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Acoustic spectrum of liquids
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Acoustic Spectrum of Liquids

As is now well known, examination by means of a Fabry-Perot étalon reveals remarkable changes in the spectral character of monochromatic radiation when it is scattered within a dust-free liquid. Earlier studies in this laboratory[1] disclosed that the relative intensity of the undisplaced central line to that of the two Doppler-shifted companions appearing on either side of it varies greatly from liquid to liquid, being for example much larger in carbon tetrachloride than in toluene. The origin of the undisplaced central line has been until now one of the unsolved problems of the subject; its high intensity in the case of carbon tetrachloride and its practically complete polarization in this liquid as well as in toluene and carbon disulphide indicate that it cannot be ascribed to the depolarized scattering by optically anisotropic molecules.

Systematic studies have now been made with a number of liquids, including the following: acetone, carbon disulphide, toluene, water, formic acid, acetic acid, butyl alcohol, carbon tetrachloride, phenol and glycerine. The general result which emerges from this comparative study is illustrated in the accompanying Fabry-Perot patterns. Fig. 1 (*a*) is the Fabry-Perot pattern of the incident light, which is the 4358 A. radiation of a water-cooled low-density mercury arc lamp, while Fig. 1 (*b*), (*c*) and (*d*) are the patterns obtained respectively with the light scattered through 180° by the liquids phenol, butyl alcohol and acetone. It will be seen that the pattern given by phenol is indistinguishable from that of the incident radiation. A similar result has also been obtained with glycerine. With butyl alcohol, on the other hand, the Doppler-shifted companions are faintly visible, while with acetone, they are very conspicuous.

It is thus seen that in highly viscous liquids such as phenol and glycerine, the sound waves of high frequency necessary for reflecting the incident light waves are conspicuously absent. The scattering of light within such liquids must therefore be ascribed to other causes, for example, relatively immobile fluctuations of density or clustering of molecules. The greater intensity of the Doppler-shifted components with such relatively inviscid liquids as acetone or toluene, on the other hand, indicates the existence in them of organized sound-waves as part of the thermal agitation. It appears reasonable to ascribe the unshifted central line obtained with such liquids to the existence of relatively immobile fluctuations of density or clusters of molecules on which the rapidly moving sound-waves are superposed. This is clearly suggested by the comparative study of the patterns obtained with various liquids, which indicates a progressive falling off in the intensity of the Doppler-shifted components with increased damping of high-frequency sound waves due to viscosity as given by the classical formula of hydrodynamics.

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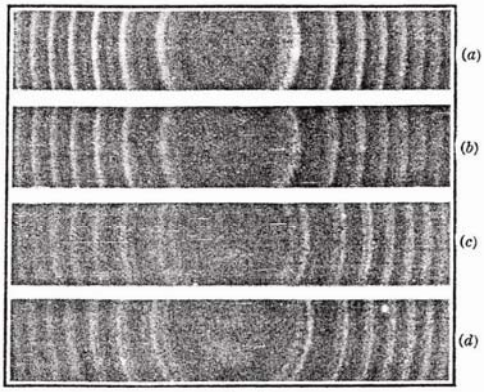

Fig. 1.

Fabry-Perot patterns of incident radiation, 4358 A. (*a*), and of radiation scattered by phenol (*b*), butyl alcohol (*c*) and acetone (*d*).