

lar world." But if electrons, belonging to world no. 2, are to be scrupulously guarded from contamination by world no. 1, how can it make sense to say that they "keep on hitting the underside" of a sheet of paper that, indubitably, is part of the familiar furniture of earth? It is Eddington who reintroduces contamination when he talks in this fashion, and he does so because he supposes that there is a scientific table parallel to the familiar table. I venture to suggest that it is as absurd to say that there is a scientific table as to say that there is a familiar electron or a familiar quantum, or a familiar potential. Eddington insists upon the lack of familiar parallels in the latter cases; surely he is justified in doing so. What is puzzling is his view that there are parallel *tables*. It suggests a return to the days when physicists demanded a model; "the physicist," says Eddington, "used to borrow the raw material of his world from the familiar world, but he does so no longer" (xv). But if the "scientific table" is to be regarded as the product of the "raw material of the scientific world," how can it be regarded as parallel to the familiar table? Eddington seems unable to free himself from the conviction that the physicist is concerned with things of the same nature as the things of the familiar world; hence, *tables* are to be found in both world no. 1 and world no. 2. There is a statement in his exposition of "The Downfall of Classical Physics" that shows how deep-rooted this conviction is. "The atom," he says, "is as porous as the solar system. If we eliminated all the unfilled space in a man's body and collected his protons and electrons into one mass, the man would be reduced to a speck just visible with a magnifying glass" (N.Ph.W. 1-2). The comparison is useful enough; the absurdity comes from speaking of the speck as a *man*. If this statement stood alone, it might well be regarded as an expository device. But the constant cropping up of the parallel tables shows that Eddington does not regard it as absurd to think of the reduction as still leaving a *man*. When, later in the book, he is expounding the conception of space required by relativity theory, he points out that our difficulty in conceiving it is due to the fact that we are "using a conception of space which must have originated many millions of years ago and has become rather firmly embedded in human thought" (81). He adds: "But the space of physics ought not to be dominated by this creation of the dawning mind of an enterprising ape." It seems to me that in allowing himself to speak of the speck as a man, Eddington is allowing himself to be thus dominated. It is true that, in the statement just quoted, Eddington was speaking of relativity physics, but I do not think that "the creation of the dawning mind of an enterprising ape" is any more appropriate to the conception of space in atomic physics. . . . It must suffice at the moment to insist that a *man* is an object belonging to the familiar world, and has no duplicate in "the scientific world."

Perhaps we may be convinced of the absurdity of the notion that there are "duplicates of every object" in the familiar world if we return to the consideration of the description of a familiar scene with which this chapter opened. I spoke there of "blue curtains," of a crimson and scented rose, of a bruised leg. Neglecting at present the consideration of the bruised leg, which—judging by Eddington's account of the adventures of an elephant—is beneath the

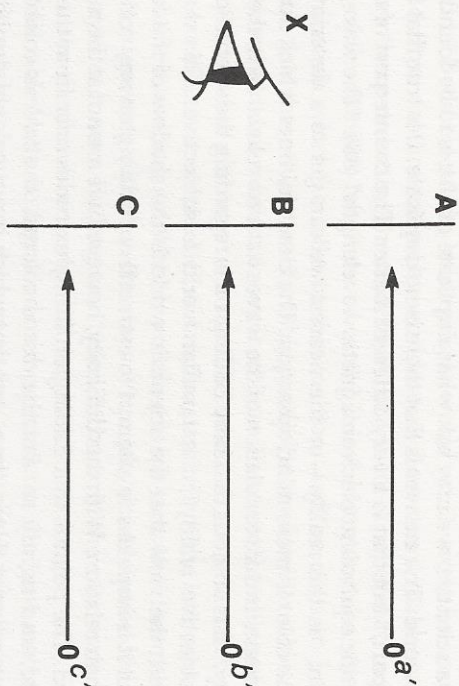
notice of a scientist, we may ask what duplicate of *blue* is to be found in the scientific world. The answer is that there is no duplicate. It is true that it has a "counterpart," but that is a very different matter. The counterpart of color is "the scientific equivalent electromagnetic wavelength" (88). "The wave," says Eddington, "is the reality—or the nearest we can get to a description of reality; the color is mere mind-spinning. The beautiful hues which flood our consciousness under stimulation of the waves have no relevance to the objective reality." It is obvious that here Eddington is regarding the scientific world as "the objective reality"; the familiar world is subjective. This does not square with the view that the scientific world is the shadow of the familiar world, but it is hopeless to attempt to extract from Eddington any consistent view of their relation. With this difficulty, however, we are not at the moment concerned. The point is that Eddington firmly extrudes *color* from the scientific world, and rightly so. But the *rose* is colored, the *table* is colored, the *curtains* are colored. How, then, can that which is not colored duplicate the *rose*, the curtains, the table? To say that an electromagnetic wave-length is colored would be as nonsensical as to say that symmetry is colored. Eddington does not say so. But he has failed to realize that a colored object could be *uplicated* only by something with regard to which it would not be meaningless to say that it was colored.

9 / Science and the Physical World

W. T. STACE

W. T. Stace (1886-1967) taught at Princeton University. He worked in *ethics, the study of religion and culture, and was a significant figure in both the academic world and public culture.*

So far as I know scientists still talk about electrons, protons, neurons, and so on. We never directly perceive these; hence if we ask how we know of their existence the only possible answer seems to be that they are an inference from what we do directly perceive. What sort of an inference? Apparently a causal inference. The atomic entities in some way impinge upon the sense of the



animal organism and cause that organism to perceive the familiar world of tables, chairs, and the rest.

But is it not clear that such a concept of causation, however interpreted, is invalid? The only reason we have for believing in the law of causation is that we *observe* certain regularities or sequences. We observe that, in certain conditions, *A* is always followed by *B*. We call *A* the cause, *B* the effect. And the sequence of *A-B* becomes a causal law. It follows that all *observed* causal sequences are between sensed objects in the familiar world of perception, and that all known causal laws apply solely to the world of sense and not to anything beyond or behind it. And this in turn means that we have not got, and never could have, one jot of evidence for believing that the law of causation can be applied *outside* the realm of perception, or that that realm can have any causes (such as the supposed physical objects) which are not themselves perceived.

Put the same thing in another way. Suppose there is an observed sequence *A-B-C*, represented by the vertical line in the diagram above. The observer *X* sees, and can see, nothing except things in the familiar world of perception. What *right* has he, and what *reason* has he, to assert a cause of *A*, *B*, and *C*, such as *a'*, *b'*, *c'*, which he can never observe, behind the perceived world? He has no *right*, because the law of causation on which he is relying has never been observed to operate outside the series of perceptions and he can have, therefore, no evidence that it does so. And he has no *reason* because the phenomenon *C* is *sufficiently* accounted for by the cause *B*, *B* by *A*, and so on. It is unnecessary and superfluous to introduce a *second* cause *b'* for *B*, *c'* for *C*, and so forth. To give two causes for each phenomenon, one in one world and one in another, is unnecessary, and perhaps even self-contradictory.

Is it denied, then, it will be asked, that the star causes light waves, that the waves cause retinal changes, that these cause changes in the optic nerve, which in turn causes movements in the brain cells, and so on? No, it is not

denied. But the observed causes and effects are all in the world of perception. And no sequence of sense-data can possibly justify going outside that world. If you admit that we never observe anything except sensed objects and their relations, regularities, and sequences, then it is obvious that we are completely shut in by our sensations and can never get outside them. Not only causal relations, but all other observed relations, upon which *any* kind of inferences might be founded, will lead only to further sensible objects and their relations. No inference, therefore, can pass from what is sensible to what is not sensible.

The fact is that atoms are not inferences from sensations. No one denies, of course, that a vast amount of perfectly valid inferential reasoning takes place in the physical theory of the atom. But it will not be found to be in any strict logical sense inference *from sense-data* to atoms*. An *hypothesis* is set up, and the inferential processes are concerned with the application of the hypothesis, that is, with the prediction by its aid of further possible sensations and with its own internal consistency.

That atoms are not inferences from sensations means, of course, that from the existence of sensations we cannot validly infer the existence of atoms. And this means that we cannot have any reason at all to believe that they exist. And that is why I propose to argue that they do not exist—or at any rate that one could not know if it they did, and that we have absolutely no evidence of their existence.

What status have they, then? Is it meant that they are false and worthless, merely untrue? Certainly not. No one supposes that the entries in the *Nautical Almanac* "exist" anywhere except on the pages of that book and in the brains of its compilers and readers. Yet they are "true" inasmuch as they enable us to predict certain sensations, namely, the positions and times of certain perceived objects which we call the stars. And so the formulae of the atomic theory are true in the same sense, and perform a similar function.

I suggest that they are nothing but shorthand formulae, ingeniously worked out by the human mind, to enable it to predict its experience, that is, to predict what sensations will be given to it. By "predict" here I do not mean to refer solely to the future. To calculate that there was an eclipse of the sun visible in Asia Minor in the year 585 B.C. is, in the sense in which I am using the term, to predict.

In order to see more clearly what is meant, let us apply the same idea to another case, that of gravitation. Newton formulated a law of gravitation in terms of "forces." It was supposed that this law—which was nothing but a mathematical formula—governed the operation of these existent forces. Nowadays it is no longer believed that these forces exist at all. And yet the law can be applied just as well without them to the prediction of astronomical phenomena. It is a matter of no importance to the scientific man whether the forces exist or not. That may be said to be a purely philosophical question.

*[Singular: sense-datum. A sense-datum is any object or quality which is immediately sensed, for example, a color, shape, sound, taste, etc. At times Space calls these sensations. —Eds.]

And I think the philosopher should pronounce them fictions. But that would not make the law useless or untrue. If it could still be used to predict phenomena, it would be just as true as it was.

It is true that fault is now found with Newton's law, and that another law, that of Einstein, has been substituted for it. And it is sometimes supposed that the reason for this is that forces are no longer believed in. But this is not the case. Whether forces exist or not simply does not matter. What matters is the discovery that Newton's law does *not* enable us accurately to predict certain astronomical facts such as the exact position of the planet Mercury. Therefore another formula, that of Einstein, has been substituted for it which permits correct predictions. This new law, as it happens, is a formula in terms of geometry. It is pure mathematics and nothing else. It does not contain anything about forces. In its pure form it does not even contain, so I am informed, anything about "humps and hills in space-time." And it does not matter whether any such humps and hills exist. It is truer than Newton's law, not because it substitutes humps and hills for forces, but solely because it is a more accurate formula of prediction.

Not only may it be said that forces do not exist. It may with equal truth be said that "gravitation" does not exist. Gravitation is not a "thing," but a mathematical formula, which exists only in the heads of mathematicians. And as a mathematical formula cannot cause a body to fall, so gravitation cannot cause a body to fall. Ordinarily language misleads us here. We speak of the law "of" gravitation, and suppose that this law "applies to" the heavenly bodies. We are thereby misled into supposing that there are *two* things, namely, the gravitation and the heavenly bodies, and that one of these things, the gravitation, causes changes in the other. In reality nothing exists except the moving bodies. And neither Newton's law nor Einstein's law is, strictly speaking, a law of gravitation. They are both laws of moving bodies, that is to say, formulae which tell us how these bodies will move.

Now just as in the past "forces" were foisted into Newton's law (by himself, be it said), so now certain popularizers of relativity foisted "humps and hills in space-time" into Einstein's law. We hear that the reason why the planets move in curved courses is that they cannot go through these humps and hills, but have to go around them! The planets just get "shoved about," not by forces, but by the humps and hills! But these humps and hills are pure metaphors. And anyone who takes them for "existences" gets asked awkward questions as to what "curved space" is curved "in."

It is not irrelevant to our topic to consider *why* human beings invent these metaphysical monsters of forces and bumps in space-time. The reason is that they have never emancipated themselves from the absurd idea that science "explains" things. They were not content to have laws which merely told them *that* the planets will, as a matter of fact, move in such and such ways. They wanted to know "why" the planets move in those ways. So Newton replied, "Forces." "Oh," said humanity, "that explains it. We understand forces. We feel them every time someone pushes or pulls us." Thus the movements were supposed to be "explained" by entities familiar because

analogous to the muscular sensations which human beings feel. The humps and hills were introduced for exactly the same reason. They seem so familiar. If there is a bump in the billiard table, the rolling billiard ball is diverted from a straight to a curved course. Just the same with the planets. "Oh, I see!" says humanity, "that's quite simple. That *explains* everything."

But scientific laws, properly formulated, never "explain" anything. They simply state, in an abbreviated and generalized form, *what happens*. No scientist, and in my opinion no philosopher, knows *why* anything happens, or can "explain" anything. Scientific laws do nothing except state the brute fact that "when A happens, B always happens too." And laws of this kind obviously enable us to predict. If certain scientists substituted humps and hills for forces, then they have just substituted one superstition for another. For my part I do not believe that *science* has done this, though some *scientists* may have. For scientists, after all, are human beings with the same craving for "explanations" as other people.

I think that atoms are in exactly the same position as forces and the bumps and hills of space-time. In reality the mathematical formulae, which are the scientific ways of stating the atomic theory, are simply formulae for calculating what sensations will appear in given conditions. But just as the weakness of the human mind demanded that there should correspond to the formula of gravitation a real "thing" which could be called "gravitation itself" or "force," so the same weakness demands that there should be a real thing corresponding to the atomic formulae, and this real thing is called the atom. In reality the atoms no more cause sensations than gravitation causes apples to fall. The only causes of sensations are other sensations. And the relation of atoms to sensations to be felt is not the relation of cause to effect, but the relation of a mathematical formula to the facts and happening which it enables the mathematician to calculate. . . .

It will not be out of place to give one more example to show how common fictitious existences are in science, and how little it matters whether they really exist or not. This example has no strange and annoying talk of "bent spaces" about it. One of the foundations of physics is, or used to be, the law of the conservation of energy. I do not know how far, if at all, this has been affected by the theory that matter sometimes turns into energy. But that does not affect the lesson it has for us. The law states, or used to state, that the amount of energy in the universe is always constant, that energy is never either created or destroyed. This was highly convenient, but it seemed to have obvious exceptions. If you throw a stone up into the air, you are told that it exerts in its fall the same amount of energy which it took to throw it up. But suppose it does not fall. Suppose it lodges on the roof of your house and stays there. What has happened to the energy which you can nowhere perceive as being exerted? It seems to have disappeared out of the universe. No, says the scientist, it still exists as *potential* energy. Now what does this blessed word "potential"—which is thus brought in to save the situation—mean as applied to energy? It means, of course, that the energy does not exist in any of its regular "forms," heat, light, electricity, etc. But this is merely negative. What

positive meaning has the term? Strictly speaking, none whatever. Either the energy exists or it does not exist. There is no realm of the "potential" half-way between existence and nonexistence. And this existence of energy can only consist in its being exerted. If the energy is not being exerted, then it is not energy and does not exist. Energy can no more exist without energizing than heat can exist without being hot. The "potential" existence of the energy is, then, a fiction. The actual empirically verifiable facts are that if a certain quantity of energy *e* exists in the universe and then disappears out of the universe (as happens when the stone lodges on the roof), the same amount of energy *e* will always reappear, begin to exist again, in certain known conditions. That is the fact which the law of the conservation of energy actually expresses. And the fiction of potential energy is introduced simply because it is convenient and makes the equations easier to work. They could be worked quite well without it, but would be slightly more complicated. In either case the function of the law is the same. Its object is to apprise us that if in certain conditions we have certain perceptions (throwing up the stone), then in certain other conditions we shall get certain other perceptions (heat, light, stone hitting skull, or other such). But there will always be a temptation to hypothesize the potential energy as an "existence," and to believe that it is a "cause" which "explains" the phenomena.

If the views which I have been expressing are followed out, they will lead to the conclusion that, strictly speaking, *nothing exists except sensations* (and the minds which perceive them). The rest is mental construction or fiction. But this does not mean that the conception of a star or the conception of an electron are worthless or untrue. Their truth and value consist in their capacity for helping us to organize our experience and predict our sensations.

10 / Physical Objects as Not Reducible to Perceptions

C. H. WHITELEY

C. H. Whiteley (1908–) has taught for many years at the University of Birmingham in England. His interests are in metaphysics and theory of knowledge. He writes on topics such as phenomenalism, which holds that physical objects are not directly perceived, but are rather "constructions" out of "sense-data" (perceptual items such as colors and shapes). On this view, which Whiteley rejects, the physical world, and thus science, rest upon the assumption that we do not directly perceive tables and trees.

The problem I shall discuss is: What reason have we for believing that there are physical objects? My purpose is not either to raise or to dispel doubts as to the existence of physical objects; this doubt constitutes a medical rather than a philosophical problem. The point of asking the question is that, while there can be no reasonable difference of opinion as to whether there are physical objects, there can be and is reasonable difference of opinion as to how the notion of a physical object is to be analyzed; and if we are clear as to what grounds there are for believing in physical objects, we shall also be clearer as to what sort of physical objects we have grounds for believing in. Also, it is worthwhile to inquire which other beliefs are logically connected with, and which are logically independent of, the belief in physical objects.

I make one important assumption at the outset: namely, that by a physical object or process we mean something that exists or occurs apart from and independently of our perceptions, and of our experiences of other kinds. The distinction between the physical or "real" world and the "subjective" or "imaginary"—illusions, hallucinations, after-images, shadows, rainbows, mental pictures, what we merely suppose, imagine, or expect—is a distinction between things and events which exist or occur whether anybody is aware of them or not, and things and events which have their being only as and when somebody is aware of them. A belief in physical objects is a belief in things which are sometimes at least unobserved by the believer.

It is obvious that the existence of such things is not a question to be settled by sense-perception alone. That there is a material world cannot be established or even made plausible merely by looking, listening, touching; it is not *given* in the way in which the existence of something red and something round, of sounds, smells, aches, feelings of sadness, can be given. I do not mean that the something red or round cannot be a physical object; I mean that it cannot be known to be a physical object just by looking at it or otherwise perceiving it. For I cannot, simply by perceiving something, tell whether that something continues to exist when I cease to perceive it. This logical necessity is not evaded by naïve realism, which holds that the something red or round which appears to sight is (usually at least) identical with a physical object; for though this may be so, we cannot know it just by looking. Nor is it evaded by phenomenalism; for no phenomenalist does or plausibly could analyze statements about physical objects into statements asserting the *actual* occurrence of sense-data; he must add statements about what sense-data *would* be sensed if certain conditions were fulfilled; and this fact is not given by sense-perception, but reasons for it are required. That there are physical objects is not something we observe or perceive, but something we suppose or assume (to call it a "hypothesis" or "postulate" is to suggest something rather too deliberate and self-conscious). In old-fashioned language, it is a transcendent belief; it goes beyond the evidence.

Thus there is no logical absurdity in denying or refusing to admit the existence of a material world. To say that there are no physical objects, while doubtless very foolish, does not involve a man in any logical contradiction, nor does it force him to shut his eyes to any patent and indisputable facts. An