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THE DIALECTICAL ARGUMENT AGAINST ABSOLUTE SIMULTANEITY. I

IT has been generally recognized that Einstein's most original and his most far-reaching innovation was the proposal to extend the conception of relativity from space to time.[1] Science as well as common sense had—even when it admitted that "time" is simply a name for a special mode of relatedness—always assumed that there is a single universal order of temporal relations, to a place in which every event can be unequivocally assigned; it had therefore conceived that there is such a thing as absolute simultaneity, that a temporal cross-section of the whole of empirical reality could be taken, in such wise that every actual event would be either definitely and unqualifiedly contained in, or definitely and unqualifiedly excluded from, that cross-section, not by virtue of any convention or arbitrary definition, but by the objective inter-relations of things; and it had likewise assumed that the sum of events constituted a single absolute linear sequence which is the history of the world. It is in not only challenging these assumptions, but also offering a proof of their inadmissibility, that Einstein appears as the arch-revolutionary in the history of the philosophy of nature. I can conceive of no task more obviously incumbent upon philosophers of our time than that of endeavoring to determine, through the most searching possible logical scrutiny of the proposed proof, whether this revolution is successful, or how far it reaches. For the transformation of our fundamental conceptions which it at least appears to demand, and which it is commonly construed by physicists as demanding, is not only radical, but singularly widely ramifying. It seems to entail not merely a new physics, but a new logic, which would affect our mode of reasoning on many problems besides those with which Einstein himself is primarily concerned; it seems also, as has already been suggested, to imply the meaninglessness of the whole notion of a general cosmical history which all the philosophical discussions during the past three centuries concerning the sequence called "evolution," and concerning the significance of the time-process, have pre-

[1] It had, indeed, been approximated by Lorentz in his conception of "local times"; these, however, were merely local disparities of clock-readings and did not exclude the assumption of a single "real" time which embraced them all. Whether Einstein's theory actually dispenses with this assumption we shall inquire at a later point.

supposed.[2] Philosophers ought not, I venture to suggest, to take over from physicists and mathematicians a new fundamental logic and a new metaphysics without a more active exercise of the critical faculty than has thus far—with some notable exceptions—been apparent.

The proposed proof of the relativity of time is of two sorts. On the one hand, the new conception is proffered as a way of escape, otherwise unattainable, from the predicament in which theoretical physics found itself in consequence of the unexpected results of the Michelson-Morley and other experiments. On the other hand there is offered an independent argument, supposed to be cogent in itself, to show not merely the unreality of absolute simultaneity, but the inconceivability or meaninglessness of the idea of it—an argument which, it is implied, critical reflection might well have reached at any time since the discovery of the finite velocity of light. It is exclusively with this latter argument that the present paper will be concerned.[3] Familiar though this piece of reasoning is, it seems advisable to recapitulate it here, in such a way as to make as explicit as possible whatever tacit assumptions it involves and its precise logical structure.

The argument may be resolved into four steps.

(*a*) The first is the enunciation of a general thesis belonging wholly to the province of logical theory or (in one acceptation of the term) epistemology. Einstein finds physics full of propositions about the simultaneity or non-simultaneity of events; he finds these concepts playing a decisive rôle in interpretations of the Michelson-Morley and other experiments; and his special originality as a physicist is that, at a crucial point in the history of his science, he suddenly begins to behave like a philosopher. He does not, that is, first go forward in quest of new experimental facts or even of new hypotheses about such facts; he does not, in the first instance, introduce a new mathematical technique; instead, he engages in what, if performed by one conventionally classified as a philosopher, would, I suspect, be likely to be somewhat contemptuously called by many physicists "dialectic"; he turns, namely, to the analysis of fundamental concepts, raising the prior question: what do we or can we really *mean* when we predicate the attribute "simultaneity" of two or more events? And not content with this lapse into the odd regressive habit of the philosopher, he pushes the inquiry yet another degree farther back into the region of abstract notions, and asks,

[2] That it does this is, for example, expressly affirmed by Bertrand Russell: "The universal cosmic time which used to be taken for granted is thus inadmissible" (*A B C of Relativity*, p. 50).

[3] With certain other aspects of the doctrine of the relativity of time I have dealt in another paper which I hope to publish shortly elsewhere.

fairly explicitly, what the last-mentioned question itself means. What, in other words, is the meaning of "meaning"? What conditions must be fulfilled in order that a term—whether "simultaneity" or any other—shall have any meaning at all, and under what generic sort of difference must all particular differences of meaning between concepts be subsumed? It is the question to which the pragmatism of Peirce and James, in its initial form, proposed a reply. Any answer to this question will, of course, be equivalent to the formulation of the requirements for any significant and distinct definition of a term. Upon Einstein's answer the whole superstructure of the primary argument for the relativization of time will be found to be based. Thus the "restricted" hypothesis of relativity, in its most original feature, is not so much a physical theory from which philosophical conclusions may be drawn as it is a philosophical theory from which—with the aid, of course, of other considerations—physical conclusions have been drawn.[4] It is this fact that justifies my previous remark that the discussion of the Special Theory is primarily the business of the philosopher—at least if the logic of definition is admitted to be a part of his business.

It is true that Einstein's temporary reversion from the problems of experimental science to those of the mere anatomist of ideas is a case of *reculer pour mieux sauter;* for the answer he finds to his fundamental question in pure logic is a (not wholly consistent) expression of what I shall call the "radically experimental theory of the nature of meaning." By this name I designate the following duplex thesis: Any general attributive term—such as the adjective "simultaneous" and the abstract noun "simultaneity"—(i) has "meaning" only if its definition formulates some practicable method by which the applicability of the term in question to a given subject of discourse can be experimentally determined, i.e., describes some event capable of being directly observed at first hand under exactly determinable conditions, which event shall serve as the criterion for such applicability;[5] and (ii) the occurrence of such event, under the conditions set forth in the definition, *is* the meaning, and the whole meaning, of the term. The first clause of this thesis obviously might be, and by many would be, accepted, without the second. It may seem to common sense innocuous and reasonable to say that no

[4] It is, as will appear in the sequel, somewhat to be regretted that Einstein did not proceed *en philosophe* one step farther, and ask, more definitely than he does, the still prior question: In what way can we go about getting an answer to the question concerning the nature of "meaning." If a difference of opinion arises with regard to this question, or with regard to the number of separate meaningful ideas we possess, how is such a dispute to be settled?

[5] The words "experimentally" and "experienced" are big with ambiguities, which we must try to clear up later. To do so now would postpone too long the exposition of the rest of the argument about absolute simultaneity.

term "means anything" unless it implies some concrete possible experience whereby we may judge whether objects or events possess the attribute which it names; but it doubtless seems to most persons highly paradoxical to say that no term can ever signify anything *more* than what is actually given in the verifying experience or experiment. The experimental means of determining whether the character expressed by the term is present in a given situation is commonly conceived to be usually merely the sign or circumstantial evidence of something else—and it is this something else that is said to be the "meaning" of the term. If I meet a featherless biped who never talks, orally or otherwise, I can never judge whether or not he thinks, and it may no doubt plausibly—though, as I believe, quite falsely—be said that talking is an essential part of the "meaning" of thinking; but the assertion of the behaviorist that thinking is nothing but talking does not (as yet) generally pass for a self-evident proposition. To take a physical instance, astronomers were long able to judge of the probable distances of remote stars whose parallax could not be measured, only by observing and measuring the "apparent brightness" of the stars. The degree of brightness, that is, was the sole experimental criterion (admittedly a poor one) of distance which they could apply; they did not even then, however, suppose themselves to *mean* by the star's distance its "apparent brightness." These remarks are not intended as criticisms of the radically experimental theory of meaning, but only as aids to the understanding of its import.[6]

It is not, indeed, entirely clear from Einstein's general statement of what a legitimate definition of "simultaneity"—or of anything else—must be, that his argument presupposes the second as well as the first clause of the experimental theory of meaning as above defined. A proposition asserting the simultaneity of two events—e.g., that lightning has struck two places, distant from one another, at the same time—has, he observes, no significance if there is no way "to determine by observations whether in the actual case the two events took place simultaneously or not."

> The concept "simultaneous" does not exist for the physicist until he has the possibility of discovering whether or not it is fulfilled in an actual case. We thus require a definition of simultaneity such that this definition supplies us with the method by which (e.g.) we can decide whether or not both the lightning strokes occurred simultaneously. As long as this requirement is not satisfied, I allow myself to be deceived as a physicist (and of course the same applies when I am not a physicist), when I assume that I am able to attach a meaning to the statement of simultaneity.[7]

[6] What the "experimental" meaning of "distance," as applied to bodies outside our planet, can be for the contemporary astronomer, or whether the term so applied can possibly have such meaning, is a nice question which it will be expedient for the present to leave undiscussed.

[7] *Relativity*, p. 24.

And to show the crucial place of this consideration in the argument, Einstein begs his reader "not to proceed farther until he is fully convinced on this point." This passage by itself might be construed as merely laying down *one* simple *conditio sine qua non* of meaningfulness, not as asserting that "the method by which we can decide whether or not" any predicate is "fulfilled in an actual case" is *all* that the predicate can signify. It is only after we have examined the subsequent steps of the argument, that we shall be able to see that the assumption about meaning which Einstein actually applies presupposes both clauses of the radically experimental theory and to note further implications of that theory as used by him. To the second step of the argument, then, we now turn.

(*b*) That step, of course, consists in the framing of a definition of "simultaneity" which will meet the requirements of the experimental theory. In proceeding to this is Einstein really inventing a completely new meaning for this familiar word? The question of the nature of his logical procedure at this point we shall find to be a curiously involved one. For the present purpose of a preliminary summary, however, it suffices to say that he appears to take over at least a part of the definition from ordinary usage. For him, as for everybody, "simultaneity" is the name of a relation between events, and specifically, of the relation of temporal togetherness. That some sense must be supposed, even at this stage of the argument, to attach to the adjective "temporal"—at least enough to enable us to distinguish in thought between temporal and spatial togetherness—is evident. But the definition is for Einstein incomplete until it specifies that directly observable or experimental *criterion* of temporal togetherness demanded by his doctrine of meaning. And in fact he recognizes three different possible definitions corresponding to three classes of pairs of events about the simultaneity of which question may be raised—though only the third is important for his main argument. (i) There is, first, psychological or subjective simultaneity, the conjunction in a single specious present, in the experience of one individual, of two or more sense-data or other items of content. Here, of course, the empirical criterion is simply the directly experienced togetherness of the data. A truly radical empiricist with respect to time would declare this to be not merely a sufficient but the only possible "experimental" definition of simultaneity; for it designates the only way in which any temporal togetherness of things can ever become a fact of immediate experience. Einstein, however, like most physicists, is too much of a realist to be content with so subjectivistic a definition of the concept; to this really thorough-going relativization of time he is manifestly averse—whether consistently or otherwise we shall not

now inquire. He clearly assumes, at least in this part of his reasoning, that in perception we are dealing with physical objects or events which are not—at all events, are not initially to be assumed to be—the same facts as the sense-data through which we perceive them, and the temporal togetherness of which is therefore not necessarily identical with the temporal togetherness of the percepts corresponding to them. Psychological simultaneity is therefore not sufficient for his purpose; what is needed is a "physical" definition of the term. (ii) There is, however, one class of physical events in which psychological simultaneity may be regarded as the virtual equivalent of physical simultaneity—viz., those events which occur in the immediate vicinity of one another and of the body of the observer. Where there is very close proximity in space, the observer may treat the time at which an event is perceived as approximately the same as *its* time; and if he has set up clocks the readings of which are determined by some convention, he may "understand by the 'time' of the event the reading (position of the hands) of that one of the clocks which is in the immediate vicinity (in space) of the event."[8]

(iii) This, however, aside from being only a definition of approximate or virtual physical simultaneity, does not apply to events which are distant in space from one another, and at least one of which, therefore, must be distant from the place occupied by the observer—since he can not be in two places at once. Of such events observation is possible only by means of signals of some sort, transmitted through space from the locus of the event to the locus of the observer. This spatial separation of event and observer would, indeed, not render it inadmissible to identify the time (as subjectively apprehended) of the observation with the time of the event, if it were possible to transmit such signals with infinite velocity. But even the kind of signal which would best serve the purpose—being uniform and speedier than any other—namely, light, is known to move with a finite velocity.[9] The physical definition of simultaneity must

[8] *Relativity*, p. 28.

[9] Einstein himself (*Relativity*, pp. 27–28), it should be noted, insists that he is not here making either "a supposition or a hypothesis about the physical nature of light," but merely a "stipulation in order to arrive at a definition of simultaneity." Other expositors of the theory explicitly recognize that an already experimentally-established factual proposition about the behavior of light-rays must here be introduced into the argument in order to justify the new definition; e.g., Birkhoff writes: "Then came the last step in advance, made possible only by the realization that light travels at a finite velocity, that absolute simultaneity is meaningless unless defined by a physical process" (*Origin . . . of Relativity*, p. 23). The above summary provisionally accepts this version of the argument; the logical difficulties involved will be examined presently.

therefore take this fact into account: i.e., the temporal togetherness of the events must be assumed to be identifiable with the observed temporal togetherness of the arrival of the signals only when the spatial relation of the events to the observer is by definition such as to exclude the possibility that the joint arrival of the signals may be due to the fact that one of them came from a point nearer the observer than the other. The required definition, then, must be in terms of the following operation: Let the distance *A*-*B* on the line joining the loci of the two events be actually measured off on some rigid reference body by laying down a measuring-rod in the usual manner; let an observer be placed at a point between *A* and *B*, and equidistant from them, and let him be provided with instruments (e.g., mirrors) "which allow him visually to observe both places *A* and *B* at the same time" [10]—or more precisely, which allow him to observe the arrival of light-signals from those places at the same time. If he then in fact perceives at one and the same instant the arrival of two light-rays known to have been projected or reflected from *A* and *B*, the events indicated by the two signals (e.g., lightning-strokes at *A* and *B*) may be said to be simultaneous. Such, then, is the new experimental and physical definition of simultaneity from which revolutionary consequences are shortly to follow. It is to be borne in mind that, according to Einstein, this is the only definition of the term, applicable to physical and distant events, which has any meaning whatever.

(*c*) We pass now to the third step of the argument. The physical circumstances under which the specified experimental criterion of simultaneity might conceivably be appplied are of two sorts. The system on which are situated, or to which are referred, the points *A* and *B* (the sources of the light-signals) and the *M* mid-point between them, may remain at rest during the transit of the signals from *A* and *B* to *M*, or it may, during that interval, be in (unaccelerated) motion in the direction of either *A* or *B*, relatively to some other system of reference.[11] It can not be assumed *a priori* that the results of the test of the simultaneity of the events would be the same in the two cases; and (so runs the argument) it is easy to see that they could not be the same. If the system *S* is at rest and the test is applied, the events will, of course, as has already been implied, be "simultaneous"; and the same is true with respect to any other system adjacent and parallel to the first along the axis on which the light-rays move, and remaining at rest with respect to it. But if, while the light-signals are moving from *A* and *B* towards *M*,

[10] *Relativity*, p. 26.

[11] The case of rotatory motion is, of course, excluded from consideration in the Special Theory.

the second system, S', is in motion with respect to the first in either direction, the signals emitted from A and B, respectively, can not reach the mid-point of that system at the same moment. If the system S' is moving towards the point B and away from the point A on the system S, then the rays proceeding from B will reach the mid-point M' sooner and those proceedings from A will reach M' later. The definition of simultaneity will not be satisfied for the observer on S', and he will necessarily conclude that the events at A and B (which the observer on the "stationary" system S finds to be simultaneous) are non-simultaneous. And since simultaneity "means" the joint arrival of signals at a point (initially) [12] equidistant from their source, it follows that the same events will *be* both simultaneous and non-simultaneous. It is here that it becomes evident that the second as well as the first clause of the radically experimental theory of meaning is explicit in Einstein's argument. If it were once granted that the real simultaneity of the events could *be* something other than what it is empirically known as, by a given observer, the proof of the relativity of simultaneity to the state of relative motion or rest of the observer would not follow. We should, in that case, simply conclude that the joint-arrival of the rays was not a valid test of actual simultaneity except for bodies remaining at rest during the transit of the rays. The conclusion that both observers are right, though their judgments are contradictory with respect to the same pair of events—i.e., that there is no such thing as an absolute simultaneity of two events—presupposes the complete identification of the positive or negative results of the experimental test specified in the definition with the *fact* of simultaneity or non-simultaneity, as the case may be.

(*d*) A proposition asserting the simultaneity of two events is, obviously, an assertion concerning the magnitude of the time-interval between them—namely, that the interval is equal to zero. If, then, judgments about the simultaneity of the same pair of events must differ, when the reference-bodies used by the two observers are in uniform relative motion, it follows that time-intervals are not the same for the two systems, and that, in general, the determinations of time valid for the one will not be identical with those valid for the other. Thus "every reference-body has its own particular time; unless we are told the reference-body to which the statement of time refers, there is no meaning in the statement of the time of an event." The previously customary assumption that "the statement of time has an absolute significance, i.e., that it is independent of the state of motion of the body of reference, is incompatible with the most natural definition of simultaneity." [13] This last, of course,

[12] There is here an equivocality which will be examined later.

[13] *Ibid*, p. 32.

is an odd understatement by Einstein of the conclusion which ought to follow from his premises, namely, that such an assumption is one to which our minds can catch no intelligible import whatever.

This reasoning has been so generally hailed as cogent and "epoch-making" by physicists and mathematicians that a non-mathematical philosopher might well be diffident about expressing any doubts concerning it which may arise in his mind—if there were any mathematics in it. But since there obviously is none—though, of course, it may be expressed in a mathematical form—and since it plainly falls within a province of logic with which philosophers have not been unaccustomed to deal, I shall now have the temerity to indicate what seems to me some fatal defects in the argument.

1. Let us first ask why a special definition is requisite for simultaneity-at-a-distance, after we are assumed to be already acquainted with the meaning of the term "simultaneity" as applied to items in a single perceptual field or to events occurring at a single place? The relativist's answer to this question is, of course, as follows: We are in quest of a definition or of definitions of simultaneity, the fulfilment of which can be experimentally verified by any one who may wish to pronounce upon the simultaneity or non-simultaneity of two actual events. Now, with respect to their mode of possible verification, simultaneity-at-one-place and simultaneity-at-a-distance must evidently differ. The former can be verified directly (or virtually so) by any observer who is at, or immediately adjacent to, the place where the two events occur, when they occur. But the latter can be verified only indirectly, for two reasons: first, the observer can not be at once in two places, namely, at the places distant from one another where the events occur, and he must therefore judge as to their simultaneity by means of some report or signal, transmitted through space from the places of the events to his place; and, second, it is known (or postulated) that any such transmission occupies some finite time. This difference, then, in the ways in which the "simultaneity" can be verified, in the two instances, necessitates differing definitions of "simultaneity" itself, if the definitions are to be of *verifiable* simultaneity and therefore to be in terms of possible means of verification.

This seemingly simple reasoning invites some comments. It contains, it will be noted, the admission that before the special definition of simultaneity-at-a-distance is reached we already know the meaning of *some* specifically temporal relation between events which is called "simultaneity." We actually experience this type of relation whenever we are aware of the compresence of two or more distinguished items of sensory content in a single perception, and the relativistic physicist also objectifies this relation (in defini-

tion *b*, iii, above); he recognizes that it may obtain (apart from any percipient) between two physical events, provided that they occur at one place or are separated only by a negligible distance. This notion of the simultaneity-relation we can not, indeed, define in terms of any other sort of relations, for it is manifestly a logical primitive. But we can say what other notions do *not* enter into its meaning; in other words, we can tell from what concepts we are able to distinguish it. And it is clear that it is distinct from the concepts of spatial distance or proximity; for various sense-data may be spatially separated, by widely different distances, in the visual field, and yet all be perceived as having the same relation of simultaneity. Likewise in the concept of the simultaneity of two physical events at the same place (admitted by the relativist to be ultimate and absolute), though the notion of spatial togetherness is associated with that of temporal togetherness, the two relations are obviously regarded as distinct by the relativist as by everyone else. There is, then, nothing in the primary notions of either the relation of simultaneity taken by itself, or the relation of spatial distance, taken by itself, which makes it evident that the essential *meaning* of "simultaneity" must alter when the distances between the spatial loci of two events are supposed to be increased from zero, or some extremely small magnitude, to an appreciable magnitude. In short, the reason for seeking a new "definition" of "simultaneity," when the events whose simultaneity is in question are distant from one another, lies not at all in the already-accepted concept of the simultaneity-relation as such, but solely in the different situation of those events with respect to a possible verifier-of-their-simultaneity, who is subject, in his processes of verification, to the practical disabilities that he can not be in two places at once, and that he can not receive instantaneous signals from any distant places. One is therefore impelled to ask whether the new so-called definition, that of simultaneity-of-events-at-a-distance, is really a definition of a quite *different* type of relation between events or whether it is merely a statement of a difference in the procedure by which the actual *existence* of the *same* kind of relation (i.e., the same relation between events that is empirically exemplified in the joint-perception of two sense-data, or in the joint-occurrence of two events at one place) can be ascertained under altered physical conditions. If the latter only is intended, Einstein's special definition (*b*, iii) tells us nothing about the meaning of simultaneity, and is not a definition at all, but an inference, a reading-off of *one* implication, or supposed implication, of a concept already defined, or already understood without the need of definition. If, on the other hand, Einstein's formula is to be construed as implying that, when the places of occurrence of events

are distant, the "simultaneity" of these events is not at all the same sort of relation between them as that designated by the same term when applied to unilocal events, some awkward consequences follow. As a matter of terminology, at least, it is obviously an odd, arbitrary, and confusing thing to use the same name without distinction for two essentially different relations. If Einstein holds that physical events a mile, or 186,000 miles, apart can never be simultaneous in the perfectly familiar sense in which the perceived motions of two fingers when I snap my hand are simultaneous, or in the sense in which two events occurring at points a millionth of a millimeter apart may be simultaneous, he would have done well, in the interest of clarity, to have invented a new term, and to have used it exclusively, when speaking of spatially separated events. The failure of so careful a writer to make such a terminological distinction naturally suggests that he does not hold the view which would require that distinction. On the other hand, most of his argument can not be reconciled with such an interpretation. Usually he seems to conceive that he is presenting a real definition of a distinct concept which need in no degree conform to the recognized meaning of "simultaneity." And it is essential that his procedure should be so construed if the proof of relativity of simultaneity (*c*, above) is to follow. For, as has been remarked, in senses *b*, i or *b*, ii, simultaneity is, for the relativist as for others, an absolute and unequivocal or dyadic relation; two events either have it or do not have it; but the relation of simultaneity in the case of distant events is for him by its very nature a respective, or triadic, relation; the same two events may have it and not have it, depending upon a certain other relation between them and different observers or verifiers, or the reference-bodies on which they are.

Let us, then, interpret Einstein's argument in the second of the two ways which we have been distinguishing. The nature of the relation between events which is to be called "simultaneity" when the events are at distant places is not supposed to be already known to us from our knowledge of what is meant either by the simultaneity of data in our experience or by the objective and absolute simultaneity of events at one place (e.g., of the arrival of two signals at a common point). The latter mode of relation, it is assumed, can not subsist between events at a distance; if it could, no further definition would be necessary. Now the proposition that it can not so subsist in the case of such events is not self-evident; it requires proof. The proof, it will be said, is contained in the radically experimental doctrine of meaning, of which the truth is by the relativist presupposed. If every concept which is to have any meaning at all must be defined in terms of specific experimental means

of verifying its fulfilment or non-fulfilment in any actual case, then, obviously, wherever the means of verification necessarily vary, the meaning of the concept will vary—i.e., we shall have to introduce, by a new definition, an essentially different concept.

But this last, as a generalization, would be an amazing and preposterous thing to assert. It would imply—to take a crude, but for that reason all the more illuminating, example—that if a bedridden cripple should look out of the window and observe the rain falling on one man, and should then observe another man, whom he could not see through the window, entering the room with wet clothing, his inference that rain had fallen upon both could not have for him the same meaning in the two cases, i.e., that the concept "rain-falling-on-man" would require in the second case a new definition—would not, in short, be the same concept. In more general terms, the proposition that concepts can never be identical where modes of verification are different would signify that no inferred fact could possibly be the same *kind* of fact—answering to the same definition—as any directly perceived one, since inference and direct perception are radically dissimilar modes of verification. If it were true that, wherever means of knowledge or grounds of belief differ, the nature of what is known or the import of what is believed must necessarily likewise differ, the greater part of science would manifestly be impossible; for science largely consists in taking concepts of qualities or relations made familiar to us in perceptual experience and extrapolating them into places or times in which the existence of the given qualities and relations is not, and can not be, directly and perceptually experienced by those individuals—be they historians, geologists, physicists, or psychologists—who perform this act of extrapolation. Science, of course, employs certain tests for determining when such extension of a given kind of attribute beyond the instances in which its presence can be immediately observed is legitimate and when there is no sufficient justification for it; but the plight of the man of science would be desperate indeed if he were compelled to admit that as soon as he begins, on inferential grounds, to extrapolate his empirically-gained concepts, they either change their meaning or cease to have any meaning at all. But into this absurdity the stictly experimental theory of meaning—the theory, that is, which seems to be implied by Einstein's argument—must —fall. Identifying the *ratio cognoscendi* with the fact to be cognized—asserting, in the words of one of its most consistent spokesman, that "we mean by any concept nothing more than a set of operations, physical or mental," and that "the concept is *synonymous* with the corresponding set of operations" [14]—this doctrine

[14] Bridgman, *The Logic of Modern Physics* (1927), p. 5.

necessarily implies that diversity of operations is always equivalent to diversity of concepts, that the presence of one and the same quality or relation can not possibly be attested by dissimilar experimental criteria.

It is, then, impossible to accept the major premise necessary to prove the conclusion that the primary concept of the relation of simultaneity can not retain its meaning when the original direct method of its application to events is for some reason, such as the spatio-temporal remoteness of the events from the observer, no longer available. No reason whatever appears for supposing that this mode of relation may not obtain between pairs or groups of events irrespective of their particular spatial relations, either to one another or to an observer. Two distant events, therefore, *may* be simultaneous in precisely the same sense as two immediately adjacent events; and what that sense is we know as well as we know the meaning of any relational concept whatever, since the nature of the relation is experienced by us at every moment. The "what" of "simultaneity," in short, may be—and, if the word is to be used in the sense familiar to all mankind, must be—the same wherever the events of which it is predicated; but the "that" must, of course, be established by a special procedure when the perception of the events can not itself be actually or virtually simultaneous with their occurrence. It is, of course, conceivable that no such procedure is available—that "simultaneity" in its primary sense may be necessarily incapable of *verification* when the events are distant from the observer; but if this could be shown to be the case, it would not follow that such a relation can not hold good between such events, or that some other kind of "simultaneity" must thereupon be defined. All that would follow would be the necessity of recognizing certain limitations of our possible knowledge. We obviously can "mean" all manner of things which we have not verified, and even things which we can not verify; and the attempt at verification itself presupposes an already meaningful concept or hypothesis which would be unaffected in its import even though the attempt to determine its *truth* should be a failure. The experimental theory of meaning is, in fact, radically opposed to the spirit of scientific empiricism, in so far as it declares that a quality or relation which, in certain instances, *is actually* exemplified in experience *can not* exist in instances beyond the reach of experience; and, of course, to say that the concept of it has no meaning in the latter instances is a way of saying that it can not exist in them.[15] It is not, however—

[15] As Professor W. D. MacMillan has observed, "to say that simultaneity does not exist because it is unattainable in practice is like saying that a straight line does not exist because it, too, physically is unattainable. Shall we then put geometry into the discard because it is ambiguous and without meaning? (*A Debate on the Theory of Relativity*, 1927, p. 61.)

as we shall see—true that simultaneity at a distance is necessarily unverifiable.

If, then, we should attempt to carry out rigorously the radically experimental theory about meaning and apply it to other concepts as well as to that of simultaneity, we should be compelled to transform physics, and our ordinary view of nature, far more widely and sweepingly than Einstein himself has proposed. If "a concept does not exist for a physicist until he has the possibility of discovering whether or not it is fulfilled in an actual case," we must relegate to the limbo of the unmeaning a whole series of concepts which most physicists and astronomers who suppose themselves to have embraced the Special Theory continue cheerfully and unsuspectingly to employ. One of the first to go would, clearly, be the concept of light as a thing that moves. We have, and can have, no experimental acquaintance with light as a "traveller"; no man at any time has seen light where there is no matter; we must, in Bridgman's phrase, cease to talk about light and speak only of "illuminated objects." The conception of a luminiferous somewhat that passes invisibly from one such object to another is one of those interpolations which the science of the past has made—and certainly with very happy results—for the purpose of linking actually observed things together into a coherent system; but such interpolations must be eschewed by a radically experimentalist philosophy of nature, not merely on the ground that they are unverifiable, but for the more fundamental (supposed) reason that we "can attach no meaning" to the terms used ostensibly to define them. Other common notions which must similarly be discarded by such a philosophy have been pointed out by the only contemporary physicist known to me who makes a near approach to consistency in his radical experimentalism. Since, Bridgman observes, "local time" has been shown "not to be a satisfactory concept for dealing with events separated by great distances in space or with phenomena involving high velocities," we consequently "must not talk about the age of a beam of light, although the concept of age is one of the simplest derivatives of the concept of local time. Neither must we allow ourselves to think of events taking place in Arcturus *now* with all the connotation attached to events taking place *here* now. It is difficult to inhibit this habit of thought, but we must learn to do it." It does not mean anything "to talk about the entire present state of the universe independent of the process by which news of the condition of distant parts is determined by us."[16] Just as most of the propositions about temporal relations customary in astronomy have, according to this logic, no signification, so do most of the propositions

[16] *The Logic of Modern Physics*, p. 76.

about spatial relations; for example, "to say that a certain star is 10^{-5} light years distant is actually and conceptually an entirely different *kind* of thing from saying that a certain goal is 100 meters distant."[17] Nor is it only the physicist and the astronomer who must completely alter their notions of what they are talking about, and admit that they have hitherto been, for the most part, using words without sense; the historian and geologist are summoned to an equally humiliating admission and an equally difficult amendment of their ways: "All our other concepts must be modified when applied to the remote past; an example is the concept of truth" (i.e., the truth of retrospective propositions). "It is amusing to try to discover what is the precise meaning in terms of operations of a statement like this: 'It is true that Darius the Mede arose at 6:30 on the morning of his thirtieth birthday.'" What is evident is that if the very meaning of all propositions must thus be restated in terms of possible processes of experimental verification external to the event to *be* verified, then the proposition that one has existed comes to signify no more than certain actual or possible performances on the part of posterity—all of whom in turn must pass in the same manner, not into mere oblivion, but into obliteration from the category even of that which has been. Pastness can never be experimentally verified; *ergo,* all propositions in the past tense become meaningless. Yet, oddly enough, even the *almost* radical experimentalist whom I have been quoting seems to suppose that there was such a thing as a "remote past"—though its remoteness and preteriteness are, most obviously of all, incapable of description in terms of any operations which present or future experimentalists might conceivably perform.

I am well aware how strong a hold that plausible but (as I can not but think) extremely muddled doctrine, the experimental theory of meaning, has upon the minds of many contemporaries, especially amoung physicists; I therefore do not underestimate the resistance—and the misunderstanding—which the foregoing observations are likely to encounter. I shall, no doubt, seem to some to be attempting, in the worst philosophical manner, to reason about a question of physics from a vague *a priori* concept not defined in experimental or "physical" terms; whereas, in fact, I have been chiefly urging that we have, as the relativist admits, one unequivocal notion of simultaneity which *is* given us through experience; that the word ought never to be used to designate anything but the type of relation which corresponds to this empirical concept; that, in other words, we ought not to go about getting up, by free definition, new "meanings" of simultaneity; that in accordance with this one con-

[17] *Ibid.,* p. 18.

cept all our judgments about what events are or are not simultaneous should be determined; and that, finally, we ought not to fall into the extraordinary and ruinous error of confusing the means of inferring the existence of this or any other relation or quality, in cases in which its existence is not directly observable, with the nature of the fact to be inferred.

While these considerations, if true, suffice to invalidate the primary premise upon which Einstein's argument concerning simultaneity rests, the acceptance of that premise would not render the argument convincing. It has numerous other, entirely independent logical defects, as I shall endeavor to show in the next installment of this paper.[18]

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HOW "PROPOSITIONS" MEAN

IT is very gratifying to observe that in America the critics of Pragmatism (thanks no doubt to the numbers of pragmatists they encounter!) are beginning to understand it, whereas in Europe they have never yet got to the point of trying to do so. The former are in consequence raising real difficulties, of which the discussion tends to philosophic progress, and are not merely "ruminating." To an old controversialist like myself, therefore, it was a real pleasure to read Professor Hocking's apposite, graceful, and penetrating paper on "Action and Certainty,"[1] and especially his list of the five propositions which give him pause (p. 228). They are clearly of primary importance for any form of Pragmatism, as is Professor Hocking's challenge to the first of them, that "the meaning of concepts and propositions is always functional." He infers that "if the meaning were to be found in the working there should be a unique and unambiguous correspondence between these entities: this correspondence does not exist," and so he finds it impossible to accept "the correspondence of meaning and working." I agree that Professor Hocking's criticism touches a vital spot, and if it really penetrated beneath the surface, it would be fatal; but I think I can show him that it does not.

I shall first endeavor to show that the desiderated correspondence between meaning and working *does* exist, if meaning be taken as personal and not as verbal, i.e., as it is and must be taken by Pragmatism. For if we inquire what is meant by saying that "a proposition's meaning is functional," we speedily discover that what it

[18] To be continued in the next issue, No. 24.

[1] This JOURNAL, Vol. XXVII, No. 9, pp. 225–238.