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The molecular scattering of light in liquids and solids

As was pointed out by the late Lord Rayleigh, the basis of his theory of the blue sky, namely, that the molecules scatter the incident energy independently of each other's presence, is only true for gases in consequence of the freedom of movement the molecules possess in this state of matter. In connection with the problem of the colour of the sea and of deep waters generally it is necessary to know the scattering power of ordinary liquids, such as water, and I find this can be very simply accomplished by application of the theory of local fluctuations of density arising from molecular movement, originated by Einstein and Smoluchowski and utilised by the latter to elucidate the phenomena occurring near the critical state. The general formula for the scattering power of a fluid is

$$\frac{\pi^2 RT\beta}{18N\lambda^4}(\mu^2-1)^2(\mu^2+2)^2,$$

where β is the compressibility of the substance, μ its refractive index, R, T, N being the usual constants of the kinetic theory. The scattering power of water comes out from this formula is about 160 times that of air. Not only is this in agreement with observation, but I find the coefficient of extinction of light due to scattering

$$\frac{8\pi^3 RT\beta}{27N\lambda^4}(\mu^2-1)^2(\mu^2+2)^2$$

closely represents the observed transparency of pure water in the region of the spectrum where there is no selective absorption. Work is now in progress testing the formula in the case of other liquids.

It is clear that an application of the same idea of local fluctuations of optical density and of Debye's theory of the thermal movements in solids would give the theoretical scattering power of transparent crystals for ordinary light. This is also being tested.

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