Book Review

The Logic of Special Relativity. By S. J. Prokhorovnik.

More than 60 years have elapsed since the appearance of Einstein's epoch-making article in the Annalen der Physik, on the electrodynamics of moving bodies. In the intervening years relativity became an integral part of our physical world picture, penetrating almost all aspects of contemporary physics, from school teaching to the most sophisticated realms of quantum mechanics. Yet even today there is no universally accepted agreement on the exact standing of the theory within the general framework of physics and the correct interpretation of its assertions.

Some regard relativity as an all-embracing theory of space and time which has influenced our ways of thinking about the physical Universe more deeply than almost any other single physical theory in the history of science. Others regard relativity merely as a technical device involving formal manipulations with Lorentz transformations and adding little (if anything at all) to our knowledge of the physical Universe beyond what is laid down in the equations of these transformations. Further down the scale there are those who reject altogether the basic assumptions and experimental foundations of the theory which they regard as wholly inadequate.

The philosophical implications of relativity have been examined by numerous writers from Bergson to Whitehead, but no one has yet attempted a comparative survey of the current physical interpretations and controversies arising from these interpretations. Prokhorovnik's "The Logic of Special Relativity" is therefore a welcome and important addition to the voluminous literature on relativity. The title of the book must not be taken too literally; it is not so much the logic of the theory itself but that of its numerous contributors which is under scrutiny. This is particularly true of the discussion of the notorious clock paradox which appears in some form or other in nearly every chapter of the book.

The author gives a faithful account of the Dingle-McCrea-Builder controversy, without committing himself explicitly in either way. He gives a clear exposition of the paradox itself and the arguments surrounding it, making extensive use of a diagrammatic device due to Arzelies. One point on which the exposition is not very clear is the exact meaning of the term "absolute" when applied to time dilatation and similar effects. In a sense any observable effect (such as the mass-energy relation or the relativistic Doppler-effect) is absolute, and it is hardly surprising that relativity does produce such effects—it would be a disaster if it would not.

Paradoxically, the chapter which the reviewer has found most interesting is the one on absolute motion in which the author takes a more definite personal stand and in which the clock paradox is only marginally touched upon. This of course is a chapter to which the author himself has made substantial original contributions and he gives an excellent account of how the theory of (special) relativity looks like if the existence of a distinguished reference frame or state of absolute rest is assumed. For the cosmologist it is hardly necessary to stress the intrinsic interest of such an approach since he is anyhow forced to accept an absolute inertial frame, corresponding to the state of motion of the substratum relative to which the Universe appears to be isotropic.

The "logic of absolute motion" rests on two assumptions:

(a) There exists a distinguished frame of reference in which the propagation of energy is isotropic.

(b) Movement of a body relative to the distinguished frame is associated with a single effect, the Lorentz-Fitzgerald contraction.

These two postulates and Einstein's conventions on synchronization suffice to deduce the whole fabric of relativistic kinematics. Of course in terms of absolute time, that is time synchronized with respect to the distinguished observer, light propagation becomes unisotropic when the observer is in motion, but the anisotropy effects cancel out in Michelson-Morley type experiments and the net result is the same as in conventional relativity.

There are definite advantages in this approach even for those not interested in cosmology. All relativistic "paradoxical" effects are reduced
to a single easily visualizable physical effect, namely contraction in the direction of motion, and the clock paradox is quite easily resolved, in favour of the conventional (non-Dingle type) solution. Another great advantage is that extension to 3-space, usually a cumbersome and dubious procedure, is achieved here with remarkable ease.

Against these advantages the orthodox relativist might argue that (i) the distinguished state of motion does not show up in local (non-cosmological) observations, that is, in precisely those phenomena to which special relativity normally applies; (ii) there is an artificial anisotropy introduced into the theory which again does not show up in local observations; (iii) the second postulate (B) appears to be quite arbitrary in comparison with the usual Einstein postulates of which of course it is a consequence.

The first two objections are to some extent removed in the last chapter where yet another postulate (McCrea's light-hypothesis) is introduced in order to meet cosmological requirements. On the cosmological scale the distinguished frame *does* show up in concrete physical effects, but this is only to be expected since the extended system is equivalent to a certain general relativistic model.

The third objection cannot really be dispelled on physical grounds alone since the answers given by the new approach are identical (locally) with those given by orthodox relativity. It is the individual's outlook towards laws of nature in general which will ultimately determine his stand towards Prokhovnik's case for the ether. Perhaps the greatest single merit of this book is that it brings home more vividly than any previous writing the fact that relativity is perfectly consistent with an ether-like hypothesis and that our acceptance or rejection of such a hypothesis is a matter of taste rather than of substance.

G. Szekeres.

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