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Science and the Unobservable*

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A NEW phenomenon has appeared in modern physics, namely, an attempt to apply with rigour the principle that only that which is observable is significant. This is not intended to be a precise statement of the principle. It is at least vague, and perhaps inaccurate, but on that very account it is the most suitable statement with which to begin our discussion. For the principle itself has not yet been clearly isolated from its applications. Consequently it is manifested here in one form and there in another, appearing to some as an outstanding example of scientific arrogance and even absurdity, while to others it has an authority which raises it above common sense and reason alike. It is therefore important to try to understand the meaning of the principle and to reach a point of view from which its validity may be justly appraised.

It is Einstein who is responsible for the present virility of the principle. Let us hear him speaking of the crux of his theory—the idea of the simultaneity of events occurring at different places.

"The concept" of simultaneity, he says, "does not exist for the physicist until he has the possibility of discovering whether or not it is fulfilled in an actual case. . . . As long as this requirement is not satisfied, I allow myself to be deceived as a physicist (and of course the same applies if I am not a physicist), when I imagine that I am able to attach a meaning to the statement of simultaneity. (I would ask the reader not to proceed farther until he is fully convinced on this point.)"[1]

Here, on the other hand, is a comment by M. Jacques Maritain, the well-known French Catholic philosopher, on this passage:

"Let us, then, obey our author and read no farther, for this little parenthesis, 'the same applies if I am not a physicist', is of direct concern to us who have not the honour to be physicists, and it presumes to introduce us into the most fallacious metaphysics. . . . It is a fault so obvious to the eyes of a philosopher to confuse the *meaning* of a concept . . . with the *use* which may be made of the concept in this or that field of study, . . . that we hesitate to impute such a mistake to anyone, whoever he may be. Everything goes to show, however, that Einstein has made this mistake."[2]

It is not surprising that a physicist and a philosopher should take opposite views of this question, but the matter cannot be disposed of on simple psychological grounds. Here are the diametrically opposed views of two men of science:

"The general point of view" of relativity, writes Prof. C. G. Darwin, "of questioning the reality of anything unobservable is one of the greatest revolutions in scientific thought that has ever occurred. . . . The great idea which Einstein contributed to scientific philosophy was the principle that if a thing is essentially unobservable then it is not a real thing and our theories must not include it."[3]

This remark has caught the eye of Mr. Albert Eagle, now a mathematician, but in other days an experimental physicist, whose name is known wherever spectroscopy is practised.

"To me," says Mr. Eagle, "this 'great idea' is the most savage example of the application of

* From a Friday evening discourse delivered at the Royal Institution on November 26.

what is known as the principle of *Occam's Razor* of which I have heard. . . . Einstein's 'great idea' requires us to surrender our common sense for the sake of an arbitrary dictum of his which he and his followers have raised to a fetish. It is preposterous, and to my way of thinking is so inherently idiotic that I cannot understand anyone wasting his breath in giving utterance to such a view."[4]

Finally, here is the attitude of another philosopher, Rudolf Carnap—perhaps the leading exponent of the most active of modern schools of philosophy, the so-called "logical positivism". Carnap, the philosopher, not only accepts the principle; he uses it to reduce to nonsense those branches of his own subject known as metaphysics and ethics.

"I will call *metaphysical*", he writes, "all those propositions which claim to present knowledge about something which is over and above all experience. . . . Metaphysicians . . . are compelled to cut all connection between their propositions and experience; and precisely by this procedure they deprive them of any sense."[5]

Now when men who are neither fools nor liars agree that a certain idea is either the greatest discovery of a generation or the silliest nonsense imaginable, but cannot agree as to which it is, it is clear that there is more than a difference of opinion; there must be some defect of understanding also. It therefore becomes a matter of importance to state this principle precisely, so that we shall at least know what we are doing when we bless or curse it. And in seeking to assess its value we must avoid the error of ascribing greater or less weight to the opinion of a physicist than to that of another. Einstein is perfectly right in saying that if this principle holds for him as a physicist, it holds for him also if he is not a physicist; and M. Maritain offers him a licence which he cannot accept when he allows him to apply the principle in physics but not outside. If we talk nonsense, and plead in extenuation that we are only talking as physicists, we fall short of the ideal of rational speech, distinguished precedent notwithstanding. The question must be considered on general rational grounds. Are we to admit the unobservable into our scheme of things, or are we not?

Let me for a moment adopt the legal method, and state the case for each side independently, as an advocate might state it. Take first the case for the principle. It is necessary, say its supporters, as a safeguard against irresponsible invention. If we allow that an entity might exist and be significant to thought, although it is essentially unobservable, what is there to prevent us from postulating any number of such entities and invoking them to remove any difficulty that might arise? Suppose, for example, I assert that there is a binkum sitting on the table in front of me, and that this tremendous fact, rightly understood, is the final, completely satisfying solution of the problem of evil. If you reject the principle in question, you have no grounds for denying the statement. You may say that you cannot detect my binkum, but I reply that of course you cannot, because he is unobservable. If you want to know how his existence solves the problem of evil, I say that it is its nature to do so, and the definition of him, according to your own contention, is quite independent of any means you adopt to investigate him. If you ask, "What is a binkum, anyway?" I reply that that is immediately evident; I cannot put it into words, but everyone knows what a binkum is. If you retort that you do not know, I shrug my shoulders and say that you must be speaking as a physicist.

Stupid as this example sounds, it contains a precise parallel to the case of simultaneity. M. Maritain and those who agree with him claim that the simultaneity of spatially separated events is something independent of our means of observing it. When asked what it is, they claim that its nature is immediately evident and that everyone knows it. But Einstein says he does not know it, and Einstein is an honourable man. And the only reply is that Einstein and his followers must be speaking as physicists.

We can now press home the point. We agree, let me assume, that science and philosophy are better without the binkum: How, then, can we exclude him? Only, says counsel for the defence of the principle, by refusing to grant existence to anything that is essentially unobservable, and denying any unobservable property to an existent thing. That means that everything whose existence we acknowledge must be definable ultimately in terms of observation. If there is the slightest relaxation of this requirement, in comes the binkum with passport signed and sealed.

The case seems established, but we must hear counsel for the other side. His argument is a *reductio ad absurdum*. Certainly we do not want the binkum, he says, but your device for keeping him out is both presumptuous and absurd; you are throwing out the baby with the bath-water.

Consider for a moment what your principle implies. It asserts that there is nothing in the universe except what you can observe—nothing in the physical world beyond the reach of your senses. How do you know that the universe does not contain things apprehensible only by senses which you do not possess, which perhaps you have lost in the course of evolution or have not yet acquired ? Moreover, what about the past ? You cannot observe that, for it has gone ; therefore, you say, it has no meaning, it must not come into our description of reality. Such nonsense necessarily follows if your principle is granted. Exclude your binkum by all means—we hold no brief for him ; but find some sensible way of doing it, without assuming potential omniscience

The problem, I think, is now set clearly before us. If we admit the unobservable, there is no check on empty speculation ; if we reject the unobservable, we confine the universe within the bounds of human potentialities and make nonsense of history. What are we to do ?

It is evident that we must begin by examining the word 'unobservable'. Both sides wish to exclude the binkum ; both wish to allow the universe a richer content than we can at present perceive. The 'unobservable' that is to be proscribed must therefore include the obviously idle fancies but exclude the legitimately transcendental.

There are reasons of various kinds why we may be prevented from observing a thing, but I think they can all be summarized under four headings. First of all, there is what I will call the *practically* unobservable ; namely, that which is unobservable because of the practical difficulties of observing it. The far side of the moon affords an example. That region is unobservable because we have not solved the problem of interplanetary travel, or performed some equivalent feat of practical ingenuity. It is conceivable that in time this disability will be removed, so that practical unobservability may be merely a temporary characteristic.

Secondly, there is the *humanly* unobservable ; by which I mean the unobservable which is so because we do not possess the necessary faculties for observing it. I cannot, of course, by the nature of the case, give examples of this, but I can give analogies. A great deal of the universe would be humanly unobservable if we had no sense of sight ; and to the musically insensitive the significance of a great composer may be said to be humanly unobservable. If, then, there is in the universe some existence which no creature has the faculty of apprehending, that existence is humanly unobservable.

Thirdly, there is what I will call the *physically* unobservable. A thing may be said to be physically unobservable when we have the faculty for observing it if Nature will co-operate, but Nature gives that faculty no opportunity for exercise. Thus, if somewhere in space there occurred an event from which no signal—light ray or sound wave or anything else—proceeded to other places, and if there were repulsive forces which prevented us from ever reaching the place of occurrence, that event would be physically unobservable.

Lastly, there is the *logically* unobservable ; namely, those things which we cannot claim to have observed without breaking the laws of reason. I doubt if this class is actual, since logic and observation are essentially independent, but it must be included because a great deal has been written about it. An example might be the observation of an object both larger and smaller than a given object ; but I give this example with some hesitation because geometers have an uncanny knack of inventing spaces in which such relations might not be incompatible. Be that as it may, however, if we grant a certain minimum of common agreement—such as the acceptance of Euclidean geometry in the present instance—logical unobservability becomes an intelligible notion, and we will accept it as a candidate for inclusion in our principle.

Now this classification may be simplified ; for, whatever may be the ultimate truth of the matter, it is not necessary for our purpose to put the humanly and the physically unobservable in separate classes. I will therefore group them together and call them jointly the physically unobservable. The justification for this is that we cannot tell, in any given case, with which class we are dealing. If, for example, a certain substance appears tasteless to everyone (that is, its taste is unobservable), it is impossible to say whether that is because it has a taste which our senses are not keen enough to detect, or because it has no taste to be detected. But now our principle is essentially one which, if valid, must be used ; it is not a creed which we are merely called upon to state and may then ignore. The humanly and the physically unobservable, then, become one class so far as our problem is concerned, for if in practice we reject one, we automatically reject the other also.

We have, then, three classes of unobservables, and I think the distinction between them may be expressed most simply in the following way. Let us suppose that we have discovered all the means of observation that exist in the universe, and know all their properties completely. We might then be able to imagine other means of observation which do not exist. Anything which would be observable by such imaginary means, but not by the existing means, would be *physically* unobservable. Anything which would be unobservable by *any* means, existing or imaginable, would be *logically* unobservable. Anything which would be observable by the existing means if we were also omnipotent, but which actually is unobservable because we cannot make full use of the means of observation which exist, would be *practically* unobservable.

We can now proceed a stage further. We have just seen that, for our purpose, the humanly and the physically unobservable become one class because we cannot at present distinguish between them. Let us look, then, at our latest classification, to make sure that the three types of unobservability we have now reached are immediately distinguishable. It is fairly evident, I think, that they are, if we grant the initial supposition that we have discovered all existing means of observation. For brevity, I will call that the assumption of *omniscience*, and you will understand that by this word I do not mean knowledge of everything that exists or that can be observed, but complete knowledge of the existence and properties of every means by which observation is possible. For example, omniscience implies complete knowledge of all the properties of light, but not necessarily of all objects which are visible. Now, clearly, this assumption of omniscience is open to challenge, and it is therefore necessary to see how our classification looks if it is removed. Can we then still recognize the three classes as distinct ?

There is no difficulty, I think, with the logically unobservable. Since this class consists of things which are not even *imaginably* observable, it makes no difference how much we know of *possible* observability. There can be no possible means of observation that is not imaginable. The logically unobservable, then, forms a definitely distinguishable class, independently of our assumption of omniscience.

The case is different, however, with the practically and the physically unobservable, for these classes *cannot* be distinguished if we do not regard ourselves as omniscient. We said that the far side of the moon was practically unobservable, but if we are not omniscient, how do we know that when we have overcome what seem to be the present obstacles, Nature will not face us with some unexpected difficulty like that which she kept in store for our efforts to determine our motion through the ether ? If she does, and persists in doing the same kind of thing, we shall have to call the far side of the moon physically and not only practically unobservable. And, on the other hand, when we say that absolute motion is physically unobservable, we are again assuming omniscience. We cannot observe such motion by optical, acoustical, electro-magnetic or any other means within our present knowledge, but, without the assumption, who can say that there is not some undiscovered physical medium through which it may be detected ? If there is, absolute motion is merely practically, and not physically, unobservable. It is clear, I think, that unless we are omniscient the two classes are indistinguishable.

Our analysis of unobservability, then, finally brings us to this. If we assume that we are omniscient we can distinguish three classes—the *practically*, the *physically* and the *logically* unobservable. If we do not assume that we are omniscient we can distinguish only two classes—the *actually* and the *logically* unobservable, let us call them. The importance of this conclusion for our purpose is this. We are going to look at the actual practice of physics, to see what kinds of unobservable are excluded and what kinds are not. If we find that a distinction is made between the practically and the physically unobservable, then we know that physics is assuming omniscience ; but if no distinction is made, then there is no such assumption.

Let me state the result at once, afterwards giving examples to justify the statement before proceeding to consider the validity of the principle we are considering in its definite form. The practice of physics is to recognize three classes—the practically, the physically and the logically unobservable. Of these it excludes the physically and the logically unobservable from its considerations, and aims at describing the universe in terms of the observable and the merely practically unobservable only. It thus assumes omniscience, in the sense in which I have defined the word.

It will not take us long to see that physics includes the practically unobservable. No physicist denies that the moon has a far side in the same

sense as it has a near side. We assume without question that the earth has an interior, that there are stars outside the range of our telescopes, and regions beyond the obscuring clouds of the Milky Way. All these things could be observed if known means of observation have precisely the properties we believe them to have and we had the skill to make full use of them. Hence the practically unobservable is admitted to physical theory.

We may deal equally summarily with the logically unobservable. Nasty things have been said about the reasoning of some modern physicists when they step outside the bounds of their equations, but I do not think the bare, unadorned physical theories themselves have been called illogical, either with pride or with shame. If, then, the structure of physical theory allows ontological significance to anything which is logically unobservable, it does so through an oversight, and theory will undoubtedly be reformed as soon as the oversight is discovered. We may say, therefore, that the practice of physics is to reject the logically unobservable.

But now, the unobservables the rejection of which has caused all the controversy belong to neither of these classes. Let us fix our attention on the example of absolute simultaneity, with which the discussion began. This, as we know, is rejected, and that cannot be because it is practically unobservable, for physics reeks of the practically unobservable. Nor is absolute simultaneity logically unobservable. We can conceive that the universe might be such that two events at different places might occur at the same time in an absolute sense, and that this fact might be observable. We cannot, then, escape from the conclusion that absolute simultaneity belongs to a third class of unobservables, which we shall see is what I have called the class of physically unobservables; and the recognition of this class commits physics to the assumption of omniscience.

To see that absolute simultaneity is physically unobservable, let us look at the obstacle that prevents us from observing it. Why can we not say, in an absolute sense, that two events occurring at different places are simultaneous? It comes down to the fact that we can know of the events only through some agency which travels from them to us and takes time to do so. We know of most events when we see them, but we do not see them at the moments at which they occur because the light which makes them visible takes time to travel. We can, of course, allow for this by calculating how long the light has taken to travel, but when we do so, according to standard methods and principles, we find that the results depend on the way in which we happen to be moving with respect to the bodies on which the events occurred. Furthermore, we cannot distinguish in an absolute sense between one state of motion and another. Hence we do not know what allowance to make for the time of travel of the light, and therefore cannot determine absolutely whether the events were simultaneous or not.

The unobservability of absolute simultaneity, then, depends on the fact that we cannot determine unambiguously how long light takes to inform us of an event; or, more generally, how long after an event it is possible for us to know of it. This ignorance, of course, would not be necessary if we could know of an event immediately it occurred—if, this is to say, we could observe it by some messenger which travelled at an infinite speed. This is not pure fancy. Before the time of Römer, in the seventeenth century, it was believed that light might travel at an infinite speed; and before the theory of relativity arose, it was believed that gravitational action was transmitted instantaneously. It is not uncommon, too, to imagine that there might be instantaneous telepathic communication. We can at least, then, *conceive* that an instantaneous messenger might exist, and therefore absolute simultaneity is not *logically* unobservable. It is unobservable simply and solely because, so far as our present survey of the universe has gone, there is no evidence that it is possible to learn of a distant event at the moment at which it occurs. In other words, absolute simultaneity is *physically* unobservable.

We can now, at last, give a rigorous form to the principle which is the subject of our inquiry. It is this: that *only that which is practically observable*—that is, only that which would be observable if we were able to use known means of observation to the known limits of their possibilities—*is significant.*

The next step, clearly, is to examine the credentials of this principle on general rational grounds, but before doing so I want to give another example of its application, in order to emphasize the fact that it is not an unimportant appendage of physical theory, but the very mainspring of the most prominent modern developments. Heisenberg's uncertainty principle is perhaps the best-known example, but I will not deal with that because it is too closely bound up with other

factors which there is no time to consider. I choose instead a subject which stresses the point still more forcibly because it is not generally regarded as exemplifying the principle in question, but is attacked or defended on quite other grounds. The principle has taken root so deep in the minds of physicists that they employ it unconsciously, and justify their action by arguments which appear to others either incomprehensible or absurd. I am speaking of the idea that the physical universe is finite but boundless. This idea can be made intelligible in five minutes when presented as an example of the principle of rejection of the physically unobservable, and I believe that those who accept it are convinced of its rationality because they have already accepted that principle. They are not aware of this source of their conviction, however, and therefore have to justify their belief by saying that space is "curved", that it "bends back on itself"—an "idea" which I do not think it is humanly possible to grasp except as a metaphor of the kind one meets with in the "metaphysical" poetry of the seventeenth century. Whether or not that psychological diagnosis is accurate, however, is unimportant; the main point is to see that, in terms of our principle, the idea that space is finite and boundless is intelligible without calling on such unimaginable notions as curvature.

The idea is that if we were free to move about in space eternally, wherever Nature led, we would always find ourselves apparently in the midst of a collection of stars or nebulæ, though we could not for ever be meeting new objects, but would have to endure the tedium of seeing the old familiar faces endlessly, without relief. Like our former example, this idea, in its modern form, originated with Einstein; let us see how it has impressed his contemporaries. Sir Arthur Eddington, who thinks very highly of it, writes thus:

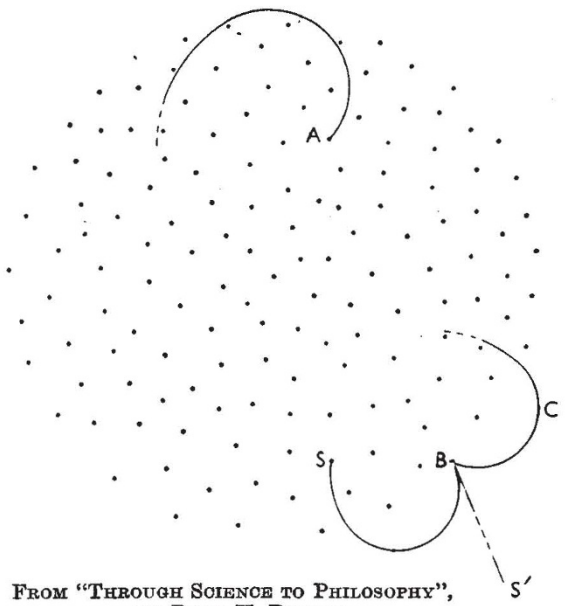
"Einstein made a slight amendment to his law to meet certain difficulties that he encountered in his theory. There was just one place where the theory did not seem to work properly, and that was—infinity. I think Einstein showed his greatness in the simple and drastic way in which he disposed of difficulties at infinity. He abolished infinity. He slightly altered his equations so as to make space at great distances bend round until it closed up."[6]

On the other hand, here is the stimulating Mr. Eagle again:

"In pre-Einsteinian days if people had been told that an author's theme in his book had been that external reality only possessed three spatial dimensions, and that therefore to talk of 'curved three dimensional space' was pure nonsense, they would have replied that they thought only lunatics thought otherwise. Now this conception is widely regarded in many circles as a 'probably may be true' one. This to me seems the measure to which both the scientific world and the general public have been bluffed by the theory. Future scientific historians will probably regard the theory as a befitting product of a mad age in the world's history."[7]

Prof. E. A. Milne is scarcely less contemptuous of this manifestation of Einstein's greatness.

"It is not necessary", he says, "to employ the vague, ill-understood, probably meaningless concept of closed, finite expanding space."[8]



From "Through Science to Philosophy", by Prof. H. Dingle

Well, the symptoms are familiar. Again we have the alternative estimates of supreme greatness and supreme folly, and we might suspect that the same misunderstanding is at the bottom of the trouble—as, in fact, it is. Let us begin with a finite collection of stars (or nebulæ) in a space which we suppose extends to infinity in all directions; we are somewhere in the midst of the collection—say, at *A* (see accompanying figure). Now suppose we try to get outside into the empty spaces. We cannot, because the gravitation of the system keeps all material bodies inside; the faster we move the greater is the attraction and we find ourselves following some such path as that shown in the diagram. It is the same with light; that also is drawn back, and cannot illuminate whatever external objects there may be. In fact, no physical existence that we know of can escape. All that is perfectly conceivable.

We picture, then, a finite universe from which we cannot escape. The next point is that it is impossible for us to know whether we are at its centre or its boundary ; in either case we appear to be surrounded by stars on all sides. Obviously an observer at the centre (or at A) sees stars all round, but so does an observer at B, for the light of the stars inside is bent, so that he sees them whichever way he looks. The light of a star at S, for example, is bent so that the star appears to be at S'. This is a very ordinary phenomenon, exemplified every time we look at a mirror ; an object appears in the direction of the light that enters our eye, and not necessarily where it actually is. We are therefore not only confined within the universe, but also necessarily without the possibility of the *experience* of being at the boundary ; however we move, and wherever we go, we must always see the same kind of thing—stars more or less uniformly distributed all round.

All that is of the nature of simple, traditional physics : now comes the crucial point. Since the region outside the system is physically inaccessible and unobservable, and the *experience* of being at its frontier is physically unattainable so that it is never possible for us to know whether we are there or not, we leave these things outside our description of the universe. We give the name 'space' to the volume which contains what we can observe, and describe it simply according to our experience as both finite and boundless. We can still, of course, conceive that there is an infinite region outside (wherever 'outside' may be), but that is merely another way of saying that the region is not *logically* unobservable. The rejection of infinite space is, in fact, precisely similar to the rejection of absolute simultaneity : it represents an economy of ideas—we are to introduce no conceptions which are not necessary for the description of the physically observable.

It may be worth while to point out that this account of finite boundlessness differs from the statement that space is curved in the fact that it says nothing about any intrinsic *property* of space. There is no need to try to think of emptiness with a curvature ; we have simply to think of possible experience, and keep within its bounds. Of course, for mathematical purposes the conception of curvature is useful because it allows us to employ the technique of Riemannian geometry to solve particular problems, and for the mathematician it may have some æsthetic value, as the poetry of Mr. T. S. Eliot is said to have for those "in the know". But for the purpose of understanding it is worse than superfluous ; it is definitely misleading.

What, now, of the validity of this principle, which has taken charge of physics and threatens to direct all future philosophical thought ? Let me repeat the principle : it says that *nothing which is logically or physically unobservable is significant.* This statement must be appraised on pre-scientific, general rational grounds, and we can best approach the task by returning to the rival arguments set out earlier and considering them in the light of our rigorous statement.

The essence of the argument for the principle is that it is needed to prevent arbitrary invention of existences or arbitrary dogmas about them ; and it meets this requirement by saying, in effect, that everything that exists is observable by known means. The argument against the principle is that we have no right to assume omniscience ; that although it may be granted that the logically unobservable cannot exist, it is presumptuous to say the same of the physically unobservable.

We are therefore in this dilemma. If we deny the principle, we have no check on idle invention ; it may be that all that we know, and have taken such pains to find out, is trivial, while the great, important facts of the universe are not even suspected and are unattainable. On the other hand, if we accept the principle, we close the door to all experience outside that which our present knowledge allows. Let me repeat that this dilemma is not a domestic affair for physicists. In physics it concerns at present only existences observable by sense perception, but clearly it is equally relevant, in the appropriate forms, to all spheres of thought in which we regard ourselves as apprehending some independent existence by means of human faculties.

This last sentence, I think, gives the clue to the solution of the problem : "all spheres of thought in which we regard ourselves as apprehending some independent existence by means of human faculties". That is the attitude which I have assumed throughout this discussion—the attitude of naïve realism in which we picture an objective universe existing independently of our thought of it and our examination of it. It is the attitude which we always assume in everyday intercourse and in most scientific discussions also. We regard scientific research as an exploration of this independent universe, an attempt to discover what

it contains and to understand the pre-established relation of one part with another. It is this conception of science or philosophy that makes possible the dilemma by which we are faced. If the universe exists independently of our experience of it, then clearly it is presumption on our part to deny that it can contain anything inaccessible to experience. On the other hand, if we abstain from this presumption we make all inquiry a mockery, for we have no guarantee that anything that we may discover is more than a triviality, an insignificant part of a universe the essential elements of which are eternally unknowable.

But suppose we take the idealistic view, regarding our experience, our observations, as the primary data, and the universe as a mental construct formed to give rational coherence to those observations. The whole matter then appears in a different light, in which the dilemma is no longer seen. The statement that nothing which is logically or physically unobservable is significant is simply a statement of our aim as scientists or philosophers; it means that we confine ourselves to our purpose of deducing a universe from our observations and do not allow our fancies to intervene. There is no assumption of omniscience because there is no independent universe to know, and the arrogance disappears because we make no claim to know all the possibilities of observation. We set no limit to the possibilities of experience; we simply refuse to assert anything for which we have no (direct or indirect) justification in experience, and as observation grows the universe grows also. The objection to the principle therefore vanishes completely, from the idealistic point of view.

On the other hand, the objection to denying the principle by no means vanishes. If we do not exclude the physically unobservable from our description of the universe, we still have no grounds for not admitting the binkum and so reducing philosophy to a farce. When M. Maritain claims that a thing is independent of our observation of it, he immediately makes it impossible for us to know that we are saying anything of the least importance about it, no matter whether we adopt the realistic or the idealistic point of view. If we are realists the thing may be essentially beyond apprehension; and if we are idealists we may form it equally legitimately from observation or from fancy.

The position, then, is this. If we take the realistic view, we are left with an unresolved dilemma, but if we take the idealistic view, the principle becomes simply a statement of the object at which science has aimed throughout its history. It is not my purpose to comment on the age-old problem of idealism *versus* realism; I am concerned only with the attitude implied in modern scientific developments, and the point I want to emphasize as clearly and unmistakably as possible is that anyone who regards the recent trend of physics in general, and the theory of relativity in particular, as legitimate science or philosophy or intellectual activity bearing whatever name may be thought honourable, must either be an idealist or presume that he is omniscient. I do not wish in this place to plead the cause of either of the alternatives open to the humble. I am not anxious to cry, "Vote for realism, and down with relativity!" or "Support idealism and relativity, and throw realism to the dogs!". That is a matter for personal predilection, but it is a matter for pure reason to show that those are the only alternatives open to anyone who is not prepared to assume that he is omniscient.

The striking divergence of opinion with which we opened can now, I think, be understood. Those who, like M. Maritain and Mr. Eagle, see the principle in question as an example of presumption arising from ignorance, are realists—by which I mean that they instinctively think as realists, whether or not they would accept the title. On the other hand, those physicists and philosophers who accept the principle are, by the same criterion, idealists, though most of them speak our ordinary, everyday language which has accommodated itself to the realistic outlook. In terms of that language their utterances necessarily appear arrogant; what they apprehend instinctively as the wisdom of a self-imposed discipline is clothed in sentences which suggest to the realist the idea of arbitrary dogma. The divergence, arising as a difference of philosophical attitude, is accentuated by the necessity of expressing idealistic principles in realistic terms.

[1] "The Theory of Relativity" (English translation, p. 22) (1920).
[2] "Réflexions sur l'intelligence et sur sa vie propre", pp. 205–6 (1926).
[3] "The New Conceptions of Matter", pp. 23, 81 (1931).
[4] "The Philosophy of Religion versus the Philosophy of Science", pp. 169-70 (1935).
[5] "Philosophy and Logical Syntax", pp. 15, 17–18 (1935).
[6] "The Expanding Universe", p. 21 (1933).
[7] "The Philosophy of Religion versus the Philosophy of Science", pp. 219–20.
[8] *Z. Astrophys.*, **6**, 83 (1933).

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