all the masses of the actualized world. The following table, based upon figures given by Huntley,* gives the relative masses of the various forms. If instead of masses, the number of units were to be taken, the proportion of the light elements would, of course, be far greater.

	<i>Atomic Number</i>	<i>Relative Mass</i>
Corpuscles—all forms of electro-magnetic radiation, but not including neutrinos	0	1000
Particles—protons and hydrogen nuclei	1	650
Alpha-particles and helium nuclei	2	577
Oxygen nuclei	8	16
Iron nuclei	26	9
All nuclei heavier than nickel	>28	0.05

Table 18.1. Distribution of Hyponomic Entities

* H. E. Huntley, *Nuclear Species* (London, 1953), Tables 5-7, pp. 90 and 91.

This table demonstrates the dominance of the corpuscular and particulate states over all others. Moreover, 98 per cent. of the masses of the universe are contained in corpuscles, particles, and helium nuclei. All heavier nuclei, all composite wholes—that is all matter in the form of molecules (except hydrogen), all liquids and solids, all living matter on nearly all planets are comprised within the remaining 2 per cent of the total masses of the universe. In our solar system, for example, more than 99 per cent of all masses are composed of free hydrogen and helium.*

We shall see later that the transformations of hyle proceed from the ground-state into the particulate and from this either into stable helium or into relatively unstable composite wholes.

The extreme rarity of stable composite wholes having an inner structure more complex than that of the a-particle shows that the coupling of recurrences does not suffice to give stability unless there is a very favourable combination of potentiality and actualization. In other words, any composite whole must have an existential lying close to the direction of exact regeneration, if it is to be capable of enduring in time. The integral coupling of recurrences is the most intimate bonding of hyle, but it cannot be achieved for large aggregates on account of the second order effects in which the price of achieving an inner structure is a tendency towards disruption. We shall not expect the coupling of recurrences to produce a simple situation beyond a small number of units of hyle, after which it becomes necessary to take into account the spatial configuration in the form of a sharing of y-pencils. It should be noted that the concept of virtue regeneration

applies to the particles and corpuscles as well as to the composite wholes. It is possible to show, for example, that negative charge is stable when associated with virtual mass, as in the electron; but unstable when associated with actual mass, as in the anti-proton. Conversely, positive charge is stable when associated with actual mass, as in the proton; but unstable when associated with virtual mass, as in the positron. Mass and charge both oscillating can be stable in the photon, but can also readily be annihilated in a sudden catastrophe.

7.18.5. The Atomic Nucleus

A nuclide can be defined as a degenerate composite whole in which the parts have lost their separate identity. The stability of such an entity depends therefore entirely upon the coupling of recurrences and other internal constraints and not upon spatially distributed forces. The 'parts' of a nuclide are tripartite simple entities and combinations of such

[* Cf. H. Brown, Review of Modern Physics (1949), Vol. 21, p. 625.]

entities in groups of four; that is α -particles. All evidence, however, goes to show that these 'parts' have no permanent identity within the nucleus, and this is why we refer to it as a degenerate composite whole.

We can set down the main features of a nuclear model as follows: The nucleons are located on the absolute of the six-dimensional framework. This is the locus of all null-intervals given by

$$ds^2 = dx^2 + dy^2 + dz^2 - c^2 dt^2 - \lambda^2 da^2 - \sigma^2 dh^2 \quad (18.1)$$

where x , y , and z are, as usual, the three directions of motion, force, and spin axis projected into rectangular co-ordinates; t , a , and h , are time-like, apokritical, and hyparchic intervals; and λ and σ are conversion factors analogous to c . The nucleons can be called 'virtual in respect of spatial configuration' or 'wholly internal'. By reason of their null-situation, the nuclear particles:

- (a) Are indistinguishable and interchangeable,
 - (b) Are conservative in respect of mass and electric charge,
 - (c) Appear, when projected into any space-time [4] to move with the velocity of light,
 - (d) Have a joint probability of interaction with corpuscles and particles and hence an apparent collision cross-section,
- and (e) Are coupled in respect of recurrence and hence have a pseudo-configuration or arrangement on the surface of the null-cone.

In order to relate these conceptions to the great mass of experimental data accumulated in recent years, it is necessary to construct a model of the nucleus susceptible of mathematical treatment. The peculiar character of nuclear wholeness arises from the fact that space coupling plays little or no part in maintaining the stability of the nucleus—in fact the nuclear forces are entirely different from those of the space-extended fields we have studied in the earlier chapters. It is usual to postulate motions of the nuclear constituents in the sense of space-like displacements with time. That such a postulate is unnecessary will be evident if we consider the essentially internal character of the nucleus. It is under the sway of the inner determining conditions of time, eternity, and hyparxis—all that is space-like being exteriorized into the orbital electron field.

These features suggest a model of the atomic nucleus that combines the properties of the liquid-drop model with those of the individual particle shell model. We see here how the six-dimensional framework eliminates one more troublesome dualism from our picture of the physical world.

The merging of potentialities of tripotent entities in the virtual state

gives rise to a strong interaction that accounts for the nuclear surface energy and the energetics of nuclear reactions. In particular our nuclear model readily gives a quantitative account of the following observed properties of both light and heavy nuclei:

- (a) The constancy of nuclear density as evidenced by the systematic tendency for radii to vary as $A^{1/3}$.
- (b) The balancing of coulomb repulsions in heavy atoms by the binding force between excess neutrons.
- (c) The fission of very heavy nuclei by thermal neutrons.
- (d) The constancy of the binding force between nucleons, whether charged or uncharged.
- (e) The finite upper limit of size for alpha-radiation stability ($Z=92$). (f) The systematic variation of the energies of alpha-particle

emission with Z and N .

On the other hand, the hyparchic element of the nuclear model—which is fully consistent with its eternal and virtual pattern—accounts for all the wave-mechanical properties of the nuclei. In the first place it assigns a high degree of stability to the interlocking of four delta-pencils and so gives the alpha-particle as the basic unit for nuclide building. The recurrent properties of hyparxis give a short range attractive potential between identical pairs of nucleons and zero for odd nucleons—all of which agrees with observation. The model also accounts for such properties as:—

- (a) Zero spin for nuclei of even- Z and even- N .
- (b) Integral spin for nuclei of odd- Z and odd- N .
- (c) Half integral spin for all odd- A nuclei.
- (d) The symmetry properties of nuclear spin—mirror nuclei, etc.
- (e) The magnetic dipole momenta of the nuclei.
- (f) The electric quadrupole momenta—gamma-ray transitions between nuclear levels. (g) The property of nuclear isomerism. (h) The discontinuities of nuclear binding energies (see section

7.18.6.). (i) The existence of stable non-adjacent isobars.

It is further to be noted that the coupling of hyparchic recurrences is equivalent to the series of nuclear shells postulated by Mayer and others.* When the threefold character of the delta-pencil is taken into account we find the equivalent of the nuclear triads and hence the arising of specially favourable conditions for stability. The model suggests [* Cf. M. G. Mayer, Phys. Rev., Vol. 75, 1949, p. 1969.]

that there should be peaks of maximum coupling of the recurrences for the series of 2, 6, 14, 28, 50, 82, and 126, neutral or positive particles, and also that the intercalary series with the numbers 2, 6, 12, 20 should be exceptionally stable. Now it is well known that in the series of nuclides, particularly stable combinations are found with these numbers that for this reason have been called the **magic numbers** of the nuclear series. It is, however, only for the heavier nuclides that the significance of the magic numbers becomes obvious. With light elements, the stability is primarily influenced by the need for a balance between charged and uncharged particles that can produce the exact regenerative ratio.

The abundance of the elements must be closely related to the probability of the coupling of recurrences. The significance of the magic numbers appears in the abundance both of the isotopes and of the isobars. In general, the most abundant stable isotope is the one in which the ratio of charged and uncharged units of hylé has a middle value. When, however, one of the isotopes has a magic number of either charged or uncharged particles, its abundance is the greatest irrespective of its position. For example, in the case of zirconium, the $^{90}_{40}\text{Zr}$ is the poorest in neutrons of all the five isotopes of zirconium, and yet it is nearly as abundant as the other four put together.

The significance of the coupling of recurrences applies not only to the inherent stability of the nuclide itself, but also to the fitting together of the vectors that carry the property of spin or action, by which the coupling itself is affected. The coupling of the spin-vectors absorbs, as we have seen, a certain quantity of energy that is required for the balancing of the δ -pencils. As a result of this, the nucleus itself acquires the possibility of inner differentiation, so that a given combination—in which the main configuration is fixed, thus giving a nuclide of a known number of charged and uncharged units—can itself have different energy levels, some of which can be sufficiently stable to persist for a measurable duration of time. This gives rise to the property of nuclear isomerism. Under certain conditions an isomer, carrying considerable excess energy, can have a half-life of several years. The stability of such states, computed in terms of the probability of transitions, is so extraordinary that we can scarcely be far wrong in supposing that we have here a precursor of the hyparchic sensitivity that is so significant in the autonomic world. It should also be noted that coupling allows for the various spin quantum numbers and parities of modern nuclear physics.

7.18.6. The Masses of the Nuclides

The coupling of recurrences does not of itself ensure stability in time. Moreover, for the coupling of recurrences alone, we have no means

of calculating the amount of energy that appears in negative form in the bonding of the nuclide. This negative energy is commonly known as the mass defect, calculated as the difference between the mass of a given nuclide and the sum of the masses of the neutrons and protons of which it is presumed to be composed.

The primary requirement for the stability of a nuclide is that energy should be transferred out of time into hyparxis through the coupling of o-pencils. This is sometimes referred to as the coupling energy of the nucleons; that is, of the charged and uncharged units of hyle. This has been measured and found to equal approximately 280 electron masses per pair of nucleons or roughly the mass of the Π -meson.

The energy associated with recurrence appears as negative mass, but it is at the same time the binding-energy which would have to be overcome in order to separate the nuclide into its constituent units of hyle. Since this is a measure of the stability of a composite whole, we should be able to determine it by examining the ratio between the number of charged and uncharged units and seeing how these enter into the inner existential. If the nuclide is to have a stable existence, it must in any case have a ratio of electric charge to inertial mass that is close to the perfect regenerative ratio, 0.034. Several of the factors making for stability are the same whatever model be adopted for the arrangement of units of hyle in the nucleus. Others can be formulated by considering the requirements of hyparchic coupling and virtue regeneration. The principal factors to be taken into consideration are:

(i) Number of units of hyle A , (ii) Balance of charge and mass Z/A , (iii) The residual energy of coupling of recurrences, (iv) The self-repulsion of the positive charge—the Coulomb energy, (v) Secondary effects, due to imperfect adjustment of the existential to the recurrent series, (vi) Weakening of the regenerative effect, due to imperfect fitting-

of the shells of charged and uncharged units,

and (vii) Spin coupling effects of odd and even numbers of charged and uncharged units.

Making the simplest assumptions as to the way in which these different factors will operate, we can obtain a formula for the mass of a stable nuclide in terms of isotopic weight and charge, and the spin number.

It is well known that a variety of formulae has been proposed for

Bohr made the further assumption that the emission or absorption of energy in the form of radiation occurs only when the electron jumps from one orbit to another.

It is well known that Bohr's hazardous speculation was amply justified by subsequent discoveries of the spectral lines of hydrogen, of which at that time only the Balmer series was known. The discovery of two series in the infra-red and one in the ultra-violet confirmed the validity of the formula, without however showing how an electron could move with a centrally directed acceleration without emitting radiation as required by electro-magnetic theory. One plausible way of explaining this is to regard the electron as distributed throughout the orbit in such a way that there is not a revolving charge, but a rotating ring of 'electricity'. Since this suggestion is incapable of being tested, it does not greatly advance our understanding of the mechanism. If, however, we place the whole situation in the six-dimensional framework, we can see that the non-radiating electron must have all its recurrences identical, and therefore must possess a quasi-infinite number of locations which give a distribution equivalent to the rotating ring. When the electron interacts with a photon, one of the recurrences is fixed and a new energy-state results. For one short moment, the electron is exactly located, and then continues in its new recurrent series.

The neutral hydrogen atom is the simplest composite whole having a spatial configuration. Atomic physics studies the totality of phenomena arising from the behaviour of atomic structures and is so clearly demarcated a field of inquiry that we should expect it to be definable in terms of an existential hypothesis. It must be noted that the category of subsistence suffices for the description of nuclear, atomic, and chemical phenomena, so that we are always within the domain of quadripotence. Nevertheless, according to the principle of structure, we should expect to find seven distinct qualities of subsistence and in this sense atoms differ from nuclei, and chemical compounds from atoms. With the neutral atom we observe the true nature of composite wholeness, but not yet its full realization. Thanks to the simple character of atomic subsistence, it is possible to predict with complete confidence the detailed properties of an atomic species even before it has been discovered in nature and studied experimentally. It must be recognized, however, that this predictability applies only to the behaviour of large numbers.

There is no possibility of predicting how a given atom will behave. Moreover, the uncertainty embraces a variety of possibilities and not only a fixed transformation as in the case of spontaneous nuclear disintegrations. We shall find a progressive increase in qualitative uncertainty as we ascend the scale of existence.

7.18.8. The Chemical Bond

In the third mode of composite wholeness, the spatial configuration extends to the masses of actualized hyle. A chemical molecule differs qualitatively from a neutral atom even though both might have the same number of tripotent and bipotent constituents. The difference lies in the fact that the wholeness of a molecule is achieved by a twofold exchange of potentialities. Its constituent atoms are in a fuller sense parts than are the nucleus and the orbital electrons of even the most complex atom. It can be said that with the chemical bond we first encounter the true significance of the part and whole relationship and can see how a pattern of possibilities emerges with it.

Before considering the general case of a complex molecule, we must examine the nature of the chemical linkage. There are two main types according to whether the binding-forces arise from eternity or hyparxis. The first type is the polar bond in which two atoms are held together by the electro-static attraction between positive and negative charges. Even here, however, it is necessary to take into account the property of the sixth dimension, whereby the electrons constitute a recurrent series that, when projected into space, give not a uniquely located particle, but an 'electron cloud'. When two atoms of opposite polarity approach one another closely, and the nuclei begin to enter these electron clouds, the attraction of the positive and negative charges begins to be neutralized by the repulsion of the nuclei themselves. This effect, however, would not occur if the electron were regarded as uniquely defined or if—as in wave mechanics—it was treated as

consisting of a wave only. The particle view belongs to time, the wave view to eternity, but these require to be reconciled through the concept of recurrence in order to allow for the situation in which the valency electron behaves as if it were a shell about the nucleus.

There is, however, an even more interesting situation in the non-polar bond, such as that of the hydrogen molecule, H₂. It was shown by Heitler and London as far back as 1927 that the formation of the hydrogen molecule could be explained on the assumption that it was impossible to distinguish between the electrons belonging respectively to the two

protons. The success of this procedure in calculating the energies of formation of chemical compounds involving non-polar linkages is evidence that the sharing of electrons must have some physical meaning, but attempts at giving this a physical interpretation have not so far been very convincing.

The Pauli exclusion principle requires that no two electrons in any one atom should have all three orbital quantum numbers identical, but this condition is relaxed by the convention that 'spin' may be right- or left-handed, thus allowing a fourth pairing that can neither be verified nor even formulated in physical terms. Remembering, however, that spin has the dimensions of action, and that we have associated it with one of the three inner vectors whereby hyle is brought into relationship with the determining-conditions, we can see that two recurrent series, identical in every respect, can nevertheless be brought alongside one another without mutual exclusion; it is the resulting fusion of the recurrent series that gives the perturbation. A large difference of energy can arise through the close approach of two similar atoms as in the hydrogen molecules.

Although the chemical bond requires no new existential postulate beyond that of quadripotence, it represents an immense step in the ascent of the hyle towards conscious individuation. It is, above all, the wealth of potentialities that distinguishes the chemical compound from the neutral atom. The chemical bond with its threefold interpenetration of space, eternity, and hyparxis has a flexibility that matches the whole immensity of universal existence. The number of chemical compounds that can arise from the combinations of five or six different atoms passes all computation. Even those that can emerge from one basic scheme such as that of proteins admit of such variability that if all the actualized hyle present in the whole universe since the dawn of time were used in making single molecules, each of a different constitution, only a minute fraction of the possible combinations could be formed.

It is this enormous influx of potentialities that marks the true character of composite wholeness. Hyponomic existence must be such as to carry the whole burden of the universal actualization without being able to call upon the faculty of sensitive adaptation that belongs to life or upon the unfathomable power of affirmation of the hypernomic worlds. It can do so only because, with all its passivity, it can enter into combinations complex enough and varied enough and numerous enough to match every demand that can be made upon it. The strange fascination that chemical science exerts upon all who come to grips with it comes undoubtedly from the unending vista of possibilities that

physical science, for all its marvellous beauty and precision, can never hope to display.

7.18.9. Heat

Before proceeding to consider the higher modes of hyponomic wholeness that we encounter in our common experience, we should make a digression to take note of certain important forms of interaction, upon which the actualization of the hyponomic world is based. For an eternity-blind observer, the energy of motion manifests differently according to scale. In the molecular dimensions it takes the form of heat and we can study in the phenomena of heat and heat-transfer the three inner dimensions of time, eternity, and hyparxis without reference to the individual units of hyle. More generally, we can say that statistical processes exhibit the same basic relationships as those which we have found upon the atomic scale. For example, the quantity of heat present in a given body can be expressed as the result of three independent magnitudes : the mass of

the body, its temperature, and the specific heat of the matter of which it is composed. Mass is an extensive magnitude that we commonly represent by a scalar—that is, the weight—but which should be treated as the length of a B-pencil in the direction of time. Temperature is also usually expressed as a scalar quantity; that is, the number of units on an arbitrary fixed scale with an arbitrary zero. The specific heat in orthodox thermo-dynamics is a quantity—generally varying with temperature—but independent of time and mass. It is in itself neither an extensive nor an intensive magnitude. Since it is the link between temperature as an affirming force and mass as a denying force, it should be possible to represent it, and in this way to bring out the true significance of specific heat as a third kind of magnitude to which we have already applied the term 'coupling'.

We have hitherto considered the first three gradations of composite wholeness—nuclides, atoms, and molecules—in which subsistence appears as a single-valued property expressible as a vector in the dimension of hyparxis. In order to pass to the higher modes, we have to take into account the pattern of subsistence that is made possible by the existence of potential energy fields in the existential tract. For this we have to distinguish between three kinds of magnitudes that, taken together, make possible the phase differences by which a pattern can arise. The magnitudes are those already familiar as extensive, intensive, and coupling energies; but we must see how these can pass from one form into another. All intensive magnitudes are to be represented by a vector in eternity and therefore without reference to the quantity of hyle

present in the given whole. Extensive magnitudes are to be represented by vectors in time; that is, families of skew-parallel vectors sharing a common guide vector that is equated to the inertial mass of the whole concerned. Thanks to the properties of the null-vectors, we find that inertial mass can be converted into free energy, according to the Einstein relationship found in the last chapter. Nevertheless, the essential character of all extensive magnitudes remains unchanged and they can be represented by B-pencils with $(n-2)$ degrees of freedom.

According to the view that we have taken of the relationship between eternity and time, there can be no reconciliation except by way of a coupling force with properties that can be represented by a o-pencil. The properties required are those of sharing in the characteristics of both extensive and intensive magnitudes without fixation of either direction or magnitude. It would seem that this would require a pencil having several degrees of freedom, but non-fixation here does not mean the susceptibility to being fixed, but rather the irrelevance of fixation. The specific heat of a body measures its 'ableness to take up heat'. It cannot be measured except by a change in heat content.

A stationary temperature can be measured; indeed, in principle, 'temperature' has a definite meaning only when there is no flux. The best definition is that temperature is a measure of the potentiality of a body for changes of energy without exchanges of inertial mass. Conversely, inertial mass may be defined as the resistance of a body to adiabatic change; that is, change at constant temperature. Such definitions serve to separate the thermal and dynamical factors, but they take no account of the manner in which a given whole is put together. This is reflected in the specific heat which depends primarily upon the degree of aggregation of the units of hyle and is thus hyparchic in character.

7.18.10. Material Objects

We have taken the study of composite wholeness through its first three stages and, according to the principle of structure, there should be a discontinuity in passing to the four later stages. In the present case this discontinuity is literally and concretely present. A material object differs from a chemical molecule by the fact that it has no continuous blending of recurrences and therefore depends for its endurance upon forces that are of a new kind. Whereas, in principle at any rate, the bonding-energies of even the most complicated chemical molecule can be calculated from knowledge of its constitution; no such calculation can be made for a material object. This is true even for a minute crystal of some pure substance such as a metal or a salt. Every material object has

discontinuities that make it impossible to predict its behaviour from knowledge of the physical and chemical laws alone. For example, the mechanical strength of a crystal is usually hundreds of times less than that calculated from the lattice energies of its constituent molecules. Moreover, every material object has the properties of shape, size, colour, and texture that depend upon the possession of a surface; that is, a boundary separating a solid or liquid phase from a gaseous atmosphere. Very few of the properties that we observe directly in sense-experience could be described in terms of corpuscles, atoms, and molecules, without assuming that the character of material objects is already known.

Notwithstanding the well-marked differences between material objects and chemical molecules, both have the same existential status of quadripotence. All subsist by reason of the relationship of part and whole and all are equally without the power of renewing their own existence. In passing from a molecule to a crystal, we do not ascend to a new level in the scale of being, but we do find a new quality. That quality is expressed in the term 'material object'.

A material object coheres by reason of surface forces that hold its several parts together. One of the simpler examples is that of a single crystal. This consists of a large number of small fragments called crystallites, each of which can be regarded as a large molecule. At the surface of these crystallites free energy is available and the forces produced in this way are called the 'van der Waals forces'. These forces are very weak compared with those that operate on the atomic scale; but being spread over enormously greater areas, they endow the crystal as a whole with considerable strength. It is, indeed, upon the van der Waals forces that the strength and impenetrability of material objects as we know them almost entirely depends.

The picture of a single crystal built up from innumerable units, each of which is a small variation on one basic pattern, is also the picture of a recurrent system. We can look upon the whole crystal as the totality of the recurrences of a given crystallite form. This is the simplest and most elementary manifestation of a material object. The forces that unify the recurrences are in their nature hyparchic. They determine the 'ableness-to-be' of the crystals. They are recurrent and they have components in space—the van der Waals attraction—and in eternity—the potential-energy of the lattice system. The free surface-energy of material objects is intermediate in its character between potential and thermal energy. The status of a material object depends upon the nature of the whole-and-part relationship that it exemplifies; but irrespective of what this may be—and irrespective, moreover of its shape, size, and the material

of which it is made—it subsists by reason of the van der Waals forces acting within its volume. The ubiquity and significance of surface forces is closely connected with the quadripotence of material objects. Surface forces characterize passive endurance. The hyponomic entity is what it is only because it is isolated from what it is not. It cannot, in a living sense, share with its environment. It cannot, in a true sense, either give or take. Quadripotence is the ableness-to-be what one is; but only at the price of isolation from what one is not. Such is the nature of every material object.

7.18.11. The Higher Gradations of Thinghood

The whole-and-part relationship assumes a familiar character only when we can recognize its functional content. We expect a part to have a 'place' in the whole to which it belongs. The simplest examples of this relationship are to be found in natural objects that have become passively adapted to their environment. A pebble on the beach is rounded and polished by the action of winds and waves on the rock from which it was broken. It has a functional wholeness and not merely an isolated coherence. The rounded shape and the smooth surface are partial manifestations of the whole pebble. They are historical characteristics : we can read in them the past and see in them what it means to be a pebble. Nature provides us at every turn with examples of such passively functional quadripotent entities. The fifth gradation of composite wholeness is that which has acquired its own character, thus corresponding to the fifth category of potentiality. This 'own character' is the result of exchanges between the inner and outer world of an entity by which, as it were, it 'settles down' to become itself. It is thus inherent in the fifth type of entity that it arises from the confluence

and mutual impact of two independent processes. Thus a pebble results from the quite independent effects of chemical and tectonic agencies. Wholes of this kind can exist only in so far as the inner and outer processes are in equilibrium. When this is the result of hyponomic laws only, we have the fifth gradation.

The sixth gradation appears when autonomic forces have a part. A tree stump or a lump of coal are the results of living processes in a non-living environment. Here the parts have functional differentiation as we find between the roots, trunk, branches, and leaves of a tree. Upon the hyponomic level there is no difference between a living tree and a dead one. Both appear to us as material objects, but there is a difference between a dead tree and a pebble that consists in the character of the whole-and-part relationship. A human artifact, such as a chair or table,

has a similar functional construction that does not depend on the life-process of the tree from which the timber was derived. We can recognize at this stage how the reconciling factor has begun to gain a pattern of its own. A table is able to be what it is by reason of the 'table-pattern' to which it conforms. This pattern is individuated in the recurrent series of the table itself.

At the seventh and final gradation the thing becomes an instrument. This is the quality of composite wholeness that completes the cycle of hyponomic existence. In its passive aspect all existence is a hyponomic instrument serving for the transfer and transformation of energy. This instrument can also be called the 'universe as a subsisting whole'. In subsistence there is neither cause, nor purpose, nor meaning. Nevertheless, every instrument acquires a meaning when it is brought into relation with any manifestation of the affirming force. A table is an instrument in the service of man; outside the service of man it is merely a thing.

Quadripotence is the full flowering of hyponomic existence. When it is pervaded with life from within, it becomes a living organism. But the body remains and cannot be other than a functional instrument—a composite whole—subsisting passively and depending upon the flow of energy that derives from the mutual action of eternal and temporal forces. When the instrument is directed by consciousness in the service of the will it takes its right place in the universe.

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Part Eight - LIFE Chapter Nineteen THE BASES OF LIFE

8.19.1. Autonomic Existence

In the grand cosmic triad, life is the reconciling power that stands between the active world of creativity and the passive world of mechanism. Life is the support of consciousness and the vehicle of its manifestations. It regulates the universal processes of involution and evolution by submitting itself to both at the point where they meet. Life generates, and is generated by, the fundamental need of the universe to overcome its own contradictions. Neither a transcendent Absolute, serenely indifferent to the inconsistencies of actualized being, nor the armies of inexorable law marching rank on rank could give coherence to the world as it enters our experience. Coherence is life, and life coherence; and, since we men are first of all living beings, the problem of coherence should be our chief cosmic concern. However much our knowledge of the hyponomic world may increase—whatever power it may bestow upon us to predict events and even to control them—it can never tell us what we are nor why we exist. No intuitions of divinity—no inspired visions of the hypernomic world, however needful they may be to free us from absorption in our petty human affairs—can teach us how to live. We cannot hope to exist fully as men, and still less to transcend our human limitations, unless we can first experience the force of life and arrive at some understanding of its nature, as the source of coherence in all experience.

Modern preoccupation with the physical sciences tends to make us forget the extent to which life is involved in all the problems of existence. Things remain passively captive under their own hyponomic laws. The

'cosmic will' may remain aloof and untouched by the hazards and strivings of the worlds it has brought into existence; but life cannot escape from the consequences of creation—it is caught for ever between the upper and the nether millstones of affirmation and denial—but as it is ground to the dust it sets free the energies by which all existence is harmonized and all conflicts are reconciled.

The role of life in the universal drama is both pervasive and decisive. The autonomic world is not subordinate to the other great realms of existence—all three have an equal significance. The autonomic world arises from the clash of the other two, but its arising is not subsequent

either in time or in logic. We might even be inclined to assert that the whole universe exists only so that life might arise and play its role in the cosmic drama, but this would be to ignore the progression of the categories. The meaning and purpose of all existence could only be expressed in categories to which no sense experience can penetrate.* It is sufficient for us that we may hope to understand something of the meaning of our own existence, and for this we must first study the cosmic role of life.

Life throughout the universe is a phenomenon unique in its nature and in its manifestations, but it is not isolated. We cannot hope to situate it rightly unless we recognize that although there is no discontinuity of substance between living and non-living entities, there is always a categoreal distinction of natures. The hyponomic world can be studied adequately in terms of the first four categories of wholeness, polarity, relatedness, and subsistence. Any adequate description of life, however, requires further categories. A living organism is made of the same chemical elements as the rocks and the oceans, but its organization cannot be spoken of in the same terms.

The step that is made in passing over the threshold of life is something more than the attainment of a fifth quality of potentiality. It is the entry into a new cycle of existence, which completes itself in the four gradations of potency from the fifth to the eighth—that is, potentiality, repetition, structure, and individuality. These may appear to us to be pre-eminently biological categories, but they are encountered in all experience, and they are certainly not confined to the autonomic world. Life exemplifies but does not exhaust them, nor do they alone suffice for biological description. In our study of life we cannot dispense with the categories of the hyponomic world, nor must we forget that the higher categories of the hypernomic world are always applicable. In treating life as subject to the four autonomic categories, we are applying in a grand manner the principle of legitimate abstraction; but we must not forget that life cannot be understood except as participating in the nature of the cosmic forces that it exists to reconcile. Life is both an affirmation and a denial. It is both independent and dependent, and yet it is something more than either. This something more is that which we express in the term autonomic, which means self-regulating. When looked at from the standpoint of physical existence, self-regulation appears to be either a mere descriptive convention or a mystery. Conversely, for the believer in divine predestination, self-regulation must

[* We shall embark in Vol. II upon a further discussion of the supra-sensible categories.]

appear to be either a fiction or a delegated power. The conception of the authentic autonomy of life has no meaning if we seek to build it up from knowledge of the physical world or to derive it from the attributes of divinity. We have, moreover, become so accustomed to evolutionary notions that we tend almost inevitably to regard life as emerging from non-life. We think of it, moreover, in historical terms, as if it were a stage in the development of matter rather than an independent cosmic phenomenon.

The difficulty of our task is increased beyond measure by the very limited acquaintance with life that we men on the earth can have in the absence of communication with other planets. To ascribe to life the role of cosmic reconciliation means that we regard it as omnipresent and all-pervasive—analogueous in this respect to the electrical forces that pervade and hold together every material object.

The distinctive character of life cannot be defined in terms of a duality of substance in the Cartesian manner.

It is not to be found either in any peculiarities of form or of function. A dead body has the same form as a living one and there is no function of a living organism that cannot be simulated at least to some degree by a physical mechanism. The evidence of cybernetic devices by which machines can renew their own existence and adapt themselves to their environment may be inconclusive, but it is unnecessary to invoke it, for there is a direct and conclusive proof in the fact that all the known functions of life depend upon the same physico-chemical mechanisms as operate in the hyponomic world. Nutrition, reproduction, self-preservation, and self-regulation can all be traced to chemical and electrical agencies indistinguishable from those that maintain the existence of inanimate objects.

It is necessary thus to emphasize to the full the arguments against according a distinctive character to life. It is, for example, well known that no rigorous definition of life can be given, and that biologists are forced to rely upon description rather than definition in order to fix the limits of their science. This is, however, no argument against the autonomic character of life, for we have seen that the subject-matter of each scientific discipline is fixed by an existential postulate rather than by a functional definition.

The characteristics by which we recognize life are not functional, but can be expressed rather by such being-words as 'sensitivity', 'responsiveness', 'adaptability', 'selectivity', all of which refer to some hidden condition that makes possible the observed functions of self-renewal, reproduction, self-regulation, and self-direction.

Living wholes, whatever may be their degree of organization, link

the determining-conditions in a manner, and to an extent, that can never be observed in the hyponomic world. This is seen in what E. S. Russell has called the 'directiveness' of organic activity, that expresses the unmistakable fact that every living whole behaves as if it were striving to attain a goal. The categories of cause and purpose are so inappropriate to the discussion of the basic characters of life that persistence in retaining them has been at the root of most of the confusion that has surrounded and still surrounds the subject.

We import into the problem of life an unnecessary mystery or mystification by asking questions that have no meaning. We should not be astonished that we find no answer, and we shall be wise if, before undertaking the detailed study of life in its various gradations, we re-examine the four categories that correspond to the four gradations of potency that distinguish living wholes.

8.19.2. Sensitivity

The problem of sensitivity has always created difficulties for a one-stuff theory of existence. These difficulties were recognized by the Greek Atomists such as Leukippos and Demokritos. It is not resolved by mind-stuff theories. We have sufficiently discussed the objections to theories which pretend to explain all the complexities of nature in terms of properties inherent in the primordial stuff. We have to recognize rather that the complexity of the world results from the interaction of the opposing forces of involution and evolution, and therefore must reach its greatest intensity at the midpoint of the scale. It is here that we find life, and it is here also that sensitivity is most significant.

The concept of sensitivity is indispensable for the study of life. It is, moreover, a concept that derives from our immediate experience, since all sensation presupposes a sensitive condition. Moreover, all our observations of life must convince us that every living whole is sensitive both to its environment and to its own inner state.

In the hyponomic world we have distinguished three states of matter —the actual, the potential, and the coupled. In the hydrogen molecule, two electrons exist in a state in which the two corpuscles are partially shared by each of the protons. This cannot mean that there is an actual transfer of energy from one proton to

the other, since they remain identical. We should rather say that each proton becomes sensitive to the presence of the other through the coupling of recurrences.

Wherever it arises and whatever form it may take, sensitivity is an expression of the will acting through the determining-condition of hyparxis. There is no sensitivity either in the actual or the potential

states of matter, but only in the third or reconciling state. Since the condition of hyparxis is imposed on all existence, it follows that everything that exists must also have its measure of sensitivity, but there is a qualitative difference between sensitivity with and without organization. The sensitivity of the protons in a molecule of hydrogen is a single-valued property that gives only the possibility of oscillation about the most probable or normal state. The sensitivity of a living whole is organized. It also gives the possibility of oscillation about a most probable or normal state but the state itself can be adjusted to the environment. It is this power of adjustment that distinguishes the autonomic from the hyponomic world.

Without further discussion, we can formulate as the first law of biology:

Organic sensitivity is the first necessary condition of the arising and existence of life.

Referring to the progression of the categories, we recall that sensitivity as a gradation of potentiality falls into the fifth category of thought. This category is applicable to all experience. It is specific to life only when it is combined with the concept of organization.

8.19.3. Rhythm

The sixth category of repetition expresses itself in life in the form of rhythms not only of time, but also of size and shape. Every organism has its own specific maximum duration of life, its characteristic rhythms of activity and repose, and periodic energy exchanges, both internal and external. In addition, everything that lives has its own size, which may differ in a radical manner from that of the hyponomic entities. For example, there is no fixed size of a crystal, no length of time set to the existence of a stone or piece of wood. The living organism, however, is specifically determined in respect of its form, size, temporal duration, and regulative rhythms. Not only does repetition apply to the existence of each living whole, but it is also characteristic of the vital properties of development and reproduction. In development, cells proliferate, repeating themselves in space and in time. The pervasive character of rhythmicity in life requires no further elaboration, and we can formulate as our second biological law:

Rhythm is the second condition of life.

8.19.4. Pattern

In order to gain some understanding of the pattern of life, we must again refer to the determining-condition of eternity. In its eternal aspect all existence is a pattern of potentialities and, in this respect, there is no difference between the hyponomic and autonomic worlds. The distinction lies in the flexibility of the pattern itself: in non-living things the pattern is non-adaptive. A composite whole has no eternal differentiations. Everything that lives, however, has a potential energy gradient in eternity, and through this the different levels exert a mutual influence upon each other, without which there could be no life. The possibility of such an influence is clearly inherent in any existing whole, but in the hyponomic world it is observed only in the action of one entity upon another on the same level. In what, then, does the mutual influence of different layers in eternity consist?

It is here that we encounter the special significance of the seventh category of structure for the study of life. Although, as with every other category, structure is universal and can be found in the non-living as well as the living, there is a peculiar significance of structure for the arising and maintaining of life.

We regard the dimension of eternity as associated with the positive or affirming force, and it follows that the higher the level of eternity the greater the affirmation. Between two levels a higher will be affirming in relation to the lower, which will, therefore, assume the denying role. This can be expressed by saying that the lower affirmation stands in opposition to the higher. Every affirmation demands a corresponding response; that is to say, it exerts an organizing influence upon the passive material that it encounters. Conversely, the lower level exerts a disorganizing influence that opposes, or even breaks down, the organizing effect. Where there are, in any given whole, two different gradations of intensity of inner-togetherness, the lower intensity tends to absorb and diminish the greater, while conversely the greater intensity tends to take possession of and dominate the lower.

The mutuality of different levels in eternity thus consists in an interplay of organization and disorganization, and this we find exemplified throughout all our experience but especially in the processes of life.

The reconciliation of organization and disorganization is regulation. The pattern of life thus consists in the regulation of opposing forces. The affirmation is the pattern of potentialities that stands at the highest level of inner-togetherness of which the given whole is capable. The denial enters through the temporal actualization that corresponds to the level

at which the organism is wholly exposed to its environment. The regulation takes place at the intermediate level, and depends upon the organic sensitivity of the given whole. The outcome of these observations can be expressed as follows:

The third condition of life is a pattern of potentialities that is the source of organic stability.

It is interesting to compare this thesis with that of Dr. Maurice Vernet, who bases his interpretation of the living world on a characteristic pattern of organic sensibility, which is common to all the members of a species and linked to the particular organism by means of a sensitive regulating mechanism.*

It is very important to note the supra-individual character we have ascribed to the eternal pattern of life. The word 'man' is used to designate a group of wholes in which we recognize not so much similarities of function as a pattern that is both infinitely flexible and yet most exactly defined. The genetic constitution of any particular man is a manifestation of the eternal pattern, but it determines only what he might be and not what at any given moment he is. It is therefore in a true sense a pattern of potentialities, and at the same time an affirmation that the man himself cannot make. What is true of mankind is true of every other living species, and even of the lower forms of life which appear to have no specific sensitivity of their own.

8.19.5. Individualization

The fourth and highest manifestation of life is octopotent individuality. In it we see the characteristic manifestation of the eighth category. The transition from structure to individuality is both a step forward in the scale of existence and a return to the starting point, namely wholeness or unity. The individual is beyond structure and at the same time he is a true whole. We have seen that in the hyponomic world progressive individuation is found at each stage as we pass from the undifferentiated hyle to the corpuscular state, from corpuscles to particles, and from particles to the different gradations of composite wholeness. With the entry of life there is a new step that can be expressed in the difference of meaning between the words 'individuation' and 'individualization'.

A true individual is an autonomic entity that can direct the course of

[* Dr. Vernet's theories have been developed during the last seven years in a series of books to which reference should be made. They include: *Le Probleme de la Vie* (Paris, 1948); *Heredité* (Paris, 1949); *La Sensibilite Organique* (Paris, 1949); *L'Evolution du Monde Vivant* (Paris, 1950); *La Vie et la Mort* (Paris,

1952); *L'Ame et la Vie* (Paris, 1954).]

its own history. Where this power is organized we can speak of a 'self-directing entity'. Just as in the hyponomic world thinghood is the completed manifestation of passive existence, so is individuality the completed manifestation of reconciling existence. Up to the stage of thinghood there is no subsistence: corpuscles and particles exist only by virtue of their relationships. Similarly, in the world of life it is only a conscious self-determined being that can properly be called an individual. Nevertheless, the category of individuality is needed for all our thoughts about life. We cannot hope to understand even the simplest and most primitive manifestations of autonomic existence unless we remember that they belong to a cycle that completes itself with conscious individuality. We have thus as the fourth and highest condition of life:

All life is an essay of individualization.

8.19.6. The Threshold of Life

The four existential hypotheses applicable to life can be regarded as stages in the emergence of individuality. When, however, we try to envisage existence as a completed structure, we must look not only for the stages but also for the transitions by which one passes into the other. Between the physical and the biological worlds, there is a transition governed by what we have called the hypothesis of active surface. Between life and the supra-animate world, there is a transition that we have called the hypothesis of the individuality of the biosphere. All that we can know about life is comprised within the four stages and the two transitions that connect them with the worlds below and above. The six taken together form a complete cycle exemplifying the category of repetition.*

Among the functional characteristics of life, we find specificity, flexibility, and stability, but none of these taken alone is sufficient to characterize life itself. The atomic nuclides, for example, are highly specific, and the molecules of chemistry can be classified with even greater precision than the organic species. On the other hand, the

[* We may compare this conception with that of J. E. R. McDonagh, who advances the idea of a fundamental principle—that he calls 'activity'—rising in an ascending spiral comprising six cycles. McDonagh's first three cycles are constituted by the physical stages of sub-atomic, atomic, and crystalline matter respectively. The remaining three organic stages pass through the colloids, the vegetable and animal products. McDonagh also recognizes the triadic character of the living organism in his reference to three fundamental activities that he calls radiation, storage, and attraction, though he does not anywhere demonstrate that the mutually adjusted interaction of the different levels is characteristic of the living organism. Cf. McDonagh, *The Nature of Disease up to Date*.]

random molecular movement of gas is found to be highly flexible. The particles, many of the nuclides, and the chemical molecules can exhibit an extraordinary stability. We could, in a similar manner, produce evidence that a parallel to every characteristic of life is to be found in the physical world. It is in the combination of the various characteristics, or more exactly their togetherness, that the unmistakable character of the living whole is to be discerned. In order to ascertain the presence of life we must look for a pattern of sensitivity. It is this pattern that constitutes the individual as distinct from the mere member of a species. The individual is a self-regulating whole—a unit within the total process of reciprocal maintenance. Thus all individualization requires, on the one hand, a well-defined boundary within which independence can be established and, on the other, a sufficient elaboration of structure to enable a balance of functions to be maintained—two conditions that we find exemplified in the transition region where active surfaces and organic complexes begin to make their appearance.

Sensitivity requires a combination of unity and diversity such as we find markedly characterized in the retina of the eye, where millions of cells of a very specific constitution and construction act in a combined manner

to receive impressions that lead to visual images in the brain.

This mode of combining many minute forces to produce a complex but integrated whole is found in its most primitive manifestation in the action of the surface forces that exist already in the hyponomic world in every composite whole above the molecular level. In the colloidal state the surface forces acquire an intensity that is far greater than in crystalline bodies, and they are the precursors of sensitivity. The colloids therefore provide the conditions of life. We find in the proteins the necessary variety and specificity to carry the complex patterns of life. In the nucleic acids there is the combination of high surface energy and specificity of pattern, together with the power of repetition and self-renewal, but these lack the property of self-regulation. We thus see that we have before us the raw materials out of which life is built; before we embark upon a study of the building process we must seek to understand better what constitutes the threshold between the hyponomic and the autonomic worlds.

8.19.7. The Colloidal State

The higher gradations of composite wholeness are characterized by enclosure within a surface. This means that at least two distinct phases or states of aggregation of the hyle are present, constituting respectively the whole and its atmosphere.

Generally, between the solid surface and the ambient gas there is a third condition in the form of a layer resembling the gas in composition, but the solid in form. It is intermediate between the two, in that it is more dense than the atmosphere and less dense than the solid. This layer exists at the surface of the ordinary material objects of our common experience, but it has no great importance. Whenever the surface area becomes very large in comparison with the mass—as is the case with very finely divided solids or liquids—the surface forces operating at the boundary between the phases begin to play a dominating part in the behaviour of the system. All systems having this characteristic are said to be in the colloidal state. The concentration of free energy at a colloidal surface presents many analogies to the properties of spin on the atomic scale. The active surface is possible because of a coupling of recurrences through the possession of a common space component of the null-vectors. There are constant transformations of energy taking place at the surface of every colloid and yet an equilibrium is maintained that has at least a rudimentary form of self-regulation. We find thus a property commonly associated with life and, moreover, we can see in the high surface energy the precursor of organic sensitivity. The layers of ionized atoms held upon the internal surface of a colloidal aggregate are a super-active state of hyle. We cannot readily picture the intensity of the energy exchanges that are taking place at the surface, because nothing that can be seen under the most powerful microscope in any way corresponds to it. Even the electron microscope can show only an arrangement of large groups and not the transformations of energy and the mobility of atoms and molecules at the surface.

The physico-chemical changes occurring at the colloidal interface are not in themselves sufficient to provide the conditions of self-regulation. This depends, as we have seen, upon hyparchic regulation through which the mutual influences of organization and dis-organization can have their effect. Nevertheless, it is only in the colloid that the regulation is possible, because the hyle in its hyponomic states lacks the stability and the capacity for response that are required. Even in colloidal systems which are quite unconnected with life, we can observe behaviour-patterns that are something more than the sum of the physical and chemical processes on the molecular scale. There is a wholeness in a colloidal system that is unmistakably of a higher gradation than that which we find in ordinary solids and liquids. This wholeness arises from the reconciling influence of the surface energy between the disperse phase and the medium. It is this that gives the system a sensitivity quite unlike that of, say, a crystal. In the phenomena of thixotropy and

rheopexy—that is, the appearance and disappearance of rigidity and thickening when certain types of colloid are pressed or shaken—bulk changes of behaviour occur as a result of a relatively small external stimulus. Such effects are unmistakably precursors of the sensitivity that makes life possible.

The significance of the hypothesis of active surface will now be apparent. A surface is active when it separates two media at a different level of potential energy. In the ordinary systems of the hyponomic world, exchanges of hyle sooner or later redistribute the energy in such a way that the potential gradient disappears. An active surface is one that can maintain a potential energy difference thanks to the existence of a compensating layer between the two phases. The compensation cannot be maintained for an indefinite period unless there is some form of self-renewal. We can recognize here an analogy with the regenerative ratio of the physical world. We saw how for an entity to maintain itself indefinitely, its existential must make a fixed angle with the direction of time, and that this requires the presence of an uncompensated electric charge.

Similarly, with an active surface there is a balance between the free energy and the potential energy that ensures stability. By this means the atoms adsorbed on the colloidal surface become highly responsive to the coupling forces of the inorganic world. The laws that govern the interactions in a two-dimensional region are quite different from those that apply to bulk solids and liquids. There is, on the one hand, a severe limitation of possibilities owing to the reduced degree of freedom, but on the other there is an enormously increased stability that enables very complex combinations to be built up. A colloidal surface provides the stage upon which life can arise, but it is not a sufficient condition for its arising.

8.19.8. The Significance of Protein

The composite wholes of our common experience are nearly all built from very simple units: stone, brick, wood, paper, cloth, and the other materials of which common objects are made, are formed by the repetition of very large numbers of quite simple chemical substances. So far as we know the chemical constitution of the earth itself, we are fairly confident that the molecular species of its inner, no less than its outer, layers are relatively few and relatively simple. All living bodies provide a striking exception to this rule, for into everything that lives there enter proteins and nucleic acids, the chemical constitution of which is immensely complex. Unlike most inorganic compounds which contain

only three or four different elements, proteins may contain almost all of the known elements. Not only are carbon, nitrogen, oxygen, and hydrogen invariably present, but there are also diverse forms of iron, phosphorus, magnesium, sodium, silicon, sulphur, calcium, chlorine, iodine, lithium, and bromine. Proteins, as they exist in the living organism, cannot be studied chemically. We can know only degradation products—such as the polypeptides—that are very complicated, but are, nevertheless, several stages removed from the full complexity of protein as it exists in the living tissue.

The totality of substances known as protein has an inherent variability that, upon the scale of terrestrial phenomena, is literally inexhaustible. Thanks to their variability the proteins can serve as the 'pattern-carriers' for all the innumerable organic species of protista, plants, and animals. It is necessary to emphasize the extent of this variability. Protein is so complex that although many millions of distinct protein structures are present in living organisms, these constitute an almost vanishingly small proportion of the total number of proteins that are chemically possible. Even so simple a protein as one made up of twenty amino-acids—each acid occurring only once—would give about 2,400,000,000,000,000,000 different compounds, each containing the same amino-acids, in identical proportions, and differing only in their space relationships.*

One simple consideration must convince us, however, that the significance of protein is not confined to its chemical reactions. Every one of the multitude of species that exist in organic life on the earth has its own characteristic set of proteins. Where species have existed for millions of years, these proteins have reproduced themselves unchanged for countless generations. The eternal character of the protein structure could scarcely receive stronger confirmation. Indeed, this point so impressed Gortner that, when writing on protein isomerism, and, using italics, he declared:

"Perhaps no more striking illustration of the exactness with which vital reactions are regulated in the living protoplasm can be given than the fact that, through untold generations, a given organism reproduces the same structural configurations in the proteins that characterize that organism. The fact that each species has a different set of proteins is not the surprising thing. The surprising thing is that Nature is able to control the synthesis of proteins within a single species, so that the same proteins are synthesized by all the members of the species."+

[* Cf. R. A. Gortner, *Outlines of Bio-Chemistry* (1938), p. 446. + Cf. Gortner, *loc. cit.*, p. 447.]

To understand the full significance of the hyparchic sensitivity of protein, we have to consider the improbability—from the standpoint of chemical thermo-dynamics—that the combination of elements present in a given protein molecule should ever appear twice. The arising of the simplest protein depends upon a series of chemical reactions that it has not been possible to reproduce fully in the biochemical laboratory. Nevertheless, wherever there is life these highly improbable reactions not only occur, but conform invariably to an exactly regulated pattern that is the same for each species and even each

genotype.

"The peculiar thing about the chemistry of living matter is not that the reactions that are characteristic in it are novel, but that in the rough and tumble of ordinary liquid systems their occurrence is almost infinitely improbable. Where there is life, circumstances exist which make them the rule. . . . Forces which determine the relative position of adjacent protein molecules and so affect their behaviour are something to which there is no analogy in the growth of crystals in a saturation

structure."*

We are now confronted with two remarkable facts. The first is the specific development of individual living wholes, and the second is the specific constitution of the proteins. The facts impose certain limitations upon the origin of life, on the one hand, and the manner in which individual organisms arise and develop, on the other. We can readily see that the facts cannot be studied satisfactorily in terms of the categories of cause and effect, or of purpose and its realization. Moreover, life is neither accidental nor determined, and yet we cannot detect on the simplest levels any sign of conscious direction either from within or from without. Vitalism and mechanism are equally inappropriate. All the old categories of explanation break down, and unless this is recognized we cannot make a fresh start.

If we turn from the old categories, however, to those of sensitivity, repetition, structure, and individuality, and accept these as ultimate and not subject to further analysis, we appear to have begged the question and thrown the whole burden of explanation upon the unexplained categories that we invoke. This reproach might be justified were it not for the method of progressive approximation that has brought us to the threshold of life with some understanding of the first four categories of wholeness, polarity, relatedness, and subsistence. The second tetrad is supported by the first, and although its categories are ultimate, they are not arbitrary. The concept of pattern can be described in terms of the

[* Cf. J. B. Leathes, 'Function and Design', *Science* (1926), Vol. 64, p. 387.]

first four categories, and it is the pattern that makes life possible. The origin of life as the result of accidental combinations of the elements even under the influence of high-intensity radiation is unthinkably improbable, and yet such combinations must have taken place and only the concept of a pattern in eternity can reconcile the improbabilities.

Recent researches into the constitution of proteins tend to confirm the view that they arise and can exist in nature because they exemplify the pattern of sensitivity, repetition, and structure. There is much evidence

that the protein molecule has a spiral structure that is the observable counterpart of a linkage of recurrent elements in hyparxis. The pairs of hydrogen atoms that hold together the opposing groups in the structure of protein are in the same sensitive state as the pair of atoms in the molecule of hydrogen. There is, however, the capital difference that the sensitivity of the hydrogen field in the proteins has a pattern and structure of its own, and this makes possible the whole complex organization of life.

We must observe that when proteins are synthesized in an appropriate medium, the building materials are relatively simple amino-acids and other organic complexes, all of which must be guided into an exactly defined position and orientation, for both these are required to give the molecule its own specific character. We may conceive an organizing pattern in eternity, but its influence upon the ordering process in time depends upon a flexible coupling of a kind that can occur only in the sensitive state of hyle in hyparxis.

We have further to remember that the solitary protein molecule by itself is not alive, nor is it capable of living. The proteins come to life in the mass colloidal state where powerful potential energy gradients are present. Whenever we wish to isolate the proteins or experiment upon them, we have inevitably to destroy this potential energy gradient, and that which remains is no longer the material of life.

8.19.9. The Enzymes

Neither cause nor purpose but regulation is the characteristic of life. Even in its simplest manifestations we find regulators. Some of these are already known in the form of enzymes and other biologically active substances. These when isolated from living tissue are sometimes simple and inert. This suggests that they belong to the reconciling factor that can operate only in the sensitive state. The enzymes can be referred to as regulators of specific transformations that occur normally within living cells. Sometimes, however, the transformations can be conducted in an artificial medium. There is much evidence that enzymes are the carriers

of the third or reconciling force in the triad of life. They are not themselves altered by the reactions which they regulate, and in this respect are similar to the catalysts that perform the corresponding function in inorganic reactions.

The clearest evidence that the enzymes are carriers of the reconciling force and not an affirmative or organizing influence can be seen in the fact that they cannot bring about reactions that would not occur equally in their absence. They are not the initiators of transformation, but the accelerators and regulators. Moreover, enzyme action is generally highly specific. For example, there are many processes that depend upon the addition of water to a complex molecule with a subsequent splitting into two simpler components. This is called hydrolysis, and many hydrolytic reactions in living tissue would proceed far too slowly for the maintaining of life if it were not for the accelerating power of enzymes produced within the tissue where the reaction is required. It might be expected that one enzyme would accelerate a variety of hydrolytic reactions, but on the contrary almost every process requires a specific regulator. Enzymes are therefore classified according to the substance—called the substrate—whose transformation they regulate. Urease, for example, acts upon urea and upon no other nitrogenous substance. Nuclease acts on nucleic acid that is itself connected with the regulation of protein transformations, but it does not act upon other protein constitutions.

Although enzymes form an integral and necessary part of the structure of life, they themselves belong to the transitional region. Proteins enter the constitution of all enzymes, but the true active constituents are nucleic acids of which two main forms are known—the ribonucleic acids and the deoxy-ribonucleic acids. These are differently distributed in plants and animals and in the various enzymes and viruses by which their existence is supported and destroyed. The nucleic acids are built up from a specific form of sugar, dextro-ribose, but their structure seems to be nearly as complicated and capable of as wide variations as that of the proteins. However, the most important of the properties of the nucleic acids is their power of repetition. There seems to be little doubt that some nucleic acids are autocatalytic; that is to say, they can bring about the formation of

substances identical with themselves, providing that suitable raw material is available. Not only can the deoxy-ribonucleic acids reproduce themselves, but they can also bring about the formation of protein molecules. It has been suggested by Gamow that there is a one-to-one correspondence between nucleic acids and proteins.*

Gamow points out that all the complex structures of a chromosomal [* G. Gamow, *Nature* (1954), Vol. 173, p. 318.]

fibre are formed from only four different kinds of nucleotides, namely adenine, thymine, guanine, and cytosine. He shows that there are twenty combinations that can arise, and that these can in turn be associated with the twenty different amino-acids essential for living organisms. There is reason to suppose that the nucleic acids are the visible manifestation of the hyparchic regulators by which reproduction, development, nutrition, and the other processes of life are regulated in all species. This does not mean, however, that life is thereby reduced to chemistry. The nucleic acids are not composite wholes of an ordinary kind. They can only arise under the influence of the pattern which they themselves transmit. The transmission in turn depends upon the sensitive state that is achieved through the sharing of corpuscles. Todd refers to the deoxy-ribonucleic acids* as existing in the form of two opposed helical polynucleotide chains, wound together in a double helix, and held together by a specific hydrogen bonding between the purine and pyrimidine bases occurring only in each nucleotide residue. This picture is strongly reminiscent of recurrences and confirms the view that the hyle in the sensitive state is generated under these conditions. Further confirmation has been brought by numerous experiments on the effect of radiation upon enzymes, viruses, and the associated proteins and nucleic acids. It is found, for example, that chemical changes in the nucleic acids are brought about by radiation intensities hundreds of times less than those required for similar changes in a quadrivalent inorganic system. We thus are led to associate the sensitivity of the proteins and nucleic acids with quinquivalence and to seek in this a key to understanding the manner in which the transition is made from non-living to living forms.

[* Sir Alexander Todd, Address to Section B Chemistry of the British Association, 1955. See also N. Arlay, *Nature* (1955), Vol. 176, p. 466, for a discussion of the reproductive role of deoxy-nucleic acids.]

Chapter Twenty LIVING BEINGS

8.20.1. The Triad of Life

Every living whole exists under two opposing influences—the force of life and the force of death. Claude Bernard expressed his intuition of this truth when he wrote: *vivre c'est mourir*. Such a formulation disguises the true nature of life as being the factor that reconciles the two opposing forces. So long as the triadic character of life is disregarded, dualism is inescapable. Whether it be that of cause and purpose, mechanism and vitalism, or matter and spirit, the dualisms are all sterile. We see life held in the grip of physico-chemical laws. We see its entire dependence upon material transformations, and we contrast this with the equally unmistakable directiveness of organic activity, the sense of purpose—of goal-seeking—that manifests in everything that lives. Every attempt to find a middle way in which the antithesis disappears leads only to some compromise that will not withstand critical examination. We must have the courage to look upon life not as a compromise nor as an accident to be explained away, but as a cosmic force that is fully equal to the task laid upon it of maintaining its autonomic existence between the cosmic affirmation and the cosmic denial and, by maintaining itself, of reconciling the two.

To fulfil this task, life itself must exemplify the cosmic triad. In this sense, all life is the microcosm in which the universal drama reproduces itself and from which it is transferred to each planetary manifestation; from the biosphere to the species, from the species to the separate organisms; from the separate organisms to the intimate moments of transformation where life and death meet in the pattern of self-renewal and self-regulation.

As a cosmic force, life, wherever in the universe it may be manifested, is one and indivisible and its basic laws must everywhere be the same. Everything that lives must stand between the eternal pattern towards which it is drawn and the temporal actualization through which it must pass. Its existence is an unceasing adjustment of the opposing demands. Whatever form life may take, the adjustment depends upon the power of organic sensitivity. In all existence hyle combines, transforms, dissociates, and re-combines in the three states of potentiality, actuality,

and sensitivity. The first state is pre-eminently that of the hypernomic mode, the second of the hyponomic or material universe. The sensitive state is characteristic of life. Nevertheless, all three states enter every existing whole from the corpuscles to the galaxies, and if we were to define life as sensitivity, we should be obliged to ascribe vitality to everything that exists. Since, however, the potential or creative state is also omnipresent, we should be led into the pantheistic utterance that everything that exists is divine. Equally valid, and equally defective and misleading, would be the statement that because everything that exists is actualized, all is material and every whole is a mechanism. We should therefore hold firmly to the specific character of life as existence under the autonomic mode, and define its triad as the affirmation of an eternal pattern, the denial that arises from actualization in an alien environment, and the reconciliation that comes from a sensitive hyparchic regulator. Our study of living beings will help us to make these conceptions clear.

The threshold of life is crossed when sensitivity is organized. In the hyponomic world sensitivity is monomorphous; that is to say, having a fixed form for each entity and therefore incapable of adaptation. Monomorphic sensitivity is manifested in the phenomena of interaction and coupling. Approaching the threshold of life we find in the colloidal state, and also in the proteins and nucleic acids, the raw material of organized sensitivity. Nevertheless, the polymorphic organization itself cannot arise except in the presence of a pattern.

Organic sensitivity is life itself, and the gradations of life are distinguished by the ableness-to-be formed in and through the organic sensitivity. Life has one visible part—body—and two invisible parts—the eternal pattern and the hyparchic regulator. Every existing whole has a threefold inner world in time, eternity, and hyparxis, but the sensitive organization of the three worlds is peculiar to life. We can see the organization of the body, but we do not see the organization of the eternal pattern, nor that of the hyparchic regulator. We can only infer their nature by a close study of the four gradations of autonomic existence.

8.20.2. Quinquopotence—Viruses

The first gradation of life is represented by minute entities that differ little in size and chemical constitution from the protein and nucleic acid complexes that show no signs of life. The most studied of these forms are the viruses and bacteriophages. We may therefore use the term viral to characterize this level of existence. The virus is the living analogue of the corpuscle. It is an incomplete autonomic entity in so far as it is incapable of independent existence, but requires an environment able to

furnish the necessary materials for its autosynthesis. Moreover, it lacks true individualization that to a greater or less degree is found in every living organism. It was long ago discovered that some vegetable viruses can undergo reversible transitions between living and non-living states. When crystallized, such viruses have the appearance and properties of a physical complex entirely passive towards their environment, and it is only when they are restored to the state of a colloidal dispersion in the fluids of a plant cell that they acquire the properties and behaviour of living tissue. Moreover, the plant cell will only serve as host if its proteins and nucleic acids exactly correspond to the requirements of the particular virus.

Vegetable viruses, such as the tobacco mosaic virus, are built up from the molecules of specific deoxy-ribonucleic acids, whereas animal viruses, such as those responsible for smallpox, are ribonucleic acid complexes. The nucleic acids form twin spirals, the constructional units of which are purines and pyrimidines. We have already referred to the significance of the spiral arrangement of the protein and nucleic acid

complexes as being evidence that they are dominated by an hyparchic coupling of recurrences rather than by a potential energy pattern. It is noteworthy that the virus molecule determines three directions in space, namely the axis of the spiral, the normal to the surface, and the angle of pitch. The three directions in space correspond to the internal vectors, namely the existential or line of stability; the potential energy gradient—that is, the axis of the eternal pattern; and the direction of recurrence.

The virus maintains its cohesion through hydrogen couplings that are unlike those of quadripotent entities in that they form a continuous field of sensitivity. Through the action of this field, the nucleic acid has the power to catalyse its own synthesis, but only in a medium containing protein degradation products of the appropriate constitution. Such synthesis goes against all probability and we could not conceive that it could occur accidentally without the presence of an organizing factor. Since the organic sensitivity depends upon the presence of the nucleic acid complexes, we cannot invoke it as the source of the pattern. We are compelled to postulate an eternal component that is the primary organizer. The virus is a triad in which an eternal pattern remains unchanged. The pattern cannot act directly upon the material present in the ambient fluid, but can bring about the renewal of a particular virus through the mediation of the hyparchic coupling that is sensitive both to the pattern itself and to the external situation.

Quinquepotence is not complete autonomic existence. It is an incomplete form, in which the living substance exists only in the body of a

host that provides both the raw materials and also the conditions of life. There are other active substances such as the bacteriophages that exist in the sap of plants and the blood of animals, the action of which depends upon a pattern that is part of the overall pattern of the host. Their vital process is completely subordinate to that of the host. The same applies to the enzymes that catalyze and regulate nearly all the chemical transformations required for life. The enzymes are, within the quinquepotent range, the degenerate form of hyparchic regulator that is not itself a living material. We have thus a series somewhat analogous to those which we found among corpuscles and particles.

(i) Precursors. Nucleic acids and proteins. (ii) Degenerate forms. Enzymes, vitamins, and hormones. (iii) Primary forms. Crystallizable viruses. (iv) Transitional forms. Cell-forming viruses and bacteriophages.

Table 20.1. The Gradations of Quinquepotence

These examples enable us to formulate the chief characteristic of a quinquepotent entity. This can be referred to as dimorphic sensitivity, to express the fact that the capacity for response is limited strictly to a specific eternal pattern and by an equally specific environment. The form of the eternal pattern and the form of the environment have only a very narrow range of variation within which the particular virus or other quinquepotent entity is able to maintain and renew its own existence.

The unit structure of the viruses is immensely complex even compared with the proteins. The tobacco mosaic virus, for example, has been assigned a molecular weight of 50,000,000.* It contains some 60,000 protein groups, of which a quarter are basic and three-quarters are nucleic acids derived from deoxy-ribose. Within the virus itself there is a regulated structure that has a degree of freedom that no chemical molecule, however complex, could achieve. Between the acid and basic groupings, some ten or twelve thousand groups of nucleic acids serve to regulate and maintain the self-renewing activity of the virus. Notwithstanding its extreme complexity on the molecular scale, the system, viewed from the standpoint of the life process, constitutes a simple field of force that has no potency for relatedness. The force field differs existentially from those of the physical world in so far as it is self-

[* Cf. R. C. Williams, R. C. Backus, and R. L. Steers, *Journal American Chemical Society* (1951), Vol. 73, p. 202.]

renewing; but its dimorphic pattern is strictly analogous to the electrostatic field of a charged body. It can act only upon entities that are similarly charged. We have here the simplest manifestation of vital forces that are quinquopotent and hence carry the property of subsistence that the electrical and gravitational forces lack.

The nature of the vital force field of the viruses is well demonstrated by the action of ionizing radiation.* It has been shown that, when subjected to ionizing radiation, the energy liberated travels through the virus structure in such a manner as to break down the connections upon which the functional activity depends.+ Here we have evidence of the character of the sensitive regulator. It must depend upon a resonant amplification of the molecular sensitivities that can withstand only a limited increase of potential energy without disruption. The viruses are peculiarly sensitive to radiation. Nucleic acids, for example, absorb ultra-violet light very strongly in the region of 2,600 Å. As little as one part in a million million of nucleic acid can be detected in an ultraviolet microscope. Again, structural changes in the virus can be brought about by very small doses of radiation that leave ordinary substances quite unaffected.

It is only in the present century that biologists have come to recognize the immense importance of viral existence. When we take into consideration the extreme difficulty of studying a minute living complex—of which a million million would not occupy the volume of a pin's head—we may reasonably suppose that we have so far discovered only a very small fraction of the totality of quinquopotent entities that occupy the ground-floor of the edifice of life. Evidence is steadily mounting that all life is regulated through the agency of quinquopotent entities within the viral range. We are coming to understand more and more of the role of the biologically active substances such as hormones and vitamins. When these are isolated from the living organism, they are often found to have a relatively simple chemical constitution. When, however, they are present in the blood of an animal or the sap of a plant that corresponds to their own pattern, they are built with specific proteins, and also a variety of carbohydrates and fats, into complexes that are living entities. The complex itself forms a colloidal dispersion, and it is only the living complex as a whole that constitutes the quinquopotent entity.

[* Ernest Pollard, 'Action of Ionizing Radiation on Viruses', *Advances in Virus Research* (1954), Vol. 2, p. 109.

+ Cf. D. E. Lea, *Actions of Radiations on Living Cells* (Cambridge University Press, 1947), summarizes the results of research in this field in the rule "ionizing radiation acts on molecular units of a virus in such a way as to destroy their activity if an energy release of sufficient intensity takes place anywhere inside the molecular complex".]

These delicately balanced systems cannot be isolated and studied as such in the biochemical laboratory, for the agents required to isolate them inevitably produce a disruption of their intrinsic triad.

We have referred to the viral world as degenerate autonomic existence, but we must not forget that it is also the basis of all life. Organic sensitivity is never observed on the earth in the absence of proteins and nucleic acids built into the recurrent forms of which the viruses are the type. When they find their proper place, the quinquopotent entities perform all the basic tasks upon which the life process depends. They form the chromosomes by which the genetic pattern is transmitted from generation to generation. It is probable that the genes which are the direct instruments of heredity are quinquopotent entities of a special kind. The whole of the Chemical and electrical equilibria that are required by living organisms on every level are maintained and adjusted by enzymes, hormones, and vitamins. We have not yet understood the role of the destructive viruses that produce disease in plants and animals. It may be that we meet here with a higher form of regulation connected with the mutual adjustment of species, and that the viruses in their action are the instruments of a pattern in which the separate organism has no place.

Dimorphic sensitivity permits self-renewal but only according to a fixed pattern. The variability that is possible with sexual reproduction does not exist in the world of viruses. When the pattern of a virus changes,

it does so as the result of an external shock, as for example by irradiation with ultra-violet light and probably also under the action of cosmic rays. In the absence of such external shock, the self-renewal of a virus is simply the autosynthesis of identical chemical structures firmly held to a single pattern. This limitation is very necessary for the stability of the viral world. If it were lacking, no virus or other quinquopotent entity could maintain its existence. The proteins and nucleic acids admit of such great variation that if there were any randomness in their autosynthesis, forms would appear that would be incapable of assimilating the raw materials available in the fluids of the host. All life would quickly disintegrate for lack of the basic regulators. We must therefore look upon the dimorphic sensitivity of quinquopotent entities as the primary biological condition for the existence of every kind of living form.

We should also remark that dimorphism allows of an identical recurrence in hyparxis, and therefore the building up of large structures composed of identical units. The activity of viruses in the life of multi-cellular organisms is possible only through the multiplication of identical sub-microscopic units. This multiplication is significant not

only in allowing a sufficient quantity of material to be present, but in adjusting the existence of the viruses as between the dimensions of eternity and time. This adjustment is manifested in the great intensity and speed of action of quinquopotent entities in life-processes. The latter, for example, is to be observed in the amazing rapidity with which a minute trace of biologically active substance can affect a living organism comprising thousands of millions of cells. The rapid changes that occur in the blood chemistry of mammals when hormones such as adrenalin or thyroxin are injected into the muscles, or when alkaloids like caffeine and strychnine are dissolved in the saliva, are evidence that we are concerned here with a living process that operates upon a scale of time in which a tenth of a second is a long duration. As with time, so also with space. Even with so powerful an instrument as the electron microscope we cannot be sure that we have discovered the 'atom of life'; that is, the smallest whole that is capable of self-renewal. What we can find is not life but the degeneration products of the living entity, and these products have lost that sensitivity by which quinquopotence is to be recognized.

Life at its lower limit is an incessant exchange of energy and a constant transformation of substance. If we reflect upon the prodigious number of micro-chemical and micro-physical events that go to make up the simplest life-process, we must ask ourselves what can be the integrating factor that can combine them to form the living whole. It is of decisive importance to recognize that this factor is not to be discovered by observation of what 'goes on'. The more closely we observe, the more do we find multiplicity revealed and unity hidden. Looked at superficially and uncritically, the living whole has no difficulty in affirming its wholeness, but when we inquire as to the source of this wholeness and the form it takes, we find that we are compelled to search elsewhere than in space and time.

The unity that we seek cannot be found only by invoking a mechanism of sensitivity. There is such a mechanism, and it assures the incessant and flexible adjustment between the unchanging pattern in eternity and the changing activity that life alone can manifest. In all life-processes there is an incessant regulation of physico-chemical events that certainly cannot be accounted for in the events themselves, but which also cannot be explained in terms of an unchanging eternal pattern alone. Nevertheless, the pattern itself is necessary as the norm to which the living entity incessantly strives to return, but the striving is life itself and it resides in the mechanism of sensitivity that on the viral level is no more than the dimorphic linking of a fixed pattern to a fixed environment.

8.20.3. SEXIPOTENCE—THE CELLS

Sexipotent entities exemplify the sixth category, repetition. Their outstanding characteristic properties are multiplicity, reproduction, and proliferation, whether they be independent unicellular protozoan animals or the tissue cells of a plant or a metazoan animal. Cellular life is a characteristic form of organization that does not depend upon a particular group of chemical compounds. Cells, however, are necessary for the life of

quinquepotent entities that cannot exist except in a medium provided by the cells, and all higher forms of life are built up from cellular units. We must conclude, therefore, that wherever there is life there are cells. We need to define the word 'cell' in such a way as to render it independent of reference to any particular chemical conditions or morphological constitution, as follows:

A cell is a whole whose parts are so organized that it can divide and multiply, thus reproducing an existence similar to its own.

This definition implies that a cell is individualized to a degree that is not encountered in the viral world, though cellular existence pervades all life above the viral level. We observe cells as limited in size and duration, enclosed within an active surface, maintaining a higher potential energy than the environment, capable of nutrition, and so organized that their pattern is self-renewing and reproductive.

The sexipotent entity arises and exists through the conjunction of six independent factors, each of which corresponds to one of the first six categories.

(i) Wholeness: It is a well-defined chemical complex based upon a specific group of fats, carbohydrates, proteins, nucleic acids, and mineral salts. (ii) Polarity: It has a well-defined distinction of inside and outside, due to the presence of a continuous active surface, within which it is totally enclosed. (iii) Relatedness: It has a well-defined set of relationships, either to the whole of which it forms part or to the medium in which it exists, and also to the food which it eats. (iv) Subsistence: It has a characteristic life-cycle occupying a definite period of time. During this cycle it maintains an inner potential more intense than that of the surrounding medium. (v) Potentiality: It has its own pattern of organic sensitivity. (vi) Repetition: It can reproduce its own kind by growth and division.

The property of repetition—or reproduction—distinguishes the cell from the virus, since the latter can only catalyze the synthesis of a similar group of nucleic acids outside itself. Reproduction is a manifestation of life that has no counterpart in the hyponomic world and first appears in unicellular organisms. By reason of its basic property of reproduction, the cell can be regarded as the unit from which all living organisms are built, and even in the highest forms of life cells are the means for renewal and development. The cell is the carrier of vital energy, and here we can recognize an analogy with the corresponding stage of hyponomic existence—with the bipotent corpuscle by which the energy exchanges of the physical world are carried on. Like the corpuscle, the cell is an incomplete manifestation. Compared with the mature plant or animal it lacks the organized sensitivity necessary for the arising of an independent existence. With the important exception of the nerve cells of the higher animals, all sexipotent entities are isolated within the boundaries of their own presence. They can only react to the stimulus of the immediate environment, and therefore cannot be regarded as self-regulating.

Nevertheless, the cells are authentic representatives of the autonomic world. Sexipotence is life in the true sense of the word. The resemblance of the step made in passing from viral existence to cellular existence to that made by the hyle in its transition to corpuscular existence enables us to grasp the meaning of 'protoplasm'—a word that has had a chequered career in biology. No one doubts now that there is a basic

material of life that can never be known, since it breaks down immediately it is isolated from living tissue. It is therefore meaningless to speak of 'protoplasm' as a complex of chemical compounds that can be isolated and studied, or as the jelly-like substance observed under the microscope as the content of the cells. If the word is to convey any meaning it must be taken to refer to the basic living state of matter—the presence of which we infer, but cannot investigate. 'Protoplasm' is thus found to be a word analogous to 'hyle'—which denotes the postulated ground-state of existence. The concept of a basic living state is, however, not strictly necessary for the discussion of life and its manifestations, and we were able to dispense with it in our examination of viral existence. Nevertheless, it has distinct value in helping us to form a picture of the way in which life, in order to become manifest, requires a certain minimum organization that is found in the cell. This organization is by no means rudimentary; for the cells are highly complex entities, the several parts of which are strongly differentiated.

That the cell represents a definite step in the scale of existence is

expressed in Virchow's dictum *omnis cellula e cellula*—every cell from a cell. The step is decisive; for it is the transition from un-differentiated self-renewal to individuated reproduction. To understand the cell world we must look for the characters by which reproductive potency is distinguished. From the physical standpoint, the basic characteristic of the cell is seen in its polarity; that is, in the enclosure of the active nucleus. Every hyponomic colloidal particle has an active surface on which monolayer reactions are proceeding, but this surface can sustain potential-energy differences of an electrical character alone. It cannot set up the chemical potential required for independent existence. Each autonomic cell—just because its nucleus is enclosed—has its own characteristic time-cycle as well as its own size, chemical composition, and pattern of behaviour. Sir Charles Sherrington describes cell-existence as follows: "In the sponge-work of the cell, foci exist for different operations, so that a hundred, or a thousand, different processes go forward at the same time within its confines. The foci wax and wane as they are wanted. That the cell's field is a colloidal field makes explicable much which would otherwise not be so. But the cell is much more than a drop of colloidal jelly."* There is, on the level of the cell, a new significance in the meaning of the terms 'life' and 'death' as compared with their use in reference to the sub-cellular structures. Plant viruses can undergo reversible transitions from conditions of life to conditions of death. The 'dead' virus can apparently remain indefinitely in an inert condition, and can resume its 'life' when restored to an appropriate environment. There is no individualization and therefore no birth and no death in any ordinary sense of these terms.

It is often thought and said that because the substance of the cell is perpetually renewed by the process of mitosis, or cell-division, the unicellular organism is immortal. Mitosis has phases, but they are quite unlike the stages of the development of a multicellular organism. The cells have a definite life-cycle, but it does not begin with birth nor end with death and so seems to be perpetuated. It would be more correct, however, to say that the single cell—as a reproducing whole—stands at the point where the concept of birth and death first begins to assume its usual significance. Here again it is very necessary to bear in mind the relativity that attaches to the meaning of all being-words such as 'birth' and 'death'.

Cell structures repeat themselves both in space and in time, and without this repetition they would have no significance for our experience. Woodger writes: "The elaboration of the organism, as we en-

[* Sherrington, *Man and his Nature* (Cambridge, 1940), p. 79.]

counter it in our experience, is accomplished by the repetition of the original spatial organization. If this spatial organization were merely repeated in successive temporal parts we should simply have a uniform object persisting unchanged. But it is a fundamental and remarkable characteristic of living organisms—so familiar that we are apt to forget how remarkable it is—that they are capable of repeating their spatial organization spatially."*

Although we can regard the cell as the starting point of individual existence, it is by no means 'individualized'

in the sense that the metazoan animal—or even the plant—can be so described. Individualization is a concept that can easily be misunderstood; for we almost inevitably interpret it in terms either of our own subjective experience or of the appearance of material objects. We have seen in the sub-atomic world that the corpuscles of hyle must be regarded as completely devoid of individuation, so that any electron is indistinguishable from all the other electrons in the universe and that therefore the recurrent series of all electrons must be identical. The individuation of atoms is only one step beyond this in so far as there is a coupling of recurrences that precludes complete interchangeability. Proceeding towards the large material aggregates that satisfy the hypothesis of composite wholeness, there is a drastic fixation of potentialities that produces what might be called a negative or pseudo-individual. A table is not individuated but it is fixed in its actualization. No one can prescribe, except by convention, when in the course of its manufacture it begins to be a table, nor when it ceases to be one as it wears out.

With the emergence of life, individuation acquires a new significance by association with the hyparchic property of ableness-to-be. Each living whole is individualized to the degree that it is able to be itself, and it is precisely in regard to this quality that the cell occupies a lower gradation than the animal or plant. When we look at an ingeniously devised cinematograph film that shows the activity of the osteoblast cells repairing an injured bone, we are inclined to make the comparison between the individual cells and the members of an insect colony—or people in a human organization—at work. Such comparisons are misleading, in so far as they neglect the difference in level of being that separates the three types of organism. Not only is the cell dependent upon its environment, but it is not able to be itself without other cells. Cells reduplicate in time and proliferate in space, not only to reproduce their own existence but in order to be what they are. A single cell cannot manifest the eternal pattern of cellular existence. It is the cell colony—

[* J. H. Woodger, *Biological Principles* (London, 1929), p. 303.]

whether as a collection of protista or as a fragment of tissue in a metazoan animal—that reproduces and maintains this existence; no one actualization of a single cell can exemplify more than an insignificant fraction of the potentialities latent in their eternal pattern.

We can recognize in the cells that significant feature of existence of all gradations which consists in the need for multiplicity in order to permit the harmonizing of potentialities and actualization. The potentialities of non-living matter can (be preserved in the recurrences of very large numbers of similar entities: the potentialities of living matter also require a very large number of lives conforming to a common pattern, but—and herein lies one of the distinctive marks of life—these must be capable of differing in the details of their actualization. Sexipotent entities have no variation inherent in their eternal pattern and their potentialities must therefore be worked out through multiplication and recurrence. The sensitive hyparchic regulator has a space-like component, directed towards the environment, and it has also an eternal component, directed towards the common pattern. It thus provides a linkage between unity and multiplicity that is both flexible and restrictive. The restrictive character of the organic sensitivity in a single cell is due to the absence of mutual regulation between different levels of organization.

In denying to the cells individualization of the kind that we ascribe to animals and plants, we must not fall into the error of regarding them as a mere collection of identical 'bricks' from which a 'tissue house' is built.* The coupling of recurrences in a cell is an immensely complex system in which thousands of millions of atoms are disposed according to a definite pattern. It can acquire thus a sensitivity of a totally different order of intensity from what is possible for viral entities. It can begin to bridge the gap that separates the inner and the outer worlds of every whole. This enables the cell to participate in the eternal linkage that goes to make up the colony or the tissue. The wholeness of an animal is not the passive wholeness of a material object, but it would be insufficient to redress the incoherences of the constituent cells if these latter had no inherent pattern of sensitivity of their own.

Life depends upon reproduction not merely in the sense of continuation and renewal, but in the wider

significance of establishing the reconciliation between eternity and time. In the reproductive activity of the cells there is evidence of an organization that cannot be accounted for

[* Cf. Woodger, loc. cit., p. 294: "We are told that the cell is to the biologist as atoms and molecules are to the chemist: an aphorism as misleading as it is crude. We are told that the organism is built up of cells as a house is built of bricks: a palpable untruth."]

in terms of physical and chemical factors alone. The exchanges of energy that take place between protozoa and the fluid medium, between muscles and the blood stream, or between plant fibres and the sap, are manifestations of a transflux equilibrium that has no parallel in inorganic matter. This equilibrium could not be maintained without a regulating factor independent equally of the internal processes and of the external relationships of the cells concerned.

8.20.4. Septempotence—Organism

Septempotence exemplifies the category of structure and, as we have seen in our studies of the categories, this is associated with the concept of organic structure or pattern. In the autonomic world the septempotent organism occupies a position analogous to that of the tripotent particle in the physical world. It is the true atom of conscious existence and the instrument through which the universal reconciling force can manifest its power.

There are various ways in which septempotence can be studied. It can, for example, be regarded as the combination of a tetrad and a triad, thereby exemplifying subsistence and relatedness. As an hyponomic tetrad, the organism is a material object extended in space, enduring in time, and subject to the same physico-chemical laws as every other material object. As an autonomic triad, the organism is able fully to manifest the relationship of eternal pattern, temporal history, and hyparchic self-regulation. Since, however, the organism as such does not possess the four elements of the autonomic tetrad, it is not a complete individual. Organic sensitivity is transformed into consciousness only at the level of octopotent individuality.

The characteristic property of the septempotent entity is the presence of an autonomic structure. Whereas upon all lower gradations of existence the principle of structure is never wholly exemplified within a single entity, with organisms we reach a form of existence that is wholly and completely structural. The structure of a cell is only completed outside of itself with the help of the medium in which it exists. But a plant or an animal is fully exemplified within its own presence. This structural property of organisms is the foundation of comparative anatomy. Plant and animal morphology is a rigorous scientific discipline, and because this is so we can isolate and study the same law of structure throughout the quasi-infinite variety, and different gradations of completeness, of septempotent entities.

The morphological form of plants is lacking in certain elements that we find in all metazoan animals, and that of invertebrates has not the

same completeness as that of the higher animals. The fullest organic structure is at present found in the mammalia; but we cannot be sure that, in the future, new orders may not arise in which septempotence will be more perfectly exemplified. Nevertheless, the structure of vertebrate animals presents us with sufficient material to enable comparative morphology to be brought into relationship with the principle of structure.

The great exponent of pure morphology was Geoffroy de St. Hilaire* who recognized that it is the study of the law underlying the connection between the positions, relations, and mutual dependence of the several parts of an organism. St. Hilaire did not understand the principle of structure and in consequence his homologies are frequently arbitrary and unconvincing. Indeed, the obvious defects of his great work led to the very conception of 'unity of plan' being discredited among zoologists.+ The work of St. Hilaire and the transcendental anatomists in general suffers from failure to realize that the principle of structure is a

combination of continuity and discontinuity. Richard Owen indeed recognized that structure follows and depends upon repetition—in our terminology, that septempotence implies sexipotence—but he also lacked the necessary insight into the discontinuities that every complete structure must possess.⁺⁺ Nevertheless, he showed that the skeletal form of vertebrates is built up in seven stages and that each part in turn has a sevenfold structure. The far-reaching effects of the theories of Cuvier and Darwin have since overshadowed these speculations; yet the truest picture of animal morphology is to be found in combining Geoffroy St. Hilaire's doctrine of unity of plan and diversity of form with Cuvier's doctrine of the adaptation of parts. The connection of this scheme with our triad of eternal pattern, hyparchic adaptation and regulation, and the diversity of temporal actualization, will be obvious.

Structure is observable throughout the physiological organization of plants and animals. In the case of a vertebrate animal we find that at one end of the scale there is protoplasm, and at the other the fully differentiated organism. The first step towards differentiation is taken with the cells, the second is the more potent differentiation of tissues. Tissues give rise to processes having specific patterns of electrical and biochemical behaviour. The processes are built into organs each with a

[* Cf. *Philosophie Anatomique* (Paris, 1818), and particularly the 'Discours Prelimin-aire'.

+ Cf. E. S. Russell, *Form and Function* (London, 1916), p. 52: "A pure morphology of animal forms is impracticable."

⁺⁺ Cf. Richard Owen on the Archetype and Homologies of the Vertebrate Skeleton (London, 1848).]

definite function in relation to the plant or animal as a whole. At the sixth stage are found the great systems of nutrition, respiration, and circulation; the bone structure, the nervous system, and the reproductive mechanism. Finally, at the seventh stage all are combined as interrelated parts to form the organism as a whole. Each step in the physiological structure is marked by a change of the form of organization and a new relationship of part to whole. The necessary discontinuity is seen between the third and fourth stages in the transformation from tissue to processes by which the structure becomes specific. Tissues can be removed from one part of the organism and grafted on to another, but the processes can be what they are only in their place and in relation to the particular function which the organ or limb has to serve in the life of the entity as a whole.

As there is structure both in form and in function, so also is there a structure of development in time. This is the process by which the reproductive cell develops into the mature organism. Taking the example of the human body, we know that the ovum, which is a single cell, multiplies itself many millions of millions of times over, in order to produce an organization of incalculable complexity both in its potentialities and its actualization. The sperm cell in man is about a hundred-millionth of the weight of the body, and yet within the sperm cell and the ovum are latent all the potentialities of individualization that are present in the adult. The fact of such immense proliferation, though astonishing in itself, would present no special problem if the resulting cells were all of the same kind and their actualization could be regarded as the mere sum of the constituent members. The real problem is that of accounting for the transformations of structure which occur during the development of the single cell into the fully-formed organism. This can be illustrated by considering a typical organ; namely the eye of a vertebrate animal. The eye can be traced back to a region in the egg which, in the early stages of development, shows no structure whatever. The protoplasm in that region is homogeneous under the most powerful microscopes and no differentiation can be described in the cells which are derived from this protoplasm. Yet from this region, which at the moment of fertilization could have contained only a small number of protein complexes, all the parts of the eye are derived. Thus, from what has no visible structure are developed the elaborate mechanism of the retina, the lens, the cornea, and the optic nerve.

The immense body of evidence furnished by experimental embryology must convince us that there is some

organizing factor that regulates these transitions from potentiality to actualization. Theories have been

put forward to explain this regulator in terms of physical factors such as light and heat; mechanical factors such as the earth's gravitational field, electrical potential gradients and force fields; and chemical agents in the form of specific proteins and nucleic acids.* None of these explanations nor even any combination of them, will give a complete account of the process of development. The observed facts can be placed in four groups.

(i) The Pattern of Potentialities

The fertilized egg possesses all the potentialities of development according to:

(a) the pattern of the species, and (b) the genetic constitution of the particular organism.

Notwithstanding this double fixation of the pattern, the egg plasma has an immense potency for differentiation. Nothing, at this stage, is determined except the basic polarity. As development proceeds, the potentialities latent in the egg become actualized in stages until the animal reaches adulthood. Even with the completion of development, the potentialities remain incalculable, but they have been transferred progressively from form to function.

(ii) Differentiation

In the fertilized egg, differentiation consists in little more than the distinction between the layers of nucleus, plasma, and cortex. When the grey streak—or pigment band—appears, differentiation begins. The three layers are distinguishable, and differentiation proceeds by stages that correspond to, but are not identical with, those of the transfer of potentialities from eternity into time.

(iii) Determination

There is from the very start one fundamental determination; namely, the polarity of the egg in the axis between animal and vegetable poles. So definite is this determination that when, after a transfer-section, an egg develops in two parts, the history of the two parts is entirely different—one stopping inevitably at the stage of the blastula, and the other differentiating sometimes even as far as the embryo. Determination

[* For the discussion of gradients and the role of quantitative factors, cf. C. M. Child, *Problems and Patterns of Development*, and for a discussion of chemical factors, see J. Needham's *Chemical Embryology*. J. von Uexkull in *Theoretical Biology*, English translation, London, 1926, presents on fundamental grounds the case against exclusively physico-chemical accounts of development.]

shows well-marked stages, according to whether a given portion of tissue is able or not to maintain its own pattern after transplantation. Determination is never complete, and even in the adult, tissues remain labile; that is, able to adapt to changed conditions.

(iv) Self-regulation

The most important feature of development is the appearance of regulating fields that produce the all-important phenomenon of embryonic induction, whereby one group of cells stimulates a second group to differentiate. Very often physical contact is sufficient, as when the neural plate—the precursor of the nervous system—begins to form as soon as the cells of the dorsal lip of the blastopore come in contact with the epidermis. A characteristic feature of self-regulation is that the regulative power always remains subject to the overall pattern of the organism not only as regards the species to which it belongs, but to the detailed genetic constitution. On the other hand, separate organs, when transplanted, can carry with them a regulative power to produce in their new environment the same effects as in the original position. For example, a transplanted leg tissue prior to differentiation will attract to it the nerves that are most conveniently situated in the spine,

but unless at least one of the nerves corresponding to the overall pattern reaches the limb, its subsequent functioning will be faulty.

It is difficult to account for the combination of these four factors of potentiality, differentiation, determination, and self-regulation in terms of any of the current theories that, for the most part, invoke force-fields and chemical agents.

The simplest type of non-mechanistic explanation is that which assumes that in every living organism there is a non-material vital factor, such as the 'entelechy' postulated by Driesch. The early experiments made by Driesch and others seem to give support to the belief that a single permanent organizing factor could account for all the data of experimental morphogenesis.* As later experimental embryology brought to light the fourfold progression above described, it became evident that no such simple scheme as that of Driesch could account for all the facts. Moreover, the importance of physical and chemical stimulating and regulating agents is well-established by observation and experiment.

[* Cf. the second edition of Hans Driesch, *The Science and Philosophy of the Organism* (London, 1929), and especially pp. 258-67 on the principle of 'becoming' in its relation to entelechy.]

It is necessary also to take into account the different levels present in every organism. On the quinquipotent level, the physical and chemical agents are undoubtedly responsible for the stimulation and regulation of the cytoplasmic changes. The cells are regulated by hyparchic sensitivity. But on the level of organism there is a structure of sensitivity and it is this structure that we must endeavour to understand. The regulating mechanism of an organic individual has the property of adapting itself not only to the environmental influences present at a given moment, but also to the accumulated results of these influences that have entered into the soma or physico-chemical body. The flexibility required for the performance of this adaptive role is achieved through the structure of the regulator itself.

8.20.5. The Hyparchic Regulator

We assert that organic sensitivity is the condition and essence of life itself. We can now better comprehend what this assertion means. The eternal pattern is not peculiar to a given organism; it derives from the species of which the particular entity is a member. The soma is a thing—that is, a quadripotent hyponomic entity—and it must be the denying factor in relation to the affirmation of the eternal pattern. The process of actualization is a limitation of potentialities. If the soma were nothing but a thing, it would progressively wear out, losing at every change a little of its initial identity. The actualization of the organism follows the same path; but—and herein lies the whole significance of life—it is constantly brought back to the unchanging eternal pattern. Thus it can be itself by reason of its orientation towards what is not itself; namely the genetic pattern of the species to which it belongs. This orientation is not static, but adaptive and regulative. At every stage of development the organic sensitivity acquires the particular element of structure needed for performing its task. We can trace this rapidly through various stages in the case of a primitive animal such as a sea-urchin. On fertilization the cell has a two-fold pattern, A and B. The coupling of recurrences produces only the main axis between the animal and vegetable poles. Through cleavage, the egg cell first produces an increasingly large number of smaller and smaller blastomeres to form the blastula without drawing upon the environment for fresh material. Here the organic sensitivity remains upon the simple pattern of reproductive wholeness considered in the last section. When, however, gastrulation begins, differentiation and accretion both come into effect. There is not only a larger organization, but also a fundamental change in the type of organization present. The individuation that has made a step by gas-

trulation has produced a structure of sensitivity that is henceforward historical, in the sense that the developing organism has begun to interact with its environment; by this, the eternal pattern is already compromised. At the third stage there is differentiation of layers and a primary determination. In the gastrula there is already a determination by which the potencies are allocated to definite regions. The induction of the

neural plate and the transition to the neurula stage can be visualized as a coupling of recurrences whereby each presumptive region has its own ableness-to-be flexibly adjusted to that of the total pattern. It is this that constitutes the organizing field and from this point onwards self-regulation dominates the process of development. Self-regulation is thus the latent hyparchic power by which the embryo first acquires its own ableness-to-be. The regulating sensitivity is a structure that is flexible, adaptive and individualized. We must distinguish this regulating structure from the eternal pattern that is neither flexible nor individualized, but preserves unchanged the potentialities of the organism from the moment of fertilization to its final dissolution.

It is necessary to remember that the pattern of sensitivity is neither eternal nor temporal; but, being hyparchic, participates in the nature of both without being involved in the transformations of either. At the moment of fertilization the hyparchic regulator is brought into existence. This probably occurs at the stage of meiosis, when the chromosomal pattern of the new organism is fixed. Thereafter the hyparchic regulator undergoes a process of coupling and fixation. It does not develop in the way that the physico-chemical organism develops, and yet it does not stand apart from development like the eternal pattern. In one sense it can be regarded as a register upon which the successive events in space and time are recorded—but in a special way owing to the influence of the eternal pattern. We can regard the hyparchic regulator as built up round the epigenetic factor; that is, the influence that enables the new organism to become itself within the framework of its genetic constitution.

The table on p. 388 shows the manner in which the inner determining-conditions are related in a septempotent organism.

Many features of this table correspond to Vernet's scheme in which development is shown as a triad corresponding in all essentials to that of eternity, hyparxis, and time. According to Vernet, the active or affirming role is played by the specific pattern of sensitivity that the individual receives through its genetic constitution. It is exempt from the influences of the environment because it is non-temporal. The passive element is the physical organism itself, subject to physico-chemical

laws and developing in the matrix of its environment, from which it has to derive both the chemical substances and also the energy necessary for its growth. Between these two, the third or reconciling factor is ascribed by Vernet to the organic sensitivity that regulates both development and the activity of the adult organism.*

<i>Level</i>	<i>Hyparxis</i>	<i>Eternity</i>	<i>Time</i>
7	—	Pattern of species	—
6	—	Genetic constitution of the individual organism	—
5	Deep sensitivity	Acquired characteristics of the organism	Differentiation Determination Regulation
4	Epigenetic factor		
3	Regulator		
2	—	Physiological structure	Self-renewing mechanisms
1	—	Anatomical structure	Soma

Table 20.2. Structure of a Septempotent Entity

Studying Table 20.2, we see the inherited or genetic characters ascribed to the eternal pattern and the acquired characteristics to the hyparchic regulator. There can, however, be an interaction between layers five

and six, both of which belong to the autonomic triad. The deep sensitivity is usually preserved unchanged as the norm of the regulating process; but under severe pathological conditions it is obliged to intervene in order to restore equilibrium. This must result in the actualization of a part of the sensitized hyle with the result that the structure of deep sensitivity is weakened or impaired. Prolonged subjection to this kind of strain has an effect not only on the hyparchic regulator, but even on the genetic constitution. In this manner arise inherited defects and dispositions.

8.20.6. The Cycle of Life and Food

In order to be an individual it is first of all necessary for an entity to be able to exist in the presence of the opposing influence of organization and disorganization that act upon it from the directions of eternity and time. Organic ableness-to-be is more than the renewal of the soma and

[* Cf. particularly M. Vernet, *L'Ame et la Vie* (Paris, 1955), pp. 66-90.]

the regulation of its activity. It requires the power to withstand the degeneration that is inevitable in all temporal existence, and to do so, moreover, in an environment which at times may exert not merely a passive resistance but a destructive and even malignant influence. Septempotent existence means the completion of a seven-fold cycle of life processes between the moments of conception and death. Every entity has a natural time-period within which the actualization of its potentialities can be accomplished. The universal regenerative ratio fixes the duration of life that can be sustained by a given eternal pattern. A fixed life-cycle, identical for all wholes of a given kind, is only to be expected for the simplest entities that have no internal structure nor external reactions. With composite wholeness, even of a primitive kind such as we have found on the atomic scale among the nuclides, the life period is only fixed as the average for very large numbers. For any particular nuclide the expectation of life is unpredictable. We have traced the source of this uncertainty to the coupling of recurrences that requires that the potentialities of all individuals should be preserved in the recurrences of each separate unit.

In the evolution of the hyle towards octopotent individuality, hyparchic regulation assumes a greater and greater significance, but this does not mean that virtue regeneration ceases to be the overriding factor in determining the duration of existence of a particular class of whole. The members of each biological species have a natural duration of life that depends upon the fundamental regenerative power of the eternal pattern. In the septempotent organism the pattern has its own apokritical structure, of which the upper part is the common pattern of all members of the given species and the lower part the genetic constitution of the individual organism.

The organic sensitivity also has its own structure, and the two lower parts—by which the regulation of temporal existence is maintained—can be looked upon as the passive elements of a triad, confronted with the affirmation of the eternal pattern. They are reconciled by the organic sensitivity that must partake of the nature of both. The very term 'organic sensitivity' implies a combination of pattern and response. We may therefore suppose that the organic sensitivity is constituted by hyle in two states—virtual and sensitive—and the con-cinnity of the two states determines the viability of the organism. If the hyle were altogether virtual, the sensitivity would be completely indestructible, but it would also be incapable of interacting with the soma and its physiological mechanism. The combination of states of the hyle required for maintaining the structure of a septempotent entity is

set out in Table 20.3. 7. Wholly virtual. Pattern of species. 6. Dominantly virtual but partly actual. Genetic constitution. 5. Virtual and sensitive. Organic sensitivity. 4. Wholly sensitive. The epigenetic factor. 3. Sensitive and actual. The regulator. 2. Dominantly actual but partly virtual. Physiological mechanism. 1. Wholly actual. The soma.

Table 20.3. States of Hyle in Septempotent Entity

The structures on the first, fourth, and seventh levels are in a single state. The soma is wholly actual; the epigenetic factor, which can also be called the germ of individuality, is wholly sensitive, while the pattern of the species is wholly virtual. The genetic constitution and the physiological mechanism are counterparts in that they are both a combination of virtual and actual states. For example, the genetic constitution is actualized in the combination of nucleic acids that gives each chromosome its own combination of genes proper to the organism. The physiological mechanism reflects the genetic constitution, but it is almost wholly actualized.

Within the three hyparchic layers, the organic sensitivity and the regulator are counterparts—both sensitive, but one directed towards the genetic constitution and the other towards the physiological mechanism. The total combination makes possible a self-regulating organism. It is to be noted that according to this view, the epigenetic factor is also the repository of external influences that act upon the organism during life with sufficient intensity to penetrate the protective barrier of the physiological mechanism. It is thus that acquired characteristics can, in certain circumstances, be transferred into the genetic constitution and thus become inheritable. The organic sensitivity determines the natural duration of life and also the quantity of perceptions of which a given organism is capable, and the total number of its reactions. The potency of a given organism is only a minute fraction of the potentialities that are inherent in its eternal pattern. It is not only morphological variations, but even more the historical process that can never be fully realized in any one individual. With most species thousands of millions of individual organisms are required in order to bring the actualization of the common pattern of the species to which they belong into balance with its potentialities.

Applying these considerations to the human organism, we assign to

man a natural term of life, fixed by his eternal pattern, but this duration is extremely small compared with the length of time that would be required for the actualization of all the potentialities latent in his essence. The single life of man is therefore only a small fraction of the potential life of man. The completion of human existence would require a coupling of recurrences by which each separate organism could be linked to the potentialities of the entire human race. This can be regarded as the affirmation of man-being. Against this is set the denying force that comes from the compulsion placed upon every organism to participate in the universal transformations of energy by which the existence of the universe is maintained. No organism is autotrophic—that is, independent of an external supply of food to replenish its reserves of energy. Even so-called autotrophic vegetation depends upon sun, air, and water to enable it to maintain the process of photosynthesis of carbohydrates, to fix nitrogen, or to concentrate mineral solids. Green vegetation is no less dependent than animal life upon the supply of energy and chemical elements in suitable form to serve as its food.

We thus reach the problem of the reciprocal maintenance of everything that exists. It is a theme that cannot be studied exhaustively in the present book because considerations are involved that go beyond the limitations of natural philosophy.* We should therefore confine ourselves to the biological fact that everything that lives depends on food. Upon the hyponomic level are ten elements essential for every form of life. These are carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, calcium, magnesium, and iron. The first three—carbon, hydrogen, and oxygen—are derived by the plants from air and water, the last seven are the mineral nutrients that the plant obtains from the earth. Apart from the ten essential elements, there are many others that prove to be necessary for the normal regulation of bodily existence; that is, for the synthesis of the quinquopotent enzymes and hormones, by which growth and regeneration are regulated. It must also be noticed that there are two elements—magnesium and iron—upon which the whole energy transformation of living matter upon all levels depends; for magnesium is the key element in the structure of chlorophyll in plants and iron that of haemoglobin in the blood of animals.

The dependence of every living organism upon the supply of organic and mineral food in the requisite quantities and of the appropriate kind, plunges the plant or the animal into the struggle for existence. The capacity for multiplication of most species of animals and plants is

[* Reciprocal Maintenance is closely connected with the Dramatic Significance of the Universe that will be studied in Vol. II.]

such that only the limitations of available nourishment can hold their spread in check. The struggle for existence is thus inherent in any form of actualization that depends upon the transformation of food. Not only is there the primary struggle for food, but the organism under the influence of its eternal pattern seeks to reproduce its kind, and to manifest according to its own instinctive impulses. All these tendencies act as denying forces in the triad of regeneration. The organism is compelled to expose itself to dangers of a kind that do not threaten the existence of inanimate objects. Because it must feed, it is also compelled to be food. In the cycle of life there is no organism from the simplest quinquipotent virus to the septempotent animals that is not both eater and food. The destruction of life to supply the needs of other life proceeds incessantly throughout the biosphere, and taken together with every kind of accidental factor, results in an all-pervasive denial of the potentialities inherent in the eternal pattern of each species taken separately. The duration of existence and the quantity of experience possible for any given organism is thus, on the average, reduced to a fraction of what might normally be expected for a given eternal pattern. The destruction of one form of life by another, the hazards inseparable from the general struggle for life, and the accidents due to physical causes proceeding in the atmosphere and on the surface of the earth, all combine to shift the regenerative ratio in an unfavourable direction; that is, to shorten the expectation of life and reduce the potentialities that can be actualized.

As applied to human existence, bodily injuries brought about by influences acting solely on the physical organism—that is, that leave the hyparchic regulator unchanged—constitute an important proportion of the factors tending to produce a limitation of existence.

To regard the negative factors as inimical to existence is to misunderstand the significance of the triad. The principle 'without negation no affirmation' applies to the regenerative triad. The septempotent organism is able to be what it is, and to fulfil its cosmic function not only because it is the expression of an eternal affirmation, but also because it is committed to temporal actualization. It is possible to isolate certain tissues—as, for example, those of the chick embryo—from the living body, and to maintain them in sterile culture indefinitely by providing the appropriate organic and mineral nourishment. Isolated in this way the animal cannot reproduce itself nor even develop, and therefore it stands apart from the whole process of organic existence. Similarly, an organism—whether human or animal—isolated from the harmful and even destructive influences of organic life on the earth, would cease to be itself and would lose all possibility of fulfilling the purpose

of its existence. In the eternal pattern the organism is formed to adapt itself to a wide range of negative influences, and it is in this adaptation that the organism establishes its own ableness-to-be.

We thus reach the fundamental conclusion that every living organism is able to be itself by reason of the hazards that it encounters in the process of its temporal actualization.

8.20.7. The Hazards of Life

Every organism by the pattern of its species is under a compulsion to be more than it is able to be. By reason of its actualization in an alien environment, it is prevented from being even what it is. The hyparchic regulator can maintain only a precarious balance between these conflicting demands, and when the balance is seriously disturbed, a pathological condition arises. The physico-chemical mechanism can maintain the existence of the organism by means of its system of enzymes and hormones within certain limits of physical state and chemical constitution. Within these limits, temperature, hydrogen-ion concentration, sugar content and other properties of the blood vary according to the time of day and the activity of the organism. The processes of energy-exchange between the organism and its environment, constituted by the functions of nutrition, respiration, and sensation, bring about a constant variation of state that the hyparchic regulator can readily

adjust. This is the condition of normal health. It must be remarked that the stability of state applies to the physiological mechanism and not to the soma. It is in this sense that we can accept the saying of Claude Bernard that fixity of the inner medium is the condition of free life. The soma passes through wide fluctuations of activity. There is the diurnal cycle of sleep and waking. There is active movement and rest. There is the whole mechanism of response and defence. Fluctuations in functional activity are common to all septempotent organisms and to some extent they are manifested even in the unicellular sexipotent protozoan. Amid all these fluctuations the lower hyparchic regulator constantly draws the organism towards a state of balanced adjustment of its several processes.

From time to time the organism is subjected to external shocks that deeply or violently disturb this adjustment. These may take the form of an excessive constraint upon the functional mechanisms of the soma itself, or they may be reactions of defence against a poison or infection that threatens to disrupt the physiological mechanism. There is also at all times a liability to damage by chemical or physical agencies. In each case the resulting adjustment may call for an intervention that goes beyond the limits of physiological regulation. At this point the epigenetic

factor is brought into action, and provides an organizing stimulus of a higher order than that which the lower hyparchic regulator can evoke. Stimulated by the epigenetic factor, the physiological mechanism departs from its normal equilibria in order to restore the balance of the soma. The limitations of variation with which the restoration of normal health is possible by this means can be called 'the pathological variability of the living organism'. The limits of variability are not dictated by the soma but by the epigenetic factor; that is, the potency of self-regulation that the organism possesses. Nevertheless, we can observe in the somatic process many symptoms that indicate some pathological disturbance. Whereas normal temperature lies between 98° F. and 99° F., disturbances of a violent character may result in temperatures ranging from below 80° up to 105° F. The heart pulse, which normally oscillates between 70 and 80, may fall to 40 or rise to 200 per minute. The respiration rate, blood pressure, and blood chemistry can all be carried outside the range of normal physiological variation.

In every case there is a somatic manifestation. The conditions of life are sensitive to the regulative mechanism. The colloidal system and the protein chemistry of the organism adjust themselves to restore the equilibrium. If, however, the ensuing movements exceed the limits that are very precisely fixed for each species, the capacity for adjustment breaks down and the organism dies. Since the pathological variability must depend upon the eternal pattern, it is as much a characteristic of the species as are the conditions of normal health. It is therefore quite misleading to regard pathological regulation as abnormal. On the contrary, it is part of the normal manifestation of life to withstand the disturbing influences of the organic and inorganic environment. The disturbing conditions are themselves a part of life. Pathological variation is not caused by the disturbances, but is, on the contrary, the natural self-regulation of the organism itself. The infection does not cause the rise of temperature, but the rise of temperature itself is the necessary condition for a change in chemical activity required to meet the new conditions. The synthesis of nucleo-proteins required for the mechanism of defence is very sensitive to the temperature and the physico-chemical state of the blood. Thus the rise of temperature is itself a manifestation of the hyparchic regulator, and the same applies to all other manifestations that are commonly regarded as symptoms of a diseased state.

The epigenetic factor can be compared to the mechanism of a gramophone in which a record made of sensitive material is able to take in sounds that come to it from outside, and arrange them in a definite sequence thanks to the preformed grooves pressed on its surface at the

time of its manufacture. In normal usage the grooves are unimpaired and the record can be played over and over again, producing a definite pattern of sound. This is analogous to the development of the organism and its subsequent behaviour pattern during life. Violent or careless treatment breaks the grooves in the record, and persistent overstrain wears it out. This corresponds to pathological stresses and the ageing and death of the organism. The analogy can be carried further to the extent that the record or disc is the sensitive part of

the gramophone, but it does not itself take in or admit sounds, nor does it control the rate at which the turntable revolves. These correspond to the physiological mechanism which is of a lower order of materiality. By distinguishing the respective contributions of the different layers from the soma to the organic sensitivity, we may hope to understand better the role of heredity and environment upon the development of the organism and upon the transmission of characteristics.

The remarkable property of imitation or mimicry that is found among both plants and animals and which by no means always can be accounted for in terms of the viability of the organism, can readily be understood by considering the relation of organic sensitivity and the genetic constitution. We can see here at least the outline of a general theory of the appearance of non-adaptive characters that is one of the main puzzles of evolutionary biology. An insect genus may have within the limits of variability of its eternal pattern forms that closely resemble the leaves upon which it is accustomed to live. Through the balance of the three hyparchic layers—regulator, epigenetic factor, and organic sensitivity—the genetic pattern of unit organisms receive an impulsion towards the form in question. This process is neither attributable to random genetic mutations nor to the inheritance of acquired characteristics. The Lamarckian theory of the inheritance of acquired characteristics as the mechanism of evolution was based on the assumption that the organism can react only passively—that is, univalently—to the influences of the environment. In this form it has proved inadequate to account for the facts, but a new understanding of the process emerges when we take the whole septempotent structure into account. We can then see how the epigenetic factor acts as a buffer between the physiological mechanism and the genetic constitution. The action of this buffer is modified by the 'inner' hyparchic triad of the regulator and the organic sensitivity. Prolonged and severe stresses placed upon the hyparchic regulator can modify the organic sensitivity and—to use an electrical analogy—the resistance of the epigenetic conductor breaks down and the genetic pattern is altered. The result is then transmitted to the offspring, and if

favourable for survival can result in a new variety within the species. It is most unlikely, however, that this mechanism could alter the pattern of the species itself.

We should now consider the part played by the organic sensitivity in maintaining the vital equilibrium. Unlike the epigenetic factor, the organic sensitivity has no actualized part and is therefore not subject to development or degeneration. It is a reservoir of potentialities upon which the hyparchic regulator draws only when the limits of pathological variation are approached. Nothing in the pattern of organic sensitivity changes from the moment of fertilization to the moment of final dissolution, except through the increase or diminution of potentialities. In other words, the organic sensitivity does not 'participate' in the actualization of the entity. The organic sensitivity is not an apparatus for registering and transmitting impressions. It is rather the seat of consciousness in which awareness of impressions can arise.* Fully to understand its role, we have to complete the tetrad of autonomic existence with the study of individualization.

[* Reference should here be made to W. P. Montague's suggestion that consciousness is associated with a condition of potential energy devoid of actualization.]

Chapter Twenty-one THE UNITY OF LIFE

8.21.1. OCTOPOTENCE — COMPLETE INDIVIDUALITY

If our interpretation of experience is soundly conceived, the destiny of the universe depends upon the success or failure of the supreme task that is laid upon life of reconciling the affirming and denying forces of involution and evolution as they meet and clash in all the countless millions of stars and planets. The demand that life faces is that it should succeed in existing between the alien forces of the hypernomic and hyponomic worlds. This is the manifestation, in the realm of fact, of the cosmic drama that is being enacted perpetually in the realm of values ; and since we men are compelled, by virtue of our organic nature, willy nilly to participate in it, it behoves us to understand as well as we may the distinction between the roles allotted respectively to the merely self-regulating organism and to full octopotent individuality. The methods of

natural philosophy cannot furnish us with the whole answer; nor indeed with that part of the answer which is most needful and that tells us what are our obligations and how we must live to fulfil them. These are questions of value and we shall have to seek an answer by the study of being and will that we shall hope to undertake in the next volume. Nevertheless, it would be a grievous error to suppose that questions of value can be divorced from matters of fact. If understanding is the only sound guide to action, understanding itself must be built upon knowledge of the facts. Our ultimate search must be for a way of life, but a way can best be shown by reference to a map drawn and scaled with reasonable accuracy.

Consciousness as the reconciling factor in all the conflicts of existence can penetrate into time, and participate in the actualization of the world only through the medium of entities that can unify the determining-conditions. The self-directing conscious individual can withstand both the creative force that acts from above and the mechanical forces that act from below. For this he must be sensitive to both forces and able to distinguish between them, however they may be disguised and distorted in the course of transmission through the functions. He must, however, possess something more than sensitivity—which he shares with all septempotent entities—in order to have the power not merely of reaction

but of response. That 'something more' is individuality, the study of which will occupy us in this, the last of the chapters devoted to the autonomic world.

Individuality is fully historical in the sense that it can participate in all actualizations. It is equally and to the same degree non-historical; that is, eternal, unchanging, and virtual. These seemingly contradictory properties are possible for individuality because it is the instrument of consciousness, and the true condition of its existence is the completed inner triad of eternity, hyparxis, and time.

An individual in the complete sense is an independent factor in the universal actualization. This and no less is the meaning of self-determination. It is a power that cannot arise in any separate entity that is subject to the division of time and eternity as conditions of existence. The first seven gradations of existence up to and including the septempotent organism, are machines in the sense that they actualize solely under the mutual action of their pattern and the influences of their environment. According to our understanding of the determining-conditions, there must be a level of being at which time and eternity are fully merged and the distinction between actual and virtual disappears. Whatever exists on this level is actually all that it potentially might be. Where potential and actual are one, there individuality is present. This is the primary secret of autonomic existence.*

We recognize that autonomy is categorically as distinct from the activity of creative power as it is from the passivity of mechanism. Life is the result of the clash of involution and evolution, and therefore it is the reconciling agent that redeems the universe from the sterility of dualism. Without relationship there can be no meaning. A stream of integrative evolution, striving automatically and inevitably towards unity under the compulsion of universal laws, has no more fecundity than a stream of involution flowing irresistibly downwards out of unity into multiplicity, under the impulsion of a primal creative will. The universe is full of significance, not only because everything is in the process of creation, nor only because everything has the possibility of returning to its source, but because existence is striving to become conscious through the medium of the appearance and the development of life. A new world is coming into existence upon a time-scale measured in thousands of millions of years. It is being born in life and through life, and it will be neither all-powerful nor will it be impotent, but it

[* The autonomy of the individual is not a guarantee of the 'rightness' of his actualization within the pattern of the universal purpose. 'Rightness' can only be discussed in terms of the categories of value which will be studied in Vol. II.]

will be free. Such a world must be full of hazard—just because it cuts the leading-rein of inevitability—but it is this world alone that is bringing significance and purpose into the whole cosmic structure.

Grand cosmological speculations such as this can mean little to the natural philosopher, unless they can be related unambiguously and in detail to the data of his sense-experience—both observational and experimental. His profession does not permit him to invoke the aid of revelation from above, nor can he rely upon the intuitions that arise in his own meditations upon the universe and its meaning. His task is to tread the long and arduous path that leads from crude experience to the understanding of the laws by which all existence is regulated. For him experience is both the way and the means, but he can neither follow the one nor use the other without the instruments that are given to him in the categories and principles.

Our present task is to study the completion of life, and we cannot think of it fruitfully except in terms of all the first eight categories; for, in its fullness, life is the expression of them all—wholeness, polarity, relatedness, subsistence, potentiality, repetition, structure, and individuality. Each of these admits of a quasi-infinite range and variety of manifestations, and therefore life in its functional complexity can never be fully, or even adequately, known. Nevertheless, we can hope to understand something of life's place in the natural order if we can grasp the nature and meaning of individuality.

Individuality as self-determination implies the power of choice, and this is a property that is not merely absent, but inconceivable, on lower levels of potency than the eighth. The septempotent self-regulating organism is complete in the sense that its structure comprises all the seven qualities and divisions requisite for independent existence. But this does not suffice to make the organism an individual. Even the highest manifestations of septempotence, such as the mammalia that are able to regulate their own life-processes under a wide range of external conditions, are nevertheless almost totally unable to direct their own activity. Every animal in its activity pursues an end, and the ends may vary from self-preservation to relaxation, from reproduction to the satisfaction of curiosity; but no animal is able to choose the end it will pursue. With septempotent entities, ends are determined by factors other than conscious choice, and in general by the adjustment of the temporal actualization to the demands of the specific pattern and genetic constitution of the organism concerned. Moreover, all study of animal behaviour makes it clear that, even when apparently self-seeking, the end the animal pursues is not its own, but that of the species to which it belongs. The

cow eats grass all day long, and in consequence lives out her own life and can give birth to her calves and feed them. But we should be quite mistaken if we were to speak of the attainment of a ripe old age and the raising of children as 'ends' pursued by the cow. All her activities are directed not by her own volition but by the demand made upon her by the eternal pattern that she shares with all other members of her species and that requires her to be a cow. If a cow could, at any time, choose to behave not as a cow, she would be an individual; but this is precisely what no septempotent entity can achieve. Choice implies the selection of one out of several possibilities open at a given moment, and this is not feasible through the agency of the organic sensitivity alone. The marvellous mechanisms of adjustment and adaptation, by which the organism can meet the stresses of its environment and its own inward tendency towards decay and death, are automatic in their operation. An animal is a machine, incomparably finer and more flexible in its adaptations than any machine that man can ever hope to construct, but nevertheless a machine. An animal is sensitive, it can rejoice, and it can suffer; it also can love, and it can hate, but it does all through the agency of the organic sensitivity of its kind, and what it does it cannot choose but do. The power of choice being the first condition of individuality, we must carefully examine the meaning of choice, and the way in which it can arise.

8.21.2. The Conditions of Choice

The multiple actualization associated with different levels in eternity can be conceived as a sheaf of non-intersecting lines of time, each of which has a fixed potency according to its apokritical level. The number of levels in the sheaf is indeterminate or rather, it depends upon the kind of entity present. Primitive actualization is unipotent; there is no possibility of choice, nor even any uncertainty as to the future of a given system. The greater the intensity of inner-togetherness an entity possesses, the wider the range of actualizations open to it. Nevertheless, up to and including the gradation of septempotence an entity must actualize according to the laws corresponding to each level. There is a strict division of labour and no

possibility for an entity on one level to fill the place of another on a higher or lower. It is this fixation that accounts for the impossibility for a cow to manifest un-cowlike behaviour. Individuality and the power of choice enable an entity to break down the fixation that tends to hold it within the limits of its own genetic constitution and the acquired results of its previous life experience.

In order to grasp the distinction between sensitivity and choice, we should recognize the dual nature of septempotent existence. Every

living organism is both tender and tough. It is tender by reason of its organic sensitivity and the constant adaptation, by way of the hyparchic regulator, of its inner and outer life. On the other hand, by reason of its ability to remain itself under varying environmental conditions, it has a toughness that no physical whole can emulate. The sentient organism harmonizes opposing tendencies between tenderness and toughness in a characteristic manner at each stage of its development from the ovum to the adult. Thereafter, self-regulation proceeds through the normalizing influence of the epigenetic factor. Automatic adaptation is the preponderant influence in maintaining the existence of any organism, even when, as in the higher animals and especially man, the transition to octopotence is being made. The higher animals are endowed with an immensely complex mechanism by which their organic sensitivity can translate itself into the functional transformations of energy that take place at and across the external surface of their bodies. An adult human being is furnished with hundreds of millions of specialized nerve cells, each capable of reacting selectively to stimulations of light, sound, heat, and pressure, as well as to a great variety of chemical agencies, of which those that produce the sensations of taste and smell are only a part. From birth to death a human being receives perhaps 2,000,000,000,000,000 independent impulses at the nerve endings distributed all over his body and concentrated especially in such organs as the eye and the ear. The organism cannot react to each separate stimulation, but through its neural mechanism groups them in such a manner as to produce signals that set in motion a mechanism of response. The capacity for efferent response is a very small fraction of the capacity for receiving afferent nerve impulses. Even if we include all the unnoticed automatic inner and outer reflexes by which the body is constantly adjusting itself to impressions, it is doubtful whether a man in the whole course of his life has more than 100,000,000,000 distinct organic reactions. This means that each organic reaction is, on the average, the response to 20,000,000 separate nerve impulses that have to be integrated to produce a signal that sets in motion the single train of response. The whole of the required integration and selection is carried on by the physiological mechanism under the control of the hyparchic regulator, without the participation of any higher level of consciousness.

The epigenetic factor is only brought into operation when stimulus in some way threatens the integrity of the organism. This occurs in only an extremely small proportion of the total reactions, and it requires a further process of integration by which the hyle content of the stimuli is brought into the virtual state, and the organism becomes aware of a

threat to its existence. There is also, ever present, the deep organic sensitivity, the seat of an integral response, that is occurring continually and can be said to be the measure of the intensity of togetherness of the organism as a separate whole. If now we turn our attention to the subjective experience of choice and ask ourselves how often it occurs that a man becomes aware of the presence in him of stimulations on different levels and chooses between them, we have to rely on rather vague data, since experimental psychology has not studied this problem quantitatively. It would appear, however, that acts of choice do not occur more than a few times in a day, and then only during the early period of adult life—childhood and old age being almost entirely automatic.

An ordinary man may act from deliberate choice—including here the simplest and most trivial instances—perhaps 10,000 times during the whole course of his life. If we compare this with the 100,000,000,000 involuntary or reflex reactions that his organism will have made during the same period, we are bound to conclude that self-direction is a power that is scarcely ever exercised in man, and even more rarely in animals.

It must here be emphasized that the 100,000,000,000 automatic reactions—in which there is no element of choice—comprise not only the adjustments made by the organism for the needs of its own inner regulation and its reaction to external stimuli, but also nearly all the mental and feeling associations, reflexes, cogitations, and decisions that constitute the inner life of an ordinary man. Even where an act of choice is imperatively necessary in order to change the direction in which a man sees his actualization to be proceeding, he usually finds himself unable to make it, but behaves automatically according to his own genetic constitution and to the results of past experiences registered in his epigenetic factor. In this he is no different from a cow or any other septempotent entity. The moments of genuine choice constitute a very small proportion of the total reactions of man, and even these are made almost invariably at trivial moments in which the decision has little importance for the future history of the entity concerned.

8.21.3. The Gradations of Individuality

Man can be described as a being who can choose, but seldom chooses; who, although octopotent, manifests constantly as if he were only septempotent. This strange situation requires to be clarified if we are to understand the significance of human existence. Our experience forces us to conclude that man, as we know him, is not an individual, but can

manifest individuality at relatively unimportant moments of his life. Man should therefore be characterized as a degenerate octopotent entity.

Here we may make a comparison between the hyponomic and the autonomic worlds. In the former, composite wholeness is reached through a transitional phase consisting of the nuclides that, although quadripotent, behave almost entirely as if they were tripotent entities; that is, as particles and not things. Similarly, man, though octopotent, behaves almost always as if he were septempotent; that is, as an animal and not as a man. This leads us to ask the question whether our experience can disclose any examples of non-degenerate octopotent entities that will enable us to study true individuality.

In man, the transformation of the power of choice into individuality is the meeting-point of fact and value. It cannot be discussed without reference to concepts of aim, of obligation, and of the purpose of man's existence; all of which fall outside the scope of the present volume. Natural philosophy can only establish the fact that man is an individual in so far as he has the power of choice; but in so far as he is not truly self-directing nor free in his manifestations, he is only an incomplete or degenerate representative of the class of octopotent entities.

The stringent conditions that must be fulfilled before an entity can be regarded as a true individual seem to be at variance with the ascription of individuality to all forms of life. We have distinguished the use of the words 'individuation' and 'individualization' by ascribing the first to composite wholeness and the latter to living organisms. A thing is individuated in so far as it is a particular whole enduring in time and recognizable by its size, shape, position, and properties. An organism is individualized in so far as it can maintain its existence on a higher potential level than its environment and can be recognized by its form and function. True individuality is reached only when the potentiality of the organism is such that it is able to initiate processes that do not arise either from the stream of involution, or from that of evolution, passing through the entity and its immediate environment. Even this formulation can be ambiguous, for every septempotent entity brings into existence an influence—its own epigenetic factor—that is neither involutionary nor evolutionary. So long as the epigenetic factor remains unconscious, there is no power of self-direction, and we should properly regard entities in such a condition as pre-individualized. They have the functions of an individual in so far as they are self-regulating, but no individualized being in so far as they have no conscious self-direction.

These considerations provide us with a means of defining the eighth

order of potency as the level of existence at which the intensity of inner-togetherness and the ableness-to-be

are merged into a common actualization in the individual being. A degenerate individual, such as a man, has the requisite ableness-to-be in so far as his epigenetic factor contains the power of choice. He is not a true individual because his intensity of inner-togetherness is not sufficient to maintain itself at that level of consciousness at which time and eternity are merged.

It is now possible to define three gradations of true individuality. The first is that in which the entity can be conscious of its own genetic constitution and direct its activity according to this awareness. This is the individuality which consists in ableness-to-be oneself. The second gradation is that in which there is awareness of the specific pattern. In this case the entity is able to direct his activity not only according to his own genetic constitution, but also according to the pattern of potentialities that belongs to the entire species of which he is a member. As applied to man, the second gradation of true individuality is exemplified in him who is aware of himself as a human being, and is able to share in the experience of all other human beings through participation in the pattern common to all mankind. The third and highest gradation of individuality transcends the limitations of any single species and is present in an entity that can be aware of the universal pattern of life and understands its role as the cosmic reconciling force.

It must be emphasized that these descriptions are nominal only. The gradation of inner-togetherness that is required to be able to withstand the impact of experience at the three levels can never be known by one who has not himself attained it. An ordinary man exercising his power of choice only in trivial matters cannot participate in the experience of a truly individualized human being, who can see his own destiny and choose what is necessary for its fulfilment. Nevertheless, even upon the level of degenerate octopotency, a man may for brief moments enter into that state of consciousness at which this experience is possible, and thereby realize for himself that he is not what he might be.

It will be necessary to devote a special section to the study of the relation of the individual to the species; for this relationship exists whether the individual is conscious of it or not.

8.21.4. Organism and Species

Every gradation of life falls within certain limits of intensity of inner-togetherness. Within these limits, potency conforms to one of the four characteristics of self-renewal, reproduction, self-regulation, and

self-direction. There is in passing from stage to stage a progressive transformation in the relation between the organism and its environment. Viral existence requires a precisely regulated environment that compensates for its own lack of autonomic potency. Reproductive wholeness can tolerate a greater variation in the environment and has moreover a genetic constitution common to all cells of a given kind. There is, however, no distinction between the genetic constitution of the individual organism and the eternal pattern of the species. This distinction only becomes possible at the level of sexual reproduction, which in turn calls for self-regulating wholeness. Sexual reproduction occurs only when there are two levels of eternal potency, one of which carries the pattern of the species, and the other the genetic constitution. We have already referred to the dualism inherent in septempotent entities, and here we should remark that the division of sexes occurs only at this level of existence. There also begins here to be a distinction in the true sense between the inner and the outer worlds of the given whole. Having a complete structure, the septempotent entity is able to be itself, and at the same time to react selectively to the stimulations received from its environment. Nevertheless, the ableness-to-be of the plant or metazoan animal depends upon the support of, and remains limited by, the eternal pattern of the species. The species thus constitutes the individual of which the septempotent entity is an incomplete manifestation. This very important conclusion requires elucidation, and will involve us in a brief examination of the facts disclosed by genetical science. It will be sufficient if we confine ourselves to animal genetics and to the manner in which the potentialities of a species are manifested by way of the individual organisms.

The stability of species and their coherence is one of the most striking facts known to biological science. The

fact is known to all biologists; but the interpretation of the fact has led to the misunderstandings between the vitalist and mechanist schools. The 'idée directrice' of Claude Bernard and the 'entelechy' of Driesch are attempts to interpret the facts without invoking a dualism of matter and spirit, but they have not proved satisfactory nor can the unity of the species be accounted for in terms of evolutionary principles such as the 'élan vital' of Bergson or the 'creativity' of Whitehead. On our view it derives from the pattern in eternity common to the whole species within which interbreeding is possible. The pattern is the directing force.

When once we grasp the fact that the entire life-process of every animal is directed by the eternal pattern of the species to which it belongs, we are bound to conclude that an organic species is a true

individual of the first order; namely, one that directs its activity according to its own genetic constitution. The organic species are not individuals of a higher order, for they do not concern themselves with the pattern of other species than their own.

The eternal pattern of a species is constituted by hyle in an almost fully virtual state. The potentialities of the hyle in this state are such that one pattern can regulate the existence of millions of animals as if it were a part of each of them, and yet as if it were at all times an undivided whole. The pattern itself is not fixed, but on the contrary has an immense range of adaptation. Within this range there are combinations by which different racial types can arise. It must here be noted that we refer only to septempotent metazoan animals. Cells and viruses have not the same specific stability, and can be changed by functional agencies such as the ultra-violet irradiation, chemical poisons and stimulators, conditions of temperature, pressure, and the like.

Genetical science has established the importance of the pattern of potentialities transmitted through the chromosomes in the male and female gametes. The chromosomes themselves are built up from proteins and nucleic acids that vary from species to species, but which, within each species, are perfectly definite and remain unchanged through countless generations. Through sexual crossing, the distribution of the genetic factors can be varied, thus giving rise to the genetic constitution of each organism, and the mode of crossing can be traced with little ambiguity to the arrangement of nucleic acid molecules with reference to the protein basis. In this blending, the organism displays its astonishing combination of fixity and fluidity. On the one hand, the chromosomes have an almost incredible stability that enables the species to retain its unvarying eternal pattern over tens of thousands of generations, at each of which the organisms have to meet with destructive and disruptive influences from the environment. On the other hand, there is a perpetual flux whereby the 'hereditary substance' which, on the hyponomic level, is a combination of nucleic acids, is transformed into the hyparchic regulator by which the differentiation of the cells is directed. Behind the visible structure of the chromosomes is the hyparchic regulator, behind this in turn is the epigenetic factor through which alone the miracle of development is directed. As the ovum is fertilized and begins to divide and multiply, the specific proteins must be unerringly selected out of untold millions of possible forms and synthesized by a series of highly improbable chemical reactions. As differentiation proceeds, the epigenetic factor continues to maintain a pattern that can survive harmful chemical influences and physical damage. It would be necessary

to examine in detail the immense body of data that has been established by experimental embryologists in order to make clear the inadequacy of any account of development that does not refer back to a stable, unchanging pattern, common to the entire species to which the organism belongs. One example will serve to illustrate the practical difficulty of explaining development in terms that reject the conception of an epi-genetic factor. When cut into segments, a hydroid—an organism with a well-marked polarity—will regenerate the base and tentacles, but by chemical means—such as a reversed concentration of oxygen in the medium—it is possible to reverse the polarity and cause tentacles to regenerate at the end that normally would produce a base. The experimental evidence of regeneration in many species shows that there is an agency at work that can interact in the most intimate manner with the physico-chemical environment.*

We have seen in our physical studies that wherever there is interaction there also has to be a coupling of

recurrences in hyparxis. In the world of animate existence it is the coupling of the nucleo-proteins that regulates the development of the cell and the growth of the embryo. This coupling leads to the formation of the hyparchic regulator that could be represented by a system of o-pencils; that is, a non-transitive, directional, and recurrent pattern that can adapt itself step by step to the requirements of growth. The hyparchic regulator, however, could not perform its task if it were not constantly in the presence of the eternal pattern that prescribes the form towards which the organism shall tend. The supreme organizer of existence, from the moment of fertilization to the end of the life-cycle, is the eternal pattern, but this being almost wholly virtualized, cannot react directly with the physico-chemical organism. The eternal pattern itself stands between the specific form and the regulators. It therefore serves to transmit a form of organization that is common to all members of the species, and it is this form that we have next to consider.

8.21.5. The Unity of the Species

We must henceforward look upon the septempotent organism as an atom of individuality rather than as an individual in its own right. If we consider a plant such as the common oak tree or an animal such as the domestic horse, we recognize that neither can be itself except as a representative of the species to which it belongs. Everything that a cer-

[* Such an agency could not be a principle of 'emergence' as suggested by Lloyd Morgan, or a 'directiveness' of the kind postulated by E. S. Russell.]

tain oak is, and all that happens to it in the course of its long existence, is strictly subordinated to the pattern of *Quercus robur*, even to the extent that it is found only where there is a heavy chalk soil. Each species has its own pattern of existence and its own range of variability. In nature the several species of plants and animals unerringly find the conditions of existence appropriate to their pattern and maintain its integrity, sometimes for very long periods of time. There are, for example, to be found among the lamellibranchiata and echinoderms, species that have survived unchanged for hundreds of millions of years. Surveying these facts we cannot doubt that the species has a greater intensity of inner-togetherness than its separate members. This is possible only if it occupies a higher level of potency; that is, octopotent individuality. In our observations of organic life it is the separate organisms that engage our attention, and prevent us from seeing the individuality of the species. It sometimes happens that we catch a glimpse of the inner-togetherness of a whole species of plants or animals, but we do not understand the significance of what we see. Ouspensky describes an experience of seeing all horses in one cab-horse: "A dog once gave a similar sensation. At the same time the horse and the dog were not simply horse and dog; they were 'atoms', conscious, moving 'atoms' of great beings—the 'great horse' and the 'great dog'. I understood then that we are also the atoms of a great being, the 'great man'."*

Our difficulty in seeing things in this way arises from the tendency to use functional descriptions, and especially to characterize species in morphological terms; that is, by enumerating the visible elements of structure, with emphasis upon those features by which classification is most easily established.+ No one would think of denying the usefulness of the systems of biological classification, especially where ecological problems are concerned. The descriptions in terms of form and function are, however, reliable only for the larger divisions, and the taxonomist

[* Cf. P. D. Ouspensky, *A New Model of the Universe*, p. 323.

+ Cf. D'Arcy W. Thompson, *Growth and Form*, p. 727 (quoted by J. S. Huxley in *Problems of Relative Growth*): "The morphologist, when comparing one organism with another, describes the difference between them point by point and 'character' by 'character'. If he is from time to time constrained to admit the existence of 'correlation' between characters (as a hundred years ago Cuvier first showed the way), yet all the while he recognizes this fact of correlation somewhat vaguely, as a phenomenon due to causes which, except in rare instances, he cannot hope to trace; and he falls readily into the habit of thinking and talking of evolution as

though it had proceeded on the lines of his own descriptions, point by point and character by character. But if, on the other hand, diverse and dissimilar fishes can be referred as a whole to identical functions of very different co-ordinate systems; this fact will of itself constitute a proof that a comprehensive 'law of growth' has pervaded the whole structure in its integrity, and that some more or less simple and recognizable system of forces has been at work."]

frequently has great difficulty in allocating individual specimens, or even genotypes, to a given species.*

Hybridization is regarded by many biologists as the most reliable test of a species. Breeding within a species is normally successful, and the offspring are fertile; whereas between species there is either no offspring, or it is sterile, like the mule. Caullery asserts that "... the criterion of fertility of crossing remains the one sure touchstone for defining a species. Fertile hybrids produced by crossing between species are very rare exceptions. The sterility of crossing between species remains the infinitely dominating factor—the law, as absolute as any biological law can be, for none is exempt from exceptions".+ Dobzhansky has suggested that inability to exchange genes is a more accurate criterion than infertility ; but the concept of closure within the boundaries of an individual is common to both views.

The geographical unity of a species when combined with the absence, or rarity, of fertile unions outside its ranks, are both facts that confirm the view that a species is a true individual of the first kind defined above. This is of the utmost importance for understanding the pattern of life. It shows that there is a unity and integrity of the species that may not readily be transgressed. Even more compelling proofs of the individuality of the species are to be found in what Vernet calls "the specificity of the sensitive excitability of the organism'. ++

Within each species there are many differences of form, as we can readily see in domestic animals such as the dog or the pigeon. But there are certain rhythms that remain common to all the varieties. For example, the maximum duration of life is remarkably constant for the different species of animals. For man it is about a hundred years; for the great apes, less than thirty; for horses, forty to forty-five; for the domestic cow, twenty; for the sheep, ten to fourteen; for the dog, seventeen to twenty; for the cat, fifteen to sixteen; for the bear, thirty-five; for the rat, five to seven; and so on. These limits are common to each race of the species, notwithstanding the great difference in size and appearance of the varieties within it of which each race is composed. The same applies to functional rhythms such as respiration, heart-beat, sexual activity,

[* That the morphological definition of species has little significance beyond convenience of classification is illustrated by the definition given by Regen (G. T. Regen, *Organic Evolution*, Brit. Assn. 1926) : "A species is a community, or a number of related communities, whose distinctive morphological characters are, in the opinion of a competent systematist, sufficiently definite to entitle it or them to a specific name."

+ L. Caullery, *Le Probleme de l'Evolution*, p. 343. Cf. also Vernet, *l'Evolution du Monde Vivant*, p. 229, and S. T. Coleridge, *Theory of Life* (London, 1848).

++ M. Vernet, *L'Ame et La Vie*, p. 65.]

and so on. Similar stability is to be found in the characteristic foods, in the chemistry of the blood, and in the regulating mechanisms by which the organism maintains the fixity of its inner environment. These characteristics bind the separate organisms to the species to which they belong far more closely than does the morphological structure. They also determine the amplitude of the variations compatible with normal or with pathological conditions and, at the extreme limit, with survival.

There is, moreover, for every species a certain norm or characteristic pattern. This is susceptible of wide variability that can be brought to light by breeding. Nevertheless—as the breeder well knows—the purity of a variety is maintained only at the expense of strict supervision. It is possible to establish an inherited variation,

as when a temperate plant is transferred to a tropical climate and there develops evergreen characteristics. Although these characteristics may persist indefinitely in the new environment, they quickly disappear as soon as the plant is restored to its natural habitat.

From such evidence, which could be extended in many directions, we reach the conclusion that the species is itself an individual possessing an immutable pattern in eternity that acts constantly to draw the members of the species back towards the normal or stable varieties. These latter may consist of numerous genotypes; which are, in general, adaptations to certain environmental conditions, thus demonstrating the principle that the pattern in eternity is at once stable and mobile.*

The adaptation of the species to its environment calls for an hyparchic regulator analogous to that of the organism. There is, however, an important distinction that consists in the fact that a species may endure almost indefinitely under changing environmental conditions, provided that the limits of specific variability are not exceeded.

Some species are abundant and widespread, others are very rare. It has been observed that the abundant species have a larger reservoir of inheritable variation, both actual and potential. Such species have a high potency of adaptive change, whereas there are rare species that, though quite distinct in their biological character, flourish for a short period of time, and then disappear. The power of adaptation must therefore be looked upon as a property that is part of the eternal pattern. The relationship between species, whether rare or abundant, and the organisms of which it is composed, is always fundamentally the same, and indeed the domination of the species over the type is greatest in those that are rarest. Haldane has shown that the struggle of rare species [* Cf. M. Vernet, loc. cit., p. 181.]

is seldom between organisms so much as between the species as an individual and its environment.*

The stability of species is not ultimate. It derives from the superior pattern of the genus and this in turn from those of the family, class, order and so on up to that of the biosphere as an individual whole. Each such group has its own typical factor of stability. That of the genus, for example, turns upon a pattern of excitability that can be recognized in behaviour—everyone sees this in comparing *Canis* and *Felis*. Each genus makes its own characteristic contribution to total experience of life on the earth. Among the higher groupings we reach, with the families, significant elements in the total mechanism of reciprocal action of the autonomic world. At each stage there is the eternal pattern and there is also the corresponding form of hyparchic regulator. These together enter the actualizations that we observe to maintain on the one hand the ecological harmony of life and on the other to adjust life to the ever-changing conditions and needs of earthly existence.

8.21.6. The Origin of Species

The general conclusion to be drawn from the study of distribution of variations—the clines or character gradients—is that the regulation of existence depends upon the eternal pattern of the species acting through the epigenetic factor present in each organism in the course of its own development, whereas the adaptation of the species itself to its environment depends upon the hyparchic regulator of the species as an individual responding to the joint action of inherent variability and environmental influences.

Here there is a very important conclusion to be drawn as to the significance of organic evolution. It is commonly held that the problem of evolution is to account for the origin of species, whereas nearly all the data refers to adaptation of the varieties of the species to their environment. There is almost no evidence that the eternal pattern of an individual species could have arisen in consequence of an evolutionary trend. A great part of the data claimed as evidence for universal biological evolution can be accounted for more satisfactorily in terms of the hyparchic regulation that is possible for an individual; that is, self-directing entity. This regulation occurs within the limits of variability of the eternal pattern of the species as an individual being, and the data of breeding

[* J. B. S. Haldane, *The Causes of Evolution* (London, 1932).]

can be explained without assuming any modification of the pattern itself.

The ascription of conscious individuality to organic species may encounter the objection that we do not observe behaviour of a kind that we should expect from a conscious individual. The mutual adaptation of species appears to be a blind struggle for survival and nothing more. There is a twofold answer to this objection. First of all, we know very little of the pattern of behaviour of a conscious individual, but by hypothesis it must at the first gradation be directed towards the realization of his own eternal pattern. Now this is exactly what we do observe in the history of the organic species, every one of which, within the limits imposed by the pressure of the environment, works out the possibilities of existence that correspond to its own nature. Furthermore, our growing knowledge of symbioses must convince us that the Darwinian view of a blind competition for survival must be replaced by a recognition that for the most part the organic species prefer co-operation to war. Whenever man, using all the powers and knowledge of which he can dispose, has sought to reorganize the relationships of species within any area, large or small, he has found the problems of adjustment beyond his ability to resolve. The more closely we study organic life, the more are we forced to admit that the species are more intelligent than man; they have a greater sense of direction and constancy of purpose.

Evidence as to the relative status of the unit organism and the species can be found everywhere in the fact that where the interests of the two are in opposition, it is always that of the species that prevails. Sexual reproduction has little to commend it from the standpoint of the organism. Simple division of the kind that suffices for the reproduction of sexipotent entities places a far smaller strain upon the organization and permits an indefinite continuance of identical units. As animal breeders are well aware, the crossing of genes impairs the purity of a breed, but it strengthens the characteristics of the species. Moreover, the fecundity of the organism inevitably results in an immense destruction that has no regard for the interests of the unit, but it is the means whereby the species keeps a high potency that enables it to make full use of all favourable opportunities and to confront periods of food shortage or natural catastrophe without extinction. It is an observable fact that the wholesale perishing of unit organisms as a result of catastrophes scarcely disturbs the existence of the species, which can always reestablish itself provided that a few genotypes survive. It must further be recalled that for the most part species have the unity of geographical distribution and a community of rhythm in time that endow them with a

continuing individuality that sometimes can reach to the second phase of quasi-immortality.*

No one can doubt that during the long history of the earth's crust— over a period of not less than five hundred million years—the constitution of organic life has changed. Not only has the dominating form of life changed from epoch to epoch, but new orders of plants and animals have made their appearance in a manner that suggests that they were the results of evolutionary changes of earlier orders. There is, however, no conclusive evidence that a new order could arise from inner changes in the genetic constitution or outer changes in the environment. The discussion of this very important issue obliges us to take account of the sevenfold structure of life on the earth. The great divisions of animals and plants are called phyla, and these admit of subordinate classes down to the species. The structure can be illustrated by considering the classification of the common rabbit and the rose of our gardens.

7. Kingdom. Animal. Vegetable. 6. Phylum. Chordata. Cormophyta. 5. Class. Mammalia. Dicotyledones. 4. Order. Lagomorpha. Rosales. 3. Family. Leporidae. Rosaceae. 2. Genus. *Oryctolagus*. *Rosa*. 1. Species. *Oryctolagus cuniculus*. *Rosa canina*.

Table 21.1. The Taxonomy of the Rabbit and the Rose

There is no doubt that there has been a general pattern of development and yet attempts to construct a

phylogenetic system in which the different steps can all be shown as a geneological tree have proved disappointing. This does not, however, justify the belief that the extraordinary sevenfold structure of organic life has arisen through blind chance or the action of mechanical forces. Various theories of evolution seek to account for the origin of species by the combined action of the struggle for existence and mutations in genetic constitution, brought about either by environmental conditions or by chemical factors in the chromosomes. For some time it appeared that the mutations postulated by de Vries might account for the origin of species, but Goldschmidt and

[* Cf. J. von Uexkull *Theoretical Biology*, (London, 1926), p. 293: "I think there can be no doubt that every species represents really an independent organism with a character of its own endowed with tremendous longevity." The present chapter owes much to the arguments in Uexkull's great but neglected work.]

others have reached the conclusion that mutations alone cannot pass beyond the potential energy barrier within which the species is enclosed. We have here a situation analogous to that of the atomic nucleus that can only change when a very high energy is concentrated. Goldschmidt therefore proposed a mechanism of systemic mutations, but this is purely speculative in that we have no evidence that such mutations are ever observed. They would, in fact, have to produce viable monsters— the rarest of occurrences. Still less likely is the possibility of fertile breeding of such monsters.

It is true that some biologists, such as J. B. S. Haldane and R. A. Fisher, have made calculations purporting to show that de Vriesian mutations, giving only a small advantage to the mutant and occurring as rarely as one in a million individuals, can sweep rapidly over an entire species. Against this we have the undoubted fact that after fifty years of close study, no evidence has come to light that advantageous mutations ever do arise. The fruit fly, *Drosophila melanogaster*, has been observed through thousands of generations, and many millions of individuals, and the early expectations of finding evidence of specific mutations have been disappointed.

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This does not mean that variations do not occur, but they remain within the inherent variability of the eternal pattern of the species, and they maintain themselves not by forming and stabilizing a new pattern, but by an adaptation of the epigenetic mechanism. That transformations of pattern do occur is established by the palaeontological evidence, but we must acknowledge that no mechanism has yet been proposed that could give a sound basis for evolutionary phylogeny.

It is easy to see why biologists have clung to the hope of discovering a mechanism either in the environment or within the organism, or both, that would account for the origin of species; for the only alternative to such a mechanism would appear to be a return to the doctrine of ad hoc creation, and the abandonment of the fundamental belief in the universality of natural laws.

As nearly always happens with such antinomies, we find that the dualism which cannot be resolved has been artificially imported by faulty premises. It is assumed that a new species must arise in nature either from the result of antecedent causes or as the realization of a conscious purpose. There is no more need to accept this dilemma in regard to the origin of species than to do so in regard to the epigenetic development of the unit organism. The datum of experience is the ordered structure of life. We may not readily discern the seven steps in the structure nor the discontinuity that separates the genus from the

family. But it is evident that there is a pattern of life on the earth and that, in relation to this pattern, the genera play a role that is neither causal nor purposive. Proceeding further, we reach the conception of the biosphere, and with it the upper limit of autonomic existence. If we regard the biosphere as primary, the species and genera as secondary, and the unit organisms as tertiary in their significance, we should no more say that the species arise from the action of causes or to fulfil a purpose, than we should say the same about an organ in relation to the body of which it forms a part.

The basic conception that underlies our approach to the study of life is that of the unity and uniqueness of the autonomic mode of existence. When interpreted, with the help of our framework laws, we find the threefold structure of eternal pattern, hyparchic regulation, and temporal actualization. There is, however, a difficult step to make before these general notions can be applied to the practical problems that confront the biologist. At the present time the various branches of biology—or, as some would have it, the various separate sciences classed as biological—are sadly lacking in any unitary conception. The general biologist has a twofold task: to describe and to interpret the observations and experiments made in the several interwoven branches of his science. The first part of the task can be accomplished by a logical process, but the latter calls for intuitions that transcend the limitations of logic. The specialist tends to mistrust interpretations that go beyond observation and yet simple description is powerless to bring unity into the results furnished by experiments that penetrate into quite different aspects of life. The classical morphological taxonomy has proved unable to establish unambiguous criteria for the classification of species, genera, families, or even the great orders of animals and plants. Evolution—described only fifteen years ago by J. Huxley as *The Modern Synthesis*—is now seen to be very uncertain and erratic, whether viewed as a working hypothesis, as a taxonomic principle, or as a guide to biological experimentation. Even today most biologists still hold—almost as an article of faith—that if the history of life on earth were fully known, then the phylogenetic series would provide an infallible key to all taxonomic problems. But this faith cannot long be sustained in the face of evidence that, in the changes that, during geological time, have occurred in the biosphere, it has rather been the pattern of potentialities that has moulded the outward forms than the morphological transformations that have dictated the functional manifestations. If the invisible has directed the visible, then morphological phylogeny must be looked upon as the description of results rather

than an indication of causes. This is implicit in the tendency to rely upon genetical, ecological and geographical criteria in taxonomy, a tendency still in its early stages that has not yet disclosed the key to a fundamental systematics. All this is quite comprehensible if we realize that morphology, histology, genetics, and ecology can only give us the results of the interaction between the eternal pattern and the environment. The true source of order in the autonomic world is the hyparchic regulator of the biosphere transmitted through the phyla, the families, genera, and the species to each separate organism. The hyparchic regulator of the biosphere is an immensely complex system; but this should not preclude its systematic study. The metazoan organism has also an immensely complex system of regulation that reconciles the life of the soma to the conflict between the environment and the pattern. We must picture the hyparchic regulator of the biosphere as exercising its organizing influence in stages that correspond to the main taxonomic division of phyla, classes, families, and genera to adjust the forms of life on the earth to the climatic and tectonic influences on the one hand and the requirements of the eternal pattern of biospheric existence on the other.

If, then, we are to make practical use of these new conceptions, we must search in the autonomic world for the nature of the regulator as we have done in the case of hyponomic entities. We shall then find many threads that lead from the observed data to the underlying pattern of organic excitability. We cannot embark upon such an undertaking within the limits of the present work, but one example may serve to suggest a line of research that might be pursued.*

The genus *Crataegus*, which includes our familiar hawthorn, is spread throughout the temperate regions of the Northern Hemisphere. *Crataegus* is a sun-loving shrub that exists everywhere in a state of equilibrium between woodland and grassland. As a genus—with the exception to be discussed below—it is notable for the small number of species—usually not more than two or three—that inhabit any one area. Thus *C. oxycantha*, the common hawthorn, is almost the only species indigenous to the British Isles. During the nineteenth century extensive deforestation took place in North America as large areas were brought under cultivation. There then occurred a very remarkable change in the thorn population among which a large number of new species arose. According to Brown,⁺ ten species were known in 1890, while between

[* I am indebted to Dr. P. van Royen, of the Rijksherbarium, Leyden, for drawing my attention to *Crataegus*.

+ H. B. Brown, Torrey Bot. Club Bull., 1910, 37, 210.]

1896 and 1910 a total of 866 species were reported. Many of these are true Linnaean species, showing clear morphological and genetic distinctions.* Such a development cannot be accounted for in terms of the mechanism of natural selection, for the emergence of the new species was far too rapid for chance mutations to have an effect of the kind postulated by Fisher and Haldane.+ in their calculations. The stability of the genera of the family Rosaceae, to which *Crataegus* belongs, precludes any explanation in terms of cross breeding with other genera. Furthermore, there are several other genera of the family Rosaceae that were affected by the cutting down of the forests; but none responded by a similar proliferation of new specific forms. We are thus driven to conclude that the behaviour of the thorns was due to some factor inherent in the pattern of the genus as a whole. In other words, we find here evidence of individuality and individualized response to a change in the environment. We can go further and see that the notion of an eternal pattern would not suffice to account for the sudden appearance of many hundreds of new species unless it were combined with the action of an hyparchic regulator. In order to elucidate the structure of this regulator, we should need to study the chemical and climatical consequences of the deforestation and combine the data with knowledge of the genetic constitution of the old and new species. These results would then be related to the ecological data, including any change in the microbiology of the region. It would be noted, for example, that the seeds of *Crataegus* pass undigested through the alimentary tract of animals and germinate much more readily after being acted upon by the digestive juices. This is usually explained on chemical grounds, but is more likely to be evidence of a specific hyparchic sensitivity that may account for the ability of the thorns to respond to the situation created by the disappearance of the normal consociate woodlands. We should then look for evidence of changes in the habits of the thorns—such as flowering times and growth rates, together with the usual morphological criteria.

The investigation would be guided throughout by the hypothesis that the eternal pattern of the Rosaceae is sensitive to a certain mode of existence that is itself capable of a wide range of variation manifested in the various genera of the family. From a study of *Crataegus* we might find reason to predict that some other genus having few species

[* For a brief account see Stanley A. Cain, *Foundations of Plant Geography*, New York, 1944, pp. 384-6.

+ R. A. Fisher, *The Genetical Theory of Natural Selection* (Oxford, 1930), and 'The Rate of Spontaneous Mutation of a Human Gene', *J. Genet.*, 31, p. 317: J. B. S. Haldane, 'The Part played by Recurrent Mutations in Evolution,' *Amer. Naturalist*, 67, p. 5.]

—such as *Mespilus*, the medlar—might, when exposed to a certain environmental excitation produce numerous species in the endeavour to adapt itself to the changed conditions. In such a manner an experimental procedure might be developed that would have wider significance than the studies, at present so popular, of mutations experimentally induced by chemical agents such as colchicine or physical influences such as irradiation. These would then fall into place as a special case of the more general phenomenon of the organizing influence of the eternal pattern of the biosphere acting through the complex mechanism of hyparchic regulation at the different stages of differentiation into phyla, families, species, and varieties. We shall refer to this mechanism as the orthogenetic factor.

It must be understood that this mechanism does not produce new living forms out of dead matter nor new species out of alien cells. There is a continuity in life as in all other modes of existence. The orthogenetic factor is not a supernatural power—on the contrary, it is the very core and mainspring of all that we regard as natural. The basic assumption is that of latent variability. This is in no way strange or new to biologists.*

The problem that we have to resolve is twofold :

1. Where is the latent variability stored ?

2. How is it held in check when not required ?

The first question cannot be answered in terms of chromosomal pattern alone. Crossing can only produce new varieties, not new genera.+ The mutations of de Vries cannot account for the conservation of potentialities. Nothing that either changes in time or endures in time has the required properties—hence we are led back to the conception of an eternal pattern that holds all the potentialities of all forms of life in an orderly coherent structure.

The second question is commonly answered by invoking the struggle for survival. But this does not account for the cardinal fact that climate and not ecology is the main factor in determining the changes of species. We are thus led back to the notion of the hyparchic regulator. The fundamental triad that maintains both the phylogenetic and the ecological balance of vegetable life is indicated in Table 21.1.

[* Cf. J. Huxley, *Evolution*, pp. 56, 112, and 496. "The enormous plasticity of e.g. pigeons under artificial selection is proof that their previous stability was the effect of selection-pressure, not of any reduction in intrinsic variability."

Cf. also Cain, loc. cit., p. 326.

+ The 'synthesis' of new species of plants such as the famous *Galeopsis tetrahit* of Muntzig from genetically distinct ancestors remains strictly within the limits of variability inherent in the genus.

Cf. Cain, loc. cit., p. 472.]

Affirmative. The Eternal Pattern of the family. Reconciling. The Hyparchic Regulator. Denying. The Environment (climate, soil, and selection).

Table 21.1. The Stability of Vegetable Families

The combined action of these three can produce such small-scale phenomena as the exfoliation of species of *Crataegus* already cited and the grand-scale phenomena of so-called organic evolution. Under the organizing influence of the eternal pattern a rearrangement of chromosomal nucleic acids can set in motion the systemic mutations that lead to such proliferation of species as in *Crataegus* and *Acacia* or the appearance 'of new genera in response to changed climatic or edaphic influences.

8.21.7. The Biosphere

We are confronted with an obvious difficulty in our attempt to reestablish the overall pattern of life in the fact that we have direct contact with only one manifestation of biospheric wholeness; that is, with the visible autonomic existence present on the surface of the earth. We have evidence that through geological time there have been profound changes in the character of autonomic existence, and that these changes have occurred at intervals of several million years. We should therefore regard life on the earth as a recurrent series of biospheric existences rather than as a single manifestation actualizing without discontinuities. Even at the present time there are the survivors of earlier forms of life that do not appear to be needed for the transformations of energy as they are now proceeding on the surface of the earth, and that do not fit into the pattern of existence of the biosphere itself.

Since organic life began to leave its traces in the earliest sedimentary rock, not less than 1,500,000,000 years ago, there have been fundamental changes in the pattern of life. The evidence that one pattern has arisen by continuous transformations out of another is unreliable and scanty, and yet there is also no evidence that new forms of life have arisen abruptly in such a manner as to suggest a special creation. We are thus brought again to the triadic conception of life as the reconciliation of an eternal pattern and a temporal history through an hyparchic factor. The eternal pattern with which we are now concerned is organized at the level of octopotent

individuality. It is thus something distinct from the septempotent pattern of the species. The distinction can be made if we regard the octopotence of the species as being single-valued. It is the potentiality of being itself that makes of

the species a true individual of the first order. Individuality of the second order arises at the level of the family, where a definite role is played by the entire community of species and genera in regard to the biosphere as a whole. It is only at the level of the biosphere itself that we can postulate a fully organized octopotent pattern; that is, true individuality of the third and highest grade known to us upon the earth. The three gradations can be described as monomorphic, dimorphic, and tri-morphic octopotence, and once the distinction between these three grades has been grasped, we can understand something of the pattern of the biosphere. It is also very necessary here to remark that a precisely similar distinction of grades is to be observed in the development of individual man where the three supra-normal levels previously discussed correspond to consciousness of one's own destiny, consciousness of one's relationship to life as a whole, and consciousness of the cosmic plan.

The eternal pattern of the biosphere contains all the potentialities of autonomic existence actualized over a period of many millions of years. The actualization is itself of an unimaginable complexity, in which millions of different species and millions of millions of unit organisms are linked together in the common task of transformation of hyle from the hyponomic to the autonomic state. The central direction and organization of this task is performed by what we have called the orthogenetic factor of the biosphere. This endows each species with its own eternal pattern, and determines the course of its evolution and involution.

According to our existential systematics, the biosphere should represent the transition from autonomic to hypernomic existence. We cannot therefore expect to understand it if we approach it only from below, as the highest manifestation of life. Just as life itself is supported by the special properties of the active colloidal surface, so must we suppose that the hypernomic existence penetrates into life at the point of contact between two phases. This strongly suggests that the film-like character of the biosphere is significant for its cosmic role. It was the Austrian geologist Suss who first suggested that life and the earth's crust are related to one another in a manner that indicated the operation of some hitherto unsuspected laws. Later, Vernadsky, studying the cycles of transformation of the chemical elements in the upper layers of the earth's crust, and also in its atmosphere, reached the conclusion that organic life plays a decisive role both in the concentration and in the distribution of both rare and common elements.*

[* W. Vernadsky, *Geochimie* (Paris, 1924).]

Later still, Goldschmidt, in his painstaking investigation of the mode of distribution of the rarer elements in the earth's crust, showed that many observed concentrations of the elements can be traced back to the action of one of the three gradations of life—organic, cellular, or viral.*

The two-dimensional character of the biosphere is very striking. It has all the properties of an active surface film analogous to that which we found in the colloidal world. The greater part of biospheric activity is confined to the actual surface of the earth. Even at a depth of one ten-thousandth of the earth's diameter, little is to be found except a few bacteria living in oil-well brines or in the ocean bottom. The mass of the biosphere is very small compared with that of the other layers at the earth's surface. It is one seventy-thousandth of the mass of the ocean, and one three-hundredth of that of the gaseous atmosphere. The earth's crust itself is at least a million times more massive than the totality of life that breeds upon its surface. Notwithstanding its film-like character, the chemical activity of the biosphere is remarkable in its effects. The supply of the free oxygen in the atmosphere upon which the state of our earth depends is maintained by the photo-synthetic activity of green vegetation. The chalk cliffs and coral reefs are evidence of the massive character of biochemical action—nearly all fixed carbon in the crust of the earth has been captured from the atmosphere by living organisms. The migrations and concentrations of ore deposits have largely been produced by living agencies. The activity of plants, animals, and microorganisms has resulted in the formation

of the great concentrations of coal, petroleum, carbonates, and siliceous sediments.+

It is known that plants accumulate and concentrate certain elements in their cells—as aluminium is concentrated by the lycopods and silicon in grasses. It is also to be noted that the geologically most ancient organisms are able to concentrate a much wider range of elements than the modern animals and plants.++

The scale of bio-chemical activity may be gauged from the fact that it is estimated that a thousand million tons of organic matter is daily

[* Suss, *The Face of the Earth*. See also W. Vernadsky, *Le Biosphere* (Paris, 1932), pp. 338-9, and V. Goldschmidt, various scientific papers on Geochemistry. For more recent data see *Geochemistry*, by Kalervo Rankama and Th. G. Sahama (Chicago, 1950).

+ It has been suggested that hydro-carbons are of orogenic formation, and even that they may have taken part in the primitive formation of the earth's crust. This view, however, is closely associated with the belief that life itself originated at the same time. The oldest trace of organic activity goes back some 1,400,000,000 years to the Archaean fossil *Corycium enigmaticum* (Rankama and Sahama, loc. cit., p. 321). ++ Cf. A. Vinogradov, *Compt. Rend.*, 197, 1673, 'The Elementary Composition of Chemical Organisms and the Periodic System of the Chemical Elements'.]

synthesized, under the action of the sun's light and heat radiation, from the carbon dioxide of the atmosphere. Approximately the same amount is returned to the atmosphere by oxidation, so that an immense transflux equilibrium is maintained in the more active forms of chemical energy.*

The decisive character of the bio-chemical activity can be inferred from the fact that land plants alone assimilate in ten years a quantity of carbon equivalent to the total amount bound as carbon dioxide in the lower atmosphere. If the total carbon reserve present both in the oceans and the atmosphere is considered—some 17,000,000,000,000 tons—it is found that plants assimilate a quantity equal to the whole of this reserve in less than a hundred years. All the oxygen now present both in the surface of the earth and in the atmosphere has repeatedly circulated in the cycle from the atmosphere, through the biosphere, into the oceans, and back again, at intervals of about two-and-a-half million years. This estimate, due to Rabinovitch,+ is of very great interest, as it gives a figure of two to three million years for the duration of a given manifestation of the biospheric pattern—a figure that agrees both with the geological evidence and with an estimate based upon the study of cosmic rhythms.++

It is noteworthy that in many cases the chemical activity of living organisms has little to do with their own needs. Bacteria do not directly concentrate the elements, but most of them produce enzymes and bio-catalysts that continue, for long periods, to regulate the chemical reactions that have gradually produced some of the principal concentrations—such as the vast iron deposits of the great lakes in America. Elements thus concentrated which are independent of their value as nutrients are called 'ballast elements', and they appear to pass through a given species without participating in its particular life needs.§

All this evidence goes to show that the biosphere plays a role needed for the transformations of energy and matter on the surface of the earth, and that we should seek for its pattern rather in the needs of the earth itself than in those of its own self-preservation.

The individuality of the biosphere can teach us much that is essential for our understanding of the cosmic drama in general, and of human destiny in particular. The actualization of the biosphere has very probably continued for more than 1,500,000,000 years with no replenishment or renewal of pattern from outside sources. As the cells stand below the level of sexual reproduction, so does the biosphere stand above this

level.

[* Rankama and Sahama, loc. cit., p. 336.

+ E. I. Rabinovitch, *Photo-Synthesis and Related Processes* (New York, 1945). ++ P. D. Ouspensky, *In Search of the Miraculous*, p. 332.

§ See A. Frey-Wyssling, *Naturwissenschaften* (1935), Vol. 23, p. 767. 'The Elements Indispensable for Plant Nourishment'.]

It does not appear to be a member of a community of organisms like itself, but is concerned only with a process of transformation in the solar system, in which the earth, the sun, and the moon are principal agencies.* No less striking in its isolation from other individuals of like nature is the intimate connection between the biosphere, the earth, and other heavenly bodies. The eternal pattern of the biosphere stands at the threshold of novempotence, and is thus the first direct expression of the creative power that we have encountered as we have traced the ascent of hyle from the ground-state through the different levels of hyponomic and autonomic existence. Within the biosphere itself the regulating mechanism must have its own threefold structure, as in each unit organism. The orthogenetic factor is the means whereby the affirmative pattern is reconciled with the mechanical processes of transformation that proceed in the many species and genera of which the biosphere is composed. The visible pattern of the biosphere is to be found in the interrelation of genera. It is noteworthy that the normal duration of a species undergoing transformation is some two to three million years, that corresponds with the time period provisionally assigned to the cycle of actualization of a given biospheric pattern. The quarternary geological epoch can be taken as the latest cycle of manifestation of the pattern of the biosphere. It has lasted at the present time about one million years, and we are therefore about one-third of the way through the cycle. During this time there have been the great ice ages and the appearance and disappearance of continents, markedly changing the distribution of land and water masses on the earth. Throughout this time the domination of the mammalian order is slowly giving place to that of the primates. The 'genus' homo has become a dominating form of life; and one, moreover, that is sufficiently individualized to constitute the single 'species' of homo sapiens. The dominance of man has now attained the same degree as that of the amphibia in the carboniferous epoch or the reptilia in the mesozoic. It is only by morphological standards that man can be classified as a sub-species of the order of primates. Judging by his significance in the biosphere and the changes that have resulted from his appearance on the earth, man should be distinguished from the other craniata as a new class of entity. While this new class has made its way to the position of dominance in the past 500,000 years, the pattern of organic life has remained stable, especially in regard to the great transformations of energy and matter taking place through the animal and vegetable kingdoms together with the sub-stratum of cellular and viral existence. So marked has been the stability of the biosphere that

[* Cf. Rodney Collin, *The Theory of Celestial Influence* (London, 1954), pp. 49-57.]

there is no evidence that any new species has arisen on the earth during the past million years. We may conclude from this that the orthogenetic factor is not only a means for ensuring a transformation of genera according to the changing needs of the earth, but also the means for preserving the stability of life itself. Just as the epigenetic factor serves during the period of development for bringing about differentiation and determination, whereas in the adult it serves for maintaining stability and restoring disturbed states to the norm—so also should we see in the orthogenetic factor of the biosphere a means for harmonizing evolution and involution, for maintaining stability, for regulating relationship of the several parts of the biosphere, and above all, as the instrument of its individuality. As in man, the epigenetic factor may become conscious, and then is the seat of his individuality; so also may we suppose that the orthogenetic factor in the biosphere is becoming conscious of itself and of the needs of higher levels of affirmation and may at some future time bring into harmony with these needs the process of hyponomic actualization on the surface of the earth.

8.21.8. The Hypernomic Role of the Biosphere

The hypothesis of biospheric wholeness implies that all the manifestations of life on the earth are unified in respect of being, will, and function. This is only possible if there is a single affirmation that transcends the existence of the biosphere as the pattern of the species transcends the life of the organism. This transcendent power is the pattern to which the existence of the biosphere conforms—that organizes its potentialities and regulates its actualization. The biosphere, being an intermediate mode of existence, does not correspond to one of the twelve great orders of potency and must therefore derive its wholeness from the superior order of novempotence. This is manifested in the category of pattern that belongs to the planetary world. Pattern, though immanent in all autonomic existence, is nevertheless transcendent to it in origin. The pattern of the biosphere is not its own, but one that it receives from the earth its mother. By realizing the pattern of the hypernomic world the biosphere fulfils its destiny as the reconciling force in the cosmic triad. The biosphere is, however, by hypothesis, a free individual that is fully octopotent and we must therefore conclude that its self-realization is conscious and voluntary. This raises questions that we are not ready to pursue, for they lead us into the domain of values and so outside the scope of a natural philosophy.

The biosphere is the reconciling force in a triad that relates the creativity of the sun to the pattern which resides in the earth itself.

This pattern renews itself from age to age according to the plan which the solar system exists to accomplish. This plan cannot be known in its full significance upon any of the levels of autonomic existence. We can observe the consequences of its action, and can make certain limited inferences as to its form, but we cannot, within the limitations of our autonomic nature, know the affirmation from which it proceeds.

The biosphere should be for us the richest source of experience from which to derive material for understanding the decempotent plan. Unfortunately we study the biosphere almost exclusively in its significance for our somatic concern—as a source of food, and of raw materials for our somatic undertakings. Even 'pure' biology confines its aims to a better knowledge of the mechanical processes of life and does not seek to understand the individuality of the biosphere. And yet the subject is not inaccessible to our observation; we have accumulated sufficient data to make a working hypothesis as to the nature of the biospheric pattern. According to the doctrine of reciprocal maintenance, the biosphere must serve for the transformation of energies required for some form of existence other than itself. This other form of existence cannot be the same as the biosphere, since reciprocal maintenance cannot be cannibalistic—one species living upon itself. By definition the biosphere is the highest form of autonomic existence and we are thus led to the hypothesis:

The Biosphere exists to transform energies required for the maintenance of some form of hypernomic existence probably within the solar system.

In order to apply this hypothesis to the interpretation of the biospheric phenomena and other data derived from terrestrial observations, we must inquire into the kinds of energy transformed by living beings that differ from those that participate in hyponomic processes only. Such energies must evidently be connected with life itself and most probably consist of hyle in the sensitive or partly sensitive state. We should therefore re-institute a systematic inquiry into the varieties of sensitivity arising in all forms of life from protozoa to man and search for the laws that govern the transformation of one form of sensitivity into another. Together with this inquiry we should re-examine all the known data concerning the interdependence of organic species including bacteria and search for evidences of a biospheric organization. The eternal pattern of the biosphere may be inferred from knowledge of the orthogenetic factor that regulates the development and transformations of species of animals and plants.

By combining all that can be discovered in these researches we may

find it possible to distinguish forms of sensitive energy, the production of which does not serve any, or at least no exclusive, terrestrial purpose, and so make a step towards establishing the role of the biosphere in the general economy of the solar system. Such researches would then link up with the astronomical and astrophysical observations by means of which scientists are engaged in studying the hypernomic worlds.

Part 9 - The Cosmic Order - Chapter Twenty-two EXISTENCE BEYOND LIFE

9.22. 1. The Four Hypernomic Gradations

Everything that lives must die, therefore immortality can have meaning only as a state that is beyond life itself. That which does not live and yet does not perish is able to renew life and we see the reflection or projection of this power in the pattern of the biosphere. Starting from the hypothesis that there must be modes of existence that are predominantly affirmative, we discover ample evidence that there is an organizing power that regulates existence without participating in its processes. This power has the character of will, but, according to our conception of the fundamental triad of existence, will cannot manifest except in relationship to being and function. Since we cannot know either will or being, we must look for functional systems that can be associated with the affirmative will. We know of the existence of the heavenly bodies— planets, suns, and galaxies, and we make the working hypothesis that these are the visible manifestations of the hypernomic modes of existence.

Our greatest difficulty at this point is to form some conception of the meaning of the phrase 'existence beyond life'. It is a being-symbol that can have for us a definite meaning only in so far as we can discover in our own experience a state or form of existence that does not participate in any of the functional processes of life and yet is conscious and voluntary. There is convincing evidence that some men are capable of discovering this, but cannot describe in functional terms what it is that they discover. It is, however, sufficient for our present purpose that we can conceive modes of existence in which the functional and perishable is subordinated to the voluntary and imperishable. We can further go some way towards representing to ourselves the relationship of being with the aid of our study of the biosphere as the carrier of the pattern that enters it from beyond life itself. Our next task is to carry this undertaking farther into the hypernomic worlds. Our justification for embarking upon such a venture is the intuition of the universal similarity uniting all existence—an intuition that has guided us throughout and that is no less necessary for the investigation of the physical and biological worlds than for those we are now about to study. We do not

formulate this intuition in deistic terms, but it is worth recalling here the words of Schiller, "The universe is a thought of the deity. Since this ideal thought-form has overflowed into actuality, and the world born thereof has realized the plan of its creator, it is the calling of all thinking beings to rediscover in this existent whole the original design."* The categories of the hypernomic world are in Plato's words "the contents of the creative mind of God, the final causes of the world and the inspirers of our thoughts". These passages may serve to us both as an encouragement and as a warning: the former in that they show how the noblest minds have perceived the reality of existence beyond life and the latter by reminding us that sign-words like 'God' and 'thought' can be used to convey a false sense of concreteness in a context where not even symbols can express the meanings for which we are searching. The hypernomic world makes itself known to us in its gestures, not by thoughts and not by signs. The interpretation of the hypernomic gesture calls for a patient investigation of functional manifestations rather than the poetic leap into the dark. We happen to live in an age when, for some reason not yet apparent, it has been given to man to discern not only the inconceivable vastness of the universe but also its orderly coherent structure of worlds within worlds. We must not allow ourselves either to reduce the universe to a mechanical toy or to dissolve it into a spiritual dream. The hypernomic world is beyond life ; but it is firmly compounded with the autonomic modes into a reality that can be known and understood within the limits of our human powers.

9.22.2. The Universal Character of Supra-animate Wholeness

The manner in which the pattern of a superior whole exerts a common organizing influence upon an indefinite number of subordinate wholes is to be observed in the relationship between an organic species and its member organisms. The affirmation of the specific pattern presides over the destiny of each unit organism, and at the same time establishes the conditions of its existence. The individuality of the species transcends the distinction of one and many. The individual differs from the atom because it can divide and yet remain itself. It can be multiplied and yet not lose its identity. This peculiar property, unknown in the hyponomic world, is possible for individuality because its existence is virtual and not actual. The individuality of the biosphere does not consist in the

[* F. Schiller, *Theosophie des Julius*, *The World of Thinking Beings*.]

opposition of A and not-A—biosphere and not-biosphere—but in the unity of pattern that makes possible a singleness of affirmation.

We have already remarked upon the transitional character of the biosphere that makes it analogous to the active surfaces which mark the transition from physics to biology. It is an error to regard the biosphere as an organism similar to a plant or an animal, but of a greater complexity and duration of life. The biosphere as an individual does not live. The species and genera live, develop, and transform, but the biospheric pattern remains. The biosphere is an affirmation rather than a manifestation of life. Autonomic existence is manifested in the life and death of organisms. Its nature and destiny are asserted in the pattern of the biosphere.

It has been noted that the biosphere fits over the earth as a glove fits over a hand, and this physical analogy corresponds to the underlying relationship by which the pattern of the biosphere is created. The earth could presumably exist without life, but life as we know it would be impossible except upon the surface of a planet exactly like our own. The physico-chemical conditions on the earth are indeed so exactly attuned to the needs of life that relatively insignificant changes in temperature, in the quality of solar radiation, in the composition of the atmosphere, in the salinity of the oceans and the chemistry of the soil, would be sufficient in a very short space of time to wipe life off the face of the earth. Herein we see that the pattern of the biosphere is something more than the complex system of genetic relationships by which the different species of animal and plants are kept in equilibrium. It is a response to the condition of the earth at the present period of the earth's history. In the past, when conditions have been different, the forms of life were quite other than they are today.

We should, however, be wrong to divorce earth and biosphere as two unconnected modes of existence. The biosphere is an individual, but at the same time it is an integral part of the earth itself. We could not conceive the biosphere being peeled off the surface of the earth as the skin is peeled off an onion. It is what it is only so long as it remains a part of the earth's structure.

It is unnecessary further to emphasize the intimate connection between the earth and the biosphere, or to produce evidence that the state of the biosphere depends upon conditions at the earth's surface. Our problem is to understand how the two are related as components of a triad. We are accustomed to look upon the earth only in its hyponomic aspect; that is, as a material system undergoing energy transformations. When we recognize that the biosphere is an integral part of the earth, we see

that the earth itself has an autonomic aspect. Neither the one nor the other tells what the earth is as a mode of existence. For this we have to turn generally to the whole planetary system of the universe, and take into account the probability that millions upon millions of planets exist on which there are manifestations of life. According to the progression of the categories, pattern should be the dominant character of the planets as occupants of the ninth existential gradation. This can best be understood if we reflect that life, as an autonomous power, can fulfil its cosmic function only if it has a designated place within the universal order. The pattern of planetary existence endows every entity—able to be sensitive to its influence—with a

particular place and destiny. The planets, as the pattern-bearers of the universe, are thus interposed as regulators between the free creative power of the stars and the autonomy of individualized existence.

Passing from the planets to the suns and stars, we see the tenth category of creativity pervading every galaxy and manifesting in the suns, which may be regarded as individual entities existing two stages beyond the upper limit of life. The stars are sometimes compared with atoms, but no analogy could be more misleading; for the principal characteristic of the atoms is their lack of individuation, which makes them interchangeable and indistinguishable. Moreover, the atom is not susceptible of subdivision without ceasing to exist as such. The stars have properties in every way contrary to these. No two stars are identical, nor can the destinies of any two stars be interchanged. They are fully individualized, and yet they are capable of indefinite subdivision. They are complex wholes that comprise among their parts the planetary systems, and within the planetary systems all the limitless variety of autonomic existence. One of the outstanding characteristics of decempotent entities is the manner in which they fulfil their destiny without mutual interference. Interaction between stars is one of the rarest events in the universe—so rare that it has been calculated that two galaxies, each containing a hundred thousand million stars, can pass right through one another with scarcely a collision or even a mutual disturbance between any two stars.

The independence of the stars is the condition of free creativity, and yet they are not cut off from the higher pattern of the galactic systems that constitute the level of undecimpotent existence. Both the stars as such and the galaxies as such are universal manifestations. At each of the three levels we have a characteristic universal affirmation. There is a planetary affirmation that is universal and common to all planetary existence. It is independent of energy exchanges or any other form of

communication in space and time. In the limitless variety of planetary patterns, one cosmic role is always enacted; namely, that of establishing the conditions for the arising and development of autonomic existence. Similarly, all suns conform to the one solar quality of free creativity, that with all its variety remains true to one unvarying type. The unity of pattern and the diversity of form that we see in all the heavenly bodies, gives us a key to understanding the common character of all hypernomic existence. We see the diversity, but we can only infer the pattern from our understanding of universal laws.

9.22.3. The Trans-finite Triad

We can only hope to understand something of the hypernomic worlds by looking beyond the incomplete manifestations of the triad in our common experience towards its ultimate—that is, cosmic—significance. The relationship of the affirming and denying forces admits of a limitless variety of forms. In one of these we can look upon denial as the manifestation of sameness and affirmation as the manifestation of difference. The hyle in its primitive ground-state is pure denial, for the very reason that it is everywhere the same and is therefore in a state of maximum entropy. At the other extreme we place the cosmic affirmation, regarded as a plenum in which the pattern of all patterns teems with potentialities beyond all possibilities of actualization. The two extremes are equally inaccessible to any finite experience, for they lie beyond barriers through which no existing entity can ever pass. Pan-hylism—that is, the doctrine that the undifferentiated ground-state is ultimate and all existence mere aggregations of the hyle—can explain nothing; but pan-psychism—that is, the doctrine that the reality is one infinite consciousness within which all existence is but Maya, a dream—is equally unsatisfying. This does not mean that we do not have to take into account the ultimate realities that lie beyond all possible experience. The notion of infinity is no longer invested with the halo of mystery that was ascribed to it in former times. The notion of a limit is as precise, and as amenable to exact analysis, as the notion of a finite quantity; wherever we can think of a limit we can also think of that which is beyond.*

We may think of the ground-state of the hyle and the cosmic autocrat respectively as two limits that can be expressed by the numbers zero and infinity, and yet find it possible to think of being that has less than

[* We owe much to the genius of Georg Cantor, whose work, Contributions to the Founding of a Theory of

Trans-Finite Numbers (1915), showed how clear concepts can be formed of limits, and hence of finite and trans-finite numbers. Moreover, the trans-finite ordinal numbers are no harder to conceive than the trans-finite cardinals, and they allow us to associate infinity with the notion of an endless becoming.]

no existence, or more than infinite existence. It therefore matters comparatively little whether from a physical standpoint the existing universe is to be regarded as finite or infinite. The Sanskrit term Mahato mahiyan—greater than the great—expresses the notion of infinity better than that of adding numbers without end. When the limit of greatness is reached, there is still that which is beyond greatness itself. Similarly, the undifferentiated ground-state is the least of all existence, but beyond it there is the 'less than least'—that is, non-entity beyond existence.

With these considerations in mind, we can define a trans-finite triad in which the affirming power is that Being that lies beyond all existence, and the denial is that Non-being which is less than non-existence. Between these two forces, existence itself—that is, all the universe, actualized and unactualized, potential and recurrent—is the reconciling force through which Being and Non-being merge into reality. This formula could be called the 'postulate of the non-ultimate character of existence' or the 'postulate of transcendental reality'. By its very nature, the postulate is unverifiable by any procedure available to the natural philosopher but it does not follow that it can have no meaning. We have to bear in mind that the realm of existence is non-ultimate in a sense that can be verified in our immediate experience. Values are transcendental with respect to facts and the transfinite triad assumes a direct significance if we reflect that the experience of Being and Non-being is present whenever we experience the need to understand meanings. Our very interest—the study of fact—is itself not a fact. The postulate of the transfinite triad is the only means available to us of expressing in factual terms the conviction that fact is not the end of experience.

9.22.4. The Finite Cosmic Triad

Within the existing universe we can discern the two streams of involution and evolution. This does not mean that the universe itself is divided into two parts, one in the process of involution—that is, a flowing out of the source—and another in evolution—that is, returning to the source. The twin processes pervade everything. Using concepts properly applicable only to life, we may say that everything is dying and everything is being born. Moreover, the twin process is not subject to the separation of the determining-conditions. There is a coming into existence in time and a perishing in time. But there is also a timeless structure of levels in eternity, in which the higher levels exert an organizing influence on those below, while the latter exert a disruptive force upon those above. The organizing and the disorganizing forces are the

eternal aspects of involution and evolution, and this is why it sometimes appears that involution as a creative positive force must be regarded as good, and evolution as a disruptive disorganizing force is regarded as bad. In the dimension of hyparxis, evolution and involution appear quite differently; for evolution is in the direction of ableness-to-be, achieved through the differentiation of recurrences, whereas involution is the tendency towards the separation of recurrences, towards sameness and, finally, the exact repetition of the most primitive entities. In space, involution is manifest in the complexity and the profusion of form, whereas evolution is seen in simplicity and unity of design.

We can only hope to reach a fuller understanding of evolution and involution if we succeed in combining these very different notions and realizing that they are manifestations of the affirming and denying forces in what can be called the finite or inner cosmic triad.

Everywhere and in everything, evolution and involution are in opposition, but there is also everywhere a factor of reconciliation, the nature of which varies in passing from level to level. Whereas involution and evolution are everywhere the same in their fundamental tendency, the third or reconciling force takes forms so diverse that it is often impossible to discern its operation.

Conceived as a relationship of time and eternity, involution is transition from the pure potentiality of universal consciousness towards the fully actualized passive state of the existing world; whereas evolution is the ascent of hyle by successive stages of integration from the un-differentiated ground-state towards the prime source. In the twofold process man occupies a definite position as one of the species of the biosphere. In the present geological epoch, the position of mankind is that of the dominant species, which yet remains subordinate to the biosphere. It is not human life nor human consciousness, but all life everywhere on all planets of the universe, that manifests the third force in the inner cosmic triad.

9.22.5. The Relationships of Space

The determining-condition of space enables the existing universe to acquire a structure of position, size, shape, and relative motions. Lines, surfaces, and solids themselves constitute a triad that allows a diversity both of forms and processes; all existence actualizes through motions, and motions derive from linear cosmodesic paths. All transformations require separation, and separation depends upon two-dimensional surfaces. In all relationships there has to be a combination of joining

and dividing. They cannot be sustained in less than three dimensions of space.

The relativity of size is one of the most remarkable features of the phenomenal world. At the lowest limit of our possible observation are the corpuscles and the ultimate particles. They are so small that no means of observing them directly could ever be devised. Their presence is inferred in their transformations, in which all their recurrences must participate. The smallest particle of matter that can be seen under the most powerful electron microscope is far less than a millionth of an inch in diameter, and each of the galaxies is so huge that light travelling at a velocity of one hundred and eighty thousand miles a second would take more than fifty thousand years to traverse it from end to end.

[illegible]

If now we consider any single manifestation of autonomic existence, such as the biosphere of our own earth, we can calculate its mass in terms of green vegetation in the forests and oceans and all other living forms. This gives a total of about 10^{39} ultimate particles for the whole of autonomic existence on the surface of the earth. We thus have a striking relationship that can be written:

$$N_{\text{crit}} \times N_{\text{univ}} = (N_{\text{loss}})^2, \quad (22.1)$$

where N_{comp} is the number three that represents the simplest possible relationship and N_{univ} is the number given by Eddington, representing the greatest complexity. N_{sim} is the geometrical mean of these two limiting quantities. This is a very interesting result, because it suggests that each manifestation of life such as we see in the biosphere stands about midway between the largest and the smallest wholes of which we

can have a possible knowledge through our organs of sense-perception.

It may be that the fundamental laws that govern existence set limits to the relationship possible for any given class of wholes. The corpuscle, as the non-individualized unit of hyle, requires 1079 recurrences, because it has to preserve all the potentialities of the material universe. These calculations must not, therefore, be taken as deductions from self-evident premises, obviously valid and independent of all existence. On the contrary, they are connected with the limits of human perception and cannot be separated from human experience. They nevertheless strengthen our belief that life itself occupies a position midway between the two extreme states of the hyle, but this again is not to be taken as a synthetic a priori proposition. It is an empirical consequence of the manner in which the world presents itself to our experience.

The limits of possible human perception are indeed vast; and compared with these limits the amount we actually know is very small indeed. The earth is very close to us and we have methods of exploring its interior and studying its past history that are not available for the study of the stars or even the remaining planets of our own system. Nevertheless, the earth and its history remain enigmatic. We can study the completed life-cycle of an organism and we can know something of the arising, dominance, and decay of organic species. Through such studies we can infer the presence of the hyparchic regulator by which every organism maintains the balance of regeneration and decay. We know of nothing corresponding to this in the existence of the earth, and we are certainly not entitled to speak of the 'life of the earth' except as a figurative expression. We are constantly led into error by supposing that to know the history of an entity is the same thing as knowing the entity itself. The very word 'history' is properly applicable only to living entities. The earth in its real nature is supra-historical. It is the affirmation of a pattern of existence and not its actualization. We know almost nothing of this pattern except as it is reflected in the conditions of organic life.

There is implicit in nearly all cosmological speculations the assumption that what we can know about the history of the stars is not less, in proportion to their size, than what we can know about events upon our own scale, but there are serious errors in this supposition. In the first place it is obvious that the means that we have at our disposal for the investigation of events upon a great scale are restricted as compared with those by which we study our close environment. We know our bodies and the objects with which they come in contact, not only by sight, but also by sound, touch, taste, and smell. We can change the course of

events and can then observe the results of our intervention. Of all these means, light-signals are almost the sole instrument available to us for the study of events far beyond the surface of the earth. This limitation is, moreover, only a minor disability compared with that which results from the difference in nature that separates us from the stars.

The great events of the universe are not only larger, but incomparably more varied and complex in their structure than the small events that are occurring on the surface of the earth. The astronomer allocates the stars to classes; but he constantly discovers that new sub-classes must be created, and even begins to suspect that no two stars are even approximately alike. Men are intensely individuated as compared with animals, and animals are equally so as compared with cells or protein molecules. This intensity of individuation compensates for the growing complexity of structure found in the ascending scale of being. The little that we know of conditions of life on other planets must at least convince us that, if life exists, it must be utterly different from that which we know upon the earth. In other words, the biosphere must be a unique individual among all the hundreds of thousands of millions of biospheric concentrations upon the planets of all the universe. Such is the complexity of organic life upon a planet that it is most improbable that a second biosphere like that of the earth could exist anywhere in the universe. The individuation of the planets and of the stars must represent a still greater degree of intensity, and the complexity of the possible relationships must increase in a geometric scale in passing from one level of existence to another. This means that our possibility of knowing a star is not merely proportionately less than our possibility of knowing the earth, but, in the literal sense, incomparably less.

We may trace the 'history of the stars'; we may witness what appears to us to be the 'birth' of a star; or we may believe that we can follow the course of its final dissolution, either towards explosive destruction or its perishing for want of material to maintain its activity. But, whatever we may discover about the effects of energy exchanges, we remain as ignorant as our remote ancestors of the nature of a star and the meaning of its existence.

9.22.6. The Dramatic Significance of the Universe

Affirmation is an active or positive characteristic. We must be on our guard against confusing activity and actualization. The force is not that which moves, but the source of the movement. That which transmits an active force ceases to do so when it merges with the result. A man thrusting his weight against a door transmits a force tending to make it

open. If the lock gives way and the door flies open, the man may follow it, and from being active becomes passive and falls to the ground. In a similar fashion it is the destiny of the active force always to produce activity, but in doing so to suffer a diminution of its own affirming power. We meet here with the supreme paradox of existence—that it is affirmation that involves and denial that evolves. But since neither can exist without the other, the conflicting stress of involution and evolution can maintain themselves only by the very fact that they are opposed.*

This opposition—the 'strife' of Heraclitus—may or may not be reconciled. In this uncertainty lies the dramatic significance of the universe. The reconciling force, that we have seen in all life as the hyparchic regulator, is itself a result. Since the consequences of the meeting of the two streams of evolution and involution must be incalculable even for a supreme intelligence, reconciliation is hazardous and unpredictable. That this is so can be verified in terms of human experience, where the arising of the spirit of man can be seen as a consequence of the opposition between his eternal pattern and his temporal actualization. We cannot see it in the universe, for we are unable to grasp the nature of the affirming force that transmits the pattern of all existence. We must note, however, that existence beyond life does not consist in 'doing' anything and therefore, in so far as we identify life with activity, the higher world is a non-living world. It is, however, affirmative and therefore potential. According to the relativity of being, potentiality itself must be relative and we shall expect to find different levels of existence beyond life, each characterized by a certain intensity of its potential pattern. The classification of the sciences has suggested that there should be four such gradations from planetary to universal being.

Affirmation can be regarded as an organizing pressure. The affirming force makes a demand that serves in its turn as a vivifying or spiritualizing factor for the denying force with which it is confronted. The earth makes a demand upon the biosphere. All life perpetually serves the needs of the earth and the pattern of existence to which the earth belongs. We should expect that, in a similar manner, the earth itself is confronted

[* We should note here the ancient tradition of the twofold path that was claimed by Heraclitus of Ephesus as his own invention, but was certainly derived from the Babylonian dualists. The two statements "out of all one and out of one all" and "the path upwards is the path downwards" epitomize the whole conception. Heraclitus recognizes that the fire on its downward path must lose its heat and turn finally into the earth. The upward path, *anathymiasis* [greek], is that of evolution. Moreover, Heraclitus identifies the affirming force with the eternal fire that appears in the world as the sun.]

with the needs of the planetary world that in their turn constitute the affirming force. This means that, relative to its mass, the earth must be more actualized than the sun, the sun more actualized than the galaxy, and the galaxy more actualized than the whole universe. Actualization is an ageing process; it is the using up of potentialities—that which has used up its potentialities is old, even if it is new. That which keeps its potentialities intact is 'ever young'. Realizing this, we may see a solution of the paradoxical observation that the earth, although 'newer', gives evidence of being older than the sun, and in the same way the sun may be

regarded as older than the galaxy, and the galaxy older than the universe itself. So disconcerting indeed is this observation that up to the present no astronomer has been prepared seriously to follow out the consequences of observations that suggest the relative seniorities in the reverse order to what seems inevitable.

Nevertheless, it would not be correct to say literally that the earth is older than the sun, for this would be to think in historical terms that do not apply to existence beyond life. There is a relationship of actual to potential that must be conceived as beyond eternity as well as beyond time. Astronomical cosmology is encountering more and more facts that contradict the old theories according to which the earth was formed from the sun and the moon from the earth.

There is an aspect, however, in which the universe can be said to have a history. When we observe the transformations of energy by means of light-signals and other methods of extending our sense-perceptions, we place ourselves in a perspective that makes the universe appear to be historical and we can therefore speak about the 'evolution' and 'history' of the stars. Such a form of speech is not false, but it is fundamentally subjective. The way in which we are compelled by the limitations of our sense-perceptions to observe the universe, and by the limitations of our mind to think about it, constitutes the so-called 'history of the universe'.

So far we have conceived existence beyond life as a pattern outside of space and time, and therefore to some extent analogous to the eternal pattern of an individual organism. To give fuller expression to the quality of affirmative existence, we must penetrate farther into the meaning of the tenth category of 'creativity'. The pattern of the individual organism is a consequence of its heredity and the conditions of fertilization and growth. It is only the hyparchic regulator that can be called self-created, and that only for conscious being constructed on the same pattern as man. Even with man, the eternal pattern is something given or imposed. Every man is presumed to have the choice to be or not to be, but he can in practice only be what he is; namely the actualization

of his own pattern. With existence beyond life it is otherwise; for existence is centred in the pattern itself, not in its reconciliation with the denying force. Life is response to an affirmation, but existence beyond life is affirmation itself. The earth is what it affirms, and the sun likewise. The difference between one supra-animate level and another consists qualitatively in the degree of freedom that resides in the power to create its own pattern—to make its own affirmation rather than to accept that of a higher order. It is precisely because the sun is less actualized than the earth that it is freer in respect of affirmation. The galaxy in its turn is freer than the sun, because by far the greater part of its existence remains potential.

Chapter Twenty-three THE SOLAR SYSTEM

9.23.1. Creativity and Sub-creativity

The solar system is our cosmic home and we should know it as a man knows his own hearth. It is, recognizably, a great whole composed of many connected parts; yet we know very little of its interrelations. When we take stock of all that astronomical science can tell us, we learn little more than that there is a collection of masses transforming energy on a vast scale and yet—apart from our own biosphere—lifeless and without use or purpose. Regarded in hyponomic terms, the solar system seems to lack even the coherence and significance of a material object and to be a mere collection of tripotent entities actualizing almost without interaction. We discover no context within which its existence could have a recognizable meaning. It is little more than observational material for the study of physical and chemical transformations.

What we know of the solar system can be summarized in a few sentences. It consists of sun, planets, asteroids, comets, dust, gas, free particles, and corpuscles, together with fields of force—gravitational, electric, and magnetic. We have learned not a little of the physics and chemistry of the sun and the planets, and we can make surmises as to their origin and the probable course of their future physical transformations. Notwithstanding the spectacular advances in solar physics that have been made within the last generation, we

have come to little more than the realization that the solar system is an entity more highly organized and integrated than was formerly supposed. To know the solar system in such a manner is like knowing a man from a distance of several miles and, by means of various tests, ascertaining his weight, shape, and chemical composition. A man thus investigated may be known as a material object; but his significance as a human being or even as a living animal, may remain, not merely unknown, but unsuspected. The case in regard to our knowledge of the solar system is really worse than this; for we should seek to know the sun not only up to the level of octopotent individuality, but as a manifestation of creative power, the carrier of the cosmic plan, at the tenth gradation in the scale of existence.

A systematic investigation of the hypernomic world should begin with

the planets—novempotent entities—and only thereafter pass to the study of the decempotent stars. We are, however, confronted with the difficulty that we have no direct access to the hidden nature of the planets, and must therefore feel our way by indirect methods. The unity of the solar system makes it possible to search for the respective roles of the sun, the planets, and the subordinate members of the system, and so perhaps to learn something of the relationships of the hypernomic world.

We need to render more concrete the existential hypothesis according to which plan-creation is assigned to the sun and pattern-creation to the planets. We may, for example, picture the sun as standing to the planets as a master towards his pupils, and look upon the minor constituents of the solar system as candidates that have not yet entered the school. The master states the problems, and the task of the pupils is to work out the solutions. The kind of problem will depend upon the master's special field of interest. If he is a chemist he may set his pupils to undertake research into a particular group of chemical compounds. If he is a painter he may set them to study the work of the schools in which his interest is engaged. The fact that every teacher is a specialist places a severe limitation upon the range of problems studied in his school, but however specialized may be a field, there remains a considerable uncertainty as to the outcome of a particular research. In such a situation we could refer to the teacher as the 'creator' of the plan of campaign, and to the pupils as the 'creators' of the conditions in which the solution is found. It is to be remarked that the teacher does not 'create', but 'formulates' the problem, and the pupils do not 'create', but 'find the solution'.

Carrying the analogy farther, we may regard a correctly stated problem as a completed whole and therefore as exemplifying the law of structure. It should therefore have seven principal qualities, and each of these another seven subordinate features and so on down to the limit at which further detailed specialization becomes impracticable. If the master had seven pupils, each might be entrusted with one line of experimentation, while their assistants in turn would carry out the routine manipulations required for the assembly of data. Interpreting the analogy, we might regard the solar system as falling into major groups of seven, each divided into subordinate groups, within which a certain pattern of planetary existence is worked out. The ancient tradition that the sun and the planets exemplify the sevenfold character of a complete structure is one of those fragments of the lost cosmology, which reach us in the form of legends and symbols that have little meaning when interpreted literally,

but are nevertheless evidence that at some time, some men, somewhere, attained to a deep understanding of the universal laws. So little of their work remains, and that little is so distorted that we can scarcely hope to make anything of it until we have ourselves worked out again, from first principles, the application of the universal laws to the data of natural science.

Our present problem is to grasp the role of the sun as a plan-creating power in the context of its own status in the universe of stars. Our sun is a star, and no two stars are alike. We must understand, moreover, that this assertion cuts deeper than the corresponding assertion that no two men or no two grains of sand are alike. At each stage in the ascent of the scale of existence, the potency for individuation acquires a new degree of freedom. No two men are alike, either in their genetic constitution or in the results of their actualization in time. Nevertheless, the range of variability is not great, and a thorough knowledge of a few individual men

could give us a good grasp of human nature. We should not expect the same to apply to the stars, where there is an incomparably greater range of possible patterns. Let us consider only the best known property of the stars; namely their luminosity. The very high intensities of energy associated with stellar existence allow the stars to have temperatures ranging from near absolute zero to thousands of millions of degrees. The transformations of hyle are very sensitive to temperature, and often obey an exponential law according to which the rate of change is doubled for relatively small increments of temperature. Two stars may differ little in any characteristics such as mass, luminosity, and colour, but may be entirely different states of potentiality. The current classification of stars is based upon these measurable characteristics, together with observable differences in their secular and cyclic changes of brightness. To suppose that animals could adequately be classified in terms of their size, colour, and rate of breathing would be less absurd than to believe that the current classification of the stars can give any insight into their true variety. There are, for example, millions of stars of very nearly the same mass and luminosity as the sun, and also, like the sun, free from any spectacular variations of luminosity. The pattern of existence of a star—one indistinguishable from the sun by any known tests—could vary in so many ways that no two of a million million need be even approximately alike in this respect. Such calculations refer, moreover, only to the hyponomic existence of a star, and do not take into account the six levels of potency from the fifth to the tenth, each of which adds a new degree of freedom to the inherent variability of the eternal pattern.

We have considered hitherto only the variations of eternal pattern,

but there are also recurrences to be taken into account. Whereas a perfected octopotent individual has only one recurrence, or temporal actualization, entities of a higher level can have many independent recurrences, each complete in itself. At the level of the sun, the recurrences must be equal in number to the varieties of the eternal pattern. These in turn must equal the number of manifestations in space of similar entities and this gives us a basis of comparison. Let us suppose that the visible form of the sun is actualized in the universe in a thousand million stars, visually indistinguishable in respect of their mass and luminosity; then each of these stars has a thousand million patterns of potentiality, a thousand million recurrences, and a thousand million lives in time. Expressed in this way, the diversity of hypernomic existences appears to be no more than a chaos of weakly coupled multiplicities. This does not take account of the integrative power of the higher orders of potency. In the hypernomic worlds, the disjunctions of the determining conditions are—ex hypothesi—subordinated to the consciousness of unity.

In the autonomic world we are subject to such disjunctions as 'one and many', 'this and that', 'now and then', 'here and there', 'potential and actual', 'same and other'. None of these applies to modes of existence in which the affirming principle is dominant. This confronts us with an extreme difficulty of language and even of thought. For example, we observe the sun of our solar system and we locate it in time and space as being different from the other stars of the galaxy. This is true only of the hyponomic element of the sun's existence. This element must be present in everything that exists and it is this element that makes it possible for us to 'know' the sun. There is also an autonomic element consisting in all the forms of life that occur on the earth and the other planets. But that which is distinctively 'solar' is the hypernomic, creative element by which the sun exists as a manifestation of the universal affirmation. This hypernomic element is neither the 'same' nor 'other' in regard to all the remaining suns. All are both one and many, both the same and the other, both here and there, and so on, with all the possible disjunctions of our experience. If we wish to understand the hypernomic world we must look for its powers—that is, the forms of its affirmation. Since we cannot 'know' affirmation, we are compelled to study the functional element, but in doing so we must not be satisfied with functional knowledge alone; for this would mean cutting ourselves off from the possibility of answering any questions as to the 'how' and 'why' of existence. The task is not quite beyond our powers, providing we hold fast to the categories which are given to us

in our own immediate experience. Pattern, creativity, domination, and autocracy are encountered in all experience and we can, therefore, apply them to the affirmative modes of existence.

We shall, in the next chapter, examine the possible varieties of stellar existence, and their place in the universal order; but we are now concerned only with the plan-creativity of our own sun, as limited within the framework of universal laws. The conception of a subordinate creativity appears to contradict that of a universe governed by laws. The dilemma is resolved by way of the quasi-infinite freedom associated with the pattern of a decempotent entity. The cosmic harmony is undisturbed, and the universal laws fail of nothing in their sway by the free action of a creative power that has an almost unlimited range of actualizations and recurrences within which to work out its own special destiny. Free creation is, however, possible only on the level of decempotence. Below this level the potentialities are too limited, and all that is possible is the working out of a problem set from above. For the levels of existence higher than the sun, free creativity would or might disturb the cosmic harmony. A simple example taken from hyponomic observations will illustrate these assertions. It has been observed that stars sometimes explode with cataclysmic violence to produce an outpouring of energy thousands of millions of times greater than their normal radiation. These cataclysms are referred to as super-novae, and they occur so rarely that in the last thousand years only two or three super-novae have been seen among the hundred thousand million stars of our galaxy. Astronomers believe that these cataclysms have important consequences within the galaxies, and provide material for the formation of planets; but they do not affect existence in other galaxies or the economy of the universe as a whole. It would, however, be a quite different matter if all the masses in the galaxy were to undergo a catastrophic explosion, converting a great part of the energy into corpuscular form. Such a catastrophe might disrupt the entire universal order by breaking down the linkage of space, time, and eternity. The sudden annihilation of a galaxy in this manner might, for instance, have the effect that all the masses of the universe would return into the ground state of the hyle and the entire cosmic order would be shattered.*

The curious but not unexpected conclusion reached is that only the individual stars are of the appropriate size and cosmic importance to occupy the role of independent creators. Planetary and all subordinate

[* It was shown by Eddington that a force-field exceeding a certain limiting intensity, such as would be produced, for example, even by the mere existence of a single star a million times more massive than our sun, would have the effect of 'closing up' space and time round it and isolating the star and its space-time from the rest of existence.]

existence is too limited. The galaxies and all superior existences are too great and too powerful. There is a further conclusion to be drawn; namely, that at the level of solar existence the mutual limitation of the determining-conditions, that we have traced from corpuscles to organisms, is no longer operative. In considering the threefold nature of time, we saw how conservation and irreversibility arise through the linkage of time with eternity and hyparxis. At the level of the sun this linkage is replaced by the full merging and mutual absorption of the determining-conditions. The actualizing of the sun can therefore be non-conservative and reversible, but only upon the hypernomic levels of its own existence. The energy-exchanges that we observe in the sun obey the same physical laws as those of any hyponomic entity; but there is also an invisible sun free from the thermo-dynamic laws, and able to make and unmake the worlds that arise through its creative power.

It is now generally believed that the earth and the other planets of our solar system have come into existence by a process that is independent of the arising of the sun itself. The sun must be looked upon not as the mother of the planets producing them out of her own substance, but as the father impregnating the unformed planetary material with the plan of his own genetic constitution. The plan and the pattern stand to one another as male and female principles, the former affirming and potent and the latter denying and actual. In its turn the pattern becomes creative and enters, as the cosmic affirmation, into the constitution of the biosphere. The solar plan evokes the planetary pattern as the author's manuscript evokes the printer's formes. The plan can be called prepotent in the sense that it affirms the possibility of a pattern of potentialities.

Even on the hyponomic levels the sun is predominantly virtual while the planets are predominantly actual. The sun carries its plan as a creative affirmation, while the planets establish through their patterns the

conditions of existence. The sun gives out energy but does not exchange. The earth receives energy but does not exchange. Each therefore actualizes according to a characteristic pattern of existence. Nevertheless, the pattern of the earth is dependent, for it cannot be realized without the help of energy from the sun, and perhaps also from the rest of the universe. Furthermore, it requires the presence of the biosphere, a form of existence that, although terrestrial, nevertheless owes its origin to solar influences.

9.23.2. The Earth

The most significant characteristic of the earth is its polyspherical structure. As beings existing in the thin surface film of the biosphere,

we witness an immense and constant influx of energy by which the whole surface activity of the earth is maintained, but we do not readily picture the transformations taking place within the immense regions below the outer mantle, where solar influences scarcely penetrate. Similarly, we are accustomed only to organisms whose structure is adapted to a reaction with the environment of space and time, and can have little conception of the existence of entities built on the pattern of concentric spheres. Novempotence occupies a level of existence where the disjunctions of time, eternity, and hyparxis are subordinated to an affirmative pattern. Whereas in the autonomic world the pattern regulates from above, in the hypernomic mode of existence the pattern itself is an integral part of each entity. This results in a merging of identity at the highest level so that 'separateness' ceases to have its usual meaning. Community of pattern can thus be described as diversity without separation. This property is shared by all hypernomic entities and it is reflected in their autonomic and hyponomic parts. One of Plato's finest insights is his vision in the *Timaeus* of the polyspherical structure of the universal being. We find this structure manifested in the form of the planets and the solar system.

The structure of the earth is adapted to exchanges of energy and transformations of substance, but not to behaviour as we know it in the autonomic world; it is indeed so unlike that of the animal body that we find it hard to believe that the earth itself is a conscious being standing higher in the scale of existence than the individual organism.

According to our present knowledge, however, it appears that at the centre of the earth is a solid core about which lie the inner and outer mantles. Then follows the crust at the surface of which are the hydrosphere and the biosphere. Around these extend the dense gaseous atmosphere, and above this the ionosphere, where matter exists in states of special sensitivity that enable the earth to respond to the great variety of impulses received from the sun and the other planets. This mode of organization appears to have characterized the earth during three to four thousand million years and is shared by the other known planets, although in varying forms and degrees.

Our human experience presents itself to us as a turbulent flow of sense-impressions, inner associations of thought and feeling, physiological and physical changes, ever succeeding one another like the eddies of a mountain stream. We are inclined to regard this turbulence as an intense mode of experiencing existence, and it is only with difficulty that we could conceive that a greater intensity of consciousness might be able to remain what it is—neither vehement nor passive. Compared with

the incessant activity of organic life, the earth abides in a state of majestic calm, broken only by local disturbances that, however violent they may appear to us, are, nevertheless—in relation to its great mass—like the spring breezes hardly ruffling the surface of the ocean.

There now seems to be good reason to suppose that enormous movements—quite rapid upon the scale of geological time—are taking place within the mantle of the earth. A prodigious liberation of energy must be required for such movements which are sufficient to shift the earth's centre of gravity far enough to cause a measurable change in the interaction of the earth, sun, and moon and, hence, in the length of the terrestrial

day. It is calculated that the shifts in the earth's mass that have been observed in the last fifty years would require continual exertion of 10,000,000,000,000,000 horse-power; that is, about a hundred times as much as the total energy that the earth has received from the sun in the same time. If such calculations can be relied upon, the activity in the interior of the earth must be at least a hundred times greater than all that is taking place upon its surface and in the oceans and in the atmosphere. Again, the reciprocal thrusts set up by the inner movements of the earth must produce conditions of tension that react upon the biosphere and upon every organic individual.

The well-regulated and systematic development of the biosphere during the past fifteen hundred million years could have proceeded only under the influence of exactly appropriate conditions. These in turn require that the affirmative force of the earth should express itself in all the spheres, and not only at the surface. Moreover, the measurable changes in the distribution of energy must represent only the external manifestation of the eternal pattern that organizes the whole complex process of actualization in time.

The geological history of the earth shows a very remarkable sequence of conditions at its surface, ranging from ice ages to periods of torrid heat, from intense activity of volcanoes and earthquakes to complete calm, from brilliant sunshine and temperate conditions to the presence of a thick mantle of cloud veiling the sun continuously for millions of years. Until recently these changes have been interpreted as due to the gradual cooling of the earth and the consequent hardening and shrinking of its crust. It is now known, however, that far more complex processes have been at work, acting sometimes to intensify and sometimes to diminish the transformations of energy, so that in relation to any given epoch it is impossible to determine whether at that time the earth was growing colder or hotter. Moreover, it has been assumed that the development of the biosphere and the successive emergence of different

organic species occurred almost independently of the earth's own transformations, which acted merely as factors favourable or unfavourable for given forms of life, whereas we now see the two as intimately linked.

The history of the earth has been interpreted by geophysicists solely in terms of the thermo-dynamic laws, and that of the biosphere solely in terms of the doctrine of automatic biological evolution. These theories, however, have proved to be incompatible, and, moreover, they fail to account for the observed facts. The changes of climate from one epoch to another cannot be accounted for from geological considerations alone,* nor can the biological species—assumed to develop independently by a sequence of events due to a changing environment—have arisen from the action of the external conditions alone. On the contrary, the species dominant in each of the great epochs have corresponded to the exigencies of the prevailing climatic conditions, and the latter have been organized in such a way as to ensure the chemical and physical changes required for maintaining the existence of the biosphere. The evidence of geochronology places the age of the earth between three and four thousand million years. This estimate is arrived at by two or three independent methods of calculation, the most important being based upon the proportion of the various isotopes found in the most ancient rocks. The calculations made by Holmes appear to be the most reliable and suggest some three thousand five hundred million years as the length of time during which the earth's crust has remained approximately as it is today. An independent conclusion is obtained from the study of helium in meteorites, and these appear to be slightly younger than the earth. It should, however, be noted that in speaking of the age of the earth, reference is made only to the igneous rocks and not to the earth itself. We have no means at present for deciding whether the so-called 'age of the earth' refers to the period that has elapsed since it first came into existence, or to the period since it underwent a major transformation of substance resulting in the exposure all over its surface of minerals containing lead and the radio-active elements in their 'primeval' state.+

The consciousness of the earth, as the transmitter of the affirming creative power of the sun, must not be confused with that of the biosphere, as a part of the universal reconciling force. Those who have

[* Cf. A. Darby, *The Changing World of the Ice Age* (New York, 1934); also F. E. Zeuner, *Dating the Past*

(London, 1952).

+ Cf. Arthur Holmes, *Nature* (March, 1949), p. 453; also F. E. Zeuner, loc. cit., P. 348.]

sought to give a deeper meaning to our conception of the earth's existence have tended to compare it with the living organism, and some have remarked that the biosphere may be compared to the nervous system of a cerebrate animal. The comparison has a certain value, but only in so far as every hypernomic entity has its own autonomic level. The true characteristic of the earth is its novempotence that raises it into the affirmative mode beyond life. For the earth as a sub-creative entity, the biosphere is merely the instrument by which its task is fulfilled.

The individuality of the earth must arise, as that of other manifestations of individuality, from the meeting and clash of the affirming and denying forces. The earth requires to be itself in order to fulfil its own destiny in the presence of the overpowering affirmation of the creative power of the sun. Nevertheless, individuality does not represent the highest gradation of existence of a planet. We regard the planet as a hypernomic entity, and therefore a direct agent of the universal will. It is this ninth gradation that raises the earth's level of being above that of the biosphere, or any living being that has not passed beyond individualization. The earth is itself as an individual and yet more than itself as a creative force. Novempotence is a level of existence that stands beyond the point of merging of time and hyparxis, and also of eternity and space. The merging of time and hyparxis is possible only in an entity having an independent will, for then recurrence and repetition are unified. The suggestion that the earth may renew the cycle of its existence can be understood only if we suppose that recurrence in hyparxis and repetition in time are unified. When this unification occurs, recurrence and repetition can be replaced by the synthetic term reintegration, by which we should understand a renewed manifestation of a pattern without dependence upon a fixed context. When there is recurrence in hyparxis the context in space and time remains unchanged; each cycle of existence takes place in the same environment. The difference between one recurrence and another lies in the eternal pattern, for according to the hypothesis, recurrences serve to permit unactualized potentialities to exist. Thus planetary recurrence can be defined as a multiplicity of existences within the same context but with different potentialities. On the other hand, repetition in time means a change of context; but for autonomic entities this requires a stability of pattern. Transmission by heredity is an example of repetition in time, in which the pattern remains, but the environment changes. With hypernomic entities, of which the earth is the first we have so far studied, we meet with a new and deeply significant mode of self-realization in which an independent

variation of both environment and pattern are possible, without loss of identity. Clearly such a situation could occur only if there is a level of existence above that of individuality. Individuality is needed in order to support and withstand the stresses of the twofold variation, but above it there must be a pattern-creating factor without which there would be no coherence in the self-realization of the being concerned.

Although our knowledge of the earth's history is incomplete, we can reach certain provisional conclusions. The most important of these is that there is ample evidence of the existence of a plan as distinct from a pattern. When we speak of the plan of terrestrial existence we refer to the sub-creative role that interprets a higher demand in the form of a plan to be actualized in space and time. A plan is a pattern intentionally brought into existence and the 'plan-producing power' is the characteristic property of novempotence. The step from individuality to sub-creativity is made by the power to bring into existence a specific plan of actualization. All the history of the earth, including the arising and development of the biosphere, is evidence of a plan that is beyond the separation of eternity and time.

The picture that we finally reach of the earth is that of a sub-creative power, existing in its own right above the level of octopotent individuality, carrying its potentialities in space and eternity, in a structure of seven mutually-related concentric spheres and existing in a series of incarnations—that is, manifestations in the autonomic world of the hypernomic creative will. Thus conceived, the earth is an immensely great being compared with the life that it supports; but it is nevertheless subordinate to the higher gradations of creativity.

The creativity of the earth is not free, for it must be realized within the plan of the solar system. We can see here a parallelism between the lowest gradations of each of the three great realms of existence; namely the hyle is an un-differentiated source of material existence; the active surfaces are an undifferentiated source of life; and the planetary worlds are an un-differentiated source of cosmic creativity.

We may succeed in throwing a little further light upon these conceptions by examining what we know of the various planets and subordinate formations of our own solar system.

9.23.3. The Planets

Since we regard novempotence as the bearer of the universal pattern that is both one and many, we should expect to find it distributed throughout the universe with some of the characteristics attributed by Hartmann to the unconscious will. The cosmologies of Schopenhauer,

Hartmann, and their followers were lacking both in coherence and applicability, chiefly owing to the failure to make the all-important distinction between hypernomic and hyponomic existence. Nevertheless, there is in the notion of an universal pattern a valid and important contribution that serves to link the philosophy of the unconscious with the philosophies of emergence and creativity. These latter, when carefully examined, have the appearance of universality, but not the substance; for they really turn solely upon the study of planetary existence. It will, in future, be necessary to situate them within the universal cosmology and so bring their significance into a truer perspective.

The planetary world has a twofold significance. From one aspect it is the point of emergence of hyle from individual to universal existence, and we must think of it in terms of a triad that connects the sun and the planets through the mediation of the biospheres. From the other aspect, the planets are carriers of the universal creative pattern that needs differentiation in order to manifest. To understand this relationship we must think of a triad in which the individual planets, such as the earth, are related to the plan created by the sun through the mediation of the planetary world.

We may conceive here four gradations of novempotence: (i) the undifferentiated universal pattern, (ii) the earth and other inner planets as the simplest pattern

bearers capable of independent existence, (iii) the major planets, such as Jupiter, in which a relationship with full creativity can be discerned,

and (iv) the planetary world as a whole, regarded as a subsistent entity capable of sustaining the true creative processes initiated in the sun.

It will be remarked that these four gradations are analogous to those of the hyponomic and autonomic worlds. A further elaboration of structure should be possible, but for the present we defer this in order to examine the evidence of astronomy that the planetary world may be regarded as an entity distinct from the sun or the planets taken separately.

Until recent times the planets were regarded as satellites of the sun— offshoots of the process of the sun's own formation, having no independent history. These views, though still current, are now rejected by the majority of astronomers. Since Copernicus, Galileo, and Newton convinced the Western world that geocentric beliefs had to be abandoned, we have been accustomed to over-emphasize the subordination of the

planets to the sun, and to interpret the solar system in exclusively heliocentric terms. Recently, many facts have come to light that are incompatible with this interpretation. Our small planet, the earth, is, owing to its close proximity, strongly influenced by the gravitational field and electro-magnetic discharges of the sun; but the great planets, Jupiter, Saturn, and Uranus, are far less dependent. The sun and the planets constitute

distinct modes of being. The sun is incomparably more massive—being nearly a thousand times as heavy as all the planets together—but on the other hand, the energy of rotation, or angular momentum, of the planetary world is far greater than that of the sun. In our hyponomic studies we came to regard angular momentum, which has the dimension of action, as one of the three basic properties of existence, and hence we should conceive the planets as contributing to the solar system an element no less significant than that brought by the sun with its great mass and reserves of energy. Having found, moreover, that potential energy should be associated with eternity and action with hyparxis, we should expect the sun, as the creative power, to be the main source of potential energy, and the planets, as the reconciling power, to be the main source of action. This fully agrees with the observed facts, for the mass of the sun is largely in the form of atomic hydrogen, and its reserve of potential energy available through the conversion of hydrogen into helium is prodigious.

There appears to be little interaction between the members of the solar system as compared with the constant exchanges of substance which we are accustomed to observe between material objects of our earthly environment. This is, however, an illusion due to the differences of time-scale. The natural unit of time for planetary transformations must be measured not in centuries but millions of years, and upon this scale the solar system would appear as a composite whole with closely interrelated parts.

It should be remarked that the repeated failure of attempts to give a consistent account of the origin of the solar system has largely been due to a disregard of the independent status of the planetary world. The earliest of modern theories was that suggested by Kant and put in mathematical form by Laplace. This attributed the formation of the sun and planets to a single process of condensation of a primitive nebula. A later theory suggested that the planets were torn from the body of the sun either by the close approach of, or actual collision with, some wandering star. None of these theories, however modified, can give a satisfactory account of the distribution of angular momentum, since they lack a plausible explanation of the way in which angular momentum

could have been transferred from the parent mass to the daughter bodies. More recent theories suppose that the sun and the planets were formed by the action of galactic forces upon the clouds of dust and atoms with which the great part of galactic space is filled. It is worth quoting here the views of Urey, one of the proponents of an aggregation theory, but also one who clearly recognized that the dynamical processes alone could not account for the formation of the planets. He says: "The chronology of events given is a complicated one, but the true one is certainly even more complicated. There is a tendency on the part of all investigators to search for a simple explanation of observed facts and to accept such simple explanations rather than more involved ones. Their attitude is correct, of course, when applied to statements of fundamental laws, as experience shows. However, phenomena observed in nature which are the result of the operation of these laws are always very complicated, so much so that the details escape the capacity of the human mind. We will never be able to reconstruct the complete course of events which led to the solar system."*

If the solar system originated without the intervention of a vagrant star, it would seem probable that other planetary systems are associated with a far greater proportion of the stars than is commonly supposed. If they were formed by aggregation, most stars should now have associated planetary systems; whereas if it was produced as a result of a collision, similar planetary systems must be of extreme rarity.+

It is now generally believed that magnetic forces have played a greater part than was previously thought possible in the distribution of masses and angular momentum. It will be recalled that in our development of field theory,++ it was shown that a magnetic-field will arise not only from electric currents, but also from the rotation of massive bodies. Unquestionably, magnetism plays a great part in the structure of the universe, and we may well expect to find that magnetic forces have made it possible for the sun and the planets to develop and exist independently, in a way that would have been impossible under the action of dynamic forces alone. Of all the hyponomic forces, the magnetic-field is that which is best adapted for carrying and transmitting a pattern. The earth is a magnet and the distribution of its magnetic-field can best be understood by reference to the structure of concentric spheres discussed in section 2. The plan of the solar system is likely also to be

carried in the hyponomic world by a pattern of magnetic-fields.

[* H. C. Urey, *The Planets: Their Origin and Development*, p. 223.

+ Cf. H. Spencer-Jones, *General Astronomy*, p. 444.

++ See Chapter 14, Appendix p. 505, and *Proc. Roy. Soc.*, p. 198-39.]

9.23.4. The Shape of the Solar System

The solar system exemplifies all the gradations of potency from the first to the tenth. As a purely dynamical bipotent system it has great stability, both in the periodicity of its motions and in its shape. The science of celestial mechanics established long ago that the dynamical stability of the system is based upon an invariable plane, and that all the orbits, with the exception of that of the extreme planets Mercury and Pluto, deviate by only a very small inclination from this plane. Viewed from a distance, the solar system would have the appearance of a very thin flat disc.

Some light upon the structure of the planetary world is thrown by a study of the relationships of distance. There is a curious empirical rule known as Bode's Law, according to which the solar distances of the planets can be derived from the series of numbers 0, 3, 6, 12, 24, 48, etc., by adding four to each term and treating the earth's distance as ten. The scheme is shown in Table 23.1.

	<i>Primary Series</i>	<i>Bode's Derived Series</i>	<i>Observed Planetary Distances</i>
Mercury	0	4	4
Venus	3	7	7
Earth	6	10	10
Mars	12	16	15
—	24	28	—
Jupiter	48	52	52
Saturn	96	100	95
Uranus	192	196	192
Neptune	384	388	301
Pluto	768	772	395

Table 23.1. Planetary Distances

When Bode drew attention to this relationship in 1750, none of the outer planets had yet been discovered, but William Herschel was so impressed by the agreement of Bode's series with the known planetary distances that he began to search in the predicted position and discovered the planet Uranus in 1781. In 1801 Piazzi discovered Ceres, a very small planet revolving roughly at the distance of twenty-eight units, in the previously unfilled position between Mars and Jupiter. Since then more than two thousand of such asteroids ranging down to

less than one mile in diameter have been found within this gap. It will be noted that the outermost planets, Neptune and Pluto, seem jointly to occupy the ninth position corresponding to Bode's number 388. The chief point of interest for our purpose in Bode's Law is that it indicates that the solar system has a shape that could not be predicted from dynamical considerations alone. It is not unlikely that each of the planets was separately formed by an aggregation of materials concentrated under the joint action of three forces—the sun's gravitational attraction, the centrifugal force due to the angular momentum of the system, and the solar

magnetic field. These factors can be compared to the physico-chemical influences on the growth of an organism, in so far as no single one of the three can account for the pattern of existence to which the organism conforms.

In order to gain some insight into the relationships of the solar system, we must distinguish true planets from incomplete manifestations of planetary existence. The seven planets—Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune—constitute a single group by reason of certain distinctive features without which the polyspherical structure that we have associated with novempotence could not be sustained. The most important of these is the possession of an atmosphere, without which there could not be any form of life. A second essential feature, the significance of which has not yet been discussed, is the possession of satellites which can range from one in the case of the earth up to twelve or more with the great planets Jupiter and Saturn. The third characteristic is the possession of a sufficiently great central mass to permit internal energy transformations independent of the energy received from the sun. According to these requirements neither Mercury nor, probably, the recently discovered Pluto qualify for inclusion as true planets and will be assigned to an intermediate class. They revolve about the sun instead of another planet; but most of their characteristics are those of satellites.

We can now attempt a classification of the minor constituents of the solar system as follows:

The Sub-planetary Bodies

(i) The semi-planets occupying the innermost and outermost

orbits, namely Mercury and Pluto, (ii) The major satellites having a diameter exceeding two thousand

miles, namely the moon, Io, Europa, Ganymede, and Calypso,

satellites of Jupiter; Titan and Triton, the great satellites of

Uranus and Neptune.

(iii) The minor satellites, ranging from Rhea of the planet Saturn—

with a diameter of 1,150 miles—down to the tiny Dimos and

Phobos, satellites of the planet Mars. (iv) The asteroids, comprising some two thousand bodies, of which

only four, Ceres, Pallas, Vesta, and Juno, exceed a hundred miles

in diameter. (v) The comets, that have the least mass and yet penetrate more

deeply into space than any other known constituents of the solar

system. (vi) Meteorites varying from several tons down to a fraction of an

ounce in weight, and mainly concentrated in definite regions. (vii) Interplanetary dust and gas of exceedingly low density and yet,

owing to the great volume occupied, having, in the aggregate, an

appreciable mass.

Table 23.2. Sub-planetary Members of the Solar System

In the whole of this exceedingly complex organization, the seven true planets occupy a dominating position. They contain more than ninety-nine per cent. of the mass of the solar system apart from the sun, and nearly all its angular momentum. According to the conception of novempotence, the seven true planets alone can be regarded as capable of transmitting the creative impulse. All the remainder are subsidiary or incomplete manifestations of novempotence.

The true planetary world can be regarded as a sevenfold structure in which Jupiter occupies the central position. The transitional step between the third and fourth gradations of structure is provided by the asteroids, the origin of which most astronomers agree with Oort in ascribing to the catastrophic destruction of a former planet similar to the earth.

The principle of structure affirms that seven distinct qualities are required for the formation of a completed whole. Each of the true planets should therefore represent one of the qualities inherent in novempotence; that is, in sub-creativity. The analogy previously suggested that compares the sun and the planets to a master and pupils can be carried further if we suppose that each of the pupils is specially endowed with qualities that enable the master to assign to him a particular part in the task to be accomplished.

We might therefore hope to learn something of the plan of the solar system if we could discern in each of the planets a characteristic structure of concentric spheres and surmise therefrom the nature of autonomic existence that a particular planet can support.

9.23.5. The True Planets (i) Venus

The surface of Venus is hidden from us by a dense blanket of dazzling white clouds. It has a heavy atmosphere, apparently composed mainly of carbon-dioxide gas. Physically speaking, the earth and Venus are twin planets. They are of approximately the same size and density, and must have been formed from similar materials under the combined influence of gravitation, magnetism, and angular momentum. Notwithstanding their physical likeness, the conditions in the spherical shells are utterly dissimilar.

Since on Venus there is probably no liquid water, and yet according to our conception of the role of autonomic existence some form of life should be present, we may suppose that the medium of exchange is in the form of saturated carbon compounds such as carbon dioxide and stable hydrocarbons. The transformations of solar energy in the presence of abundant carbon dioxide, especially in a planet close enough to the sun to receive a far higher proportion of charged particles than in the case of the earth, should suffice to enable self-regulating organisms to develop, providing there is an autonomic pattern to exert the needful organizing influence.

The presence of life on the earth would be inconceivable were it not that we know it for a fact. We have seen, moreover, that the fact can be explained only in terms of a biospheric pattern corresponding to the needs of the earth. A similar biospheric pattern corresponding to the needs of Venus would produce an entirely different set of chemical combinations; but the basic constituents—namely, an active surface, a medium of exchange, a labile set of compounds analogous to proteins and nucleic acids, a reproductive and genetic mechanism—could all be produced in a medium of carbon compounds in which water would play a role as subordinate as do liquid hydrocarbons on the earth.

In any attempt to deduce the character of autonomic existence that would be possible on Venus, we meet with the difficulty that present-day terrestrial chemistry has studied very little of the low-temperature reactions that would be possible in the absence of water. The transformations of solar energy that we know upon the earth represent only a very small proportion of those that we could picture to ourselves with our current knowledge. The unknown and unsuspected transformations must far outnumber those that we happen to know from our terrestrial researches.

Forms of autonomic existence on Venus are likely to be dominated by

the greater intensity and variety of solar radiation. An atmosphere composed mainly of carbon dioxide and subjected to intense radiation would be exceptionally favourable for photosynthesis, but also unfavourable to the arising of stable forms capable of prolonged existence. We may therefore surmise that any conscious existence on Venus must be of a very transient character, reaching perhaps great intensity, but unable to persist long enough for free individuality to develop. Such a view would be in agreement with the quality that we should ascribe to Venus as the first member of a sevenfold structure. This quality would be that of sharply defined potentialities, but only rudimentary actualization. It must be noted that if the surface of the planet abounds in substances of high chemical potential, bacterial activity may be enormous. Recollecting the conclusion that a single species of protozoa may have, as a whole, a high level of consciousness, we cannot rule out the presence of life on Venus based upon the same carbon cycle as that of the earth.

(ii) The Earth

The characteristic of the earth is the struggle for existence, due to the predominance of potentialities over the means for their actualization. The earth may be regarded as a great field of experimentation in which, throughout hundreds of millions of years, different forms of life have arisen in response to the pressure of an organizing pattern. The earth creates a demand for harmony without being able to provide the conditions in which full harmony is possible. In this state of tension lies the true significance of the concept of 'survival of the fittest' that is without question a dominant factor in life upon the earth. Without struggle no species is able to exist, and without effort no man can reach individuality. This element of effort and strife is the second quality in the sevenfold structure of planetary existence.

(iii) Mars

Mars, in common with all true planets, has a structure of concentric spheres. The atmosphere is thin compared with Venus and water scanty compared with the earth. Even such little water as is present is mainly frozen—in the form of solid ice at the polar caps or as clouds of ice particles.

The evidence that life exists on Mars in any form comparable to that of the earth is slender and confined mainly to the observation of seasonal changes in the marking of the planet. At the great distance of Mars—at the nearest some thirty-four million miles—we can only observe changes occurring upon an immense scale. We are therefore obliged to base our

suppositions, not upon direct visual observation but upon the physical conditions prevailing at the surface of the planet. The most marked differences from those on the earth are the low force of gravity and the composition of the atmosphere, in which carbon dioxide predominates; and also the extremes of temperature, varying from little above freezing in the daytime to many degrees below at night, even at the equator. These three conditions are compatible with the existence of very large slow-moving organisms living upon the very simple forms of vegetation that are compatible with the Martian atmosphere, heavily protected against the changes of temperature and able to utilize directly the ultra-violet light of the sun, against which the thin atmosphere would not provide the same effective screening as at the surface of the earth. Such slow-moving organisms could have long duration of existence as compared with that of terrestrial animals and could, in the course of their long lives, develop modes of conscious experience that we on the earth do not know.

Interpreting these speculations in terms of the seven qualities, we should expect that autonomic existence on Mars would be relatively small in quantity and variety, but that there should be organisms capable of a very high degree of individuality. The restless struggle for existence that plays so great a part in earthly life would be absent, but the independence of consciousness and function should be more pronounced than we find even among highly developed men and women.

Finally, we may suppose that the means of communication and cooperation would be more highly developed than on the earth, chiefly on account of the longevity imputed to the inhabitants of Mars. If the so-called canals of Mars are of artificial construction, they give evidence of the presence of beings able to produce concerted works upon a very great scale.

According to the principle of structure, Mars stands at the third gradation of existence, to pass beyond which requires the help of an influence coming from a different source from that by which life itself originates. The consciousness of beings living on the planet Mars would be associated with a greater power of seeing potentialities but fewer means of actualizing them than we have on the earth. Such beings would be able to see better than we do on the earth the significance and direction of their own existence; but would also be aware of their dependence upon an extra-planetary force to enable them to reach their goal. The eternity-blindness that we have found characteristic of the human observer would be mitigated in the case of the ordinary inhabitants of Mars and perhaps entirely overcome by a certain proportion of them.

(iv) The Transition Region

Between Mars and Jupiter is the point of discontinuity at which a new influence can impinge upon the evolutionary and involutionary transformations of the solar system. According to astronomical theory, the transition region is associated with the existence of comets. Oort calculates that there may be 100,000,000,000 comets, of which only a very small proportion are at any time present in the inner region of the solar system. They are presumed to form a great cloud stretching out to more than 100,000 times the distance of our earth from the sun.

The transition region is directly occupied by thousands of asteroids moving in orbits of widely varying eccentricity that are only connected by the common gravitational field of the sun. They are not true planets in the sense that some form of life can be present on their surface, but they may play a very important part in the transformation of individual beings arising in the three inner planets—Venus, the Earth, and Mars.

In the region of the asteroids the solar system intercepts influences that come from the galaxy, and we may think of a supra-terrestrial state of individualized existence in which consciousness is dissociated from an autonomic organism and finds for its support one of the small independent members of the solar system.

If it is accepted that the asteroids and comets may have originated with the explosion of a true planet, it may also be surmised that this cosmic event was connected with the appearance of autonomic existence in the solar system. If the catastrophic end of Oort's planet occurred six hundred million years ago, some of its fragments may have reached the earth and been responsible for the introduction of a new pattern of life, and marked the end of one cycle and the beginning of another. It need hardly be remarked that we are here in the field of speculation in which there is no observational data to guide us. Nevertheless, we cannot but feel that the transition region, with its asteroids and comets, must play an important role in maintaining the flexibility and interrelationships of the planetary world.

(v) Jupiter

Since the moons of Jupiter were first observed by Galileo in 1610, astronomers have regarded the Jovian family as a miniature solar system. The mass of Jupiter is 317 times greater than that of the earth, and is calculated to be about 2-1/2 times the combined mass of all the other planets. This great mass exerts appreciable perturbations upon all the motions of the solar system, and entitles Jupiter to be regarded as a dark companion of the sun, standing itself at the threshold of solar existence.

Nevertheless, according to the criterion that the energy of a star is predominantly virtual and that of a planet is predominantly actual, Jupiter is a true planet. Jupiter exemplifies to the fullest degree the structure of concentric spheres, presenting a mode of existence far more complex and richer in potentiality than that of

the inner planets.

The polyspherical structure of Jupiter has certain features in common with that of the sun, particularly the absence of a well-marked surface of separation between the atmosphere and the lithosphere. Nevertheless, there is an unmistakable qualitative difference. The various spheres of matter and energy of which the sun is composed are themselves undergoing incessant transformations that make it most improbable that there could be upon it any form of existence corresponding to the terrestrial biosphere. If life is associated with the sun, we should speak of it as the life of the sun rather than life upon the sun. Jupiter is, on the other hand, a typical planet in that there is a distinction between conditions of autonomic existence and autonomic existence itself.

For all the advances in astro-physics, we know very little of the conditions prevailing on Jupiter beneath the reflecting outer mantle of cloud. The opaque clouds that hide the solid surface are immensely thick, probably several thousands of miles, and the pressure exerted by the atmosphere upon the lower layers must be so great as to liquefy all gases. Moreover, owing to the great mass of this planet, it is able to retain both hydrogen and helium, so that the proportion of these gases should not have changed greatly since the planet was first concentrated. The atmosphere of Jupiter must therefore be in a relatively stationary condition, consisting of concentric shells of varying composition according to the conditions of temperature and pressure, each shell merging into the other without any sharp separation of phases such as we find in air, water, and earth.

If the earth is producing energy in its interior, it cannot be doubted that Jupiter must do so to a far greater degree. Although the outermost surface of Jupiter at the reflecting layer of cloud appears to be very cold—perhaps 130 degrees below freezing in the Centigrade scale—the energy transformations in the interior must, nevertheless, be very intense, evolving great quantities of heat. Moreover, even the outermost temperature of Jupiter is considerably higher than would be expected if it were heated by the sun's radiation alone.

If now we consider the quality of existence possible on a planet having the constitution of Jupiter, we realize first of all that we have made a transition from two-dimensional to three-dimensional existence. The biosphere of the earth, and certainly that of the planet Mars also, is

thinly spread upon the surface; but on Jupiter there are thousands of miles in depth where there exists a fluid sufficiently dense and yet sufficiently mobile to sustain the energy-exchanges required for some form of life. We should therefore look upon the biosphere of Jupiter as three-dimensional, with freedom of movement upwards and downwards in the gravitational-field, as well as in a horizontal plane. The intensity of energy concentration in Jupiter must vary enormously. We have direct evidence of this in the powerful activity of the great 'red spot' and other markings visible upon the planet. From the chemical standpoint, conditions of existence favour both the great stability that we have postulated for existence on Mars and the mobility that we find on the earth. Methane and ammonia predominate, both gases being favourable to photosynthesis at low temperatures; but the forms of hyponomic existence must be completely different from anything that we know upon the earth. We can speculate as to the biochemistry of Venus and Mars, but that of Jupiter is so remote from terrestrial conditions that we have little relevant knowledge upon which to draw. There is little incentive for terrestrial chemists to study the chemistry of low-temperature high-pressure systems, for the products would be completely unstable and useless under ordinary conditions on the surface of the earth. The low-temperature chemistry of nitrogen is probably more varied and more interesting than that of any other element, but it has been little studied. Nevertheless, our knowledge is consistent with the theory that un-saturated nitrogen and carbon compounds that would on earth be explosively unstable could, in the atmosphere of Jupiter, form complex structures, capable of sustaining energy transformations far more complex than those of the animal nervous system. Beings with bodies so constructed could have perceptions throughout the range of electromagnetic radiation, and therefore a direct knowledge of the universe that would enable them to follow the working-out of the pattern of existence, not only upon their own but upon other planets also.

Mankind seeks to direct its existence with the precariously preserved knowledge of a few thousand years of scientific investigation. From the past, only fragments of knowledge can reach us—little or nothing of the experiences of being and will. We are almost powerless to foretell the future, except to predict the mechanical processes of the hyponomic world. The dimensions of eternity and hyparxis are closed to us. We live almost entirely in two dimensions of space and one dimension of time. If, as we suppose, there is organized life on Jupiter, then the most fully-developed beings on that planet may well be conscious of their existence in hyparxis as well as in eternity, and being free in regard to

the three dimensions of space and the three of time, could be expected to attain to the full realization of octopotent individuality.

(vi) The Planet Saturn

The composition of Saturn is more like that of the sun than any other planet, including Jupiter. The external appearance of this, the second of the great planets, suggests—even at the distance of a thousand million miles from which we observe it—conditions of existence that are strange and dramatic. Saturn is surrounded by satellites of a greater variety than any other planet. At a great distance from it, it has a great moon like those of Jupiter, and also a number of lesser moons. It also has two small nearby moons and, most remarkable of all, three 'rings' encircling it, in appearance like flat discs, nearly forty thousand miles across, and composed of minute separate particles of ice or snow. A further distinct feature of Saturn is the fact that its great satellite, Titan, has been found to possess an independent atmosphere, and therefore to have at least the potentiality of supporting autonomic existence.

Owing to its great distance, Saturn receives very little energy from the sun and, moreover, of this nearly half is reflected. Even the outermost layers of Saturn absorb considerably less than a hundredth part of the energy absorbed by an equal area of the earth's surface. The semi-gaseous atmosphere of Saturn is some 16,000 miles in thickness, and nearly all the energy received from the sun must be completely absorbed and dissipated within the first few miles of cloud. Consequently, throughout the great bulk of Saturn's atmosphere, all transformations must depend upon energy received from the planet itself. There is reason to believe that this is very much more intense than is the case with any other planet except, perhaps, Jupiter.

From such considerations we may regard existence on Saturn as 'quasi-solar', in the sense that the transformations of the whole planet merge into the transformations of individual existence. Saturn might thus be regarded as one true meeting-point of the streams of involution and evolution; that is, of the contact between universal existence and individual existence.

Thus, comparing the two planets Jupiter and Saturn, the former can be regarded as the scene of the perfecting of individual existence, and Saturn as the transition from individual to universal existence.

(vii) The Outer Planets

Uranus, Neptune, and Pluto are beyond the normal vision of man. They do not belong to the planetary world as it was known to the

ancients, or as we ourselves can see it when we search the night sky. Not one in a million human beings has ever seen one of these planets, even through a telescope. Their influence upon the motions and the transformations of the earth would appear to be small, and even their position varies little in the course of years.

Uranus is a great planet nearly half the diameter of Saturn, and it has five moons in retrograde motion. The planet itself turns in the opposite direction to that of the rest of the planetary world. Neptune is somewhat smaller than Uranus, but it has an immense moon, Triton, believed to be the largest of all the satellites in the

solar system. Far too few observational data are available to permit any interpretation of the conditions of existence in the outermost planets, but according to the principles of structure, they should be more applicable to the total actualization of the solar system than to that of individualized beings.

9.23.6. The Minor Constituents

In the creative activity of the planetary world, all the minor constituents must play a necessary part. In the case of our own planet, the earth, we observe the intimate connection there is between the moon and the biosphere, especially in the influence of the moon upon the rhythms of life. We can discern a triad of the sun—the true planets—the satellites and minor constituents, in which the latter transmit the denying force. We may thus look upon the totality of minor constituents, from the satellites down to the planetary dust and gases, as the passive component in the total existence of the solar system. The main constituents form a thin flat disc four thousand million miles in diameter, but only a few million miles thick. If, however, we take into account the cometary cloud and the distribution of ultra-tenuous gases, the solar system can be regarded as a sphere with an outer atmosphere bisected by the densely filled planetary world that lies near to the invariable plane. The whole system is an entity upon the level of decempotent existence, and in order to grasp its significance we have to leave the first, or novempotent, level of universal existence and undertake the study of the higher worlds.

Chapter Twenty-four THE COSMIC ORDER

9.24.1. The Creative Triad

Rationalism and empiricism are like those two strangers roaming over the surface of the earth whose chance meeting is so remote a probability. If they should be banished from the earth to peragate the vast spaces of the universe, no blind chance could ever assure that they should meet again. If, therefore, we discover a convincing agreement between the conclusions drawn from the rational principles of our human experience and the empirical data furnished by the study of the visible universe, then we should regard this as evidence that everything that exists—including our own human minds—is built and directed upon one common plan.

Our foundations must now be put to the supreme test of bearing the structure of the whole knowable universe. The five higher categories, beginning with individuality and ending with autocracy, were formulated to give names to five elements of experience that are distinct from one another and not expressible in terms of the first seven categories from wholeness to structure. If the basic assumption of the homogeneity of all experience is valid, then we should be able to derive from the twelve categories a systematic ordering of all the valid knowledge that mankind has acquired of the universe and its structure. We require for this a working as distinct from an existential hypothesis, and this we may hope to construct after a closer examination of the meaning of the categories in our common experience.

Though man's creativity is but the shadow of a shadow, we see nevertheless how it issues from an autocratic will in the form of a plan of action. The will itself is beyond consciousness and it is incomprehensible; but that which enters consciousness dominates the functions and arouses in them the conception of a plan. Thus the autocratic principle acts upon one level, the force of desire or intention dominates upon a second, and the creativity itself arises at a third level in consciousness and finally becomes the source of a pattern on a fourth level in the functions. These four levels correspond respectively to the four categories of autocracy, domination, creativity, and pattern.

When we transfer these observations to the cosmic scale, we are led

to postulate here also four distinct levels of existence, the highest of which must be prior to the separation of essential forms and stand at the point of limitless potentialities that we assign to duodecimpotent autocracy; that is, the supreme affirmation of all affirmations within the existing world. To the second level we ascribe

the dominant power by which the will is realized. This corresponds to the undecimpotent level of existence, which is the third manifestation of the hypernomic mode. It is through this gradation that the unity and the multiplicity of the universe are reconciled. At the next stage comes the category of creativity by which we understand the power that creates a pattern. At the fourth is the pattern itself through which the cosmic will is finally actualized.

The three highest levels constitute a triad in which the autocratic potency is reconciled by the dominant consciousness to the inevitable limitation of all the partial patterns. This consciousness is itself neither active nor passive. It is that by which all existence is able to be itself. As existence passes from duodecimpotence to undecimpotence there enter the distinctions of will, being, and function, subsequent to which will itself ceases to be autocratic and is thereafter manifested as the laws of framework. The unconditioned will belongs only to the autocratic mode.

The third stage of involution has two aspects according to whether the plan is viewed from 'below' or from 'above'. In the last chapter the role of the sun was, without discussion, assumed to be that of the affirming pattern-creating power of the solar system. This is the individual aspect of solar existence. In its universal aspect the sun, like every other star, is an instrument of the autocratic will; and therefore a passive or denying force. The reconciliation of the autocratic all-embracing will and the universal free and individualized creative power is effected through the common cosmic dominating consciousness.

This interpretation of the categories that transfers them from human experience to the cosmic totality—if regarded as a deduction from premises assumed a priori to be self-evident—would be a speculative leap that must outrage any empirical common sense. Here, if anywhere, the rational must accept to be confronted with the empirical, or the whole of our undertaking will dissolve in the mists of speculation. We should therefore regard the concept of the four levels of hypernomic existence as a working hypothesis with the help of which we shall attempt to systematize all that astronomical science can teach us about the universe and its structure.

We commonly think of the 'universe' as the totality of all material

objects accessible to present or future observation. The means of observation are primarily visual, but have recently been extended to include the study of long-wave electro-magnetic radiation, and the properties of the high-energy particles that reach our earth and have been called the 'cosmic rays'. It may be that in the future new and hitherto unsuspected sources will be discovered, from which we shall learn more about the universe.

Certain effects—such as the recession of distant nebulae and the distribution of masses and luminosities among the stars individually visible—give reasons for questioning whether the universe could have existed in its present form before the so-called 'time horizon' that limits our possible observations to a period of not more than ten thousand million years. The limitation of the observable universe both in space and in time is generally regarded as being a consequence of our dependence upon light signals for knowledge of distant events. Most astronomers believe, however, that existence is not confined within the limits of any observation possible for man, and picture the universe as expanding endlessly in space. They believe, moreover, that the consequent attenuation in the distribution of matter is compensated by the 'creation' of new material.

According to such views, galaxies complete their transformations and disappear into endless space, and yet the universe remains what it is and always has been. Such a conception of the universe, vast though it is, is inadequate in so far as it fails to include the unactualized potentialities that far outnumber the 'historical', or observable, worlds.

Even when we have taken into account the dimensions of eternity and hyparxis and have extended our conception of the universe to include all its potentialities and all its recurrences, we remain, nevertheless, within the sphere of hyponomic existence. The astronomical picture takes no cognizance of life and its role in the cosmic scheme, nor does it provide a place for the affirmative power by which the creative activity is

impelled.

The belief that the plan of the universe is not wholly inaccessible to man's empirical investigation has been founded on two quite distinct, and even opposing, conceptions. The first is that of 'man the measure'. According to this conception, the plan of the universe is disclosed in the pattern of our perceptions and knowledge; we know it because it performs in the same manner as the machines that we construct in our laboratories; we know it as manifesting in the theories that occur to our minds; we know it because we can make sense of the past and can predict the future. From this standpoint, natural science—the processes

of observation, experiment, and deduction, followed by technical application—is man's crowning glory. "The sciences have a great responsibility ; they alone can furnish the picture of the whole, the teaching of the whole, on which the mastery of his world depends."*

The opposing conception regards the universe as the measure—as the link between human experience and the Autocratic Will that is, by definition, unknowable. This view seeks for a plan in the universe and, recognizing that man must himself be a manifestation of the same universal plan, regards the understanding of man and the understanding of the universe as one problem—indivisible and yet to be approached from many sides, according to the data that becomes accessible to our experience.

As with all existence, the temporal actualization of the universe must be governed by dynamical and thermodynamical laws, but these laws can no more disclose the plan of all existence than they could enable us to predict the pattern of life. There is a mechanistic fallacy that consists in treating assertions about the active and reconciling principles as if they were interchangeable with assertions about the passive or denying principle. The universe can have no meaning for us until we recognize that it is existence beyond life—the plan of which is transmitted through every gradation of wholeness down to corpuscles and atoms. With our organs of perception we look at the universe from below, but we must strive to see it from above with our understanding. Understanding emerges from knowledge and consciousness by way of the principles. Our consciousness alone can reconcile the perennial conflict between the simplicity of the principles and the complexity of knowledge— between the affirmation of a single plan and the denials of the planless disorder into which our sense-experience is plunged.

In order to form some conception of the universal plan we must assemble and set in order all possible information about the chemical constitution and physical condition of the stars, and not only to classify them, but to seek for that which lies behind the historical process. Like everything else that exists, each star must have a history; but history, as a single temporal actualization, is even less significant in relation to the whole existence of a star than it is in relation to that of a living entity. A

[* Erich Kahler, *Man the Measure* (London, 1945), p. 639. Kahler recognizes that in the present position of science and technology "the directive no longer comes only from above, it comes from below; not only from a Creator, but from a Creation, from conditions that man has produced, without knowing it or wishing it, in his mad chase for earthly goods" (p. 640). Such a form of humanism may recognize the faults of contemporary man, but it firmly places man in the centre of his universe, and though apparently looking forward, in truth makes no advance on that of Petrarch.]

star in its non-historical aspect is the affirmation of a single plan. It is only the limitations of our perception that impose upon us the illusion of innumerable unrelated stars.

Eddington's splendid researches into the conditions obtaining in the interiors of stars began with the observation that all known stars fall within the narrow range of masses from 10^{27} to 10^{29} tons.* Most stars are made almost entirely of the two simplest elements, hydrogen and helium. Even the few tentative steps that we have made towards the discovery of a stellar plan suggest that all stars are alike; yet each star is unique, and so entirely different from all others that the same conditions of

existence are never duplicated in the universe. This paradox of likeness and uniqueness can be resolved only when we understand that every star, in its plan, contains all the potentialities of every other star, and in its recurrences, passes through all possible actualizations. It can, therefore, truly be said that if we could know our own sun, we could know the plan of all stars. Nevertheless, this would not mean that we could know the will of the universe; for, in regarding the greater system of the galaxies, we have the intuition of a yet higher mode of existence.

9.24.2. The Sun—Decempotence—Creativity

If we seek to comprehend the nature of solar existence, we should consider first two obvious characteristics, evident even to a cursory examination. One outstanding feature is the prodigious and unceasing outpouring of energy, and the other is the remoteness of the sun from its nearest neighbours. These two properties make solar existence utterly different from that of the planets. Even the greatest of the planets, Jupiter, gives out little of its own energy; moreover, it is close enough to its neighbours in the planetary world to be able to interact with them in its motions and transformations. Of all the planets, Saturn appears to be that which is nearest to the sun in chemical composition, but its output of energy is so small that its surface temperature is estimated at 155° below freezing.

Even at its outer surface the physical activity of the sun is indescribable. The whole surface—flares, granulations, sun-spots—glows with intense brilliance. Within a few terrestrial hours there can appear in the sun a sun-spot large enough to engulf the earth without trace. The corona, at a temperature of 1,000,000° C, extends to a hundred thousand miles and is in constant intense motion. According to the Einstein relation $M = E/c^2$, the sun loses, in the form of radiation, the equivalent of four million tons of matter converted into energy every second.

[* A. S. Eddington, *The Internal Constitution of the Stars* (Cambridge, 1926), p. 249.]

The planets intercept little more than one part in a hundred million of the sun's radiated energy; the remainder escapes into outer space, where a small proportion—less than one ten-millionth part—is intercepted by the stars and dust clouds of the galaxy. Beyond the galaxy there are thousands of millions of star systems, but so vast is extra-galactic space that absorption into matter cannot account for a millionth part of the sun's energy, however far it penetrates into the distant regions of the universe.

We are evidently confronted here with a crucial problem—the question of the possible non-realization of the universal pattern. Taking the analogy of an acorn, we can see that the novempotent earth creates a pattern that only one out of many thousands of acorns can realize. If growth into an oak is regarded as 'success' for an acorn, non-germination must be regarded as 'failure'. Non-germination does not mean, however, that the unsuccessful acorns are wasted. They may serve as food for animals and so enter into higher processes of transformation, or they may form humus and be assimilated into the earth's surface to maintain the potential for future life. Whatever may be the fate of an acorn, there is for the biosphere as a whole no waste and no useless products. If the stars may be regarded as containing the seeds from which the universal plan can be realized, then we should not be surprised that only a few stars should be successful. Indeed, our whole world-outlook would be shattered if we were forced to conclude that almost the entire energy poured out by the sun was going fruitlessly to waste. The acuteness of the problem is increased beyond measure by the realization that all stars have a similar outpouring of energy that cannot be accounted for by absorption into matter, but which must in some way contribute to the maintenance of the cosmos.

From a material and historical standpoint, the universe appears to be disintegrating without purpose or plan. A hundred years ago, Kelvin suggested that the sun and all the stars are threatened with an early 'heat death' for lack of any source from which their energy can be replenished. The discovery that a vast reserve of energy is available in the conversion of hydrogen into helium has, by human calculation, prolonged the life-expectation of the stars in most cases on the average to ten thousand million years, and in some cases to far more than

this. Nevertheless, the major fact remains unchanged; namely, that the energy of the stars radiated into space appears to serve no purpose in the cosmic economy beyond maintaining physical conditions in a few planets, and this could have been done with a thousand-millionth part of the energy expended.

In all our studies we have seen that what is apparently wasted upon

one level is used upon another, and sometimes the conversion is evolutionary—that which is not used upon a lower level may prove to serve a purpose upon a very much higher level. The energy radiated by the stars has very little significance for the visible universe, but it may have a decisive importance for the economy of the potential universe inaccessible to sense-perception. This would mean that the energy radiated passes into matter in the virtual state, unless and until it happens to be intercepted by atoms in the actual state. It appears, therefore, that there is a constant replenishing of a reserve of matter in the virtual state that must serve some universal purpose.

Some inkling as to the destiny of the radiated energy should provide us with a clue to comprehending the whole cosmic economy. Inevitably, the attention of astronomers is turned towards the visible and measurable properties of the universe. The energy output can indeed be calculated; but, unless intercepted, it is unobservable. We have to remember that a considerable proportion of this energy is in the form of the neutral corpuscles or neutrinos that ordinary matter cannot intercept.

The second characteristic of the sun may help us to elucidate the problem of the first. This second characteristic is the isolation of the sun from other stars. Although the solar system is a very loose aggregation compared with any terrestrial object, it is very compact when assessed in terms of the stars. The average distance between the planets is less than ten thousand times their diameter. The distance from the sun to its nearest neighbour is more than ten million times the sun's diameter. It is noteworthy that the ratio of distance to size reaches its maximum with the stars. With the galaxies and other great cosmic concentrations, the relative distances are much smaller. For example, our galaxy is separated from its nearest neighbour, the great nebula in Andromeda, by a distance only about twenty times its own diameter. The isolation of the stars from one another is an objective fact and not merely an illusion due to their great size. Throughout the whole scale of existence there is nothing comparable to this isolation. Taking the whole volume of the solar system as unity, the region of space in which it exists alone—unaccompanied by any other star or cosmic concentration of any kind—is 40,000,000,000,000. The ratio is roughly the same as though two men started to wander at random from opposite poles of a planet ten thousand times larger than the earth. Two such neighbours would have only the remotest chance of meeting one another accidentally. So also are near approaches of stars the rarest of astronomical events. Jeans has calculated that in our own galaxy, a collision between stars or even the close approach of stars within the galaxy, is so improbable that in the

course of the past two thousand million years not one in a hundred million stars is likely to have passed through such an encounter.

The sun moves in the galaxy alone and self-sufficient, and yet it is the manifestation of the universal pattern that we can find throughout the starry universe. Its isolation is the condition of its creative power, which would be nothing if it were not free. On the other hand, it appears that the creativity of the sun is purchased at the price of a ceaseless outpouring of its own substance without having passed through the stage of actualization. Furthermore, the creativity of the sun is—as we have seen—but a minute particle of the potentialities of all existence, and therefore it can be completely specific and individualized, having its own role to play distinct from that of any other star. The sun is able to evoke in the worlds subordinate to itself a creative activity that makes possible the arising of sentient and conscious experience.

The two remarkable properties that we have been considering in some detail enable us to specify more closely the meaning of creativity as applied to the stars. Creativity is the power to evolve a pattern that remains omnipotent in so far as it leaves open the details of actualization. Again we may say that a pattern is a

condition to which events must conform, whereas creativity is a demand that events should occur. Our increased detailed knowledge of the sun and its influence upon the planetary world strengthens the conviction that this influence has the character of a stimulus rather than of a determination. One of the best studied of such influences is the connection between the magnetic field of the sun and the pattern of existence upon the earth. The sun does not condition the earth's climate, nor does it determine the weather. It can, however, be said that the pattern of terrestrial weather conforms to the sun's magnetic plan. The sun-spot cycles do not so much produce, as evoke, changes of weather. Of deeper significance is the influence of the sun's radiation upon the pattern of life. We cannot suppose that the sun directly produces the pattern of life by the distribution and intensity of radiation. We can, however, account for the arising of different forms of life on the earth as a response of the earth itself, in the form of changing conditions, to the creative power that issues from the sun.

The sun creates, not by doing anything but by being what it is. Nevertheless, in order to be, the sun pours out its own substance without return. If we are to understand the sun as the creator of life's pattern, we must take note of the difference between the relationship of the sun and that of the earth towards our own biosphere. The relationship comprises three modes of individuality. The biosphere itself is the complete manifestation of octopotence. The same individuality is

present in the earth and in the sun, but there are, in addition, properties that transcend life and individuality itself. The earth, as we have seen, is but a manifestation of a universal creative activity that it transmits by way of a pattern of existence. The earth establishes the conditions for the life of the biosphere, and at the same time demands a certain pattern of life corresponding to its own needs. There is thus a reciprocal maintenance of existence between the biosphere and the earth. There is no such reciprocity between the sun and the biosphere. The sun is exempt from the needs that permeate the existence of the planets and enable them to evoke the autonomic activity of the biospheres. The demand that is made by the sun is of a different order. The sun requires that all existence subordinate to itself should participate in the fulfilment of the plan of its own existence.

The creative triad: sun-planetary world-biospheres, is limited to the single manifestation of the cosmic plan represented by the being of the sun itself. This limitation is inconceivably stringent; for the sun is but one out of 1,000,000,000,000,000,000,000—a thousand million million million—stars. In any one of the sun's recurrences and any one of its actualizations, only an infinitesimal fraction of the potentialities of the universal plan can be realized. The planetary world as we know it is one of these actualizations, and because it represents a fraction so infinitesimal of the totality of possible planetary manifestations, the fate of the universe can scarcely be influenced by whether or not it succeeds in fulfilling the role for which it is created. The existence of the biosphere is completely hazardous and there is no means whatever of predicting to what extent any given biosphere will conform to the pattern of cosmic existence; and there is no reason in any purely statistical assessment why this should matter to the universe, or even to our own galaxy.

A similar conclusion can be reached empirically if we consider the evidence regarding the origin of life upon the earth. It appears that at some time not less than fifteen hundred million years ago, the synthesis of self-catalyzing nucleic acids must have been accomplished. Moreover, a sufficient variety of such substances must have been produced to enable the mutual action of enzymes in the regulation of synthesis to be achieved. It is by no means possible that such a combination could have arisen solely by random combinations in the absence of any organizing influence. On the other hand, the organizing influence itself could be no more than a pattern of potential energy with a very wide range of variation in the forms in which it could actualize. A high degree of uncertainty must be imported into the interaction of a random combination of the heavy and light elements from which the earth was

formed and the organizing pattern derived from solar creativity. This uncertainty stands at the point of intersection of the two streams of involution and evolution and the outcome of the meeting is unpredictable. We meet here the first stirrings of the universal drama, the unfolding of which will lead us into the domains of

consciousness and will, and so into the subject-matter of the next volume. We must, for the time being, pursue our own journey and, quitting our cosmic home—the solar system—venture into limitless space in which the next entity we encounter is the Milky Way, the galaxy in which our solar system has its being.

9.24.3. The Galaxy—Undecimptence—Domination

In domination we recognize a power that acts without participation. In human experience we can distinguish between performing an action, making another perform an action, and ordering the performance. At the third stage the directive power is not spent in the action, but remains aloof. In the autonomic world we can see a projected or partial manifestation of domination in the action of the epigenetic factor that directs the development and life-process of an organism without participating in its adjustments to the environment. The full manifestation of this power is possible only when the concentration of existence is so great that all individual entities are merged into a state of universal presence. This transition occurs in passing from the sun to the galaxy. In some strange way, the essential secrets of existence are always accessible—usually they are so obvious as to escape notice. Thus, for example, we can look at the stars on a moonless night and recognize in our own experience the way in which individuality is swallowed up in the immensity of the Milky Way. To the naked eye, the galaxy appears to consist of innumerable stars; but those that can be counted are barely five thousand, from the first to the sixth magnitude—that is, a range of brightness of one million to one—an astonishing testimony to the sensitivity of the human eye. Great modern telescopes can photograph stars down to the twenty-second magnitude, and of these the Milky Way alone contains over ten thousand million. Even this great number is little more than about one-tenth of the total number of stars of which our galaxy is composed. Not only are many stars too faint to be photographed, but great numbers are obscured from sight by clouds of dust that scatter the light. Strangest of all, the most important concentration of stars that lies at the centre of the galaxy is invisible to us; for radiation of the wave-lengths to which our eyes are sensitive is entirely absorbed by the intervening clouds of dust. Nevertheless, the longer wave radia-

tions, which can be intercepted by means of radar apparatus, can penetrate through the clouds and have enabled astronomers to identify and locate the centre of the galaxy.

Long, patient studies of the motions of the stars have shown that our galaxy is rotating and that it has the form of a spiral. We should hardly have looked for this had it not been that galaxies similar to our own can readily be seen in powerful telescopes, and we have relatively near to us, in terms of cosmic distances, a twin of our galaxy in the great spiral nebula in Andromeda. There is now little doubt that our sun exists in a world comprising more than a hundred thousand million suns, each of which has its own characteristic form and constitution. The galaxy combines three distinct shapes, each of which corresponds to the forms associated with one of the three modes of existence. It has the appearance of a composite whole but with limbs and organs like an animal. It has also the polyspherical structure of a hypernomic entity. We shall adopt the term autonomic body to denote the spiral system of the galaxy. This is not intended to suggest a living organism, but rather to emphasize the analogy between the reconciling role of the central system and that of the biosphere.

The autonomic body of our galaxy is a disc of immense breadth and relatively very little thickness; composed mainly of stars undergoing active transformations according to one general plan. These are the so-called 'main sequence stars' sometimes also termed 'Population 1'. These stars are distributed in the form of a rotating spiral with two principal arms. The polyspherical structure consists of a very concentrated core of most active stars, surrounded by great clusters of inactive stars in the form of a sphere that envelops the whole autonomic body and other little-explored spheres of isolated stars and clouds of dust and gas. The inactive stars are usually referred to as Population 2, or stars 'not of the main sequence', for the very existence of such stars in any great quantities was not suspected until recently. They are stars to which it is hard to assign a 'history' or trend of development or decay.

Such is the visible hyponomic aspect of the galaxy which is the only part of its existence of which we have

any reliable knowledge. Nevertheless, we can draw certain conclusions as to the respective roles of the different parts if we examine their observed shape and constitution.

The autonomic body of main-sequence stars is sandwiched between two saucer-like concentrations composed mainly of stars that, according to the usual interpretation, are 'old' stars. It contains the largest and brightest stars and it is whirling in space with an angular momentum so prodigious that its origin is one of the greatest of cosmic enigmas. Our

sun belongs to the autonomic body of the galaxy, being situated about two-thirds of the distance from the centre to the edge of the disc. Its velocity about the centre is more than a million miles an hour and yet, so huge is the galaxy that one complete revolution requires some 200,000,000 years. The autonomic body is composed not only of stars but of clouds of dust and atoms in varying degrees of concentration, and these clouds are also in a state of violent agitation. The great concentration at the centre of the autonomic body is hidden from us by these clouds—but its brightness is so intense that it is visible to the remotest regions of the universe that light can reach.

In the living body there are stars whose brightness is a hundred thousand times greater than that of our sun. These are the red super-giants, one of which is UW in the Great Bear, pouring out energy at a rate several million times greater than the sun. It is producing radiation at a rate equivalent to the annihilation of 27,000,000,000,000 tons of hydrogen per second. If our sun were to lose its substance at this rate, it would be bankrupt within a few centuries. Even more significant than the intense activity of the autonomic body of the galaxy is the possibility—still little more than a conjecture—that it is the scene of the birth of new stars by the concentration of dust and atoms in the whirling dust-clouds.

The thickness of the disc of the autonomic body is one ten-thousandth of its diameter, so that it is almost as two-dimensional in shape as the biosphere itself. It is an organized whole with a complex structure of interrelated parts. Furthermore, it is pre-eminently historical—it had a beginning in time and no doubt will have an end.

Compared with the autonomic body, the globular clusters and vagrant stars of the polyspherical body seem to be without beginning and without end. We can observe, in the heavens, galaxies in which there is no spiral structure and which seem to have become stabilized as spherical or ellipsoidal structures that are unlikely to undergo further change. The stars in these galaxies belong more often to Population 2 than to the main sequence. A giant elliptical system such as Messier 87, when photographed in the most powerful telescopes, looks like a ball of fire surrounded by globular clusters of stars. There is no evidence of the turbulent motions of the spiral galaxies, nor are there super-giants pouring out energy in reckless profusion. It happens that there are elliptical galaxies relatively close to our own—such as N.G.C. 205 that is adjacent to the great spiral nebula in Andromeda. This galaxy has been resolved into stars and appears to consist exclusively of stable stars similar to those of Population 2 of our own galaxy.

We have thus a first picture of our galaxy as an immensely great system consisting of a relatively passive spherical structure comprising nearly a hundred thousand million stars bisected by a thin disc of intense activity with only perhaps one-tenth as many stars—but those among the brightest in the sky.

Before we can attempt an interpretation of these observations, we must examine more carefully the stellar composition of our own and other nearby galaxies.

The first noteworthy characteristic of the stars that compose our galaxy is that very many are double stars. It is evident that two stars that appear to be close together may look so only because they are in the same line of sight—one may be far more distant than the other. Late in the eighteenth century, however, the great astronomer Herschel discovered that many stars which nearly coincide in the line of vision are true pairs, revolving one around the other in their common gravitational field. Tens of thousands of such pairs of stars

have since been discovered and investigated, and in consequence we have learned more about the masses of the stars, and have also established the very important fact that these pairs must have existed as such since the time of their formation ; for, as we have already seen, the probability of a sufficiently close approach for two stars to enter the gravitational field of one another is vanishingly small.

The observation of double stars shows that the two members of the pair can be astonishingly dissimilar. The best known example is Sirius, which is a star of more than average brightness and is accompanied by a very small star that has one ten-thousandth part of its brightness. The companion of Sirius has half its mass, but only one sixtieth of its diameter; so that its density is sixty thousand times greater. Moreover, Sirius radiates energy derived from the normal source—that is, the transformation of hydrogen into helium—whereas its companion has little convertible hydrogen and must be producing its energy either by gravitational attraction or some hitherto undiscovered mechanism. At the other extreme we find a pair of stars in Virgo that appear to be almost identical. Between such extreme cases there are almost all possible variations. Moreover, the distances between a pair may be so great that they can be seen as separate stars with the naked eye or they may be so close as to seem to be in actual contact with one another. We have spoken of twin stars, but there are also triplets and even stars containing as many as seven or eight components.

From the standpoint of dynamical theory the pairs or groups of stars must have been formed simultaneously on account of the unlikelihood

already mentioned of two independent stars ever coming within the effective range of each other's gravitational field. On the other hand, from such calculations as can be made of the time-periods required for stars to reach a particular state, it would seem that one member of a pair must often have existed for a very much shorter time than the other.

Two considerations of interest to our main problem emerge from the study of star groupings. The one is that the variety of conditions created by single stars is almost infinitely multiplied when multiple stars are taken into account. It appears that more than half the stars in the sky are binary or even multiple stars, and therefore the conditions of existence gain an additional dimension as compared with what would be calculated from consideration of the potentialities naturally inherent in our sun. It must furthermore be remembered that our sun at a great distance would appear as a single star, and yet it is accompanied by a very considerable companion in the planet Jupiter. Therefore, there may be dark, invisible stars, too small to cause observable perturbations, existing in conjunction with many of the stars that appear to us as single.

The second consideration concerns the life-history of stars. Data that is being accumulated provides evidence that by no means all the stars of Population 1 of our galaxy could have come into existence simultaneously. The process of the arising and disappearance of stars must, therefore, have an element that is historical.

Population 2, on the other hand, appears to be on the whole non-historical. The globular clusters which are the most imposing assemblages of Population 2 are composed of stars that appear to have neither beginning nor end. It is usually conjectured that these stars were derived originally from stars of the so-called 'main sequence'; that is, the historical stars of Population 1. There is, indeed, very strong evidence that the globular clusters surrounding each galaxy represent different levels of existence. This is mainly found in the so-called RR Lyrae stars that are pulsating variables with a period varying from 1-1/2 to 2-3/4 hours, and are observed to be all of similar colour and luminosity. It was shown by Martin Schwartzschild that such stars are totally absent from some of the globular clusters, whereas others contain hundreds or even thousands of them. There can be little doubt that the RR Lyrae stars represent a level of existence in which a very definite inner transformation is taking place, and presumably this level is connected in some manner with the condition of the whole globular cluster to which the variable stars belong. It does not, however, follow that one globular cluster is undergoing an historical transformation which will eventually convert it into another

type. We are accustomed to suppose that every process that we observe must be bringing about a change in

one direction or another. In making such a supposition we forget what we have observed about the atoms, the majority of which continue to exist unchanged for thousands of millions of years—as we can tell from our observation of the most distant galaxies whose spectra are exactly the same as those of the atoms that we study in our terrestrial laboratories. Stationary states of existence—that neither involve nor evolve—appear to be possible on all levels. There are atomic species so stable that they have remained unchanged for more than 4,000,000,000 years. There are biological species so stable that they have remained unchanged for at least 400,000,000 years. It seems that there are also stars so stable that they have remained unchanged for 5,000,000,000 years. These 'eternal unchanging' forms evidently have their part to play in the cosmic plan. To understand them we shall examine the plausible working hypothesis that the apparently undifferentiated structures of the globular clusters and the corresponding spherical shells of our own galaxy are likely to be the visible component of the invisible dominating power. The great star systems of the universe have three distinct constituents, and we can take them as the elements in a triad analogous to the cosmic triad. The first or hyponomic element is the dispersed cloud of dust, atoms, particles, and corpuscles by which the galaxy is directly linked to the hyle in its undifferentiated ground-state. The second or autonomic element—not always discernible to visual observation—is the autonomic body of main sequence stars. Here, if anywhere, the organic life of the universe is concentrated. The third or hypernomic element is hidden in the eternal unchanging spherical concentrations of Population 2 stars.*

We have a means of testing this hypothesis, by examining the question already referred to several times of the origin of angular momentum. It would not be difficult to picture the origin of the galaxy if we could assume that its parent was a rotating flat disc of gas with no stars in it, but the origin of such a disc remains the complete mystery. From a dynamic standpoint everything that exists in the universe can be more or less satisfactorily accounted for if we can assume that the primeval universe had only two basic components; one is a collection of 10^{80} electrons and protons, and the other a quantity of angular momentum. The separate arising of these two components must be postulated in any mechanical theory, because the one cannot arise out of the other.

[* The term 'eternal unchanging' is taken expressly from Gurdjieff's diagram of All Life given by Ouspensky in *In Search of the Miraculous*, p. 323. Without the help of this diagram the present chapter could scarcely have been written.]

When stated in these simple terms, the origin of the galaxy remains as mysterious as if we were asked to account for the appearance of the stars ready-made in their existing state.

We are here confronted with an element of experience that is subsumed under the category of repetition, for angular momentum is the dynamic manifestation of recurrence. We should recall the geometrical inquiry which revealed that in a pseudo-euclidean framework the o-pencil of skew-parallel vectors is recurrent in form. From bare geometry upwards through each level of existence, recurrence has proved to be an intimate characteristic of every kind of entity. Now repetition is the sixth category that follows potentiality and we should regard it as no less an element of existence than any of the preceding five. Until recently physical scientists have accepted without question that to exist means to be massive, and yet we now presume the existence of weightless entities such as the electron and even energy-less entities such as the neutrino. Thus the way has been opened for the thorough-going relativism that we have adopted throughout our inquiry. As applied to our present problem, this leads to the conception of repetition as a step towards fullness of being that enters after subsistence has given mass and potentiality has opened the way to a pattern of existence. On such a view, angular momentum does not have to be 'explained' in terms of simpler concepts; it is a categoreal property of existence and therefore ultimate. We see recurrences in everything that exists because to exist in the full sense is possible only by repetition. The hyle emerges from its ground-state already endowed with recurrence in the spin of the particles; but this does not account for the cosmic property of angular momentum by which the galaxies come into existence. We can, however, see the situation more clearly if we recall that the visible galaxies that we study are only the hyponomic levels of the invisible dominating power that is beyond creation. The hyponomic galaxy is subject to the determining-conditions and it should therefore

have its temporal, eternal, and hyparchic components. Recognizing this, the origin of the galaxies is readily accounted for: they must arise from the combination of mass (hyle actualized in time), potentiality (potential energy of gravitational and electro-magnetic fields), and recurrence (angular momenta of the galaxies and star systems). These three taken together are the necessary and sufficient ingredients for the formation of galaxies by the arising of matter from the undifferentiated ground-state. Of the three ingredients, that which acts as the organizing and regulating factor is angular momentum. We are thus led to regard the autonomic body of the galaxy—in which nearly all the angular momentum is concentrated—as the equiva-

lent on the cosmic scale of the hyparchic regulator in a living organism. There are some galaxies in which we see no spiral structure and little angular momentum. We may picture such galaxies as being asleep, passing through a stage of non-actualization between two recurrences of active realization of the cosmic plan.

Hitherto we have considered only the structure of a single galaxy, but before leaving the dominant mode of undecimpotent existence we must take cognizance of the interrelations of galaxies. Unlike the suns, the galaxies are grouped into related systems that give evidence of a common origin and continuing interaction. Thus, our own galaxy forms part of a 'local system' that includes two other great spirals, M 31 the great nebula in Andromeda, and M 33 in Triangulum, several elliptical galaxies, many globular clusters of stars and irregular clusters of which the two Magellanic clouds are so close to our galaxy that they may be regarded as subordinate entities. The whole of this system comprises several hundred thousand millions of stars. In such an immensity individual existence is submerged, and in contemplating it we find a new meaning in the concept of undecimpotent domination. If, as we suppose, the galaxies are pervaded with life, then we must also admit that the galaxies in their wholeness are far too great to intervene directly in directing the course of autonomic existence or even in creating it. And yet on our analysis life alone can bridge the gap between the hyponomic and the hypernomic worlds. It follows, then, that the galaxies may decree the arising of life and compel its creation by their dominating power. But the plan itself by which life arises appears not in the galaxies but in the stars.

9.24.4. The Universe—Duodecimpotence—Autocracy

If we were to regard autocracy as a principle of explanation and invoke it to account for the existence of the universe, we should be guilty of a serious *petitio principii*. The category of autocracy does not derive its meaning from the supposed need to 'explain' everything, but from the recurrent experience of the sovereignty of will. As we find in our experience that the will admits of no directing, we are led to assign to existence at least one element that is autocratic. The category of autocracy is thus not at all metaphysical since it remains within the content of our experience. It can tell us nothing of what is beyond experience. Autocracy does not even tell us anything about values. We cannot ascribe to it any value meanings such as 'good' or 'beautiful'. Autocracy is a fact of universal significance but it explains nothing that is not already given in experience itself. The autocratic category remains

empirical and it can serve only to discuss the datum of experience that consists in the recognition that a dominant galaxy, or even a family of such galaxies, is not the totality of all existence. There is a supra-galactic existence though we cannot know either its limits or its structure. We can, however, associate with the conception of cosmic wholeness as the limit of possible knowledge that of cosmic autocracy as the limit of possible existence.

We must, however, remember that what is knowable in the universe is only its functional aspect. The being of the universe—like all other being—is unknowable, but, unlike being on a scale commensurate with our own, it is also inaccessible to our consciousness. It has been claimed that 'cosmic consciousness' is possible for man,* but if we define cosmic consciousness as the direct experience of universal being, then there must be as many gradations of cosmic consciousness as there are gradations of existence beyond life. We have also seen reasons for believing that the limitations of our sense-perception may determine the limits of the universe knowable to us, but not necessarily the limits of all possible existence.

We cannot leave our task without attempting to complete the twelve-step cycle that begins with being as the ground state of hyle, will as the determining-conditions, and function as undifferentiated potency. The limits of existence in either direction are inaccessible, but they can be approached by the help of the principles that we discover in our own experience. We have found everywhere a relationship of three forces, and the role of the affirming power becomes more and more predominant as we ascend the scale of evolution towards the greatest cosmic concentrations. There must, therefore, be a source of all affirmations that can be assigned to the cosmic moment at which the possible is separated from the impossible.

This moment is certainly not a date in time, nor is it out of time either. It is the moment of determination that is present always, everywhere, in all recurrences and at all levels of potentiality. From this moment actualization begins—not in a historical sense but also not in a non-historical sense. It is the cosmic impulse by which all existence is compelled to become what it is destined to be. This compulsive becoming is what we understand by involution, by which all potentialities are seeking actualization—all possibilities their fulfilment.

The autocratic affirmation is not transcendent or even remote. It is present in all actualizations, but its purity depends upon the medium

[* Cf. Bucke's *Cosmic Consciousness* and Ouspensky's discussion of these possibilities in *Tertium Organum*.]

through which it is transmitted. The autocrat is present in man as it is present in all living and non-living matter, but since man's nature belongs in essence to the reconciling principle, the autocrat in him is transcendental. Thus, he himself does not affirm, but he stands in the presence of the autocratic affirmation; although it is not his own affirmation, it is nevertheless at the root of his existence. According to whether he turns towards or away from this affirmation, he enters into triads of evolution or involution. The direction in which he turns presents man with the choice by which he can become himself, but it is his nature to live. Man cannot be himself and exist in those states of existence that are beyond life any more than in those that are below.

When we turn from such considerations of our own experience to the study of the universe, we must conclude that life itself is omnipresent, and everywhere on every level plays the same role in relation to the twofold movement of involution and evolution. We have seen that life on the earth is made possible by the radiant energy received from the sun, but also that this energy represents little more than a thousand-millionth of the total energy that the sun emits. We must revert, therefore, to the unsolved cosmic problem of the significance of the energy that does not enter into any materialized existence. It can be computed that since the time-horizon, some ten thousand million years ago, nearly as much hydrogen has been converted into radiant-energy as still remains available for future transformations.

If we assume that the hyponomic existence of the universe is based upon the transformations of hyle from one form into another form—as, for example, the transformation of hydrogen into helium—then we might conclude that universal history has run about half its course. Within ten thousand million years there will be very few stars left in our galaxy with any great reserves of hydrogen. This will be true even on the assumption that new stars are being constantly formed out of the galactic dust and atoms.

There is always something suspicious in the observation that we stand at the mid-point of some presumed cycle; just as we should attribute our midway position in the scale of magnitude to the peculiarity of our own perceptions, so we should also reject the belief that in an objective or absolute sense we stand at the mid-point of all time. All that we have learnt about the relation between potential and actual states and the role of hyperaxis as the dimension of reconciliation, should convince us that the universe appears to be what it is because we are what we are. We see only the using up of potentialities through the transformation of hydrogen into helium and all the

subsequent transformations of energy by which the stars finally may become cold and passive. Although we can measure the immense quantity of energy that is continually disappearing from sight* we do not stop to ask ourselves whether this may not have an even greater significance than the minute fraction that re-enters actualized forms. For example, it should be a question for us whether, in the cosmic sense, the sun is wasting all but one thousand-millionth part of its energy output, or whether, perhaps, the maintenance of planetary existence is only the visible counterpart of some invisible task that is proceeding in a dimension to which our senses have no access.

Recalling the relationships of the physical world, we can see that radiant energy is localized only by the fact of interaction between photon and electron, and that, in the absence of such interaction, light is everywhere. The intensity of invisible light must be thousands of millions times greater than the intensity of visible light. At every point of space there is an incalculable concentration of photons, not in the corpuscular state but wholly virtual and therefore wholly connected. The invisible universe of light is a plenum compared with which the visible universe is an emptiness. Actualization proceeds in the void; potentiality exists in the fullness of the invisible light. This assertion is no figure of speech, for the concentration of potential energy distributed throughout the universe is incomparably greater than the thermal energy of all the stars, while the dynamical energy of all the universal motions is in turn quite small compared with the energy of heat.

The equivalence of energy and mass could be interpreted to mean that by far the greatest proportion of the universal energy is in the form of matter, but that only a small fraction of this matter can be converted into energy that is available for transformations. For example, hydrogen can be converted into helium only at a temperature exceeding fifteen million degrees Centigrade. Consequently, if the temperature of any star falls below this enormous intensity, it is immaterial whether hydrogen is present or not—the energy of transformation ceases to be available unless a fresh impulse can be given from some extraneous source, such as gravitational contraction.

We have now to consider the evidence—chiefly based upon the Doppler shift or reddening of light from very distant nebulae—that the universe is expanding. Dynamical models have been proposed by Einstein and others that show that all the dynamical data can be accounted for in a variety of ways, of which the expanding universe is only one. Dynamical effects are, however, among the least significant of the factors that

[* See Chapter 16, p. 310, and present chapter, p. 472.]

determine the possible existence of the universe. They operate only in the passive state of matter, and in respect of actualization in time. When we place ourselves in a perspective where time and eternity are merged, expansion must be proceeding simultaneously with contraction, and this seems the most probable situation.

The question as to the ultimate destiny of the electro-magnetic radiation not intercepted by matter cannot be resolved in terms of actualization alone. For example, we cannot suppose that at the boundary of the universe there is a reflecting layer which would return the energy of radiation into our own space; for if this were the case, visible light would be concentrated at every point from all past radiating sources; there would be a white background that would have an intensity far greater than that of any star. This kind of reflux is, however, quite contrary to the conception we are examining. The radiant energy that is not intercepted should not be regarded as radiating outwards into space either for ever or until reflected or absorbed. On the contrary, though in virtual form, it remains present; and, hence, serves to build up the eternal potential from which the unipotent hyle can derive fresh potentialities. We can regard the energies given out by the stars and unabsorbed by other stars or actualized matter as returning to the pre-corpuscular state of the hyle. This completes the cycle of hyponomic evolution and involution by linking the galaxies to the corpuscles. These are the two extreme limits of the cognizable universe, and, just as the domination of the galaxies evokes the plan of solar existence, so does the dissolution of the corpuscles evoke the emergence of the particles. This

emergence is the response of the most passive mode of existence, the unipotent hyle to the most active, the duodecimpotent autocrat. Throughout all space and time the emergence of particles proceeds unperceived and imperceptible. It is estimated that in order to maintain the concentration of matter in the universe in a stable state, no more than one neutron per cubic metre need emerge into tripotent existence every century. Minute though this quantity is, it is sufficient for the formation of several new galactic clouds every year. We can now envisage a complete cycle of involution and evolution whereby the existence of the universe is maintained. The apparent waste with which the stars pour out their energy is, on the contrary, the very foundation of the cosmic economy. Entering the hyle in the primordial ground-state, it produces differences of energy content below the corpuscular level. The random variations in distribution would be such as to raise an exceedingly small proportion of the hyle to that intensity of togetherness by which a particle can emerge, Thus we should regard involution and

evolution as one self-maintaining cycle. There is, however, a new and extraordinary question to be considered. Hitherto it has appeared that only the energy absorbed by matter is usefully employed, but now it appears that it is the energy that enters the pre-corpuscular hyle that is essential to the self-maintenance of the universe. It would appear, therefore, that the planets that absorb radiant energy without re-emitting it as light are the true wasters, and that planetary existence must therefore be a source of ultimate disintegration of the universal economy. Here, however, it is necessary to penetrate more deeply into the significance of life. The energy diverted from the great universal cycle into the planetary worlds serves for the creation and maintenance of life, and from life, in turn, emerges first sentience and then consciousness. Consciousness is the universal reconciling force by which the balance of the universe may perhaps be achieved. The twin cycles of evolution and involution thus prove to give us only the polar character of existence. When we add the category of relatedness, life and consciousness produce the triad by which the mutual and yet opposing needs of evolution and involution are reconciled. Hyponomically—that is, as a measurable quantity—the energy withdrawn from the cosmic cycle may represent only a minute proportion (probably less than one part in a thousand million), but from the autonomic standpoint of quality it is supremely important, for it is this energy that holds the potentiality of transformation to serve the needs of the higher gradations of existence. The hyponomic universe is a stupendous machine grinding all existence between the upper and the nether millstones of involution and evolution. It has no direction, for the two cycles are eternally balanced and they hyparchically recur. The hypernomic universe is incomprehensible to us, for the will is autocratic, and even in its immanent workings in the existing world it is always the affirmation that dominates and demands, that creates and also destroys. Only the autonomic universe is comprehensible, because it is in that world that we men must seek and fulfil our destiny. The search will take us out of the natural order into the realms where being and will meet with function, and the transformations concern not only impersonal energies but the very essence and individuality of man himself. It is in the transformations of being and will that all values reside. By our study of the natural order we can become aware of the unity of all existence and even catch a glimpse of the cosmic plan. But the plan seen from this perspective lacks the dimension of responsibility and the qualities of joy and suffering, of love and worship, that we shall only find when we see the universe in its dramatic aspect, where life is seen not merely as a device for the transformation of

energies but as the instrument whereby the universe becomes conscious of its own significance.

We have completed our survey of the universe as phenomenon reducible to fact; but there still remains before us the formidable task of bringing order into our value experiences of consciousness and will. Until this task is accomplished, all our most important questions remain but half-answered.

Appendix I to Chapter 13

FIVE-DIMENSIONAL PHYSICS

The suggestion that physical processes can be represented in a five-dimensional framework goes back at least to 1921. One of the first to make it was Kaluza, in a paper on unified field theory, in which he showed that

the electromagnetic equations can be obtained by adding a new fifth dimension to the Riemannian space-time of general relativity.¹ Klein, in 1926, suggested that Kaluza's five-dimensional cosmic model could be used to represent de Broglie's material wave function by making the fifth dimension occur harmonically in the solutions of the wave equation.² At the time Kaluza's suggestion attracted considerable attention among theoretical physicists and in 1927 de Broglie noted that the hypothesis of a five-dimensional world would require the further assumption that our human organs of perception are incapable of perceiving the fifth variable. "The variations of this fifth variable escape entirely from our sense perception. So two points of the universe which have the same values of the four variables, space and time, but different values for the variable X_5 are for us indistinguishable the one from the other. We are, as it were, enclosed in our four-dimensional space-time manifold and all that we perceive is the projection on to this space-time of the points of the five-dimensional universe."³

It is instructive to examine the reasons for the failure of the various five-dimensional theories to carry conviction to experimental physicists, and to enter into scientific thinking in the same way as, for example, the quantum and relativity theories have done.

We must distinguish again between hypothesis formation and the reduction of phenomena to fact. The fundamental hypothesis of relativity was formulated, not by Einstein, but by Minkowski in his 'postulate of the absolute world' in that historic address, *Raum und Zeit*, delivered at the 80th Assembly of German scientists and physicians at Cologne on September 21st, 1908.⁴

According to this postulate, all phenomena can be represented in a single four-dimensional continuum of space-time, but the partition between the dimensions of space and time is different for every independently moving body. This can be translated into our language if we say that there is one phenomenal world, but in it each independent whole determines its own division between time and space. The successive actualization of a given whole

[1 A. Kaluza, *Sitz. Ber. Preuss. Akad. Wiss.* (1921), p. 968.

2 *Z. Phys.* (1926), 37, 895, and *Z. Phys.* (1927), 41, 407.

3 L. de Broglie, *Journ. Phys. Radium* (1927), 8, 65.

4 Translated in Porritt and Jefferies, *Collection of Memoirs on the Principle of Relativity* (London, 1923), p. 75.]

is its own proper time, and its presence is its own proper space. Minkowski's fundamental hypothesis is fully consistent with the view of reality adopted in the present book, and because it takes into account the existence of independent wholes, it is a hypothesis relating to phenomena and not a mere generalization of facts.

The phenomenon that was the main source of disturbance for physicists who, since the work of Newton, had taken it for granted that one absolute space and one absolute time is common to all bodies, was Michelson's attempt to determine the velocity of the earth relative to the luminiferous ether. The phenomenon then observed can be reduced to fact in various ways. It could be regarded as a failure of Maxwell's electrodynamics; it could be accounted for empirically by the Fitzgerald contraction; Lorentz showed that it was equivalent to a group of transformations; but Einstein established its true significance as a demonstration that the notion of absolute simultaneity had to be abandoned. At each stage there was an improved and more consistent reduction to fact, but there was no essential step forward towards understanding the connection between existence and framework.

Minkowski, in his postulate of the absolute world, recognized that in future a new attitude towards all our

experience would be required, and he asserted that the postulate of the absolute world must be valid without exception. It is worth recalling the steps by which Minkowski elucidated this postulate. The logical starting-point is the fundamental assumption that Minkowski calls the 'fundamental axiom' of proper time, namely:

The substance of any world-point may always, with the appropriate determination of space and time, be looked upon as at rest.

The close connection between this axiom and the principle of wholeness can readily be seen. It tells us simply that every whole, in so far as it can be regarded as independent of other wholes, has an unique presence and actualization.

The second stage consists in recognizing that the velocity of light has a special status that is independent of substance. This advance was most clearly marked by Einstein himself in the formulation:

Any ray of light moves with the determined velocity c , whether the ray be emitted by a stationary or by a moving body.

Minkowski arrived at the notion of a fundamental velocity by way of the transformations that leave the expression of the laws of nature unaltered, "It is possible to make any change in the system of reference that is in conformity with the transformations of the group G_c and leave the expression of the Laws of Nature unaltered."⁵

Neither Minkowski nor anyone else recognized at the time that the assertion that there is an ultimate limiting velocity is a statement about framework and

[⁵ Minkowski, *Raum und Zeit.*, p. 79.]

not about substance. For example, he says that " c would stand as the upper limit for all substantial velocities, and that is precisely what would reveal the deeper significance of the magnitude of c ."⁶

He does, indeed, compare the invariance of electro-magnetic equations for the group G_c with the observed phenomena:

The concept of rigid bodies has meaning only in mechanics satisfying the group $G_{[00]}$.⁷

Here we have a tentative recognition of the possibility that a body rigid for one set of observations may appear to be plastic in another set. The idea that rigidity itself may be relative to the mode of representation is familiar from geometry; but as a physical concept it has given rise to many difficulties.⁸

In the special theory of relativity, relative rigidity refers only to the assumption that all systems of reference must be invariant for G_c . Not much more can be discovered so long as the inquiry is restricted to situations that satisfy the hypothesis of existential indifference, and it is demonstrated in Chapter 14 that when rigidity is given a realistic interpretation it can serve to provide a link between uniform and accelerated motions.

The third step in Minkowski's elucidation is to make use of Einstein's recognition that there is no reason for preferring the proper time of one body —an electron, for instance—to that of any other. This is, of course, a fundamental departure from Newton's conception of absolute rest, and is the true justification for applying the term 'relativity' to the principle enunciated. The effect of the whole procedure is to provide a simplified manner of displaying the laws of physics. Minkowski's specific contribution was to show that the framework could be put into the form of a four-dimensional manifold by treating the velocity of light as a conversion factor between space and time, and also by treating time as an imaginary quantity. The simplification achieved in this way can be said to be the culmination of classical mechanics, for it showed that the laws of

dynamics and electro-magnetism could be given a simple and convincing expression in the four-dimensional representation.

As far back as 1907, Einstein realized that he had not really established a principle of universal relativity, but had demonstrated only the unique significance of the velocity of light. He therefore put forward, in 1916, a more general principle, formulated as follows:

The general laws of nature are to be expressed by equations which hold good for all systems of co-ordinates: that is, are co-variant with respect to any substitutions whatever.⁹

[6 loc. cit., p. 80.

7 Max Born, *Ann. der Physik* (1909), Vol. 30. This and other references to the conception of relative rigidity are given in notes by A. Sommerfeldt on Minkowski's paper.

8 H. Weyl, *Raum, Zeit und Materie* (Berlin, 1919).

9 A. Einstein, *The General Theory of Relativity*, loc. cit., p. 117.]

The first step by which Einstein develops the general theory of relativity consists in making certain assumptions as to the manner in which measurements made in space and time are related to the four co-ordinates. These assumptions, which are strictly valid only in an infinitesimal region where the local acceleration can be neglected, lead to the invariant expression for the square of the linear element.

The next step consists in selecting an appropriate assumption as to the way in which the general expression can be applied to non-linear motions. This really amounts to laying down certain symmetry conditions which the measurements must fulfil. The third step passes straight to the laws of momentum and energy by way of the Hamiltonian function.

In his first announcement of the theory, Einstein was at pains to make these assumptions plausible by appealing to our intuition that there cannot be privileged systems of reference corresponding to the actualization of some arbitrary whole. He also showed that his equations of motion were more successful in reducing phenomena to fact than those of Newton, particularly as regards the behaviour of light in a gravitational field. We have here again to distinguish between the hypothesis relating to phenomena and the alternative ways in which phenomena can be reduced to facts. Soon after Einstein published his general theory of relativity, Whitehead showed that the equations that serve to summarize the observed facts can be set up without the particular assumption that Einstein makes as to the manner in which the physical measurements should be related to the co-ordinates.¹⁰

Einstein rightly claimed that the mathematical instrument he had created in his development of the tensor calculus gave a means of generalizing physical laws of matter so that they could fit in with the general theory of relativity. This is an achievement of the utmost brilliance, but we must not be blinded to the arbitrary character of the assumptions made. Einstein himself claimed that the general principle of relativity "makes us acquainted with the influence of the gravitational field on all processes, without our having to introduce any new hypothesis whatsoever".¹¹ He remarked further that "it comes about that it is not necessary to introduce definite assumptions as to the physical nature of matter (in the narrower sense). In particular, it may remain an open question whether the theory of the electro-magnetic field in conjunction with that of the gravitational field furnishes a sufficient basis for the theory of matter or not. The general postulate of relativity is unable on principle to tell us anything about this." This, in the terminology we have adopted, is an admission that the general theory of relativity is not an existential hypothesis, and therefore is not generally applicable to phenomena. Its history, during the thirty-five years since it was first formulated, fully confirms this conclusion. The expectation that the combination of electro-magnetic and gravitational theory would give an

adequate account of matter has not been fulfilled.

[10 A. N. Whitehead, *The Concept of Nature* (Cambridge 1920), pp. 180-3.

11 A. Einstein, *loc. cit.*, p. 152.]

Indeed, the whole trend of physical science has been to put aside the hope of gaining a deeper insight into the nature of the physical world, in favour of a symbolical description that is mathematically consistent even if not physically intelligible. Heisenberg wrote in 1952: "It must be noted that the status of the restricted and general principles of relativity is very different. The whole of modern physical theory is impregnated with the consequence of special relativity, whereas the general theory has remained an ingenious and impressive speculation that has made little contribution to the progress of physical science."¹²

Since 1927, many workers, and particularly Rosenfeld and Flint,¹³ have kept alive the conception of a five-dimensional world, but it has not been generally accepted by physicists, notwithstanding the fundamental role played by the five independent co-ordinate E numbers in Eddington's remarkable researches into the origin of the fundamental physical constants.¹⁴ Eddington, however, did not regard his E_5 as specifying an independent direction in a geometrical manifold, but only the measure of the local curvature. Hence the confusing result that E_5 can be either real or imaginary according to whether one or many particles are present.¹⁵

As with Einstein's general relativity, the Weyl-Dirac-Eddington hypothesis is an endeavour to squeeze the data of physics into a space-time framework, and is thus of a fundamentally different character from the theory put forward in the present book. Eddington,¹⁶ in the *Relativity Theory of Protons and Electrons*, divides his form of the Riemann-Christoffel tensor into a kinematic part and an electrical part. In *The Combination of Relativity Theory and Quantum Theory*,¹⁷ this division is made the basis of an attempt to derive the constants M/m and hc/e^2 which are, of course, both pure numbers. There has been little disposition among theoretical physicists to accept Eddington's analysis, notwithstanding the ingenuity of the statistical treatment.

Five-dimensional theories directed primarily to the removal of contradictions in wave mechanics and quantum theory were developed by Flint.¹⁸ In

¹² Werner Heisenberg, *Philosophic Problems of Nuclear Science* (London, 1952), pp. 12 and 13.

¹³ H. T. Flint, *Phil. Mag.* (1945), Vol. 36, p. 365; L. Rosenfeld, *Bull. Acad. Roy. Belge* (1927), p. 304.

¹⁴ Sir A. Eddington, *Relativity Theory of Protons and Electrons*. N.B.—The E -numbers are non-commutating roots of minus one. They are therefore equivalent to the use of a five-dimensional representation manifold of which three co-ordinates are real and two imaginary.

¹⁵ *Ibid.*, p. 250.

¹⁶ *Ibid.*, p. 189.

¹⁷ A. Eddington, *The Combination of Relativity Theory and Quantum Theory* (Dublin, 1943), p. 48.

¹⁸ H. T. Flint: (1) 'Metrical Theory in Relation to Electron and Proton', *Proc. Roy. Soc.* (1931), Vol. CXXXI, p. 170; (2) 'Development of the Quantum Equation', *Proc. Phys. Soc.* (1936), Vol. XLVIII, p. 453; (3) 'Ultimate Measurement of Space and Time', *Proc. Roy. Soc.* (1937), Vol. CLIX, p. 45; *Phil. Mag.* (1942), p. 360; (4) 'Quantum Equations and Nuclear Field Theories', *Phil. Mag.* (1945), Vol. XXXVI, p. 634.

these theories, the fifth dimension is related to the wave function. The main objective is to relate particle mechanics both of electrons and protons and also of the atomic nuclei to quantum theory, by the use of the harmonic possibilities of a fifth dimension. The geometry is that of the Riemannian space-time of Einstein.

We also have series of studies in which five-dimensional theories have been introduced, in which a definite physical significance is ascribed to the fifth dimension. Wilson,¹⁸ defining the five-dimensional cosmic manifold to contain the paths of all particles which describe geodesics, extended the Hamilton variation principle to five dimensions and connected this with the propagation of the de Broglie material wave. It was not until later¹⁹ that papers began to appear in which the physical significance of the fifth dimension was related to considerations of energy and entropy. In 1942, Caldirola²¹ defines the fifth dimension in terms of the time and energy content of a system:

$$x^5 = \frac{T}{E + \epsilon} dt.$$

Caldirola's objective is to derive the meson field from the metric, using a generalized five-vector. The geometry of Caldirola's five-dimensional manifold is that of a four-dimensional Riemannian space with the dimension of time added as a fifth. The suggestion that unified field theory could be derived from an Euclidean five-dimensional manifold has been made by Wong and Cheng in 1946.²² They do not, however, derive the fields from the character of the cosmic manifold, but introduce both gravitational and electrostatic potentials as independent vectors in the Euclidean five-dimensional space. They say that if a proper assumption is made as to the nature of the charge distributions in the fifth dimension X_5 , the field equations and the interactions with particles can be obtained. The fifth dimension is assumed to be space-like, but "As the momentum and velocity of a particle in the fifth dimension have never been observed, they are assumed to be zero". The purpose of the paper is to derive the couplings of the meson theory.

Giao²³ in 1946 suggested a new way of employing an $(n + 1)$ dimensional cosmic manifold, which is Euclidean in character but contains the n -dimensional Riemannian spaces responsible for the field potentials. The peculiar feature of Giao's theory is that he identifies physical existence with mathematical non-arbitrariness. The definition of a 'non-arbitrary mathematical being' is derived from the conception of the range of variation of a variable as

¹⁸ W. Wilson, 'Relativity and Wave Mechanics', *Proc. Roy. Soc.* (1928), Vol. CXVIII, p. 441.

¹⁹ In fact, several years after the greater part of the present book was written.

²¹ P. Caldirola, 'Meson Field Equations in Five-Dimensional Space', *Nuovo Cim.* (1942), Vol. XIX, p. 23.

²² K. C. Wong and K. C. Cheng, "A Five-dimensional Wave Theory", *Phys. Rev.* (1946), p. 316. A similar suggestion was made earlier by *Nature*.

²³ A. Giao, 'The Generalized Cosmological Problem and Relativistic Wave Mechanics', *Portugaliae Physica* (1946), 2, p. 1.

'container' and a function of the same variable as 'contained'. The use of five dimensions then follows from certain a priori assumptions as to the kinds of function which are significant. Giao can be regarded as an extreme exponent of the disregard of the principle that relations imply relata. He appears to assume that a

certain kind of relation (mathematical non-arbitrariness) can stand existentially on its own feet. It will be evident that these conceptions are superficially similar but actually quite foreign to those in the present book.

An alternative approach to the construction of a cosmological model is to retain Weyl's starting-point of an affine geometry.²⁴ Everything that is possible along this line has probably been done by Schroedinger,²⁵ in a paper of extreme beauty in its mathematical generality. Schroedinger's purpose is, in part, to bring the laws of interaction in the form of Proca's meson field into a single cosmological structure with gravitation and electromagnetism. The general approach employed in the studies of Schroedinger, Born, and others, who have made contributions of recent years to the generalized field theory, when interpreted in terms of our categorical scheme, appears to amount to a denial that hyparxis has the same status as space and time and to a disregard of the determining condition of eternity. The degrees of freedom required to compensate for this restriction in the framework are obtained by relaxing the conditions upon the permissible relations in the space-time system. In particular, both Born and Schroedinger appear to obtain their additional parameters by arguments extraneous to the affine cosmic geometry.

Another group of theories is represented by Einstein's "bivector hypothesis".²⁶ The procedure is to obtain a more general framework than that of the Riemannian geometry with a single curvature function by substituting the contravariant metric tensor by a contravariant bi-vector. This appears to be equivalent to postulating an affine geometry into which the metric is-introduced as two independent Riemannian manifolds. The procedure is thus open to the same metaphysical objections as that of Schroedinger and has the added disadvantage of giving field equations which it is almost impossible to solve.

Generally speaking, it can be said that the investigations of the thirty years which have passed since Einstein first suggested the use of a Riemannian geometry have failed to give results which justify the departure from the Minkowskian geometry of special relativity.

An entirely different approach has been suggested by Dingle in which he distinguishes two kinds of time, one dynamical and the other thermal.²⁷ Having recognized that the thermodynamical character of time is not given at all in the scheme of general relativity, Dingle writes: "The next move on

[24 H. C. Weyl, *Space, Time and Gravitation* (1919).

25 E. Schroedinger, 'The General Affine Field Laws,' *Proc. Roy. Irish Acad.* (1946), Vol. 51, p. 41.

26 A. Einstein and V. Bargmann, 'Bi-vector Fields', *Annals of Mathematics* (1944), Vol. XLV, p. 1.

27 H. Dingle, *Through Science to Philosophy* (1937).]

the part of field theory is obviously to make the molecule of heat give up the spatial time-measure system of mechanics, and adopt a new system for itself in which time is measured in terms of the intervals of some measurable thermal quantity. If this is done it will itself become rationalized in terms of a pure field theory, and the last remaining task of physics, so far as the formulation of metrical laws is concerned, will be to amalgamate mechanics, electro-magnetism, and thermodynamics in one unified field theory. For those who have some acquaintance with the technique of general relativity I venture to make a very brief first and last incursion into mathematical language to state this rather more definitely.

"The proper-time interval between two mechanical events in the space-time continuum is roughly represented in Einstein's theory by the expression:

$$ds^2 = FdT^2 - GdS^2$$

where dT and dS are the familiar time and space intervals, respectively, and F and G do not concern us except for the fact that the absolute velocity of light is involved in them. Now omitting electro-magnetism for simplicity, consider the interval in the spatio-thermal-temporal continuum corresponding to a prospective Field theory embracing mechanics and (relativity, not Newtonian) thermodynamics. The simplest generalization, which will suffice for the purpose of illustration, gives it the form:

$$ds^2 = FdT^2 - GdS^2 - KdH^2$$

where dH is the chosen thermal interval.

"This interval, dH^2 , would be potentially capable of containing all the paradoxes of quantum theory without their paradoxical aspect. The quantum of action, h , would be involved in F and K just as the velocity of light, c , is involved in F and G . The uncertainty expressed in the quantum principle would be the analogue of the uncertainty, according to current general relativity, of the 'now' of Newtonian time, and like that indefiniteness, would disappear from proper measure instead of, as in quantum theory, remaining as an imperfection of formulation. The further paradox of quantum theory, that the data necessary to determine an event appear sometimes to lie in the future of that event, would also have an obvious explanation. They would not lie in the *proper* future but only in the *co-ordinate* future—namely, that obtained by neglecting the term in dH^2 : it is, of course, only in microscopic phenomena, where dS and dT are so small that the term, normally negligible, would become considerable that this paradox arises.

"I apologize for this lapse into jargon. It is not necessary for the appreciation of the general argument, but it does give more precision thereto if one understands the symbolism. Making all due allowance for the fact that it is a speculation (for H has yet to be identified, and K formulated so as to express the laws of heat) it shows at least a *conceivable* direction of development which would secure all the advantages of the quantum theory without requiring the inconsistencies which now accompany them."²⁸

²⁸ Dingle, *loc. cit.*, pp. 299-300.

It will be evident that Dingle here approaches very closely to the distinction we have made between time, eternity, and hyparxis.

The thermo-dynamic distinction between time and eternity²⁹ is also implicit in the work of Fantappie who distinguishes between the two cosmic processes of entropy and syntropy.³⁰ His syntropic phenomena are

irreproducible, intensive and unobservable, and closely approach our conception of eternity as the storehouse of potentiality.

Finally, reference should be made to the very important work of Podalanski, by which he sought to unify field theory and quantum mechanics by means of a six-dimensional geometry.³¹ He states specifically, however, that his representation "may be classified as an embedding theory, the electro-magnetic force having the character of forces of constraint". The eternity blindness of the observer and its relation to the strain in the quasi-rigid measuring system is recognized in the notion of 'harmlessness' by which is meant that there is no physical change in the observer by reason of his displacements in the fifth and sixth dimensions. It must, however, be recognized that the thermo-dynamic distinction between time and eternity is missing from Podalanski's theory as from all that precedes it.

This review, though brief and necessarily incomplete, will suffice to shew that mathematicians and theoretical physicists have long recognized the possibility that the framework of four-dimensional space-time would prove inadequate. The step that has to be made can be soundly taken only if we recognize the fundamental distinction between function, being, and will. If existence and the determining conditions are in any way confused, the scheme of representation we shall set up will inevitably prove to be abstract and conventional. When, on the contrary, we find that phenomena in all their endless variety can be represented in terms of one and the same geometry, we may feel confidence that we are close to experience itself and not to some artificial construct of our own minds.

[29 See Chapter 8, p. 158.

30 L. Fantappie, *Principi di una Teoria Unitaria del Mondo Fisica e Biologica* (Rome, 1945).

31 J. Podalanski, 'Unified Field Theory in Six Dimensions', *Proc. Roy. Soc.* (1950), 201a, pp. 234-61.]

Appendix II to Chapter 14

UNIFIED FIELD THEORY

1. SIMPLIFIED MATHEMATICAL TREATMENT*

The derivation of the field equations for centrally directed forces in a five-dimensional manifold has been given elsewhere.† A simplified treatment can be given by regarding space, time, and eternity each as a single dimension. This is equivalent to considering only the momentary direction of the force in space. This enables us to use as the framework of reference a three-dimensional manifold with one imaginary axis ${}^1Q$ (space-like) and two real (time and eternity-like) axes ${}^2Q$ and ${}^3Q$. These are taken as mutually orthogonal in a manifold which is pseudo-Euclidean. Regarding d^1q as imaginary, the interval is given by,

$$ds^2 = -(d^1q)^2 + (d^2q)^2 + (d^3q)^2 \quad (1)$$

where d^1q , d^2q , d^3q are displacements along ${}^1Q$, ${}^2Q$, ${}^3Q$ respectively.

The observations required to enable such an interval to be measured can, in general, only be made by the universal observer Q who is not restricted to a single stratum of eternity. To enable them to be related to the observations of an (eternity-blind) observer O we consider the measuring system $O-M-R$ of which the physical organism of O is an integral part. This will be said to have 'quasi-rigidity' in the sense defined below (and as discussed in Chapter 14). Here 'quasi-rigidity' does not mean imperfect rigidity in the sense of deformability by observable space-time forces. It means that for the observer Q the system $O-M-R$ does not necessarily preserve its spatial configuration in being displaced in the manifold. For any measurements that O can make, his system is perfectly rigid, but it is limited and local and cannot therefore coincide with that of Q . This discrepancy is expressible by a set of conditions as follows.

Let U_1 , U_2 be the directions of space and time measurement of O and let U_3 be the direction of his instantaneous existence, i.e. his 'proper-eternity'. Intervals that for O are purely time-like will be expressed as $\Delta \tau^2$, those that are space-like by Δx^2 , and those that are eternity-like by $\Delta \epsilon^2$. The measuring system $O-M-R$ is a miniature universe set in the true universe of Q . It cannot therefore be very different from the universal directions ${}^1Q$, ${}^2Q$, ${}^3Q$.

* Elsewhere in the book the space-like axes have been taken as real and the time-like as imaginary; in this Appendix equation (1) conforms with the usual convention.

† J. G. Bennett, R. L. Brown, and M. W. Thring, 'Unified Field Theory in a Curvature-free Five-dimensional Manifold', *Proc. Roy. Soc., A*, 198 (1949), p. 39.

We therefore have:

$$(1) \quad \left. \begin{aligned} U_1 &\cong {}^1Q \\ U_2 &\cong {}^2Q \\ U_3 &\cong {}^3Q \end{aligned} \right\} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (2)$$

where the symbol $\cong$ means coincident to the first order of small quantities.

- (2) The space-time of O is confined to a single level in eternity. This is expressed by the requirement that U_1 is orthogonal to the projection of U_2 into ${}^2q = 0$.
- (3) Because O is incomplete and Q is complete, there cannot be identity between the direction given by the orthogonal $\tilde{\omega}$ to U_1 and the universal direction of eternity ${}^3Q$. On the other hand, there can be no divergence that would lead to a different situation at different levels in eternity. This is only possible if $\tilde{\omega}$ makes a null-angle with ${}^3Q$.
- (4) It is necessary to allow for the inner-togetherness of the system $O-M-R$, which must be different from that of Q . This effect can only arise within the system of O himself. Consequently U_3 and ${}^3Q$ will not, in general, coincide. Here again, however, a persistent divergence is excluded. Therefore we must have the further condition that U_3 makes a null-angle with ${}^3Q$.

The expression 'null-angle' refers to the relation between two vectors having the same or different components, but such that the cosine of the angle between them, defined in the usual way, is unity. Thus, if the unit vector $(if, f, 1)$ defines the direction of $\tilde{\omega}$ in Q 's manifold, $\tilde{\omega}$ makes a null-angle with ${}^3Q$. Then $\tilde{\omega}$ is a skew-parallel of ${}^3Q$. The four conditions of quasi-rigidity lead to simple expressions for the unit vectors which define the directions U_j and $\tilde{\omega}$, ($j = 1, 2, 3$),

viz.

$$\left. \begin{aligned} U_1 &= (a, ib, if) \\ U_2 &= (-ib, d, -f) \\ U_3 &= (ic, e, 1) \\ \tilde{\omega} &= (if, f, 1) \end{aligned} \right\} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (3)$$

where

$$\left. \begin{aligned} a^2 &= 1 + b^2 + f^2 \\ d^2 &= 1 + b^2 - f^2 \end{aligned} \right\} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (4)$$

The quantities b, e, f are all real and small.

The effect of the presence of material objects (in general massive charged bodies) is to destroy the isotropy and homogeneity of the manifold of Q . This is expressed by making b, e , and f vary with ${}^kq$ where $k = 1, 2, 3$.

It can be shown that the conditions of integrability where b, e , and f can be treated as functions of x^1, x^2 , together with the characterization of O 's measuring system (quasi-rigidity), leads to the inverse square law of force. For the present purpose, it is assumed that b, e , and f vary with x^1, x^2 —i.e. they could be ascertained for any given moment of space and time by measurements made locally by O .

2. GENERAL EXPRESSION FOR THE INTERVAL

In order to give scope for observations by O which are not local *i.e.* not rigidly attached to the system $O-M-R$, we can consider a body P moving independently of O . This is the 'unconstrained freely-falling body'. P is assumed to make no contribution to the field *i.e.* P has negligible mass and charge compared with O and the field-producing body S . We have to express the interval ds for the motion of P . By definition, the path of P is a cosmodesic, *i.e.* a straight line as verifiable by the universal observer Q . Except where very great accelerations are involved, the path of P will lie very close to the general direction of temporal actualization. This can be expressed by the requirement that the cosmodesic of P makes an angle $(\frac{1}{2}\pi - \lambda)$ with ${}^2Q$, where λ is a small angle.

Now, from the relationships given in equations (3):

$$\left. \begin{aligned} d^1q &= a \Delta x^1 - ib \Delta x^2 + ie \Delta x^3 \\ d^2q &= ib \Delta x^1 + d \Delta x^2 + e \Delta x^3 \\ d^3q &= -if \Delta x^1 - f \Delta x^2 + \Delta x^3 \end{aligned} \right\} \quad (5)$$

We have in addition:

$$d^1q = ds \sin \lambda.$$

This enables us to eliminate Δx^3 , which is the interval that O cannot measure on account of his eternity-blindness. We then have a relation between the measurements made by Q in the three dimensions of space, time, and eternity, and those made by O in his and our limited and eternity-blind measuring system.

$$\left. \begin{aligned} d^1q &= ie ds \sin \lambda + (a - ef) \Delta x^1 + (-b + ef) i \Delta x^2 \\ d^2q &= e ds \sin \lambda + (b + ef) i \Delta x^1 + (-d + ef) \Delta x^2 \\ d^3q &= ds \sin \lambda \end{aligned} \right\} \quad (7)$$

Substituting from (7) in (1) gives the required relationship as:

$$\begin{aligned} ds^2 \cos^2 \lambda - 2ds \sin \lambda [i \Delta x^1 (a + b) + \Delta x^2 (d + b)] \\ = (\Delta x^1)^2 [1 + f^2 - 2ef] + (\Delta x^2)^2 [1 - f^2 + 2ef] \\ + 4i \Delta x^1 \Delta x^2 ef \end{aligned} \quad (8)$$

This equation is accurate to the third order of small quantities.

3. THE GENERALIZED LAGRANGIAN

Since the cosmodesic is straight, the interval must satisfy the variational condition:

$$\delta \int ds = 0 \quad (9)$$

If, now, a Lagrangian function L is introduced by the relations:

$$\left. \begin{aligned} \frac{\Delta x^1 \cos \lambda}{\Delta x^2} &= 1 - \frac{L}{m_s c^2} \\ \frac{\Delta x^1}{\Delta x^2} &= \frac{i V'}{c} = v' \end{aligned} \right\} \quad (10)$$

where m_0 is the inertial mass of P and c is the velocity of light, we can write (9) in the form:

$$\delta \int \left(1 - \frac{L}{m_0 c^2} \right) \sec \lambda \, dx^2 = 0 \quad (11)$$

Now λ , being the angle made by the straight cosmodesic of P with the perpendicular to ^2Q , is independent of time and position. Also m_0 is constant. Consequently (11) is equivalent to the classical variational equation:

$$\delta \int L \, dt = 0 \quad (12)$$

for the motion of a particle in a field of force, time being measured in the usual way. By combining (8) and (10), a quadratic for the Lagrangian L is obtained. The quadratic, when extended to five dimensions, can be simplified by adopting conventions which lead to the well-known forms for gravitational and electro-magnetic fields respectively. This treatment serves to show that the postulates of Chapter 14 give the unified field theory to the same order of accuracy as the observational data. It is worth pointing out that no absolutely rigorous derivation is possible because of the relative character of the existential postulate. The quasi-rigidity of Q 's measuring system is not merely a convenient approximation; it is the source of the observed deviation of the apparent path of P from the straight line which Q finds from his own more 'objective' standpoint. The very existence of the system $Q-M-R$ prevents a complete dissociation of space, time, and eternity.

The special character of the gravitational and electro-static fields can best be seen by deriving them *ab initio*.

4. THE GRAVITATIONAL FIELD

The situation in which the inner stresses of the field-producing body and the test body P can be neglected corresponds to the absence of electric charge. Since the absence of inner forces means that there is no inner potential energy, we must have U_2 coincident with ^2Q . This is the condition of a gravitational field. The forces arise through the non-coincidence of the plane of the space-time axes with the plane orthogonal to ^2Q . This means that $\bar{\phi}$ is not coincident but makes a null angle with ^2Q . Consequently we have:

$$\begin{aligned} \theta &= 0 \\ f &\neq 0 \\ b, d, \text{ and } f &\text{ small and finite.} \end{aligned}$$

hence

$$\left. \begin{aligned} U_1 &= (a, ib, -if) \\ U_2 &= (-ib, d, -f) \\ U_3 &= (a, a, 1) \\ \bar{\phi} &= (if, f, 1) \end{aligned} \right\} \quad (13)$$

where

$$\left. \begin{aligned} a^2 &= 1 + b^2 + f^2 \\ d^2 &= 1 + b^2 - f^2 \end{aligned} \right\} \quad (14)$$

It follows that:

$$\left. \begin{aligned} d^1 q &= a \Delta x^1 - ib \Delta x^2 \\ d^2 q &= ib \Delta x^1 + a \Delta x^2 \\ \text{and } d^3 q &= ds \sin \lambda \text{ as before} \end{aligned} \right\} \quad (15)$$

This enables us to write (1) in a form that does not involve Δx^2 , viz.

$$\begin{aligned} ds^2 \cos^2 \lambda &= (a \Delta x^1 - ib \Delta x^2)^2 + (ib \Delta x^1 + a \Delta x^2)^2 \\ &= (\Delta x^1)^2 (a^2 - b^2) + (\Delta x^2)^2 (a^2 - b^2) \end{aligned} \quad (16)$$

Making use of (14) this gives:

$$ds^2 \cos \lambda = (\Delta x^1)^2 (1 + f^2) + (\Delta x^2)^2 (1 - f^2) \quad (17)$$

Noting that Δx^1 is an imaginary (space-like) co-ordinate and that we are considering only the direction of instantaneous acceleration of P , we can see that (17) is equivalent to the Schwarzschild equation providing the function f is correctly assigned (for a full discussion, reference must be made to the paper cited).

The interpretation of (17) calls for careful attention to the character of the operations performed by O in obtaining the data regarding the apparent path of P . The angle λ is imperceptible to O , who projects the path of P into his own momentary framework of observation. We do not therefore have to consider a general metric in the sense of current field theory. There is a universal metric only for Q . O cannot make measurements outside the limits of his own measuring system. He can therefore only take into account the instantaneous directions of actualization and acceleration (*i.e.* time and space).

Equation (17) gives the results of O 's measurements and no more than this, whereas in the usual interpretation of the Schwarzschild equation the metric is implicitly regarded as independent of O 's experience. The interpretation of (17) as a consequence of the assumptions made as to the character of O 's measuring system makes the treatment fully relativistic in the true sense of the word. It can readily be seen that the apparent track of P as observed by O corresponds in every way to the motion of a body falling freely in a gravitational field of force, including the Einstein correction to the Newtonian theory.

A simple derivation of the gravitational potential is obtained by omitting the Einstein correction term $f^2 (\Delta x^1)^2$ and using equations (10) and (17),

$$\left(1 - \frac{L}{m_0 c^2}\right)^2 = 1 - f^2 - \frac{(V')^2}{c^2} \quad (18)$$

whence,

$$L \cong m_0 c^2 \left[1 - \left(1 - \frac{(V')^2}{c^2} - f^2 \right)^{1/2} \right] \quad (19)$$

Comparing this with the classical Lagrangian:

$$L = m_0 c^2 \left[1 - \left(1 - \frac{(V')^2}{c^2} \right)^{1/2} \right] - \Omega_s \quad (20)$$

we have:

$$\Omega_0 \cong -\frac{1}{2} m_0 c^2 f^2 \quad (21)$$

Hence the potential energy of any body in this type of field is proportional to the inertial mass and is always negative (giving an attractive force). The postulate of quasi-rigidity leads to an inverse square law for f .

5. THE ELECTROSTATIC FIELD

The second simplifying assumption that can be made is that which neglects the non-identity of the space-time system of O with that of Q , but takes into account the inner stresses of the field-producing bodies and the test body P . We then have:

$$\left. \begin{aligned} U_1 &\neq q \\ \bar{\omega} &= q \end{aligned} \right\} \quad (22)$$

This gives $f = 0$ and $e \neq 0$.

In this case as U_1 and U_2 lie in the plane orthogonal to ${}^3Q$ and are truly orthogonal we can take:

$$U_1 = {}^1Q, U_2 = {}^1Q$$

for this means only that O is at rest with respect to the field-producing body.

This gives:

$$\left. \begin{aligned} U_1 &= (1, 0, 0) \\ U_2 &= (0, 1, 0) \\ U_3 &= (ie, e, 1) \\ \bar{\omega} &= (0, 0, 1) \end{aligned} \right\} \quad (23)$$

The situation where O is not at rest with respect to the Q co-ordinates can be reduced to an instantaneous rotation and has to be considered to account for secondary effects, in particular the magnetic field of massive rotating bodies.

From (23) we have:

$$\left. \begin{aligned} d^1q &= \Delta x^1 + ie \Delta x^2 \\ d^2q &= \Delta x^2 + e \Delta x^1 \\ d^3q &= \Delta x^3 \\ d^4q &= dx \sin \lambda \end{aligned} \right\} \quad (24)$$

Eliminating the unobservable Δx^2 and retaining only first order terms in e gives

$$\left. \begin{aligned} d^1q &= \Delta x^1 + ie dx \sin \lambda \\ d^2q &= \Delta x^2 + e dx \sin \lambda \\ d^3q &= dx \sin \lambda \end{aligned} \right\} \quad (25)$$

Inserting these in (1) gives:

$$dx^2 \cos^2 \lambda - 2 dx \sin \lambda e (i \Delta x^1 + \Delta x^2) = (\Delta x^1)^2 + (\Delta x^2)^2 \quad (26)$$

Keeping to first order terms in ϵ , the square on the left-hand side of (26) can be completed and the corresponding squared term on the right side omitted. This gives:

$$[ds \cos \lambda - \epsilon \tan \lambda (i \Delta x^1 + \Delta x^2)]^2 = (\Delta x^1)^2 + (\Delta x^2)^2 \quad (27)$$

Taking the moment when P is at rest with respect to O (i.e. the moment when P is released to fall freely), we have:

$$\frac{\Delta x^1}{\Delta x^2} = \frac{\text{vel of } P}{ic} = 0 \quad (28)$$

so that we can write:

$$ds \cos \lambda = \Delta x^2 (1 + \epsilon \tan \lambda) \quad (29)$$

Comparing with the Lagrangian form (10) we have:

$$L = -m_0 c^2 \epsilon \tan \lambda \quad (30)$$

from which the electrostatic potential is seen to be given by:

$$\Omega_e \simeq m_0 c^2 \epsilon \tan \lambda \quad (31)$$

The foregoing treatment involves approximations the legitimacy of which is only apparent from the detailed analysis in five dimensions. It is intended only to assist the reader to see how the framework conditions—combined with the postulates of pseudo-rigidity and eternity-blindness—lead to the gravitational and electro-magnetic fields. The equations for the latter (involving as they do space-variations) can obviously be derived only when the three dimensions of space are taken into account.

It will be noted that the electro-static potential is independent of the measuring system of O , for the angle λ is a property of P (the direction of the cos-modesic in Q 's manifold) which has no connection with O . When λ is zero, Ω_e is zero. This is interpreted as P being uncharged. Since $\tan \lambda$ can be positive or negative, the charge can have opposite signs and the field can be attractive or repulsive. It can thus be seen that the properties of the electro-static (and for five dimensions the electro-magnetic) field can be derived from the assumptions

(a) There is no interaction between O and P ,

$$\partial_1 = {}^2Q.$$

(b) The inner structure of P and the field-producing bodies must be taken into account

$$U_2 \neq {}^2Q.$$

(c) $O-M-R$ is a quasi-rigid system.

(d) O is eternity-blind.

The same assumptions also lead to the inverse square law of force.

This completes the scheme whereby the hypothesis leads to a single field theory for gravitational electro-magnetic fields and the gravito-magnetic interaction. For a more rigorous treatment, reference must be made to the original paper.

Appendix III to Chapter 15

THE GEOMETRICAL REPRESENTATION OF IDENTITY AND DIVERSITY

1. THE LIMITATIONS OF CLASSICAL GEOMETRY

By 'classical' we designate all geometries, Euclidean and non-Euclidean, metrical and non-metrical, in which the entities represented are assumed to be identical with themselves. Notwithstanding all the developments of affine and non-Euclidean systems, classical geometry has remained tied to its primitive purpose of 'earth measurement' in which the question whether or not an entity can be both 'same' and 'other' does not arise. If we are to set our ontology free from the limitation of single-valued existence we require a geometry that will enable us to represent situations in which each entity can be 'more than one thing at once'.

Since adding a null-vector to a finite vector leaves the latter unchanged and yet such that when projected it appears to be different, we can recognize in the pseudo-Euclidean geometry the required properties. Nevertheless, the geometry of Chapter 15 requires generalization.

In order to obtain a geometry fully adequate for the representation of physical events, we require to introduce some further property that enables interaction to be distinguished in terms of coupling and exchange. In this appendix we shall give the outlines of the geometry of an n -dimensional pseudo-Euclidean manifold and show that it possesses the properties required.

2. SKEW-PARALLEL FIGURES

The property of skew-parallelism in a pseudo-Euclidean manifold is readily extended for the construction of skew-parallel figures. As a simple example let there be two real (x, y) and one imaginary (iz) dimension, where i is written for $\sqrt{-1}$, and let $OACB$ be a unit square lying in the xy -plane.

Displace the point C to D and require AD to be a skew-parallel of OB and BD of OA . Then AD is in the direction $(\phi, 1, i\phi)$ where ϕ is a real parameter, and BD is in the direction $(1, \phi, i\phi)$. It is easy to see that D has co-ordinates

$\left(\frac{1}{1-\phi}, \frac{1}{1-\phi}, \frac{i\phi}{1-\phi}\right)$ and AD, BD are each of length $\left(\frac{1}{1-\phi}\right)$. But AC is

an Euclidean parallel of OB , and therefore is skew-parallel with AD ; similarly BC is skew-parallel with BD . Thus it may be said that the figure $OADB$ is both the same and different from $OACB$. The difference appears if $OADB$ is projected parallel to the z -axis into the xy -plane, when D projects to give

$\left(\frac{1}{1-\phi}, \frac{1}{1-\phi}, 0\right)$, whereas C is $(1, 1, 0)$. Thus $OADB$ is the same as $OACB$ in three dimensions, but the projections of the two figures into two dimensions differ.

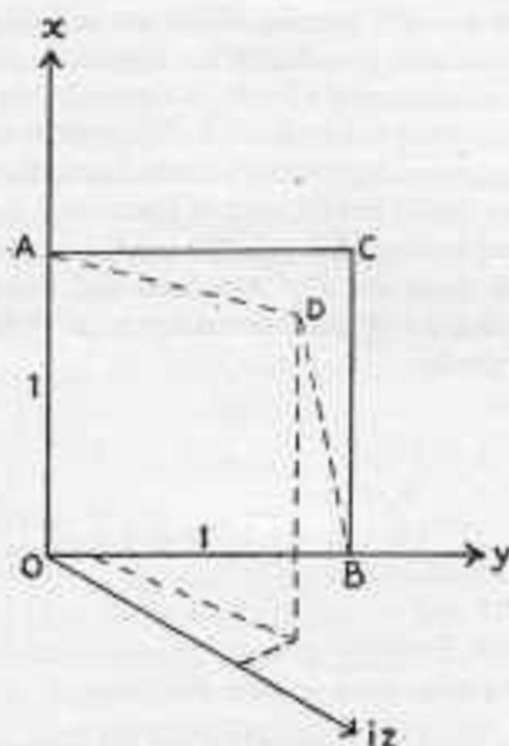


FIG. 15. 3.—*Skew Parallel Squares.*

The figure may assist in visualizing the situation if it is remembered that $\angle DAC$ is a null-angle so that there is no real separation of D and C . We can then call $OADB$ a 'skew-square'.

More generally, we shall consider the construction of a **skew-cube** in a pseudo-Euclidean manifold having k real and j imaginary dimensions, where $k+j=n$. In n dimensions, a cube has 2^n vertices and $n \cdot 2^{n-1}$ edges, these forming n sets, each set containing 2^{n-1} edges, the edges in each set being mutually parallel.

2. DEGREE OF FREEDOM

If every vertex of a cube be displaced arbitrarily, so as to form a distorted cube, there are $n \cdot 2^n$ arbitrary parameters or degrees of freedom. These degrees of freedom determine the shape and orientation of the distorted cube. We limit the distortion so that every set of initially parallel edges forms a pencil of skew-parallel. We call the cube thus distorted a *skew-cube*. In

specifying the initial edges in this way, we limit their possible orientations. The question then arises; are there values of k and j such that this limitation vanishes identically?

To proceed further, we recall that four kinds of pencil of skew-parallelisms have especial significance. We suppose there to be n_1 pencils having 1 degree of freedom. These are α - or δ -pencils, which are indistinguishable on the present analysis. Since neither potentiality nor hyparchic properties—by the combination of which fundamental identity is ensured—are directly observable, such lack of distinction is to be expected. We suppose next that there are n_2 β -pencils each having $n-2$ degrees of freedom. Lastly there are k γ -pencils if the skew-cube is to be totally linked; each of these has λ degrees of freedom where $\lambda = j-1$ if $k=j$ or $\lambda = j$ if $k > j$. The case of $k < j$ is readily argued.

Now, in each pencil there are 2^{n-1} members and therefore a pencil of opposite edges with m degrees of freedom confers $m \cdot 2^{n-1}$ degrees of freedom on the skew-cube as a whole.

Thus we have:

$$\left. \begin{aligned} n &= k + j \\ n &= n_1 + n_2 + k \\ n \cdot 2^n &= 2^{n-1} (n_1 + n_2 \cdot \overline{n-2} + k\lambda) + \epsilon \cdot 2^{n-1} \end{aligned} \right\} \quad (1)$$

which are easily seen to yield:

$$\left. \begin{aligned} n &= k + j \\ j &= n_1 + n_2 \\ 2n &= j + n_2 \cdot \overline{n-3} + k\lambda + \epsilon \end{aligned} \right\} \quad (2)$$

wherein ϵ is zero in the third equation only when the skew-cube is an entirely arbitrary distortion of the original cube; that is, only when identity is commensurate with the maximum of diversity.

We seek a solution for these equations in which ϵ is zero. If $\epsilon > 0$, then the distortion of the cube is limited; if $\epsilon < 0$, then the representation cannot admit the full diversity of skew-parallelism.

3. DIVERSELY IDENTICAL SKEW-CUBES

We accept from experience that there must be not less than three space-like and not less than one time-like dimension.

We can therefore begin by writing:

$$k \geq 3 \quad n_2 \geq 1 \quad j \geq 1 \quad j \geq n_2 \quad (3)$$

The inadmissibility of solutions that do not satisfy equation (3) can be shown by the consideration that $n_1 \geq 1$; i.e. that there must be at least one unobservable dimension in order to represent the potential energy or more generally to enable entities to be distinguished one from another.

A few trial solutions show that ϵ is zero for the following combinations:

k	j	n	λ	$(2n - j - k\lambda)$	$(n - 3)$	n_2	n_1
3	1	4	1	4	1	—	—
	2	5	2	2	2	1	1
	3	6	3	3	3	1	2

there being no solution in the first case since $j \geq n_2$.

With $k = 3, j = 2$ there are 1 pencil (α or δ) with 1 degree of freedom, 1 (β) with 3 degrees of freedom and 3 (γ) with 2 degrees of freedom. With the sixth dimension obtained with $k = 3, j = 3$, a further pencil with 1 degree of freedom is added. This result is in satisfying agreement with the discussion in earlier chapters.

When we try larger values of k , say $k = 4$, no further solutions can be found. Thus:

k	j	n	λ	$(2n - j - k\lambda)$	$(n - 3)$	n_2	ϵ
4	1	5	1	5	2	1 or 2	3 or 1
	2	6	2	2	3	—	—
	3	7	3	-1	4	—	negative
	4	8	3	0	5	—	—

There are no solutions in the second or fourth cases since n_2 does not then exceed unity as required in equation (3); nor is ϵ zero.

The above result may be proved quite generally. Evidently the full diversity of skew-parallelism is consistent with identity only in a pseudo-Euclidean manifold having 5 or 6 dimensions. Moreover, these manifolds admit the α -, β -, γ - and δ -pencils in entire conformity with the previous discussions. The presumption that the geometry here advanced is universal in Poincaré's sense is therefore justified. The geometry is sufficient to allow those entities represented by skew-cubes to exhibit identity amidst diversity.

It is interesting to note that in the illustration given on p. 270, the man's journey requires an imaginary dimension other than time if its realization is to be possible. The same applies to the null-vector U , for V is along the direction of time and U is orthogonal to V . From such considerations we can see that the six-dimensional scheme is adequate for the representation of the world of our experience and not exclusively applicable to the abstract world of dynamical theory.

This Appendix is due to Mr. R. L. Brown. A more extended treatment will be published elsewhere.

GLOSSARY OF TERMS Both New and Used with Special Meanings

ABLENESS-TO-BE The power resident in entities to reconcile their potentialities with their actualization. The inner reconciling principle of every existing whole. (3.6.8), (3.8.5)

ACTION One of the three basic properties of existence, the others being inertial mass and electric charge. Associated with hyparxis and essentially recurrent. Given by the guide vector of a delta-pencil. (6.16.3)

ACTIVE SURFACE, The assumption that there is a class of occa-hypothesis of sions characterized by the presence of a potential energy gradient. Cf. colloids. (4.10.6)

ACTUALIZATION An occasion that enters experience as temporal phenomenon. (3.7.2)

ALPHA-PENCIL A transitive family of skew-parallels having one degree of freedom. Used in the representation of eternity. (6.15.5)

APOKRISIS The separation of two levels in eternity. Hence apokritical interval as the measure of such separation. (3.8.3)

APPROXIMATION, See Progressive approximation, method of. method of progressive

AUTHORIZMOS The property whereby one single unlimited will manifests itself as manifold and limited. (1-3-6)

AUTOCRACY, The twelfth category. The element of experi-category of ence in which we recognize an affirmation that is independent of any superior affirmation.

(1-2-14)

AUTONOMIC The levels of existence dominated by the reconciling influence. (4.9.4) Existence comprising all forms of life. (8.19.1)

BEHAVIOUR The objective aspect of function. (1.3.6.a)

BEING The togetherness of experience. (1.3.4) Being is not knowable but is given in immediate experience. Being is the reconciling force in the triad of experience (q.v.). BETA-PENCIL An intransitive family of skew-parallel pencils having $k + j - 2$ degrees of freedom. Used to represent time. (6.15.5)

BIOSPHERE The totality of autonomic (q.v.) existence on a given planet. The hypothesis of biospheric wholeness is the assumption that the biosphere is a conscious individual. (4.11.6) BIPOTENCE The corpuscular state of existence. That element in every whole that is subject only to polar forces. Existence according to the hypothesis of invariant being. (4.10.3) CATEGORY An element of experience that is (a) given immediately and (b) has general or universal character. (1.2.1)

COLLOIDS The state of existence intermediate between the hyponomic and autonomic modes. Cf. hypothesis of active surface. (4.10.6) COMPLEMENTARITY, The assumption that true meanings are dis-postulate of covered only by the confrontation of contradictories. The belief connected with this that expansion and concentration (q.v.) are mutually complementary trends in the universe. (3.6.8)

COMPOSITE The assumption that there is a class of occasions WHOLENESS, in which wholes behave passively but as if hypothesis of constituted of interconnected parts. (4.10.5) CONCENTRATION The action of a denying influence upon an affirmative environment. Synonymous with evolution (q.v.). (3.6.8)

CONCRETE FORM An idea fully given in direct experience as opposed to abstract form that is given by selection from experience. (1.1.6) CONSCIOUSNESS The subjective aspect of being. (1.3.5[^]) CONTENT The positive component of the dyad of meaning. Cf context. That which is affirmed by a linguistic element. (2. 4. 2)

n.TT----tS*

CONTEXT, stable The negative component of the dyad of meaning. Cf. content. (2.4.2)

CORPUSCLE The bipotent state of hyle. Compromises electrons, positrons, photons, neutrinos and u-mesons. (7.17.2)

COSMIC WHOLENESS, The assumption that the existing universe can hypothesis of be regarded as a hypernomic entity with autocratic affirmative power. (4.12.5)

COSMODESIC A generalized geodesic in N-dimensions. Also a

null-interval. (5.13.8) 4 COUNTERPART The total existence of a corpuscle or other

entity in time and eternity corresponding to one cycle of recurrence in hyparxis. (6.16.4)

COUPLING Quantities associated with the dimension of MAGNITUDES hyparxis that serve to balance the eternal and temporal elements in composite wholes. (7.18.2)

CREATIVITY, The tenth category. The element of experience category of - in which we recognize the power of bringing new forms into existence. (1.2.12)

CREATIVITY, The assumption that there is a class of hyper-hypothesis of nomic entities endowed with free creative power. (4.12.3)

DECEMPOTENCE The second gradation of hypernomic existence. The sun and other stars. Existence according to the hypothesis of creativity. (4.12.3)

DELTA-PENCIL An intransitive family of skew-parallels having one degree of freedom cyclic in character. Suitable for the representation of hyparxis. (6-I5-5) DIMENSION An independent set of numbers, one or more of which sets constitutes a manifold (q.v.). (5-13-5) DOMINATION, The eleventh category. The element of experi-category of ence in which we recognize influence that can evoke creative activity without itself being effected thereby. (1.2.13)

DRAMATIC The combination of relativity and uncertainty with consciousness and the possibility of freedom. Thus, Dramatic Universe. (1.1.2)

DUODECIMPOTENCE The highest gradation of hypernomic existence. The universe as autocratic whole. (4-12.5)

DYAD A pair of wholes distinguishable in at least one characteristic. (1.2.4)

EPIGENETIC FACTOR The hyparchic factor that adjusts the primary development and subsequent existence of an organism to its eternal pattern. (8.20.5)

ETERNITY "The storehouse of potentialities". (3.8.3) One of the four determining conditions together with space, time and hyparxis (q.v.). Eternity is the measure of intensity of being. (3.6.9) Represented by an alpha-pencil. (6.15.6) .

ETERNITY-BLINDNESS The property of human sense perceptions which permits them to experience only actualizations and not potentialities. (5.13.9)

EXISTENCE The element of being in all experience. Existence is all possible being. Cf. stratification of existence. (3.6.7)

EXISTENTIAL The assumption that there is a class of occa-INDIFFERENCE, sions which are independent of all existential hypothesis of characters. Unipotent occasions. (4.10.2)

EXISTENTIAL TRACT The two-dimensional region containing the directions of time and eternity of a given entity A. In the existential tract all possible conservative states of A can be represented. (5-I3-8)

EXPANSION The action of an affirmative influence upon a negative environment. Synonymous with involution (q.v.). (3.6.8)

EXPERIENCE The total givenness possible for all and every consciousness, human, sub-human, and superhuman. The definite form of the indefinite reality (q.v.). (1. 3. 1)

FACT Experience of the functional order. Opposed to value (q.v.). Fact derived from experience by way of reduction. (3.6.2) Cf also homogeneity of fact. **FINITE COSMIC** The hypernomic, autonomic, and hyponomic **TRIAD** modes of existence as the ultimate relatedness of the universe. (9.22.4)

FRAMEWORK The form in which we experience phenomena. (3.6.9) The self-limitation of the will in the determination of possible situations (q.v.). (3.7.5) The totality of determining conditions of space, time, eternity, and hyparxis (q.v.).

FRAMEWORK LAWS, The assumption that a set of criteria can be postulate of universal found to distinguish possible from impossible validity of situations and that these criteria hold good for all levels of existence. (3.6.9)

FUNCTION The knowable element in all experience. The universe experienced as process. Function is primary and irreducible to any more ultimate concept. The denying force in the triad of experience (q.v.). (1.3.3)

GAMMA-PENCIL A transitive family of skew-parallels having the property of total linkage required for the representation of space. (6.15.5)

GEOMETRY The science of the representation of framework without reference to existence. (5.13.6)

GESTURE Communication of will. The highest form of language. (2.4.1)

GUIDE VECTOR The non-null vector in a pencil of skew-parallels (q.v.). In $W = V + 0 U$, V is called the guide vector. (6.15.5)

HOMOGENEITY OF The assumption that all fact, whether known **FACT**, or not known, constitutes a coherent system, postulate of (3-6-5)

HYLE The ground stuff of all possible experience. The common element of all experience. (i-3-i)

HYPARCHIC The sensitive mechanism by which the physio-REGULATOR logical organism is adjusted to environmental changes. (8.20.5)

HYPARXIS The condition of ableness-to-be. (3.6.8) One of the four determining conditions with space, time, and eternity (q.v.). Represented by delta-pencil. (6.15.6)

HYPERNOMIC The levels of existence dominated by the affirmative factor. (4.9.4) Existence beyond life. (9.22.1)

HYPONOMIC The levels of existence dominated by the denying factor. (4.9.4) (4.10.1) Existence below life. Thinghood. (7.18.1)

HYPOTHESIS, Assumption concerning the criteria for de-existential limiting a given level of being. Each existential hypothesis corresponds to a gradation of potency (q.v.). (4.9.7)

HYPOTHESIS, Scheme constructed to facilitate ordering of working facts. (4.9.5)

IDENTICAL The assumption that there is a class of occasions **RECURRENCE**, in which entities behave as if

their existence hypothesis of were renewed periodically in each of the three inner dimensions of time, eternity, and hyparxis. (4.10.4)

INDIVIDUALITY, The eighth category. That element of experience by which we recognize the capacity for independent initiative. (1.2.10)

INTUITION The recognition of meanings without the intervention of previously formed linguistic elements. Intuition is that which is given in the direct contact with experience. Intuitions are the raw material of symbolism. (2.4.7)

INVARIANT BEING, The assumption that there is a class of occasions in which entities behave as if they were self-identical throughout. (4.10.3) Bipotent occasions. (5.14.3)

INVOLUTION The trend from unity towards multiplicity. The passive element in the universal process. Synonymous with expansion (q.v.). (3.6.8)

KNOWLEDGE The subjective aspect of function. (1.3.6.a) The ordering of function. (2.5.1) Knowledge of seven kinds. (2.5.3-2.5.11)

KNOWLEDGE, Also called potential. Knowledge of potential-effectual ties that cannot be experienced directly. Effectual knowledge enables interaction of different levels to be regulated. (2.5.8)

KNOWLEDGE, Also called 'Vegetative' knowledge. Can be non-discriminative innate or acquired, consists of automatic behaviour pattern appropriate in given context. (2-5-3)

KNOWLEDGE, Discriminative or polar knowledge is ordering polar of function to adapt means to ends. Also called 'animal' knowledge. (2.5.4) KNOWLEDGE, Knowledge of system. Requires suspense of relational judgment. (2.5.5) KNOWLEDGE, Knowledge of higher categories inaccessible revealed to discursive reason. (2.5.11)

KNOWLEDGE, Also called 'value' knowledge. Knowledge of subsistent the concrete. (2.5.1)

KNOWLEDGE, Also called cyclic. Knowledge of recurrent transcendental element of will. Knowledge of verae causae. (2-5-9) KNOWLEDGE, Also called structural. Knowledge that is true capable of self-verification. (2.5.10)

LANGUAGE, See Sign, Symbol, and Gesture, also Meaning, types of (2.4.1)

LAW The objective aspect of will. (1.3.6)

LINGUISTIC The primary bearers of meaning—particularly ELEMENTS signs, symbols, and gestures. (2.4.1)

MAGIC The art by which man seeks to influence events. (1.1.6)

MATERIAL OBJECT Space-extended composite whole. Quadripotent entity having parts. (7.18.10)

MATERIALITY The objective aspect of being. (i.3.6.b) Materiality is relative and subject to the single-valued order of 'more and less'.

MATHEMATICS The language of abstract gesture. The representation of will isolated from being and function. (5.13.3) MEANING The recognition of a recurrent element of experience communicable by sign, symbol, or gesture (q.v.). (2.4.2)

NOVEMPOTENCE The first gradation of hypernomic existence. Planets. Existence according to the hypothesis of sub-creativity. The world of patterns. (4.12.2)

NULL-INTERVAL The distance between two points that are contiguous in the universal framework but separated when referred to the inner and outer determining conditions of a given whole.

(5-13-7)

NULL-VECTOR	A vector the components of which do not vanish when referred to the inner and outer determining conditions, but which has zero magnitude. (5.13.7)
NUMBER, CONCRETE	See concrete form.
OBSERVATION SYSTEM $O \cdot M \cdot R$	The human observer O together with his measuring instruments all rigidly attached to the quasi-rigid body R . (5.14.3)
OCCASION	A possible situation (<i>q.v.</i>). (3.7.2)
OCTOPOTENCE	The highest gradation of autonomic existence. Conscious individuality. Existence according to the hypothesis of self-direction. (4.11.5)
ORGANISM	The septempotent entity existing according to the pattern of a species. (8.20.4)
ORTHOGENETIC FACTOR	The hyparchic regulator whereby the biospheric pattern determines the origin and existence of species and their material relationships. (8.21.6)
PARTICLE	The tripotent state of hyle. Comprises protons, neutrons, nucleons, and heavy mesons. (7.17.3)
PENCIL, intransitive	A family of skew-parallel (<i>q.v.</i>), in which the guide vector (<i>q.v.</i>) is unique. (6.15.5)
PENCIL, transitive	A family of skew-parallel (<i>q.v.</i>), in which the guide vector can be any member of the family. (6.15.5)
PENCILS	A family of skew-parallel given by the relationship $W = V + \sum \emptyset_i U_i$ is called a pencil. V is the guide vector and U_i the null-vectors of the pencil, and $\emptyset_i$ the divergences. (6.15.5)
PHENOMENA	Experience in the perspective that is predominantly functional. Phenomena are knowable and when known are facts. Phenomena also enter value judgments as new material. (3.6.3)
POLARITY, category of	The second category. The element of experience that enables us to recognize connections and disjunctions. Hence also forces. (1.2.4) <i>Cf.</i> dyad.
POTENCY	The gradation of existence possible for an entity of a given class. The number of degrees of potency are indicated by Latin prefixes thus unipotent, bipotent, etc., up to duodecimpotent. (4.9.4)

POTENTIALITY, The fifth category. The element of experience category of by which we recognize that all existence comprises unactualized as well as actualized occasions (*q.v.*). (1.2.7)

POTENTIALITY, Potentiality of multiple subsistence arises principle of through the interlacing of triads. It

requires five independent terms. (1.2.7)

PRESENCE The intersection of the potential and actual states of a given whole. Presence is governed by the determining condition of space (q.v.). (3-8.4) **PRINCIPLE** Statement elucidating one of the categories and indicating its application to the inquiry, (1.2.1.)

PROCESS The orderly and recognizable functional activity from which we derive all our knowledge (q.v.). (1.3.3)

PROGRESSIVE The construction of concepts starting from **APPROXIMATION**, vague outlines with subsequent gradual filling method of in of details. (1.1.7) Method that consists in deepening of meanings as opposed to accumulation of facts. (3.6.1)

Q, the UNIVERSAL The hypothetical entity free from eternity-OBSERVER blindness and therefore able to set up a six-dimensional representation framework by direct measurement. (5.13.10)

QUADRIPOTE Passive existence or thinghood. Existence according to the hypothesis of composite wholeness. (4.10.5)

QUASI-RIGIDITY The property of space-extended entities (in general composite wholes) which makes them appear rigid to an eternity-blind observer but plastic to Q (q.v.). (5.14.2)

QUINQUEPOTENCE The primitive living state. Viruses. Existence according to the hypothesis of self-renewal. (4.11.2)

REALITY Indeterminate term used to designate all that exists or can exist and even hypothetical being below or beyond existence. Reality includes both phenomenal and non-phenomenal being if such there be. (1.3.1)

RECURRENCE The property whereby the ableness-to-be of any given whole reconciles its potentialities with its actualizations. (3.8.5) Derives from the cyclical nature of hyparxis (q.v.).

REGENERATIVE The ratio of potentiality and actualization **RATIO** required for maintaining the virtue of an entity constant. (7.17.6)

RELATEDNESS, The third category. The element of experi-category of ence that consists in recognizing that two independent terms can only be combined through a third independent term. (1.2.5)

RELATEDNESS, All real relationships reducible to three in-principle of dependent elements: affirming, denying, and reconciling in character. (1.2.5)

RELATEDNESS, There are four types, internal and external, types of conjunctive and disjunctive, each of which corresponds to one of the four determining conditions. (6.15.2)

REPETITION, The sixth category. The element of experience category of that consists in recognizing that 'same' and 'other' are linked by way of recurrence. (1.2.8)

REPETITION, Identity, difference, and relatedness can only be principle of combined by way of repetition and this requires a system of six independent terms. (1.2.8)

REPRESENTATION An act of will relating behaviour to framework.

REPRESENTATION The means of describing occasions in mathe-MANIFOLD matical terms. (5.13.4) A numerical system relating phenomena to facts.

REPRODUCTION, The assumption that there is a class of entities hypothesis of that, though incapable of self-regulation, are nevertheless able to reproduce their kind. (4-11-3)

RHYTHM Organized repetition as condition of autonomic existence. (8.19.3)

SELF-DIRECTION, The assumption that there is a class of entities hypothesis of that are individuals in respect of the power of self-direction. (4.11.5)

SELF-REGULATION, The assumption that there is a class of entities hypothesis of that can maintain their own existence by self-regulation according to a specific pattern. (4.11.4) See also Organism.

SELF-RENEWAL, The assumption that there is a class of entities hypothesis of that, though incapable of independent existence, are nevertheless alive in so far as they can resist degeneration at the expense of their environment. (4.11.2)

SENSITIVE STATE The opposition of potential and actual states OF HYLE (eternity and time) is reconciled by the sensitive state (hyparxis). Cf. coupling and pattern. (8.19.2)

SEMPOTENCE The third gradation of life. Organisms. Existence according to the hypothesis of self-regulation. (4. ii. 4)

SEMPOTENCE The second gradation of autonomic existence. Cells. Existence according to the hypothesis of reproductive wholeness. (4.11.3)

SIGN A sound or mark that evokes in two or more people a recognizable simple experience. Hence 'one referent—one sign'. (2.4.1)

SITUATION A fact taken without reference to its actual or even possible arising. The forms of all possible and impossible facts are situations. (3-7-2)

SKEW-PARALLELISM The property whereby two vectors that do not diverge may nevertheless have non-identical components. See Pencils. (6.15.4)

SOMA The body of an organism regarded as a physico-chemical mechanism. (8.20.5).

SPACE The determining condition of presence. (3.6.9) Represented by three gamma-pencils. (6.15.6)

STATISTICAL The property whereby different levels of INACCESSIBILITY existence are—with rare and improbable exceptions—closed to one another. (3.6.7) See also Stratification of existence.

STRATIFICATION of The assumption that there is a scale of being, EXISTENCE, each gradation of which forms a coherent postulate of system that can be studied in isolation from the remainder. (3.6.7)

STRUCTURE, The seventh category. That element of experi-category of ence by which we recognize the organic character of wholeness as distinct from mere unity or simple subsistence. (1.2.9)

STRUCTURE, Every organized structure capable of independent existence has seven independent terms. (1.2.9) SUB-CREATIVITY, The assumption that there is a class of hyper-hypothesis of nomic entities that create by way of a pattern of existence that they maintain. (4.12.2)

SUBSISTENCE, The fourth category. The element of experi-category of ence in which we recognize that events are more concrete than relations and require four terms for their expression. (1.2.6)

SUBSISTENCE, The limitation of existence requires a four-principle of term framework. (1.2.6) SUPER-

CREATIVITY, The assumption that there is a class of hyper-hypothesis of nomic entities that dominate the creative activity of the universe without participating in it. (4.12.4)

SYMBOL Sound or mark that evokes common being-experience. Symbols are multivalent. (2.4.1)

THINKING Distinguished as (a) associative, (b) logical and (i) supralogical. (1.1.4) Logical thinking polar.

TIME The determining condition of actualization. (3.6.9) Represented by a beta-pencil. (6.15.6)

TOGETHERNESS The property whereby any whole contains its own potentialities and its own history. Togetherness is the measure of being (q-v). (1-3-4) TRANS-FINITE TRIAD Being—non-being and the existing universe. (9.22.3)

TRIAD of EXPERIENCE, Function, Being, and Will as the ultimate modes of all possible experience. In this triad will is affirming, function denying, and being reconciling. (1.3.2)

TRIPOTENCE The particulate state. That element in every whole that is capable of relatedness. Existence according to the hypothesis of identical recurrence. (4.10.4)

UNDECIMPOTENCE Galactic existence. Domination of creativity. (4.12.4)

UNDERSTANDING The power to see 'how' and 'why' as a single question. (1.3.5) The subjective aspect of will. (1.3.6.C)

UNIPOTENCE The undifferentiated ground state of hyle (q.v.) in which the sole possibility is to enter determinate existence. Existence according to the postulate of existential indifference. (4.10.2)

UNIVERSAL Six-fold representation manifold with three GEOMETRY inner dimensions (time, eternity, and hyparxis) and three outer dimensions (space). (6.15.7)

UNIVERSAL The assumption that a single pattern underlies SIMILARITY, all the diversity of phenomena (q.v.). (3.6.6) postulate of Universal similarity derived from the category of autocracy. (1.2.14)

UNIVERSE, the The content of all possible experience. All that exists is the universe. (5.14.3), (9.24.1)

VALUE Value is the element of experience by which we recognize distinctions of interest. It is not fact and is therefore unknowable. Value implies hazard and freedom. (3.6.2)

VIRTUALITY The state of hyle in which its existence is wholly potential. Virtuality is relative so that any ratio of potential to actual is possible. See Virtue function. (6.16.6)

VIRTUE The measure of the potentiality of an entity or system for diversity of actualization. It is related to entropy S by the formula $J = S - S_0/S_0$. Virtue thus defined varies between zero and unity. Unity signifies that state of maximum potentiality. (3.8.3)

WHOLENESS, The first category. The property whereby an category of entity can be recognized as itself. Also the measure of gradation of responsiveness to the entities. (1.2.3)

WHOLENESS, Wholeness is omnipotent but relative. (1.2.3) principle of

WILL The affirmative content of all experience. Will is the source of the 'how' and 'why' of the universe. (1.3.5)