



Fig. 3. (a) Spectrum of main discharge in nitrogen; and (b) spectrum of afterglow, both at a pressure of 43 mm.

Full details and a discussion of these and other results at present under investigation will be published elsewhere. This work has been possible because of the generous loan of the radar set by the Defense Research Board of Canada, and the awards of a bursary to J. R. Kenney by the National Research Council of Canada and of a scholarship to W. C. Nixon by the Research Council of Ontario.

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Diamagnetic Susceptibility and Anisotropy of Ice

THE diamagnetic susceptibility of ice has been found¹ to have the mean value at 0° C. of -12.65×10^{-6} c.g.s. e.m.u./mole. This is very similar to the value of the mean susceptibility of water of crystallization in organic molecules. For example, succinic acid $(\text{CH}_2\text{COOH})_2$, and oxalic acid hydrate $(\text{H}_2\text{O}.\text{COOH})_2$, have mean susceptibilities of -54.45^2 and -56.09^3 ($\times 10^{-6}$), respectively. The mean susceptibility of the CH_2 group is known to be -11.8 , and application of Pascal's additive rule would give, by simple substitution, the value of -12.6 for H_2O .

No measurements appear to have been made of the diamagnetic anisotropy of single ice crystals. The strength of ice differs considerably parallel and perpendicular to the principal axis c . This is because, for cleavage or slipping parallel to the c axis, two bonds per unit cell must be broken, as compared with one for perpendicular directions. The only bonds in ice are long hydrogen bonds; if, therefore, the diamagnetic susceptibility of ice or of water of crystallization were a directive property of the hydrogen bond, one might expect a considerable anisotropy. If it were a property only, or mainly, of the water molecules themselves, very little anisotropy would be expected.

In fact, the diamagnetic anisotropy is almost negligibly small; so small that it is difficult to measure. Blocks of ice were cut from a sheet grown naturally in cold weather on the surface of a dish of London tapwater; these were from 13 mm. \times 5 mm. \times 3 mm. upwards in size, and X-rays showed that the c axis was parallel to the smallest dimension (that is, perpendicular to the surface of the ice sheet), and that they were single crystals. The magnet pole-pieces were packed round with solid carbon dioxide in order to attain a temperature at which the measurements could be made; if the preliminary experiments had shown that an anisotropy of some con-

siderable relative magnitude existed, then a more permanent and adjustable temperature control would have been set up. The temperature actually varied from about -5° to -15° during the course of the readings. The quartz fibres used could not be very fine, because of the experimental difficulty of manipulating the large ice crystals; that finally used was one which required an angle of twist (Krishnan and Banerjee's displacement method⁴) of $3,200^\circ$ for a benzil

crystal of mass 0.0154 gm. and anisotropy 45.6×10^{-6} . The ice crystal, the mass of which was determined sufficiently exactly from its volume and density, was fastened to the lower end of the calibrated quartz fibre, with the c axis horizontal, by means of a very small stirrup of filter paper, the anisotropy of which was also measured. No other means of suspension was found to be satisfactory, and, indeed, this was not at all ideal, for the anisotropy of the stirrup was comparable with that of the ice, and unless the paper was frozen on to the ice so that their anisotropies added up, the composite effect was that the crystal would not rest with its c axis either axial or equatorial in the magnetic field. In fact, it behaved very much like an isotropic crystal of lithium fluoride of the same dimensions which was compared with it under similar conditions.

The largest positive result observed, for a crystal which did set definitely with its c axis equatorial, was $\chi_a - \chi_c = 0.06 \times 10^{-6}$, giving the separate values:

$$\chi_c = -12.68 \times 10^{-6} \text{ c.g.s. e.m.u./mole.}$$

$$\chi_a = -12.62 \times 10^{-6} \text{ c.g.s. e.m.u./mole.}$$

It may be mentioned that the difference of the refractive indices in these two directions in ice-crystals is also extremely small⁵.

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³ Lonsdale, K., *J. Chem. Soc.*, 365 (1938).

⁴ Krishnan, K. S., and Banerjee, S., *Phil. Trans. Roy. Soc., A*, **234**, 265 (1935).

⁵ Merwin, H. E., "Intern. Crit. Tables", **7**, 17 (1930).

Positions of Three Discrete Sources of Galactic Radio-Frequency Radiation

IN a recent communication¹ an account was given of the discovery of a number of discrete sources of galactic radio-frequency radiation. Accurate measurements of the position of three of these sources have since been made from sites on the east and west coasts of New Zealand and on the east coast of Australia. The technique employed was to observe the sources at rising or setting, with an aerial on a high cliff overlooking the sea. These observations, when corrected for atmospheric refraction, allow the path of a source above the horizon to be plotted, and the time of its rising and setting—and hence its celestial co-ordinates—to be determined.

It is found that all three sources correspond within limits of experimental error to positions of certain nebulous objects. The positions of the sources