

equality at times of great sun-spot frequency may be some form of radiation which reduces the resistance of the atmosphere to currents generated by the sun. This would explain the phenomena without requiring the enormous variations in the sun's output of energy from year to year that would appear necessary to account for the great variations in the magnetic phenomena, variations moreover which—as the paper shows—do not appear to be accompanied by any but the most insignificant changes in the amplitude of the temperature inequality at the earth's surface. The importance is pointed out of reliable information as to whether atmospheric electricity potential, at low and at high levels, resembles magnetic phenomena in being largely different in years of large and small sun-spot frequency.

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“On the Theory of Refraction in Gases.” By GEORGE W. WALKER, M.A., A.R.C.Sc., Fellow of Trinity College, Cambridge. Communicated by Professor J. J. THOMSON, F.R.S. Received May 2,—Read May 28, 1903.

(Abstract.)

The present theories of refraction in gases lead to expressions for the refractive index, of which the formula

$$\mu^2 - 1 = Nf(p)$$

may be taken as typical.

In the formula  $\mu$  is the refractive index,  $N$  is the number of molecules per unit volume,  $p$  is the frequency of the waves, and  $f(p)$  is a function of  $p$  which depends on the assumptions made as to the constitution of the molecule.

The formula, although it explains the main features in the visible spectrum, cannot always be made to explain the measured temperature effects, even when allowance is made for the deviations from the gaseous laws of Boyle and Charles.

Again, in the case of the dielectric constant for some gases such as  $\text{SO}_2$  and  $\text{NH}_3$ , the value of  $K - 1$  is much greater than the value of  $\mu^2 - 1$ . In such cases we find that  $\mu^2 - 1$  varies nearly as  $N$ , while  $K - 1$  is more nearly proportional to  $N/\theta$ , where  $\theta$  is the absolute temperature.

The theories are thus inadequate, and a modification is required which will give a greater dependence on temperature.

In the theories of Voigt and Lorentz the molecule is regarded as an aggregate of electrical doublets. The individual parts are assumed to have free periods of vibration, which are naturally identified with the

spectral lines of the gas, and, therefore, must have a frequency independent of temperature.

The view adopted in the present paper is that, instead of free vibrations, we have constrained motion. Regarded from Professor J. J. Thomson's point of view, the atom consists of a large positive particle and a large number of small negative ones. Instead of supposing that these negative particles can vibrate radially, I regard them as rolling on the surface of the positive one in constrained motion. The effective control on transmitted waves is thus the rotational energy of motion of the particles, and it must be proportional to the absolute temperature.

When, by collisions or otherwise the rotational motion becomes so great that the electric attraction is overcome by the centrifugal force, ionisation occurs. The frequency or frequencies of rotation at which this occurs are determined by the electrical attractions and are independent of temperature, although, of course, the higher the temperature the greater will be the amount of ionisation. I regard these frequencies as corresponding to the spectral lines, and it will be seen that the view explains the ionisation produced by ultra-violet light, and also agrees with the fact that luminosity is probably always connected with ionisation, *e.g.*, the characteristic lines come out in the electrical discharge through the gas.

Regarded simply as obstacles, the molecules must contribute a term to  $\mu^2 - 1$ , which is proportional to  $N$  and practically independent of the frequency.

The final formula obtained is

$$\mu^2 - 1 = k_1 N + \frac{k_2 N}{\theta} f(p, \theta),$$

where  $k_1$  and  $k_2$  are constants and  $f(p, \theta)$  is a function of  $p$  and  $\theta$ . The function is fully discussed in the paper.

The formula is shown to be capable of accounting for all the known facts connected with the dielectric constant and the refractive index, while the absorption of ultra-violet light and apparent absorption, due to selective reflexion in the infra-red, is also explained.

Notwithstanding the very complex and varied facts in Air, Hydrogen, Carbon Dioxide, Ammonia and Sulphur Dioxide, complete numerical agreement between the measurements of  $K - 1$  and  $\mu^2 - 1$ , as regards both absolute magnitude and dependence on pressure, temperature and frequency, has been established.

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