Nature (London) **112** 165–166 (1923)

The scattering of light by anisotropic molecules

Prof. L V King's interesting letter on this subject in *Nature* of May 19, p. 667, calls for comment, as his results do not seem to be acceptable in the light of the work carried out at Calcutta in this field during the past two years.

Any proposed scattering formula should satisfy two simple tests, namely, that for a fluid consisting of isotropic molecules it should reduce to the Einstein formula, and that for a sufficiently rarefied fluid it should become the Rayleigh law of scattering. Prof. King's formula (3) satisfies neither of these tests, as can easily be seen on putting $\rho = 0$ in it. The appearance of the adiabatic compressibility in the formula is inconsistent with thermodynamic principles. Einstein has very clearly pointed out that the expression for scattering must involve the isothermal and not the adiabatic compressibility. Further, the omission by Prof. King of the factor $(\mu^2 + 2)^2/9$ which appears in Einstein's formula, cannot be reconciled with the acceptance of the Lorentz refraction formula for a fluid consisting of isotropic molecules.

Prof. King's explanation of the diminution in the depolarisation in the case of liquids, which occurs as the critical temperature is approached, as due to the breaking up of crystalline aggregates, seems inappropriate in view of the fact that a precisely similar effect is shown by vapours, where obviously the conception of crystalline aggregates is entirely out of place. Mr Ramanathan's paper on the scattering of light in benzene vapour at high temperatures, which is appearing in the *Physical Review*, clearly illustrates this. The effects observed both in liquids and vapours have been very simply explained without recourse to artificial hypotheses in my papers in the *Philos. Mag.* for January and March, where quantitative data strongly supporting Einstein's formulae are set out.

The fundamental error in Prof. King's reasoning seems to arise at the point where he suggests that a fluid consisting of comparatively stationary anisotropic molecules, with equally probable orientations in all directions, would scatter only polarised light. This is certainly not the case. It can easily be seen on resolving the effect due to an aelotropic molecule oriented arbitrarily that the components perpendicular to the light vector in the incident wave are affected with a sign which may be either positive or negative at random, i.e. irrespective of the position of the molecule in space, and hence, in finding the total components in these directions, we have to add the intensities, not the amplitudes. A fluid consisting of anisotropic molecules oriented at random must therefore necessarily scatter unpolarised light in proportion to its density, and as remarked in my letter in *Nature* of March 31, p. 428, considerations similar to those which enter into the Lorentz refraction formula introduce a further factor $(\mu^2 + 2)^2/9$, which increases the unpolarised scattering to be expected. The whole question will be found elaborately discussed in a paper by Mr Ramanathan in the *Proc. Indian Association for the Cultivation of Science*, vol. viii., Part I, just published.

I think I should make it clear that the suggestion made in my letter in *Nature*, March 31, and endorsed with some modifications by Sir William Bragg, regarding the relations between the liquid and the crystalline states, is very different from that put forward by Prof. King. In my opinion, neither the facts regarding the scattering of light nor the X-ray data require the assumption of the existence of crystalline aggregates in liquids. All that the experimental facts suggest is that the molecules in a liquid influence the orientations of their nearest neighbours to a sensible extent, and that this results in the amount of unpolarised light scattered being somewhat smaller than on the hypothesis of random orientations of the molecules.

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15 June