

the earth to have an ethereal atmosphere of its own by means of which the light is transmitted on the earth's surface and which is always carried with the earth in its orbital motion and also in its daily rotation near the earth's surface? We certainly do not know that such an atmosphere does not exist; and it certainly would account for the facts perfectly, without the violation of a single principle of mechanics.

Now the negative result of Michelson and Morley's experiments, in the supposed absence of this local atmosphere, constitutes the corner-stone of Einstein's theory of relativity (see *NATURE*, 111, 240, and 117, 6), and the effect of this paradoxical foundation upon even the highest intellects is illustrated by the following quotation from Sir Oliver Lodge: "The relative velocity of the light and the observer (travelling with speed u to meet it) must be $c+u$ —common sense forbids otherwise,—but if he seeks to measure it he will get, we are told and inclined to believe, not $c+u$, but . . . simply c " (*NATURE*, 107, 748). In other words, a great scientist admits that he is inclined to believe what he admits common sense clearly forbids him to believe. Must we, then, subscribe to such renunciation of our reasoning faculties and to H. D.'s appeal to blind faith before we can enter the portals of Einstein relativity?

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Dec. 7.

MR. McLENNAN'S suggestion, as has often been pointed out, is inconsistent with the observed phenomena of the aberration of light.

His letter seems to imply that, if it is rejected, we must subscribe to "renunciation of our reasoning faculties and to H. D.'s appeal to blind faith before we can enter the portals of Einstein relativity." H. D., however, did not appeal to "blind faith," nor does he subscribe to "renunciation of our reasoning faculties." In order to grant full assent to a deduction from experiment, one must first understand the reasoning leading to the deduction, and secondly, have faith that reasoning on such foundations will not mislead. The failure of many people to give full assent to relativity is generally believed to be associated with the first factor; the article in question contended that it is actually associated with the second. The difficulty—at any rate in the special theory, which contains the paradoxes mainly responsible for the theory's bad reputation—is, not to understand a fairly simple argument, but to trust the understanding to lead to the truth when deep-rooted prejudice points in the opposite direction. H. D.

Dec. 29.

The Diffraction of X-rays in Liquids containing Heavy Atoms.

It is now generally accepted^{1,2,3,4} that X-ray diffraction in liquids is mainly due to the relative positions of the molecules and only in second instance to their inner structure. If the effect of the last factor is known, some information regarding the first factor may be obtained from an analysis of the observed diffraction pattern.³ This circumstance is realised in

the case of monatomic molecules, for example, argon, or mercury.^{5,6} In most cases, however, as when using organic compounds, the inner structure is not known, and then no unequivocal conclusion, or nearly none, may be drawn from the diffraction pattern.

The use of an especial X-ray spectrograph⁶ constructed by Prof. Coster and myself for the investigation of heavy (that is, absorbing) liquids has opened up a new line of attack. The guiding principle is to introduce very heavy atoms into the liquid and to get definite evidence concerning their mutual arrangement by their diffraction pattern. This diffraction pattern will depend almost entirely on the relative positions of the heavy atoms, as in comparison to their scattering power that of the other atoms may be neglected, the scattering power being roughly proportional to the square of the atomic number under the conditions of the experiment (scattering angles of 1° to 15° using Cu or Fe K radiation).

A first application was made on the diffraction of X-rays in a solution⁷ of iodine ions in water and of carbon tetrachloride and methylene iodide in benzene. If the current view is accepted that the dissolved molecules in these cases are dispersed like the molecules in the gaseous state, then the theory^{1,3} predicts a characteristic difference between the diffraction pattern of these solutions and that of ordinary liquids. This difference is chiefly found in the amount of scattering at small angles, which should be small in ordinary liquids and considerable in gases, and consequently also with our solutions. I was able to get experimental evidence of this effect when dilute solutions (about 1 molecule dissolved in 15 solvent) are used.

A curious peculiarity, however, was found with iodine ions (potassium and lithium iodides were used) when the concentration was increased (up to 1 molecule dissolved in 3 solvent). In this case I observed a reversal of the effect, the scattering at small angles diminishing again in a marked manner with increasing concentration. This phenomenon is not to be explained as due to a geometrical close-packing of the iodine ions, for a simple calculation² shows that this influence is much too small. The effect is, however, readily explained as due to the electrostatic repulsion of the iodine ions. Indeed, this will tend to keep them apart, as if the ions were much bigger, causing in this way an apparent close-packing. With lithium iodide this effect seems to be visible at smaller concentrations than with potassium iodide.

Another application of the same method has been made in studying organic compounds, especially those with long CH_2 -chain (C_9 -dibromide, C_{13} -dibromide⁸ and C_{16} -mono-iodide were used). In this way evidence of their arrangement is obtained in a less ambiguous manner than usually.

Perhaps it is useful to add that with fatty acids, also studied, the results of Stewart and others⁹ were confirmed and extended to C_{12} , C_{14} , and C_{16} -acids. A full account is to appear in *Zeitschr. f. Phys.*

My thanks are due to Prof. Coster for his helpful criticism.

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¹ J. A. Prins, *Physica*, 6, 315; 1926.

² D. Coster et J. A. Prins, *Jour. de Phys.*, 9, 153; 1928.

³ C. V. Raman and K. R. Ramanathan, *Proc. Ind. Assoc. for Cultiv. Science*, 8, II, 127; 1923.

⁴ P. Debye, *Jour. of Math. and Phys. Massachusetts*, 4, 133; 1925; and *Phys. Zeitschrift*, 28, 135; 1927.

⁵ F. Zernike and J. A. Prins, *Zeitschr. f. Phys.*, 41, 184; 1927.

⁶ W. H. Keesom and J. de Smedt, *Proc. Amsterdam*, 25, 118; 1922; W. H. Keesom, *Proc. Amsterdam*, 30, 341; 1927.

⁷ Solutions have been studied from another point of view by R. W. G. Wyckoff ("The Structure of Crystals," New York, 383; 1924) and W. H. Keesom (*Proc. Amsterdam*, 30, 341; 1927).

⁸ Kindly put at our disposition by Prof. L. Ruzicka in Utrecht.

⁹ G. W. Stewart and others, Several articles; *Phys. Rev.*, 31, 32; 1927 and 1928; J. R. Katz, *Chemiker-Ztg.*, 51, 384; 1927.