LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Kinematical Relativity and the Nebular Red-Shift

PROF. J. B. S. HALDANE's far-reaching deductions¹ from Prof. E. A. Milne's "kinematical relativity" excite our admiration, but they must also excite in many a feeling of apprehension lest, in our eagerness to build, we ignore defects in the foundations. Before extrapolating so extensively as Prof. Haldane has done, we should surely ascertain that kinematical relativity can explain what we do know. I have already, in *Nature* and elsewhere, objected to its essentially unscientific character; the purpose of this letter is to point out what seems to me its failure to explain the one fact we have relating to the distant past, namely, the nebular red-shift.

In Prof. Milne's recent letter on "The Ageing of Light"² the "usual Doppler effect" is assumed without comment. That letter, of course, is concerned not with the nebular red-shift, which is shown by light originating in the nebula, but with the behaviour of hypothetical light originating in our galaxy and supposed to have been reflected to and from the same nebula from the beginning of time until now. Its validity also, however, depends on a satisfactory explanation of an essentially similar phenomenon.

The observation is that nebular spectrum lines are less refrangible than lines emitted here and now from (presumably) similar atoms. We all agree to express the problem thus raised by asking why the frequency of old nebular light is smaller than that of young terrestrial light from similar atoms.

Kinematical relativity answers in terms of arbitrarily chosen time-scales, of which two are particularly relevant: (a) the *kinematic* scale (*t*-time), in which all 'rigid' bodies are expanding and separating, but the frequency on emission of light from a particular kind of atom (*Z*) is the same at all times; (b) the *dynamical* scale (τ -time), in which the sizes of and distances between rigid bodies remain constant, but the frequency on emission of light from *Z* is greater the later it is emitted. The red-shift, it is held, is explicable on either scale; but this I cannot see.

Consider first the *t*-scale. The frequency on emission is the same at all times, but the nebula is receding. Only two causes of red-shift are then conceivable: (1) relative motion of earth and nebula; (2) decrease in frequency of light (not atomic processes) during passage through space. General relativity accepts (1), but kinematical relativity cannot do so because it holds that even *relative* motion can be transformed away mathematically, and we cannot attribute an objective fact to a cause destructible by "an arbitrary act on the part of the thinker"³. Neither is (2) available, for in his comments⁴ on Prof. Haldane's paper, Milne says (this seems also to be implied in previous papers, but I have not before seen so unambiguous a statement): "This degradation of the individual photons due to interacting with matter must be distinguished from their constancy of frequency in time (*t*-scale) as they are propagated through empty space". The only possibility left thus seems to be the arbitrary postulate that inter-nebular space contains matter which can affect light in a way unknown elsewhere in Nature. This has not to my knowledge been suggested,

and would be a purely *ad hoc*, and therefore worthless, explanation.

The same difficulty in different form is, of course, experienced on the τ -scale. Here the sizes of bodies (and therefore of the atoms which compose them) remain constant, but *atomic frequencies* change with time. Hence atomic frequencies must depend on something unstated which does not affect the linear dimensions, thus apparently ruling out all possibility of correlating radiation with atomic structure. Moreover, if inter-nebular matter is to be admitted, we must suppose its effect on light-frequencies to be exactly neutralized by an *ad hoc* change of light-frequency (on the τ -scale) during propagation through space, for the explanation is complete without change of frequency after emission. But change with propagation, even on the τ -scale, is denied by Milne⁵, so the inter-nebular matter essential on the *t*-scale becomes fatal on the τ -scale. Kinematical, unlike general, relativity therefore appears unable to account for the red-shift.

This comparative impotence seems to depend ultimately on the restriction of observations to readings of a single clock, which are insufficient data for describing the full variety of physical experience. Consider a missile which, by ordinary measure, is approaching an observer. By the principle which is held to validate the *t* and τ scales, the observer can properly regard its distance as remaining constant. He has simply to send a beam of light to and from the missile without pause, and regard its successive returns as equally spaced in time. The ultimate impact then does not occur until $\tau = \infty$ on this scale, and so causes no mathematical embarrassment unless the observer survives; but the comfort thus afforded is perhaps questionable. A portion of the observer's experience is made inaccessible in the description given by kinematical relativity, but it is perfectly accessible to him. One cannot help recalling Achilles and the tortoise.

It would, I believe, give satisfaction to many who find a genuine difficulty here if some kinematical relativist would (if possible at no greater length and with no more recourse to mathematics than this letter has required) explain how the theory meets the objection I have tried to express. It is clearly desirable that, before the valuable time of men like Prof. Haldane is further employed in making unverifiable deductions from the theory, we should be assured that the theory can satisfactorily account for what we do experience.

HERBERT DINGLE.

Imperial College of Science and Technology,
London, S.W.7.
Feb. 26.

¹ *Nature*, 155, 133 (1945).

² *Nature*, 155, 234 (1945).

³ Milne, E. A., *Astrophys. J.*, 91, 157 (1940).

⁴ *Nature*, 155, 136 (1945).

⁵ *Proc. Roy. Soc., A*, 158, 328 (1937).

PROF. DINGLE makes Prof. Haldane's contribution to kinematical relativity the occasion for what he thinks is an attack on its foundations. He is very simply answered: the red-shifts in the spectra of the galaxies are described in kinematic relativity as a Doppler effect due to recession. The consequences of this in relation to the ageing of light and Prof. Haldane's work have been discussed by me in a letter to *Nature* written before I saw Prof. Dingle's letter.