LXXXVI. *Maxwell's Electromagnetic Æther and the Michelson-Morley Experiment.*

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Summary.

THE fact that light manifestations according to Maxwell require an ætheric and not a material medium calls for an interpretation of Gladstone and Dale's so-called molecular refractive index m. Such index really refers to the non-material medium of molecular diameter d_m surrounding and attached to the nucleus. It is shown that by coordinating the Gladstone and Dale rule with that of Lorentz and Lorenz that the molecular index m becomes a function of the material density of the medium, and incidentally, therefore, a function of the temperature. Any increased value of m with density is to be ascribed to a further proportional filling up of the intermolecular space with a modified ætheric medium, so that eventually no pure (unmodified) æther exists between the nuclei.

Whereas, however, the intrinsically attached non-material medium moves with the individual nuclei (Bradley aberration effect), relative motion is assumed possible (Fizeau effect) between the molecules of diameter d_m and the modified æther medium filling up the pores between the molecular diameters. Only in this way can one successfully picture critical total reflexion taking place in refractive media. As a consequence, therefore, of the mass action of the Earth producing a filling-up modified æther medium, only relatively null results can follow from experiments of the type of Michelson-Morley or that of Sir Oliver Lodge. In contradistinction due to the mass action of the Sun, it should necessarily follow that an observed bending of the rays should take place due to the modified ætheric atmosphere set up †.

Types of the Æther.

When one refers to the Gladstone and Dale experiments and the establishment of the law as given in Preston's 'Theory of Light,' for example, it is usually stated that there is a molecular refractive index m which is attached to and is a property of the particular molecules of the gas in question.

* Communicated by Prof. I. J. Schwatt, Ph.D.

† Compare remarks of Dr. L. Silberstein on Prof. D. C. Miller's æther drift experiments, 'Science,' vol. lxi. Supplement, May 22, 1925.

It is with this understanding that we have the relation

$$\mu e = (e - \epsilon) + m\epsilon,$$

where e is the thickness of the plate and ϵ the thickness actually occupied by the molecules *per se*. Thus we have

$$\mu - 1 = \frac{\epsilon}{e}(m-1). \quad . \quad . \quad . \quad . \quad . \quad (1)$$

However, two considerations force one to the conclusion that ϵ/e cannot be the true density. In the first place, since light is an electromagnetic phenomenon it pertains strictly speaking to the æther dielectric, or at least, such modified æther attached to the individual molecules, in the nature of an "atmosphere" as it were, which ordinarily goes under the designation of material dielectric. It is for this embracing and attached ætherial atmosphere that Gladstone and Dale assumed a molecular refractive index m in the above formula. From this point of view, therefore, the real material nucleus of the atom plays but an indirect part. The effective diameter d_m of the atom is in fact the diameter of the embracing material dielectric or modified and attachable æther, if one desires so to designate it.

Determination of Molecular Refractive Index.

To determine the nature of the constant m use can be made of the improved formula of Lorentz, in which we set

$$\frac{\mu^2 - 1}{\mu^2 + 2} = a\rho, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where ρ is the material density of the medium and a so far is a constant to be determined. Solving (2) for μ^2 we have

$$\mu^2 = \frac{1 + 2a\rho}{1 - a\rho} \equiv (1 + 2a\rho)(1 + a\rho), \quad . \quad . \quad . \quad (3)$$

provided $a\rho$ is negligible in comparison with unity.

On the other hand, from (1) we have

$$\mu^2 = 1 + \left\{\frac{\epsilon}{e}(m-1)\right\}^2 + 2\frac{\epsilon}{e}(m-1) \equiv 1 + 3a\rho + 2a^2\rho^2. \quad (4)$$

If then in (4) we set

$$a = \frac{\epsilon}{e} = n \cdot \frac{\pi}{6} \cdot d_m^3, \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where d_m is the effective diameter of the dielectric atmosphere of a nucleus and n is the number of molecules per unit volume, we have

$$m = 1 + \frac{3}{2}\rho \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$\frac{\mu - 1}{\rho} = \frac{3}{2} \cdot n \cdot \frac{\pi}{6} \cdot d_m^3. \quad . \quad . \quad . \quad . \quad (7)$$

The important thing, then, is that the refractive index of the dielectric molecular atmosphere is a function of the density of the gas or liquid (and incidentally of the temperature). This will have important bearing on the elucidation of the Bradley Aberration effect and that of the Fizeau experiment with respect to the Michelson-Morley null observation.

Be it noted that the increase of m with ρ can be attributed to a further deepening of the modified ætheric atmosphere (so called material dielectric) about the material nucleus. Thus, whereas the dielectric atmospheres of free molecules can be conceived of as being due to a "condensation" or adsorption of the æther plenum about the molecule and due to the mass attraction, with greater and greater densities (aggregates of molecules) a pseudo-ætheric atmosphere or ætheric congelation as it were takes place in proportion to the increase in m indicated by (6).

Necessity for a Pseudo-Ætheric Atmosphere for Explanation of Total Reflexion.

That some such action must take place at least in liquids must follow from the consideration that at certain critical angles the waves of light, by the way a purely non-material type of wave motion, are totally reflected without a fair proportion $\left(1 - \frac{e}{e}\right)$ passing straight through the liquid by way of the pores, as it were. To account for this it must be assumed that due to the mass action (increase in density) of the liquid the pores are substantially filled up with a "congealed" plenum that also moves when the liquid as a whole moves.

The Fizeau versus *the Michelson-Morley Experiment.*

Whereas, then, in the Fizeau experiment it is possible for the molecularly attached types of atmospheres, of diameters d_m, to move relative to the "congelation" ætheric medium set up, in the case of the Michelson-Morley experimentwhere no relative motion occurs relatively null results can only be looked for even in so-called vacuum. This is because the Earth sets up a congelation effect quite apart from the molecular density effects of the air molecules. It follows, then, that in the outer confines of the Earth's atmosphere an ætheric slip is conceivable. As the greater densities nearest the Earth's surface are approached, overlapping congelation atmospheres are encountered till finally the entire light train is carried forward with the Earth by means of the modified æther. The null results of Sir Oliver Lodge are then to be expected and gravitational solar attraction of the light rays rationalized.

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LXXXVII. *On the Nature of the Disturbance in the Second Medium in Total Reflexion.* *By* Prof. C. V. Raman, *F.R.S., University of Calcutta* *.

[Plate XXVII.]

SOME five years ago †, an investigation was carried out in the author's laboratory of the diffraction phenomena observed when a pencil of monochromatic light is incident at slightly less than the critical angle on the boundary between two media (say, glass and air) and emerges into the second medium almost grazing the surface. The results were very interesting and suggestive, and when communicating the paper describing them for publication, I had intended to pursue the matter further and to investigate by the same methods the cases in which the incidence is made equal to the critical angle or is increased even further. But other work intervened and the subject was laid aside. Sir Arthur Schuster's recent paper on Total Reflexion ‡ recalled the subject to mind, and induced me to make some further observations. The present paper describes the experimental facts which are significant enough, and are fairly easily understood from the point of view adopted in Dr. Chuckerbutti's paper, but do not seem to fit in with Sir Arther Schuster's way of looking at the matter.

It is useful briefly to recall Dr. Chuckerbutti's work. Owing to the enormous dispersion which occurs when light is incident on a glass-air boundary at or near the critical angle,

* Communicated by the Author.

† B. N. Chuckerbutti, Proc. Roy. Soc. xcix. A Series, p. 503 (1921).

‡ Proc. Roy. Soc. evii. A Series, p. 15 (1925).