“The Principle of Relativity”

H. Holst

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Translated from the Danish

On the occasion of Dr. H. M. Hansen’s article on the principle of relativity in the 1st number of this volume, I should like to ask for space for a few more remarks, in the hope that these may contribute to clarifying further the relation between the different standpoints towards Einstein’s doctrine.

In so far as one merely applies the Einsteinian *procedure* purely phenomenologically, as a means of eliminating apparent contradictions (for example those laid bare by the Michelson experiment), no epistemological objections can be raised against it. One may of course adopt the rule that each single one of several observers in different systems, which move in relation to one another, acts as though light in his system always has the constant velocity c in all directions (and that he therefore synchronises his clocks by light signals in the way indicated by Einstein), and further that one passes over from the one of the systems to the other by the Einsteinian transformation formulae. One has further the right to set up the hypothesis that the results one finds under the application of these rules will in all domains agree with the experimental results. If it now turns out that one obtains such agreement not merely for the phenomena for which the procedure was developed, but also for quite other phenomena, indeed that one can predict new experimental results which are afterwards really found, then the hypothesis has established itself as a fruitful guiding hypothesis, and it is understandable that those who have worked with it become inclined to rely on its correctness and to regard it as an expression of fundamental peculiarities of the world. The circumstance that the different observers in following the rules of synchronisation come into disagreement about determinations of simultaneity, and that the hypothesis entails that no *criterion* can be found as to who is right, does not in and for itself make it epistemologically unacceptable that the hypothesis of the procedure’s general applicability should be correct. Lorentz has of

course by his hypothesis[*)] shown that it is (at all events apparently) *possible* to give a physical explanation of the matter completely reconcilable with the natural conception of space and time.

But as Einstein's doctrine has been put forward by its originator, and as it is generally presented, it is not merely a description of a procedure and the setting up of a hypothesis (or a dogma) about that procedure's general applicability. Besides a phenomenological side it has also an epistemological one, in that it is expressly maintained or tacitly presupposed that the rules for determinations of simultaneity are more than purely conventional, that the velocity of light is not merely *set as* constant but *is* constant and the same in relation to sender and receiver, even if these move in relation to one another, that no *meaning* can be attached to speaking of absolute simultaneity, and that a physical explanation of the contradictions mentioned becomes superfluous when one revolutionises one's conception of space and time.

It is against this side of the matter that protests have arisen. I for my part have sought to show that our thought really does get "a place where it can stand", and from which it can view Einstein's doctrine from outside, provided only that one maintains its right to increase velocities beyond all limits. If we gave up this right for thought, because there is (possibly) a definite physical limit to attainable velocities, then we should for example just as well have to give up thought's right to prolong straight lines beyond all limits, if some well-founded physical theory had led to the conclusion that our world-system was enclosed in a completely impenetrable shell. Fortunately for physics, its indispensable helper mathematics makes itself no physical scruples of this kind; it is one of its inalienable rights to let thought go beyond the physically attainable. But when thought does not let itself be stopped by physical barriers, we can, as is developed in my article, attach a definite meaning to (and give a definition of) two events being really simultaneous, even if the world-mechanism should be so arranged that we cannot find any criterion of it.

Dr. H. acknowledges (p. 28, l. 13 from the foot) that this conception of the concept of simultaneity (which coincides not merely with the one indicated by Lorentz, but with all men's tacit presuppositions — until the year 1905) can be maintained; but that the underlining of the word *can*, as well as from other utterances in the article, it seems to appear that he thinks it is not necessary for thought to maintain it. In this I disagree with him. The conception named can and must be maintained as the one which follows from our natural concepts of space and time and from the fundamental laws of our

[*)] Both here and in the earlier article there is meant by Lorentz's hypothesis or interpretation not merely the original contraction hypothesis, but this together with its later additions.

thinking. It is, I think, an illusion that we can get away from this, and it is therefore also an illusion that Einstein's doctrine gives any contribution whatever to the *explanation* of the Michelson difficulties; it merely gives simple rules for how, by the introduction of certain factors, one can eliminate the disagreements which arise, for example, between physicists who on the earth and on Mars carry out M.'s experiment.

It is another matter that when one applies Einstein's procedure purely phenomenologically, the whole question of the conception of the concept of simultaneity goes out of the discussion, and it may be said to be without interest for the working physicist, in so far as he can for the present push the matter aside.

Undoubtedly Dr. H.'s full and instructive expositions of Einstein's doctrine have been of much benefit, and there is reason to be grateful to him for the liberality with which he has in the journal given space for contributions which go against his own points of view. When in his last article he stresses the phenomenological so strongly, he at the same time opens a good way out towards the levelling of the oppositions, and a prospect that all physicists may with pleasure follow a fruitful application of Einstein's method. This is made possible in the higher degree, the more completely it succeeds in cleansing modes of expression and lines of consideration of the epistemological elements which set thought reacting.

One must however hope that the physicists who work with Einstein's procedures may not be so absorbed in the work — however fine and great the results it might yield — that they wholly lose their interest in physical explanations of the difficulties, or settle so firmly into belief in the Einsteinian hypothesis that they reject in advance attempts at explanation which, in their further development (in contrast to Lorentz's), might lead to the Einsteinian transformation equations being able to give only approximately correct results.