SOME REMARKS ON RELATIVITY.

PROBABLY, by now, even philosophers have had enough of relativity, but perhaps a few remarks on Miss Wrinch's discussion of the *Methodology of Relativity* (*MIND*, April, p. 200) may be of interest; and also in this connexion I should like to point out—in a few words—what seems to me to be a grievous logical error in the theory of relations as expounded by some of Einstein's philosophical followers.

As Miss Wrinch points out, "there are now various different views of the characteristics of space" (and Time?) "held by different writers on Relativity," but "there is still something of fundamental importance in their treatment of the notion of Space" (and Time). In the second paragraph of her article this common fundamental point is expressed by saying that "There is nothing in the External World to which we can point as being represented by the symbol for space". We may express this by saying that while the words "Space" and "Time" have meaning, they do not denote objects. According to the Absolute Theory, however, Space and Time are real existent bodies or series of points and moments; physical objects are related to Space and to Time, and Space and Time are related to physical objects, for example things are *in* Space, or occur *at* the same moment and so on; and in general the various spatial and temporal relations contain reference to points of space or moments of time.

With the Relative theory all these points and moments are swept away. Spatial and temporal relations hold directly between physical objects and their full and complete analysis contains no mention of points of Space or moments of Time or any object that might be called Space or Time; in the analysis of spatial relations Einstein regards Space as an unperceived, unreal and unnecessary *tertium quid*. With this theory, propositions like '*a* is in Time' simply mean '*a* is before, simultaneous or after something,' i.e., '*a* is temporally related,' '*b* is in Space' means '*b* is spatially related to something'. This is a general characteristic of the treatment of Space and Time by Einstein and his followers and I think it is the one to which Miss Wrinch wishes to draw our attention, but I demur from her assertion that—in the language of Modern Logic¹—"it consists in using Space as a description".

(a) It is more correct to say that it consists in using "Space"

¹ The language of modern logic seems at the moment to be the language of the *Principia Mathematica*.

as an 'incomplete symbol'. "Incomplete symbol" is a rather unhappy phrase, it would be better to speak of "disappearing symbols". An incomplete symbol may be defined as one such that if it occurs in the common expression of any proposition p it does not occur in the logical analysis of p , that is in the determinate and logically accurate expression of p .¹ Thus an incomplete symbol appears in the expression of ordinary thought and even in the abbreviations of logic, but disappears from the full expression of precise and accurate thought. And this is exactly what happens to the symbols "Space" and "Time" in the *formulations* of the theories of relativity. The words "Space" and "Time" may occur in writings *about* the theory of relativity but not in the precise and accurate formulation of the theory itself.

(b) The truth about "Space" being a description seems clear. The actual word "Space" is not used as a description either by the supporters of the Absolute or the Relative theory, but both parties use spatial relations as descriptions or as parts of descriptions. For the upholders of Absolute space the word "Space" denotes a real object or set of points and for their opponents the word is a disappearing symbol, that is so far as they speak with logical precision they do not use it at all. But spatial relations,—or rather the symbols expressing spatial relations, are used as parts of descriptions by both parties.

Consider the examples given by Miss Wrinch. "The building on my right is loftier than that." The symbol "The building on my right" is a description, whatever may be the true theory of Space or the true nature of the relation 'To the right of'.

Similarly "Equiangular triangles are equilateral" is a proposition analysable into the form—

$$(x) . f(x) . \supset . g(x)$$

with either the Relative or the Absolute theory.

Hence we cannot capture the *distinctive* characteristic of the relative theory by saying that it uses Space or spatial relations as descriptions.

Perhaps these two points can be exemplified and made clearer by considering the last two sentences of Miss Wrinch's discussion; they are "But whichever part of the general investigation is being undertaken, not in the case of any one of them is it significant to ask 'What is Space'. It is the properties and not the intrinsic nature of space which is the subject of investigation."

Discussing the latter sentence first, it should be rejected for the reason that any investigation of the predicates of an object involves an investigation of its qualities and this is the same as an investigation of its intrinsic nature. It is more correct to say that with the Theory of Relativity the subject of investigation is not space or time but the spatial and temporal properties of *objects*, for space

¹ This at least is the sense in which Russell uses it when he speaks of a class as an incomplete symbol.

and time are mere symbols which disappear when we speak with logical precision. This is the reason why, for the theory of relativity, it is never significant to ask "What is Space (or Time)?" For the symbols "space" and "time" can never be put in any really precise proposition.¹ They are in fact disappearing symbols.

Another point which seems worthy of careful consideration may be briefly expressed by saying that Einstein and some of his followers use the words that are used to denote spatial and temporal relations, in an ambiguous manner. Let me explain this by Einstein's use of the word "Simultaneous" as defined by him in his *Theory of Relativity*, Chapter VIII. In that chapter Einstein points out that the ordinary use of the word Simultaneous is of no use to Physics except when used as connecting two objects which can be observed together. To overcome this difficulty he gives a definition of the way he proposes to use the word. His use of the word may be provisionally defined like this. Consider two flashes of lightning F_1 and F_2 ; then we define F_1 as being simultaneous to F_2 if the crests of the light waves radiating from F_1 and F_2 reach some observer O situated at M the middle point of the line $F_1 F_2$, simultaneously. Now if we carefully consider this definition we see that it uses the word "simultaneous" in two quite distinct and different ways. Let us call these two relations 'primary simultaneity' and 'secondary simultaneity'. The former represents the ordinary use of the word simultaneous, the latter Einstein's use. We may now somewhat emend our definition and say F_1 and F_2 are secondarily simultaneous when the crests of the light waves radiating from them reach the observer O primarily simultaneously.² This shows that primary and secondary simultaneity are quite different relations. Primary simultaneity is a simple unanalysable relation, symmetrical and transitive. Secondary simultaneity is a complex relation analysable in the way that Uncle and Grandfather are analysable, i.e., it consists in being related to a term or terms standing in between the two related by the relation in question. In this case the relation of F_1 to F_2 consists in F_1 having the relation of 'radiating' to a certain wave crest of light say c_1 , c_1 having the relation of 'primary simultaneity' to another wave crest of light c_2 , and c_2 being 'radiated by' F_2 . The importance of this distinction between primary and secondary simultaneity is simply that, if the above is correct, then it disposes—once and for all—of the assertion that Einstein has proved *all* spatial and temporal relations to be relative. Primary simultaneity is *not* a relative relation, things either are or are not primarily

¹ This is not a contradiction. In this sentence the symbol "space" is used to denote the symbol "space," i.e., the actual word "space" and not something beyond the symbol. It is, of course, only when "space" is used in its usual sense that it is a disappearing symbol.

² Further qualifications are still required to make this definition precise, they will be considered further on.

simultaneous, without any further qualification whatsoever. We may go a little further in our opposition to some philosophical writers on relativity; but first let us make our definition somewhat more accurate, although it will still be provisional. The aim and spirit of Einstein's definitions is expressed by his dictum, "The concept does not exist for the physicist until he has the possibility of discovering whether or not it is fulfilled in an actual case".¹ Thus instead of setting out on the perhaps impossible task of finding some instrument for telling whether physical objects are or are not primarily simultaneous, he constructs the relation secondary simultaneity of such a nature that we can tell whether objects are or are not secondarily simultaneous with the senses and instruments at our disposal. Now it will be admitted that we do not observe light waves but the sense-data or *sensa* caused by the impinging of the light waves on the eye and we may agree that the sense-data are primarily simultaneous with the actual striking of the wave on the eye. Thus, keeping to Einstein's dictum, those objects which must be primarily simultaneous in order for F_1 and F_2 to be secondarily simultaneous will be objects which we can observe; they will therefore be two sense-data of F_1 and F_2 ; and our definition will now read, F_1 and F_2 are secondarily simultaneous when the two sense-data s_1 and s_2 , 'of' or 'manifested by' F_1 and F_2 respectively and observed by the observer O at the middle point M , are primarily simultaneous. Similar definitions may be given for secondarily before and after.

Now while agreeing with Einstein that we have no means of telling whether physical objects—as distinct from sense-data—are primarily before, simultaneous or after each other, it by no means follows that they are not related by these relations; and although these relations may not exist for the physicist (as connecting physical objects; for they do exist, even for the physicist, when connecting sense-data) they do exist for the philosopher.

The theory of relativity ignores the relations of primarily before, simultaneous and after except when holding between sense-data and by dealing with the corresponding secondary relations it has achieved some most important and valuable results, but this does not prove that the ignored relations do not exist. Thus despite all the asseverations to the contrary, it is still possible to maintain that every object is related by an absolute temporal relation to every other object, although in many cases it is impossible to tell whether an object is primarily before, simultaneous with or after another specified object.

It may be interesting, and may perhaps further elucidate the difference between primary and secondary simultaneity, to consider, from a logical point of view, what is meant by saying that secondary simultaneity is a relative relation, and how it happens that it is a relative relation. We have seen that when Einstein says ' F_1 is simultaneous to F_2 ' he ought to say ' F_1 is secondarily

¹ *Theory of Relativity*, p. 22.

simultaneous to F_2 ; and by this he means that two crests of light-waves radiated by F_1 and F_2 are primarily simultaneous, or more correctly that two of the sense-data S_1 and S_2 manifested by F_1 and F_2 are primarily simultaneous; and he must then definitely specify S_1 and S_2 out of the many sense-data manifested by F_1 and F_2 . " F_1 is secondarily simultaneous to F_2 ," means therefore that a certain pair of the sense-data manifested by F_1 and F_2 are primarily simultaneous; but unless we specify *which* pair, the assertion remains ambiguous and indeterminate, for there is a very large, if not an infinite, number of pairs of sense-data manifested by F_1 and F_2 that are or could be observed by persons situated around F_1 and F_2 . Einstein restricts the range of pairs of sense-data by framing his definition so that F_1 is secondarily simultaneous to F_2 when the pair of sense-data, manifested by F_1 and F_2 and observed by a person situated on the plane passing through the middle point of the line $F_1 F_2$ and at right angles to it, are primarily simultaneous. This however is still indeterminate, and the whole of the relativity of simultaneity results from the indeterminateness of this definition. With this indeterminate definition the assertion that F_1 is secondarily simultaneous to F_2 is equivalent to saying that a pair of sense-data are primarily simultaneous; but this pair of sense-data is not uniquely specified, being merely specified as one pair out of a class of pairs. The assertion ' F_1 is secondarily simultaneous to F_2 ' is really about four terms, F_1 , F_2 , and two sense-data; but while it uniquely specifies F_1 and F_2 it does not uniquely specify the sense-data. Assertions of this type may be called relative, if, when you qualify the assertion and in doing so uniquely specify the objects otherwise not uniquely specified, some qualifications make the complete assertion true and some false. This is exactly what happens with ' F_1 is secondarily simultaneous to F_2 '. The qualifications such as 'from such a point of view,' 'as measured from such a reference body,' etc., serve to specify the sense-data of F_1 and F_2 of which we are speaking. As is easily seen, because of the constant but finite velocity of light, if some of these qualifications give a true assertion then some others will give a false assertion. The proposition F_1 is secondarily simultaneous to F_2 may be compared with the proposition ' P is highly probable'. Both are really only half propositions. The former is about four objects F_1 , F_2 and two light waves, or more correctly, F_1 , F_2 and two sense-data, but only specifies half the objects, *i.e.*, F_1 and F_2 ; the latter is about p and a certain body of knowledge, but only specifies p .

This account of the relativity of simultaneity has been much longer than I intended, but if it is correct it shows, (1) that there are two meanings given to the word "simultaneous" as used by relativists and that only with one meaning is simultaneity relative. (2) That the relativity of simultaneity (a) gives the same amount of support to the theory of the Relativity of truth as is given by the relativity of propositions like ' P is highly probable,' which is no support at

all; (b) has nothing at all to do with the activity of minds. The qualifications 'for that observer,' 'as measured by so and so,' do not mean that the proposition " F_1 is simultaneous to F_2 ," is true for one person and false for another; as it stands unqualified it is really only half a proposition and is neither true nor false, the qualifications are only ways of completing it, and the reference to the observer is merely a way of uniquely specifying the two light waves or sense-data involved in F_1 being simultaneous to F_2 ; any other way of uniquely specifying these two light waves or sense-data would serve equally well.

(3) As regards subjectivity: (a) If we only loosely follow Einstein's dictum 'That a relation is not to be used unless we have a possibility of telling whether it holds in any actual case,' we can state the relativity of simultaneity for a world without minds or anything mental at all; (b) if we strictly follow the above dictum then science is forced to recognise that we do not observe physical objects but only the sense-data of physical objects. This may be a new truth for science, but it is not new to philosophy; see for example Mr. Russell's article on 'The relation of sense-data to physics,' published in 1914.

All the above arguments only apply to simultaneity, but I think they can be generalised to cover all the other relations dealt with by the theory of relativity. For example Dr. Wildon Carr in *MIND*, April, 1922, p. 177, says "... the straight line of every observer is curved for other observers." I suggest that he will find that such a proposition, if it occurs in the books of the relativists, does not mean that a line is both straight and curved, but rather something like this: "If the projection of a moving point on a plane P_1 is a straight line, then its projection on another plane P_2 , where P_2 moves relative to P_1 , is a curved line," or "If the appearances (i.e., the sense-data) of a moving point from one body are straight, then the appearances from another body are curved". And in general in all such propositions there is a multiplicity of objects concealed by the brevity of expression.

The general conclusion of these remarks is that the theory of relativity from the point of view of philosophy would be more appropriately called the theory of half-propositions; that it has proved certain complex relations to be relative but that the relations usually denoted by the words "simultaneous," "before," "after," "straight," "curved," etc., are not relative; that we can only tell whether objects have these non-relative predicates when they are objects of immediate awareness, i.e., sense-data; and that science is beginning to realise that we only observe the sense-data of physical objects, a view which is not new to philosophy.

The following flight of imagination may be of interest to philosophers and even to physicists.

"Once upon a time there was an earth inhabited by a race of men, all totally blind. Their distance perception depended on sound. In the course of time there arose an Einstein, blind, but

of infinite genius, and he propounded a theory of relativity. This theory was exactly the same as the modern theory of relativity except that where we say 'light' they said 'sound'. With this theory they proved many strange results; for example nothing could travel faster than sound. And using this theory two philosophers proved that all truth was relative. Yet it was absolutely true that mind alone was real; there was no substratum of any kind in nature; the monads alone supplied everything; and step by step the Hegelian dialectic carried the Universe into higher and higher degrees of truth and spiritual reality.

"But God smiled; and when He saw that man had become perfect in optimism and credulity, He sent another earth through the sky, which crashed into the blind men's earth; and all again returned to nebula.¹

"For the truth of relativity was itself only relative, it related only to a small selection of temporal and spatial relations; and there was much in their world that was neither man-made nor man-measured but moved by the unmotivated forces of nature."

Whether this is a true analogue of the modern theory of relativity I am neither sufficient philosopher nor physicist to decide. But it would be well if it were so; for who, having compared the idealism of the 'Reign of relativity' with the realism of 'The Dynasts,' will not agree that the latter rings more true?

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¹ Adapted from the story told to Dr. Faustus, as related in "The Free Man's Worship".