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SCIENTIFIC METHOD
IN ⁴
PHILOSOPHY

THE HERBERT SPENCER LECTURE
DELIVERED AT THE MUSEUM

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BY

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ON SCIENTIFIC METHOD IN PHILOSOPHY

WHEN we try to ascertain the motives which have led men to the investigation of philosophical questions, we find that, broadly speaking, they can be divided into two groups, often antagonistic, and leading to very divergent systems. These two groups of motives are, on the one hand, those derived from religion and ethics, and, on the other hand, those derived from science. Plato, Spinoza, and Hegel may be taken as typical of the philosophers whose interests are mainly religious and ethical, while Leibniz, Locke, and Hume may be taken as representatives of the scientific wing. In Aristotle, Descartes, Berkeley, and Kant we find both groups of motives strongly present.

Herbert Spencer, in whose honour we are assembled to-day, would naturally be classed among scientific philosophers: it was mainly from science that he drew his data, his formulation of problems, and his conception of method. But his strong religious sense is obvious in much of his writing, and his ethical preoccupations are what make him value the conception of evolution—that conception in which, as a whole generation has believed, science and morals are to be united in fruitful and indissoluble marriage.

It is my belief that the ethical and religious motives, in spite of the splendidly imaginative systems to which they have given rise, have been on the whole a hindrance

to the progress of philosophy, and ought now to be consciously thrust aside by those who wish to discover philosophical truth. Science, originally, was entangled in similar motives, and was thereby hindered in its advances. It is, I maintain, from science, rather than from ethics and religion, that philosophy should draw its inspiration.

But there are two different ways in which a philosophy may seek to base itself upon science. It may emphasize the most general *results* of science, and seek to give even greater generality and unity to these results. Or it may study the *methods* of science, and seek to apply these methods, with the necessary adaptations, to its own peculiar province. Much philosophy inspired by science has gone astray through preoccupation with the *results* momentarily supposed to have been achieved. It is not results, but *methods*, that can be transferred with profit from the sphere of the special sciences to the sphere of philosophy. What I wish to bring to your notice is the possibility and importance of applying to philosophical problems certain broad principles of method which have been found successful in the study of scientific questions.

The opposition between a philosophy guided by scientific method and a philosophy dominated by religious and ethical ideas may be illustrated by two notions which are very prevalent in the works of philosophers, namely the notion of *the universe*, and the notion of *good and evil*. A philosopher is expected to tell us something about the nature of the universe as a whole, and to give grounds for either optimism or pessimism. Both these expectations seem to me mistaken. I believe the conception of 'the universe' to be, as its etymology indicates, a mere relic of pre-

Copernican astronomy; and I believe the question of optimism and pessimism to be one which the philosopher will regard as outside his scope, except, possibly, to the extent of maintaining that it is insoluble.

In the days before Copernicus, the conception of the 'universe' was defensible on scientific grounds: the diurnal revolution of the heavenly bodies bound them together as all parts of one system, of which the earth was the centre. Round this apparent scientific fact, many human desires rallied: the wish to believe Man important in the scheme of things, the theoretical desire for a comprehensive understanding of the Whole, the hope that the course of nature might be guided by some sympathy with our wishes. In this way, an ethically inspired system of metaphysics grew up, whose anthropocentrism was apparently warranted by the geocentrism of astronomy. When Copernicus swept away the astronomical basis of this system of thought, it had grown so familiar, and had associated itself so intimately with men's aspirations, that it survived with scarcely diminished force—survived even Kant's 'Copernican revolution', and is still now the unconscious premiss of most metaphysical systems.

The oneness of the world is an almost undiscussed postulate of most metaphysics. 'Reality is not merely one and self-consistent, but is a system of reciprocally determinate parts'¹—such a statement would pass almost unnoticed as a mere truism. Yet I believe that it embodies a failure to effect thoroughly the 'Copernican revolution', and that the apparent oneness of the world is merely the oneness of what is seen by a single spectator or apprehended by a single mind. The Critical Philosophy, although it intended to emphasize

¹ Bosanquet, *Logic*, ii, p. 211.

the subjective element in many apparent characteristics of the world, yet, by regarding the world in itself as unknowable, so concentrated attention upon the subjective representation that its subjectivity was soon forgotten. Having recognized the categories as the work of the mind, it was paralysed by its own recognition, and abandoned in despair the attempt to undo the work of subjective falsification. In part, no doubt, its despair was well founded, but not, I think, in any absolute or ultimate sense. Still less was it a ground for rejoicing, or for supposing that the nescience to which it ought to have given rise could be legitimately exchanged for a metaphysical dogmatism.

I.

As regards our present question, namely, the question of the unity of the world, the right method, as I think, has been indicated by William James.¹ "Let us now turn our backs upon ineffable or unintelligible ways of accounting for the world's oneness, and inquire whether, instead of being a principle, the 'oneness' affirmed may not merely be a name like 'substance', descriptive of the fact that certain *specific and verifiable connections* are found among the parts of the experiential flux. . . . We can easily conceive of things that shall have no connection whatever with each other. We may assume them to inhabit different times and spaces, as the dreams of different persons do even now. They may be so unlike and incommensurable, and so inert towards one another, as never to jostle or interfere. Even now there may actually be whole universes so disparate from ours that we who know ours have no means of perceiving that they exist. We

¹ *Some Problems of Philosophy*, p. 124.

conceive their diversity, however ; and by that fact the whole lot of them form what is known in logic as 'a universe of discourse'. To form a universe of discourse argues, as this example shows, no further kind of connexion. The importance attached by certain monistic writers to the fact that any chaos may become a universe by being merely named, is to me incomprehensible." We are thus left with two kinds of unity in the experienced world ; the one what we may call the epistemological unity due merely to the fact that my experienced world is what *one* experience selects from the sum total of existence ; the other that tentative and partial unity exhibited in the prevalence of scientific laws in those portions of the world which science has hitherto mastered. Now a generalization based upon either of these kinds of unity would be fallacious. That the things which we experience have the common property of being experienced by us is a truism from which obviously nothing of importance can be deducible : it is obviously fallacious to draw from the fact that whatever we experience is experienced the conclusion that therefore everything must be experienced. The generalization of the second kind of unity, namely, that derived from scientific laws, would be equally fallacious, though the fallacy is a trifle less elementary. In order to explain it let us consider for a moment what is called the reign of law. People often speak as though it were a remarkable fact that the physical world is subject to invariable laws. In fact, however, it is not easy to see how such a world could fail to obey general laws. Taking any arbitrary set of points in space, there is a function of the time corresponding to these points, i.e. expressing the motion of a particle which traverses these points : this function may be regarded as a general law to which the behaviour

of such a particle is subject. Taking all such functions for all the particles in the universe, there will be theoretically some one formula embracing them all, and this formula may be regarded as the single and supreme law of the spatio-temporal world. Thus what is surprising in physics is not the existence of general laws, but their extreme simplicity. It is not the uniformity of nature that should surprise us, for, by sufficient analytic ingenuity, any conceivable course of nature might be shown to exhibit uniformity. What should surprise us is the fact that the uniformity is simple enough for us to be able to discover it. But it is just this characteristic of simplicity in the laws of nature hitherto discovered which it would be fallacious to generalize, for it is obvious that simplicity has been a part cause of their discovery, and can, therefore, give no ground for the supposition that other undiscovered laws are equally simple.

The fallacies to which these two kinds of unity have given rise suggest a caution as regards all use in philosophy of general *results* that science is supposed to have achieved. In the first place, in generalizing these results beyond past experience, it is necessary to examine very carefully whether there is not some reason making it more probable that these results should hold of all that has been experienced than that they should hold of things universally. The sum total of what is experienced by mankind is a selection from the sum total of what exists, and any general character exhibited by this selection may be due to the manner of selecting rather than to the general character of that from which experience selects. In the second place, the most general results of science are the least certain and the most liable to be upset by subsequent research. In utilizing these results as the basis of a philosophy, we

sacrifice the most valuable and remarkable characteristic of scientific method, namely, that, although almost everything in science is found sooner or later to require some correction, yet this correction is almost always such as to leave untouched, or only slightly modified, the greater part of the results which have been deduced from the premiss subsequently discovered to be faulty. The prudent man of science acquires a certain instinct as to the kind of uses which may be made of present scientific beliefs without incurring the danger of complete and utter refutation from the modifications likely to be introduced by subsequent discoveries. Unfortunately the use of scientific generalizations of a sweeping kind as the basis of philosophy is just that kind of use which an instinct of scientific caution would avoid, since, as a rule, it would only lead to true results if the generalization upon which it is based stood in *no* need of correction.

We may illustrate these general considerations by means of two examples, namely, the conservation of energy and the principle of evolution.

(1) Let us begin with the conservation of energy, or, as Herbert Spencer used to call it, the persistence of force. He says: ¹

‘Before taking a first step in the rational interpretation of phenomena, it is needful to recognize, not only the facts that Matter is indestructible and Motion continuous, but also the fact that Force persists. An attempt to ascertain the laws to which manifestations in general and in detail conform, would be absurd if the agency to which they are due could either come into existence or cease to exist. The succession of phenomena would in such case be altogether arbitrary; and Science, equally with Philosophy, would be impossible.’

¹ *First Principles*, Part II, beginning of chap. vi.

This paragraph illustrates the kind of way in which the philosopher is tempted to give an air of absoluteness and necessity to empirical generalizations, of which only the approximate truth in the regions hitherto investigated can be guaranteed by the unaided methods of science. It is very often said that the persistence of something or other is a necessary presupposition of all scientific investigation, and this presupposition is then thought to be exemplified in some quantity which physics declares to be constant. There are here, as it seems to me, three distinct errors. First, the detailed scientific investigation of nature does not *presuppose* any such general laws as its results are found to verify. Apart from particular observations, science need presuppose nothing except the general principles of logic, and these principles are not laws of nature, for they are merely hypothetical, and applied not only to the actual world but to whatever is *possible*. The second error consists in the identification of a constant quantity with a persistent entity. Energy is a certain function of a physical system, but is not a thing or substance persisting throughout the changes of the system. The same is true of mass, in spite of the fact that mass has often been defined as *quantity of matter*. The whole conception, of quantity, involving, as it does, numerical measurement based largely upon conventions, is far more artificial, far more an embodiment of mathematical convenience, than is commonly believed by those who philosophize on physics. Thus even if (which I cannot for a moment admit) the persistence of some entity were among the necessary postulates of science, it would be a sheer error to infer from this the constancy of any physical quantity, or the *a priori* necessity of any such constancy which may be empirically discovered. In

the third place, it has become more and more evident with the progress of physics that large generalizations, such as the conservation of energy or mass, are far from certain and are very likely only approximate. Mass, which used to be regarded as the most indubitable of physical quantities, is now very generally believed to vary according to velocity, and to be, in fact, a vector quantity which at a given moment is different in different directions. The detailed conclusions deduced from the supposed constancy of mass for such motions as used to be studied in physics will remain very nearly exact, and, therefore, over the field of the older investigations very little modification of the older results is required. But as soon as such a principle as the conservation of mass or of energy is erected into a universal *a priori* law, the slightest failure in absolute exactness is fatal, and the whole philosophic structure raised upon this foundation is necessarily ruined. The prudent philosopher, therefore, though he may with advantage study the methods of physics, will be very chary of basing anything upon what happen at the moment to be the most general results apparently obtained by those methods.

(2) The philosophy of evolution, which was to be our second example, illustrates the same tendency to hasty generalization, and also another sort, namely, the undue preoccupation with ethical notions. There are two kinds of evolutionist philosophy, of which both Hegel and Spencer represent the older and less radical kind, while Pragmatism and Bergson represent the more modern and revolutionary variety. But both these sorts of evolutionism have in common the emphasis on *progress*, that is, upon a continual change from the worse to the better or from the simpler to the more complex. It

would be unfair to attribute to Hegel any scientific motive or foundation, but all the other evolutionists, including Hegel's modern disciples, have derived their impetus very largely from the history of biological development. To a philosophy which derives a law of universal progress from this history there are two objections. First, that the history itself is concerned with a very small selection of facts confined to an infinitesimal fragment of space and time, and even on scientific grounds probably not an average sample of events in the world at large. For we know that decay as well as growth is a normal occurrence in the world. An extra-terrestrial philosopher, who had watched a single youth up to the age of twenty-one and had never come across any other human being, might conclude that it is the nature of human beings to grow continually taller and wiser in an indefinite progress towards perfection; and this generalization would be just as well founded as the generalization which evolutionists base upon the previous history of this planet. Apart, however, from this scientific objection to evolutionism, there is another, derived from the undue admixture of ethical notions in the very idea of progress from which evolutionism derives its charm. Organic life, we are told, has developed gradually from the protozoon to the philosopher, and this development, we are assured, is indubitably an advance. Unfortunately it is the philosopher, not the protozoon, who gives us this assurance, and we can have no security that the impartial outsider would agree with the philosopher's self-complacent assumption. This point has been illustrated by the philosopher Chuang Tzū in the following instructive anecdote:

'The Grand Augur, in his ceremonial robes,

approached the shambles and thus addressed the pigs: "How can you object to die? I shall fatten you for three months. I shall discipline myself for ten days and fast for three. I shall strew fine grass, and place you bodily upon a carved sacrificial dish. Does not this satisfy you?"

Then, speaking from the pigs' point of view, he continued: "It is better, perhaps, after all, to live on bran and escape the shambles. . . ."

"But then," added he, speaking from his own point of view, "to enjoy honour when alive one would readily die on a war-shield or in the headsman's basket."

So he rejected the pigs' point of view and adopted his own point of view. In what sense, then, was he different from the pigs?'

I much fear that the evolutionists too often resemble the Grand Augur and the pigs.

The ethical element which has been prominent in many of the most famous systems of philosophy is, in my opinion, one of the most serious obstacles to the victory of scientific method in the investigation of philosophical questions. Human ethical notions, as Chuang Tzū perceived, are essentially anthropocentric, and involve, when used in metaphysics, an attempt, however veiled, to legislate for the universe on the basis of the present desires of men. In this way they interfere with that receptivity to fact which is the essence of the scientific attitude towards the world. To regard ethical notions as a key to the understanding of the world is essentially pre-Copernican. It is to make man, with the hopes and ideals which he happens to have at the present moment, the centre of the universe and the interpreter of its supposed aims and purposes. Ethical metaphysics is fundamentally an attempt, however disguised, to give legislative force to our own wishes. This may, of course, be questioned, but I think that it is confirmed by a consideration of the way in which ethical notions arise.

Ethics is essentially a product of the gregarious instinct, that is to say, of the instinct to co-operate with those who are to form our own group against those who belong to other groups. Those who belong to our own group are good; those who belong to hostile groups are wicked. The ends which are pursued by our own group are desirable ends, the ends pursued by hostile groups are nefarious. The subjectivity of this situation is not apparent to the gregarious animal, which feels that the general principles of justice are on the side of its own herd. When the animal has arrived at the dignity of the metaphysician, it invents ethics as the embodiment of its belief in the justice of its own herd. So the Grand Augur invokes ethics as the justification of Augurs in their conflicts with pigs. But, it may be said, this view of ethics takes no account of such truly ethical notions as that of self-sacrifice. This, however, would be a mistake. The success of gregarious animals in the struggle for existence depends upon co-operation within the herd, and co-operation requires sacrifice, to some extent, of what would otherwise be the interest of the individual. Hence arises a conflict of desires and instincts, since both self-preservation and the preservation of the herd are biological ends to the individual. Ethics is in origin the art of recommending to others the sacrifices required for co-operation with oneself. Hence, by reflexion, it comes, through the operation of social justice, to recommend sacrifices by oneself, but all ethics, however refined, remains more or less subjective. Even vegetarians do not hesitate, for example, to save the life of a man in a fever, although in doing so they destroy the lives of many millions of microbes. The view of the world taken by the philosophy derived from ethical notions is thus never impartial and

therefore never fully scientific. As compared with science, it fails to achieve the imaginative liberation from self which is necessary to such understanding of the world as man can hope to achieve, and the philosophy which it inspires is always more or less parochial, more or less infected with the prejudices of a time and a place.

I do not deny the importance or value, within its own sphere, of the kind of philosophy which is inspired by ethical notions. The ethical work of Spinoza, for example, appears to me of the very highest significance, but what is valuable in such work is not any metaphysical theory as to the nature of the world to which it may give rise, nor indeed anything which can be proved or disproved by argument. What is valuable is the indication of some new way of feeling towards life and the world, some way of feeling by which our own existence can acquire more of the characteristics which we must deeply desire. The value of such work, however immeasurable it is, belongs with practice and not with theory. Such theoretic importance as it may possess is only in relation to human nature, not in relation to the world at large. The scientific philosophy, therefore, which aims only at understanding the world and not directly at any other improvement of human life, cannot take account of ethical notions without being turned aside from that submission to fact which is the essence of the scientific temper.

II.

If the notion of the universe and the notion of good and evil are extruded from scientific philosophy, it may be asked what specific problems remain for the philosopher as opposed to the man of science? It would be difficult to give a precise answer to this question, but

certain characteristics may be noted as distinguishing the province of philosophy from that of the special sciences.

In the first place a philosophical proposition must be general. It must not deal specially with things on the surface of the earth, or with the solar system, or with any other portion of space and time. It is this need of generality which has led to the belief that philosophy deals with the universe as a whole. I do not believe that this belief is justified, but I do believe that a philosophical proposition must be applicable to everything that exists or may exist. It might be supposed that this admission would be scarcely distinguishable from the view which I wish to reject. This, however, would be an error, and an important one. The traditional view would make the universe itself the subject of various predicates which could not be applied to any particular thing in the universe, and the ascription of such peculiar predicates to the universe would be the special business of philosophy. I maintain, on the contrary, that there are no propositions of which the 'universe' is the subject; in other words, that there is no such thing as the 'universe'. What I do maintain is that there are general propositions which may be asserted of each individual thing, such as the propositions of logic. This does not involve that all the things there are form a whole which could be regarded as another thing and be made the subject of predicates. It involves only the assertion that there are properties which belong to each separate thing, not that there are properties belonging to the whole of things collectively. The philosophy which I wish to advocate may be called logical atomism or absolute pluralism, because while maintaining that there are many things, it denies that there is a whole

composed of those things. We shall see, therefore, that philosophical propositions, instead of being concerned with the whole of things collectively, are concerned with all things distributively; and not only must they be concerned with all things, but they must be concerned with such properties of all things as do not depend upon the accidental nature of the things that there happen to be, but are true of any possible world, independently of such facts as can only be discovered by our senses.

This brings us to a second characteristic of philosophical propositions, namely that they must be *a priori*. A philosophical proposition must be such as can be neither proved nor disproved by empirical evidence. Too often we find in philosophical books arguments based upon the course of history, or the convolutions of the brain, or the eyes of shell-fish. Such special and accidental facts are irrelevant to philosophy, which must make only such assertions as would be equally true however the actual world were constituted.

We may sum up these two characteristics of philosophical propositions by saying that *philosophy is the science of the possible*. But this statement unexplained is liable to be misleading, since it may be thought that the possible is something other than the general, whereas in fact the two are indistinguishable.

Philosophy, if what has been said is correct, becomes indistinguishable from logic as that word has now come to be used. The study of logic consists, broadly speaking, of two not very sharply distinguished portions. On the one hand it is concerned with those general statements which can be made concerning everything without mentioning any one thing or predicate or relation, such for example as 'if x is a member of the class α and every member of α is a member of β , then x is a member of

the class β , whatever x , α , and β may be'. On the other hand, it is concerned with the analysis and enumeration of logical *forms*, i.e. with the kinds of propositions that may occur, with the various types of facts, and with the classification of the constituents of facts. In this way logic provides an inventory of possibilities, a repertory of abstractly tenable hypotheses.

It might be thought that such a study would be too vague and too general to be of any very great importance, and that, if its problems became at any point sufficiently definite, they would be merged in the problems of some special science. It appears, however, that this is not the case. In some problems, for example, the analysis of space and time, the nature of perception, or the theory of judgement, the discovery of the logical form of the facts involved is the hardest part of the work and the part whose performance has been most lacking hitherto. It is chiefly for want of the logical hypothesis that such problems have hitherto been treated in such an unsatisfactory manner, and have given rise to those contradictions or antinomies in which the enemies of reason among philosophers have at all times delighted.

By concentrating attention upon the investigation of logical forms, it becomes possible at last for philosophy to deal with its problems piecemeal, and to obtain, as the sciences do, such partial and probably not wholly correct results as subsequent investigation can utilize even while it supplements and improves them. Most philosophies hitherto have been constructed all in one block, in such a way that, if they were not wholly correct, they were wholly incorrect, and could not be used as a basis for further investigations. It is chiefly owing to this fact that philosophy, unlike science, has hitherto been unprogressive, because each original

philosopher has had to begin the work again from the beginning, without being able to accept anything from the work of his predecessors. A scientific philosophy such as I wish to recommend will be piecemeal and tentative like other sciences; above all, it will be able to invent hypotheses which, even if they are not wholly true, will yet remain fruitful after the necessary corrections have been made. This possibility of successive approximations to the truth is, more than anything else, the source of the triumphs of science, and to transfer this possibility to philosophy is to ensure a progress in method whose importance it would be almost impossible to exaggerate.

The essence of philosophy as thus conceived is analysis, not synthesis. To build up systems of the world, like Heine's German professor who knit together fragments of life and made an intelligible system out of them, is not, I believe, any more feasible than the discovery of the philosopher's stone. What is feasible is the understanding of general forms, and the division of traditional problems into a number of separate and less baffling questions. 'Divide and conquer' is the maxim of success here as elsewhere.

Let us illustrate these somewhat general maxims by examining their application to the philosophy of space, for it is only in application that the meaning or importance of a method can be understood. Suppose we are confronted with the problem of space as presented in Kant's *Transcendental Aesthetic*, and suppose we wish to discover what are the elements of the problem and what hope there is of obtaining a solution of them. It will soon appear that three entirely distinct problems, belonging to different studies, and requiring different methods for their solution, have been confusedly

combined in the supposed single problem with which Kant is concerned. There is a problem of logic, a problem of physics, and a problem of theory of knowledge. Of these three, the problem of logic can be solved exactly and perfectly; the problem of physics can probably be solved with as great a degree of certainty and as great an approach to exactness as can be hoped in an empirical region; the problem of epistemology, however, remains very obscure and very difficult to deal with. Let us see how these three problems arise.

(1) The logical problem has arisen through the suggestions of non-Euclidean geometry. Given a body of geometrical propositions, it is not difficult to find a minimum statement of the axioms from which this body of propositions can be deduced. It is also not difficult, by dropping or altering some of these axioms, to obtain a more general or a different geometry, having, from the point of view of pure mathematics, the same logical coherency and the same title to respect as the more familiar Euclidean geometry. The Euclidean geometry itself is true perhaps of actual space (though this is doubtful), but certainly of an infinite number of purely arithmetical systems, each of which, from the point of view of abstract logic, has an equal and indefeasible right to be called a Euclidean space. Thus space as an object of logical or mathematical study loses its uniqueness; not only are there many kinds of spaces, but there are an infinity of examples of each kind, though it is difficult to find any kind of which the space of physics may be an example, and it is impossible to find any kind of which the space of physics is certainly an example. As an illustration of one possible logical system of geometry we may consider all relations of three terms which are analogous in certain formal

respects to the relation 'between' as it appears to be in actual space. A space is then defined by means of one such three-term relation. The points of the space are all the terms which have this relation to something or other, and their order in the space in question is determined by this relation. The points of one space are necessarily also points of other spaces, since there are necessarily other three-term relations having those same points for their field. The space in fact is not determined by the class of its points, but by the ordering three-term relation. When enough abstract logical properties of such relations have been enumerated to determine the resulting kind of geometry, say, for example, Euclidean geometry, it becomes unnecessary for the pure geometer in his abstract capacity to distinguish between the various relations which have all these properties. He considers the whole class of such relations, not any single one among them. Thus in studying a given kind of geometry the pure mathematician is studying a certain class of relations defined by means of certain abstract logical properties which take the place of what used to be called axioms. The nature of geometrical *reasoning* therefore is purely deductive and purely logical; if any special epistemological peculiarities are to be found in geometry, it must not be in the reasoning, but in our knowledge concerning the axioms in some given space.

(2) The physical problem of space is both more interesting and more difficult than the logical problem. The physical problem may be stated as follows:—to find in the physical world, or to construct from physical materials, a space of one of the kinds enumerated by the logical treatment of geometry. This problem derives its difficulty from the attempt to accommodate to the

roughness and vagueness of the real world some system possessing the logical clearness and exactitude of pure mathematics. That this can be done with a certain degree of approximation is fairly evident. If I see three people A , B , and C sitting in a row, I become aware of the fact which may be expressed by saying that B is between A and C rather than that A is between B and C , or C is between A and B . This relation of 'between' which is thus perceived to hold has some of the abstract logical properties of those three-term relations which, we saw, give rise to a geometry, but its properties fail to be exact, and are not, as empirically given, amenable to the kind of treatment at which geometry aims. In abstract geometry we deal with points, straight lines, and planes; but the three people A , B , and C whom I see sitting in a row are not exactly points, nor is the row exactly a straight line. Nevertheless physics, which formally assumes a space containing points, straight lines, and planes, is found empirically to give results applicable to the sensible world. It must therefore be possible to find an interpretation of the points, straight lines, and planes of physics in terms of physical data, or at any rate in terms of data together with such hypothetical additions as seem least open to question. Since all data suffer from a lack of mathematical precision through being of a certain size and somewhat vague in outline, it is plain that if such a notion as that of a point is to find any application to empirical material, the point must be neither a datum nor a hypothetical addition to data, but a *construction* by means of data with their hypothetical additions. It is obvious that any hypothetical filling out of data is less dubious and unsatisfactory when the additions are closely analogous to data than when they are of a radically different sort. To

assume, for example, that objects which we see continue, after we have turned away our eyes, to be more or less analogous to what they were while we were looking, is a less violent assumption than to assume that such objects are composed of an infinite number of mathematical points. Hence in the physical study of the geometry of physical space, points must not be assumed *ab initio* as they are in the logical treatment of geometry, but must be constructed as systems composed of data and hypothetical analogues of data. We are thus led naturally to define a physical point as a certain class of those objects which are the ultimate constituents of the physical world. It will be the class of all those objects which, as one would naturally say, *contain* the points. To secure a definition giving this result, without previously assuming that physical objects are composed of points, is an agreeable problem in mathematical logic. The solution of this problem and the perception of its importance are due to my friend Dr. Whitehead. The oddity of regarding a point as a class of physical entities wears off with familiarity, and ought in any case not to be felt by those who maintain, as practically every one does, that points are mathematical fictions. The word 'fiction' is used glibly in such connexions by many men who seem not to feel the necessity of explaining how it can come about that a fiction can be so useful in the study of the actual world as the points of mathematical physics have been found to be. By our definition, which regards a point as a class of physical objects, it is explained both how the use of points can lead to important physical results, and how we can nevertheless avoid the assumption that points are themselves entities in the physical world.

Many of the mathematically convenient properties of abstract logical spaces cannot be either known to belong

or known not to belong to the space of physics. Such are all the properties connected with continuity. For to know that actual space has these properties would require an infinite exactness of sense-perception. If actual space is continuous, there are nevertheless many possible non-continuous spaces which will be empirically indistinguishable from it; and, conversely, actual space may be non-continuous and yet empirically indistinguishable from a possible continuous space. Continuity, therefore, though obtainable in the *a priori* region of arithmetic, is not with certainty obtainable in the space or time of the physical world: whether these are continuous or not would seem to be a question not only unanswered but for ever unanswerable. From the point of view of philosophy, however, the discovery that a question is unanswerable is as complete an answer as any that could possibly be obtained. And from the point of view of physics, where no empirical means of distinction can be found, there can be no empirical objection to the mathematically simplest assumption, which is that of continuity.

The subject of the physical theory of space is a very large one, hitherto little explored. It is associated with a similar theory of time, and both have been forced upon the attention of philosophically minded physicists by the discussions which have raged concerning the theory of relativity.

(3) The problem with which Kant is concerned in the *Transcendental Aesthetic* is primarily the epistemological problem: 'How do we come to have knowledge of geometry *a priori*?' By the distinction between the logical and physical problems of geometry, the bearing and scope of this question are greatly altered. Our knowledge of pure geometry is *a priori* but is purely

logical. Our knowledge of physical geometry is synthetic, but is not *a priori*. Our knowledge of pure geometry is hypothetical, and does not enable us to assert, for example, that the axiom of parallels is true in the physical world. Our knowledge of physical geometry, while it does enable us to assert that this axiom is approximately verified, does not, owing to the inevitable inexactitude of observation, enable us to assert that it is verified *exactly*. Thus, with the separation which we have made between pure geometry and the geometry of physics, the Kantian problem collapses. To the question, 'How is synthetic *a priori* knowledge possible?' we can now reply, 'It is not possible,' at any rate if 'synthetic' means 'not deducible from logic alone'. Our knowledge of geometry, like the rest of our knowledge, is derived partly from logic, partly from sense, and the peculiar position which in Kant's day geometry appeared to occupy is seen now to be a delusion. There are still some philosophers, it is true, who maintain that our knowledge that the axiom of parallels, for example, is true of actual space, is not to be accounted for empirically, but is as Kant maintained derived from an *a priori* intuition. This position is not logically refutable, but I think it loses all plausibility as soon as we realize how complicated and derivative is the notion of physical space. As we have seen, the application of geometry to the physical world in no way demands that there should really be points and straight lines among physical entities. The principle of economy, therefore, demands that we should abstain from assuming the existence of points and straight lines. As soon, however, as we accept the view that points and straight lines are complicated constructions by means of classes of physical entities, the hypothesis that we have an

a priori intuition enabling us to know what happens to straight lines when they are produced indefinitely becomes extremely strained and harsh ; nor do I think that such an hypothesis would ever have arisen in the mind of a philosopher who had grasped the nature of physical space. Kant, under the influence of Newton, adopted, though with some vacillation, the hypothesis of absolute space, and this hypothesis, though logically unobjectionable, is removed by Occam's razor, since absolute space is an unnecessary entity in the explanation of the physical world. Although, therefore, we cannot refute the Kantian theory of an *a priori* intuition, we can remove its grounds one by one through an analysis of the problem. Thus here, as in many other philosophical questions, the analytic method, while not capable of arriving at a demonstrative result, is nevertheless capable of showing that all the positive grounds in favour of a certain theory are fallacious and that a less unnatural theory is capable of accounting for the facts.

Another question by which the capacity of the analytic method can be shown is the question of realism. Both those who advocate and those who combat realism seem to me to be far from clear as to the nature of the problem which they are discussing. If we ask : 'Are our objects of perception *real* and are they *independent* of the percipient?' it must be supposed that we attach some meaning to the words 'real' and 'independent', and yet, if either side in the controversy of realism is asked to define these two words, their answer is pretty sure to embody confusions such as logical analysis will reveal.

Let us begin with the word 'real'. There certainly are objects of perception, and therefore, if the question whether these objects are real is to be a substantial

question, there must be in the world too sorts of objects, namely, the real and the unreal, and yet the unreal is supposed to be essentially what there is not. The question what properties must belong to an object in order to make it real is one to which an adequate answer is seldom if ever forthcoming. There is of course the Hegelian answer, that the real is the self-consistent and that nothing is self-consistent except the Whole, but this answer, true or false, is not relevant in our present discussion, which moves on a lower plane and is concerned with the status of objects of perception among other objects of equal fragmentariness. Objects of perception are contrasted, in the discussions concerning realism, rather with psychical states on the one hand and matter on the other hand than with the all-inclusive whole of things. The question we have therefore to consider is the question as to what can be meant by assigning 'reality' to some but not all of the entities that make up the world. Two elements, I think, make up what is felt rather than thought when the word 'reality' is used in this sense. A thing is real if it persists at times when it is not perceived; or again, a thing is real when it is correlated with other things in a way which experience has led us to expect. It will be seen that reality in either of these senses is by no means necessary to a thing, and that in fact there might be a whole world in which nothing was real in either of these senses. It might turn out that the objects of perception failed of reality in one or both of these respects, without its being in any way deducible that they are not parts of the external world with which physics deals. Similar remarks will apply to the word 'independent'. Most of the associations of this word are bound up with ideas as to causation which it is not now possible to

maintain. A is independent of B when B is not an indispensable part of the *cause* of A . But when it is recognized that causation is nothing more than correlation, and that there are correlations of simultaneity as well as of succession, it becomes evident that there is no uniqueness in a series of causal antecedents of a given event, but that, at any point where there is a correlation of simultaneity, we can pass from one line of antecedents to another in order to obtain a new series of causal antecedents. It will be necessary to specify the causal law according to which the antecedents are to be considered. I received a letter the other day from a correspondent who had been puzzled by various philosophical questions. After enumerating them he says: 'These questions led me from Bonn to Strassburg, where I found Professor Simmel.' Now, it would be absurd to deny that these questions caused his body to move from Bonn to Strassburg, and yet it must be supposed that a set of purely mechanical antecedents could also be found which would account for this transfer of matter from one place to another. Owing to this plurality of causal series antecedent to a given event, the notion of *the* cause becomes indefinite, and the question of independence becomes correspondingly ambiguous. Thus, instead of asking simply whether A is independent of B , we ought to ask whether there is a series determined by such and such causal laws leading from B to A . This point is important in connexion with the particular question of objects of perception. It may be that no objects quite like those which we perceive ever exist unperceived; in this case there will be a causal law according to which objects of perception are not independent of being perceived. But even if this be the case, it may nevertheless also happen

that there are purely physical causal laws determining the occurrence of objects which are perceived by means of other objects which perhaps are not perceived. In that case, in regard to such causal laws objects of perception will be independent of being perceived. Thus the question whether objects of perception are independent of being perceived is, as it stands, indeterminate, and the answer will be yes or no according to the method adopted of making it determinate. I believe that this confusion has borne a very large part in prolonging the controversies on this subject, which might well have seemed capable of remaining for ever undecided. The view which I should wish to advocate is that objects of perception do not persist unchanged at times when they are not perceived, although probably objects more or less resembling them do exist at such times; that objects of perception are part, and the only empirically knowable part, of the actual subject-matter of physics, and are themselves properly to be called physical; that purely physical laws exist determining the character and duration of objects of perception without any reference to the fact that they are perceived; and that in the establishment of such laws the propositions of physics do not presuppose any propositions of psychology or even the existence of mind. I do not know whether realists would recognize such a view as realism. All that I should claim for it is, that it avoids difficulties which seem to me to beset both realism and idealism as hitherto advocated, and that it avoids the appeal which they have made to ideas which logical analysis shows to be ambiguous. A further defence and elaboration of the positions which I advocate, but for which time is lacking now, will be found indicated in my book on *Our Knowledge of the External World*.¹

¹ Open Court Company, 1914.

30 SCIENTIFIC METHOD IN PHILOSOPHY

The adoption of scientific method in philosophy, if I am not mistaken, compels us to abandon the hope of solving many of the more ambitious and humanly interesting problems of traditional philosophy. Some of these it relegates, though with little expectation of a successful solution, to special sciences, others it shows to be such as our capacities are essentially incapable of solving. But there remain a large number of the recognized problems of philosophy in regard to which the method advocated gives all those advantages of division into distinct questions, of tentative, partial, and progressive advance, and of appeal to principles with which, independently of temperament, all competent students must agree. The failure of philosophy hitherto has been due in the main to haste and ambition: patience and modesty, here as in other sciences, will open the road to solid and durable progress.

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