component of which is shifted from the centre of the line by different amounts for different settings of the crystal. With the direction of incidence along the Y -axis and scattering along the Z -axis of the crystal the shift is 1.90 cm^{-1} . This shift is too large to be accounted for by the difference in the refractive indices for 4358 Å. and 2536 Å. The intensity of the displaced components is also only a small fraction of that of the undisplaced line. Hence these results are not in agreement with those observed by Gross.

In order to find out the cause of this discrepancy, the investigation has been repeated with a technique in which the mercury vapour filter has been dispensed with. The 4358-Å. line of mercury incident along the Y -axis of a quartz crystal of dimensions $3 \text{ cm.} \times 2.5 \text{ cm.} \times 5 \text{ cm.}$ and scattered along the Z -axis has been photographed in the third-order spectrum produced by a 12-ft. concave grating having a dispersion of 1.5 Å. per mm. and a resolving power of about 40,000. The spectrogram is reproduced herewith. The 4358-Å. line is accompanied by strong ghost lines on each side; but it can be clearly seen that each of these lines consists of a doublet without any central component between the two outer components. Thus the incident line is split up into only two Brillouin components during the process of scattering by quartz.

(a) Incident; (b) scattered. B, Brillouin component

The shift of each component from the centre of the line is 0.179 Å. or 0.95 cm^{-1} . The refractive indices of quartz for the two wave-lengths 4358 Å. and 2536 Å. are 1.55 and 1.60 respectively. Hence the expected shift in the region of 2536 Å. is 1.68 cm^{-1} . Krishnan and Chandrasekharan have observed only a weak doublet, each of the components being shifted from the centre of the 2536.5-Å. line by 1.90 cm^{-1} . Evidently, the main Brillouin components in their arrangement have been absorbed by the mercury vapour filter, and the larger frequency-shift of the weak doublet observed by them may have been produced by some scattering process in the absorbing mercury vapour observed previously by one of us⁴. Thus the method used by them is not suitable for studying the Brillouin components.

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Use of Coaxial-Cylinder Viscometers and Capillary-Tube Viscometers for Suspensions

WHEN a capillary-tube viscometer is used for determining the apparent viscosity of a suspension of discrete, solid particles in a liquid, it is found that the measured viscosity varies with the bore of the capillary, increasing with increasing diameter. This effect, termed the sigma phenomenon, has been investigated by several workers, but in particular by Vand¹ and de Bruijn², both of whom examined the rheological properties of suspensions of spherical glass particles in liquids inert to glass.

Vand, in a mathematical treatment of the problem, suggested that at the wall of the tube through which a suspension is flowing, there would be a layer of the liquid phase having a thickness dependent only upon the particle diameter of the solid phase. Under certain conditions, therefore, the thickness of the layer would constitute a substantial proportion of the radius of the capillary, and the flow of this liquid film would give rise to the observed effect.

De Bruijn attributed the sigma phenomenon to the interaction of particles in a suspension subjected to shear. Dix and Scott Blair³ had proposed a theory in which they assumed that the streamlining layers were not infinitely thin, and that flow took place by the telescoping of concentric fluid layers of equal thickness. Extending this theory, de Bruijn obtained an expression relating the sigma phenomenon to the concentration of the solid phase.

Both theories lead to the conclusion that the effect should also be observed in a coaxial-cylinder type viscometer, resulting in an increase of apparent viscosity with increasing annular-gap widths. In the course of extensive investigations of the factors affecting the viscosity of suspensions (the results of which will be published in full elsewhere), we have made measurements on stable suspensions of closely sized, spherical, methyl methacrylate polymer particles, having mean diameters varying from 38 to 388 microns, in an aqueous solution of lead nitrate and glycerol. Apparent viscosities were determined in a Couette-type viscometer, using annular gaps of 2, 3 and 4 mm., up to volume concentrations of 20 per cent.

Within the range investigated (ratios of annular gap to particle diameter from 5:1 to 110:1), no sigma phenomenon was detected, and in all cases the viscosity was independent of the rate of shear. The latter characteristic has already been noted when measuring the viscosity of similar suspensions using a rising-sphere viscometer⁴, but the fact that the apparent viscosity is independent of gap width in a Couette-type instrument appears to be new. The reason for, and the significance of, this observation are not immediately clear, but it leads to the possible conclusion that coaxial cylinder viscometers are to be preferred to capillary-tube viscometers for measurement of the viscosity of stable suspensions.

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