LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the eighteenth of the preceding month, for the second issue, the third of the month. Because of the late closing dates for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

Theory of the Magnetite Light Shutter

In a recent article in this journal[1] Heaps has reported that a fairly coarse magnetite suspension acts in a limited way as a magnetically controlled light shutter. To explain this phenomenon Heaps assumes (1) that the particles are oriented by the magnetic field according to Langevin's theory of a paramagnetic gas, and (2) that individual particles (or small groups of particles) cast a shadow given by $S(\theta)=A\sin\theta+E\cos\theta$ appropriate to a cylinder.[2] The total shadow S cast by all particles is then computed and an expression obtained relating measured light quantities to the applied magnetic field. Heaps finds that this simple theory fails to give the correct law of variation of light with magnetic field.

It has occurred to the writer that it is more reasonable to suppose that the magnetic entities responsible for the effect have, on the average, an ellipsoidal rather than cylindrical shape. It is easy to show that the shadow cast by an ellipsoid of revolution is given by the expression

$$S(\theta)=\{(A^4\sin^2\theta+E^4\cos^2\theta)/(A^2\sin^2\theta+E^2\cos^2\theta)\}^{\frac{1}{2}}$$
$$=E+\{(A^4-E^2A^2)/2E^3\}\sin^2\theta+O(\sin^4\theta)\cdots. \quad (1)$$

On computing the total shadow S, making approximations appropriate to $a=\mu H/kT\gg 1$ and relating S to measured light quantities, the relation

$$l_{||}-l=(1/a)[(l_0-l_\perp)^4-(l_0-l_\perp)^2(l_0-l_{||})^2]/(l_0-l_{||})^3+O(1/a^2)\cdots \quad (2)$$

is obtained, to be compared with Eq. (7) in Heaps' article. Thus, for large a, it is deduced that $(l_{||}-l)\sim H^{-1}$, rather than $(l_{||}-l)\sim H^{-\frac{1}{2}}$ as earlier predicted. Eq. (2) has been tested by plotting corresponding values of $(l_{||}-l)$ and H^{-1} computed from Fig. 1 in which Heaps summarizes his experimental observations. A fairly good straight line is obtained from whose slope the average particle moment μ has been calculated to be $\mu=1.4\times10^{-12}$. This value of μ is in substantial agreement with the value $(\mu=1.0\times10^{-12})$ obtained by Heaps from a direct measurement of the magnetization curve of a more dense suspension. Hence by substituting ellipsoidal for cylindrical particles the simple theory can be retained without resort to a more complicated analysis.

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[1] C. W. Heaps, Phys. Rev. **57**, 528 (1940).
[2] See reference 1 for meaning of symbols used in this note.

Influence of Electrostatic Fields on the Elastic Properties of Rochelle Salt

According to the new interaction theory of Rochelle salt, presented elsewhere in this issue, the strain-stress relation $y_z(Y_z)$ of a foiled crystal should be similar to the dielectric $P_x(E_x)$ relation, i.e., it should show hysteresis loops at temperatures below the Curie point and satisfy a $\frac{1}{3}$ power law at the Curie point. Since the shear modulus or the compliance coefficient s_{44} for small strain variations is determined by the slope of the strain-stress curve, these quantities will be altered when a large constant strain is superposed on the small strain variations. This effect is analogous to the observed variation of the reversible susceptibility when a crystal is subjected to a steady field.

If, therefore, a constant potential is applied across electrodes attached to the a faces of a plate of Rochelle salt, all resonance and anti-resonance frequencies of this plate will be altered, because the static field creates a large piezoelectric strain and hence changes the compliance coefficient s_{44} which enters into the equations determining those resonance frequencies which can be excited by small alternating fields in the a direction. This conclusion has been verified by measurements on a plate of Rochelle salt, 3×5 cm in area and about 1 mm thick in the a direction. The source of steady potential V is connected to the electrodes over large chokes and the crystal is connected to the measuring circuit over large condensors. This crystal

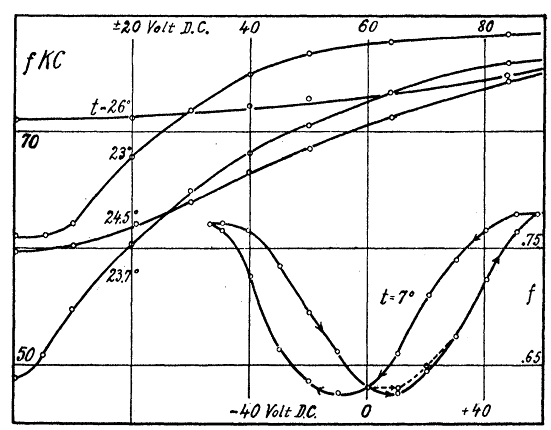

FIG. 1. Change of the resonance frequencies of a foiled plate of Rochelle salt, cut normal to the a axes, with application of a steady potential across the electrodes.