

If the stream of projected particles be tied together by an elastic force, they will continue to oscillate as they follow one after the other with the same period that they had at the start. This idea would lead on to many more, which it would be out of place to discuss until one has the result of the two experiments concerning which I ask for information.

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DR BROAD'S REPLY.

In reply to Mr Sexton's questions the following remarks may be made :

(i) (a) If the velocity of light is to be measured by observations of the times when a beam leaves A and when it reaches B, a different point, we must know beforehand that the clocks at A and B are going at the same rate and that they agree in their zeros. Even if they agreed when together at A, it would be most unsafe to assume that they would continue to do so when one is moved to B. Agreement would therefore have to be tested when the clocks were *in situ* for the experiment; this could only be done by light signals; and such signals only constitute a criterion of sameness of rate and of zero when we make definite assumptions about the velocity of light. Thus an experiment of the kind suggested would involve a circular argument if used to settle the question of the connexion between the observed velocity of light and the motion of the observer and his instruments in the ether.

(b) Even if this difficulty could be avoided, I think it is certain that no *direct* measurement of the velocity of light would be capable of detecting such relatively small differences as would be involved in the composition of the velocity of the earth in its orbit with that of light in the ether. The latter velocity is so enormously greater than the former that the composition of the two could only affect the resultant velocity by an amount below the limits of experimental errors.

(ii) The same theoretical difficulty certainly, and the same practical difficulty probably, apply to all such attempts at settling the question, and therefore to the proposed experiment with the light from a star when approaching and when receding. Dr F. W. Aston of the Cavendish Laboratory, who has kindly answered some questions that I have put to him in connexion with Mr Sexton's letter, says that the practical difficulty due to the comparatively small velocity of the earth might be overcome by using instead Positive Rays, which consist of particles moving with a velocity of about 10^7 cm. per sec. But he also says, and I agree, that the argument would still be circular, because of the difficulty about the test for sameness of rate and of zero in clocks at different places.

(iii) There is no theoretical objection to a combination of the undulatory and the emission theories, such as Mr Sexton suggests, if this be found necessary to explain the facts. In Lane's book, *Das Relativitätsprinzip* (Vieweg), it is said that W. Ritz attempted to meet the Michelson-Morley difficulty by an emission theory. Full references are given in § 2, note 13, p. 266, of Lane's book. I have not read Ritz's work, neither has Dr Aston; but if Mr Sexton cares to pursue the subject, he will find Ritz's first contribution (according to Lane) in *Ann. de chim. et de phys.*, xiii. 145, 1908. He also appears to have written in *Arch. de Genève*, xvi. 209, 1908; *Scientia*, 5, 1909; and his *Gesammelte Werke*, pp. 427 and 447. The other relevant literature will be found in Lane at the page indicated above.

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