

briefly in this note to indicate a molecular theory of the Maxwell effect we have worked out which has proved itself very successful in explaining the observed phenomena.

It is easily seen that the stresses in flowing liquid can be considered as equivalent to a set of tensions and a set of pressures acting perpendicularly to each other, and at angles of 45° to the plane of sliding. When the liquid consists of molecules which are highly asymmetric in shape, there would be a tendency for the molecules to orientate under the influence of this system of stresses in such manner that the longest dimension of a molecule tends to lie along the axis of tensions and the shortest one along that of pressures; because such orientation would evidently result in the fluid, regarded as a densely packed assemblage of molecules, expanding along the direction of tensions and contracting along the direction of pressures, thus allowing the system of stresses to do work. By considering the work done during such deformation by the acting stresses as equivalent to the change of energy of the molecules resulting from orientation under a system of couples acting upon them, we can determine the latter in terms of the viscous forces and the asymmetry of shape of the molecules; it being remembered that the orientation is opposed by the thermal agitation of the fluid and that the resulting equilibrium is to be determined statistically in accordance with the Boltzmann principle.

The birefringence of the fluid resulting from the orientation of the molecules under the viscous stresses and their known optical anisotropy, is then readily worked out on lines analogous to those used by Langevin in his theory of electric and magnetic double refraction. The final expression obtained in this way for the difference between the refractive indices n_t and n_p for the vibrations along the axes of tensions and pressures respectively, is:

$$n_t - n_p = \frac{(n^2 - 1)(n^2 + 2)}{5n\nu kT} \frac{(a_1 - a_2)(b_1 - b_2) + (a_2 - a_3)(b_2 - b_3) + (a_3 - a_1)(b_3 - b_1)}{(a_1 + a_2 + a_3)(b_1 + b_2 + b_3)} \cdot \frac{v}{c}$$

where n is the mean refractive index of the fluid, ν is the number of molecules per unit volume, k is the Boltzmann constant, T is the absolute temperature, a_1, a_2, a_3 are the linear dimensions of the molecule along the three principal axes, b_1, b_2, b_3 are the optical moments induced in the molecule along these axes by unit field acting on it successively along the same three directions, η is the coefficient of viscosity and v/c is the velocity gradient.

The birefringence calculated from our formula, utilising the optical anisotropy ascertained from observations on light scattering and the geometrical dimensions derived from X-ray data, comes out in excellent agreement with the determinations of Vorländer and Walter.

The extension of the theory to the case of colloidal solutions and gels is at present engaging our attention.

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The Excitation of Spectra by High Frequency Oscillations.

THE letter in NATURE of Oct. 8, p. 510, from Prof. R. W. Wood and Mr. Loomis directs attention to the possibility of developing spectra by means of high frequency oscillations. Work on these lines has been proceeding in this department for some time, and the

results obtained with mercury as a 'trial horse' are encouraging.

A short coil of copper tubing was wound round a horizontal hard glass tube through which a stream of mercury vapour was caused to flow. The coil was connected in parallel with a condenser, and oscillations were maintained in this circuit by means of a high-power three-electrode valve. The frequency of these oscillations was of the order of 10^6 cycles per second, the voltage applied to the circuit could be varied from 2000 to 10,000 volts, and the power input increased up to 3.5 kilowatts. The pressure inside the glass tube was adjustable by the admission of air, and the spectrum produced when the coil was activated was examined end-on by means of a quartz spectrograph.

Before a glow was visible, the resonance line $\lambda 2536.7$ was photographed with a long exposure. An increase of the voltage applied to the circuit caused the appearance of a greenish glow, which was found to be due to the lines of the *s* and *d* triplet series in addition to this line; prolonging the exposure only resulted in more members of these series being recorded. A further increase in the voltage caused the colour of the glow to change to that of the ordinary mercury arc, the photographs now showing the resonance line, the *s* and *d* triplets, the lines of the *S* and *D* singlet series, and some combination lines. Only those combination lines were present, however, which involved the arrival and departure levels of the series lines present. When the voltage was still further increased, more members of the triplet and singlet series were developed, together with additional combination lines connected with these new members.

Simultaneously excited, however, were also thirteen lines, which have not yet been allocated to any series or combination, though these have all been identified as being present in the ordinary mercury arc. Their wave-lengths were 3984.1, 3860.4, 3820.6, 3790.4, 3751.8, 3561.5, 3543.7, 3390.5, 3351.5, 2820.0, 2686.7, 2660.1, and 2540.4. They were all of very feeble intensity except the first, which was as strong as an early member of the triplet series. A step by step reduction of the pressure from 1 cm. to that of the vapour alone, keeping the voltage constant, produced the same effects as increasing the voltage when the pressure was constant. An increase in the temperature of the vapour also facilitated the development of the lines. The line $\lambda 3984.1$ was abnormally affected by pressure; increasing the pressure caused it to fade much more rapidly than the other lines.

It had been anticipated that enhanced lines due to atoms in various stages of ionisation might have been obtained, especially near the circumference of the tube, but these have not yet been observed; further endeavours to obtain them will be made. It is remarkable that although several of the lines of the *p* series are present in the ordinary arc with an intensity as great as that of some of the higher members of the *s* and *d* series, yet they have not been observed as being excited by this method, even when the exposure has been prolonged up to five hours. It is possible that they require higher voltages for their excitation than have been available so far.

It is apparent that this method of developing spectra is full of promise, and its extension to other elements than mercury, the spectra of which have not yet been analysed so completely, is proceeding.

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