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Anisotropy of molecules

Direct evidence that the molecules of gases are not spherically symmetrical and are anisotropic in their properties is furnished by the recent experiments of Lord Rayleigh, who has shown that the light scattered by molecules is, in general, not completely polarised when observed in a direction transverse to the pencil of light traversing the gas. The method used by Rayleigh, and by those who have repeated the experiments establishing this effect is a photographic one, the track of the primary beam of light as viewed through a suitably oriented prism of Iceland spar being recorded on a plate with long exposures. In view of the great interest of the phenomenon, it occurred to the present writer that it would be worthwhile to attempt direct *visual* observation and measurement of its magnitude. The chief obstacle is, of course, the extreme feebleness of the unpolarised part of the transversely scattered light. This has, however, been successfully overcome. By using the strongest possible illumination (sunlight), securing a perfectly black background, and very carefully screening the eye from extraneous light, it has been found possible to detect with dust-free air at atmospheric pressure the non-extinction of the track as seen through a nicol at any orientation. With carbon dioxide the effect is quite conspicuous, and visual determinations of its magnitude have been successfully made by Mr K R Ramanathan working in the present writer's laboratory.

A very interesting question arises whether it is possible to establish the same effect by observations on the polarisation of skylight. As is well known, there is a marked defect in the polarisation of skylight in a direction removed 90° from the sun, which is, however, in the main, due to dust and condensed water-vapour in the atmosphere and the diffuse lighting up of the sky by self-illumination and by reflection from the earth's surface. It occurred to me that the elimination of the effects due to these disturbing factors does not present insuperable difficulties. The reflecting power of landscape (about 0·08 when covered by vegetation) is known, and its effect is therefore calculable. Dust and low-lying mists may be practically eliminated by making the observations on a bright, clear day at a high-level station, and the self-illumination of the sky under the same conditions is very small *in respect of wave-lengths near the extreme red end of the spectrum.* The residual effect of self-illumination in these circumstances may be computed with sufficient accuracy by the method used by L V King (*Philos. Trans. R. Soc. London*, A **212**, 1913), the uncertainties due to the neglect of the curvature of the earth and other simplifying assumptions in the calculation being then of little importance.

In order to obtain material for testing these ideas I made observations on the forenoon of December 4 last from the summit of Mount Dodabetta, in the Nilgiris (8750 ft above sea-level), the sky at the time appearing beautifully clear, free from cirrus clouds, and almost completely black when seen through a deep red filter. The weaker component of polarisation was found to have 13% of the intensity of the stronger component. Diffuse illumination of the sky is capable of explaining only a part of this, a weaker component of about 8% intensity being indicated by the calculations. The residual 5% must therefore be ascribed to molecular anisotropy, and this is in agreement with the laboratory determinations of Rayleigh.

Observations on the molecular scattering of light in *liquids* made by the writer also show an imperfect polarisation attributable to anisotropy. Experiments in the same direction on the atomic scattering of light in crystals are being made, and an attempt is also in progress to discover the existence of an effect indicated by Sir J J Thomson's theory (*Philos. Mag.*, October, 1920), namely, the dependence of the results on the frequency of the scattered radiation.

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