With no mica in the path of the beam, a similar spot with a bright centre was obtained and could be observed directly on the screen through a microscope. On starting the discharge with a fresh cathode, only a single spot of about 0·5 mm. diameter is seen, diminishing in intensity towards the edge. After a few minutes a ring forms, and gradually increases in diameter with the formation of a centre. The centre brightens until the comparatively stable condition shown in Fig. 2 is attained at the end of about an hour of discharge.

These variations in the spot seem to show that we have here a pin-hole picture of the emitting surface of the cathode. The central spot only forms after a minute crater has appeared on the cathode through positive ion bombardment. This crater grows and with it the intensity of the spot. On examining the geometry of the system, we see that hole *B* plays but a small part, and that *C* acts as pin-hole lens for reproducing the cathode on *D*. This shows that electron beams obey the simple laws of geometrical optics. Campbell Swinton [1] suggested that cathode beams are hollow, with a central pencil down the axis for soft discharge, but did not observe this phenomenon in hard tubes.

If the distances between the diffraction images in Fig. 2 be measured, we find that the triangles formed by the images are nearly isoceles and definitely not equilateral (see Kikuchi [2]). Accurate measurements on various micas are being made.

By using beryllium as a cathode we hope to achieve more constant conditions than with electron metal. After a few hours of discharge the centred ring is formed and should remain fairly constant for a long time. On inserting fused quartz or mica diaphragms in front of the cathode with a hole about 0·2 mm. in diameter, we hope to eliminate the circle and thus obtain the very fine central pencil by itself.

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[1] *Proc. Roy. Soc.*, **61**, 79; 1897.
[2] *Jap. J. Phys.*, **5**, 87; 1928.

## Influence of Light on Paramagnetic Susceptibility

BOSE and Raha have reported [1] that they had observed a diminution of the susceptibility of a chromic chloride solution and of other coloured paramagnetic solutions, when the solutions were exposed to concentrated visible light. They interpreted their result as due to the fact that, by the absorption of light, some of the metallic ions are transferred into excited states, in which they would have a lower magnetic moment than in the basic state. This would indicate that in the case of chromic chloride, one of the three electronic spins had been reversed, with respect to the other spins, in the transition.

Specchia [2] tried to repeat these observations by the capillary ascension method, but came to no definite results. My own preliminary observations, with the aid of a long-periodic torsion balance, confirmed Bose and Raha's observations.

It occurred to me [3] that the explanation given by Bose and Raha would necessitate an extraordinary long life of the ions in the excited states, which had to be at least of the order of 0·1 second. Moreover, the energy which is absorbed will in the end for the greater part be transformed into heat, and the resulting rise of temperature of the substance will, according to Curie's law, also cause a decrease of the susceptibility. One can calculate the influence of this temperature effect for the extreme case when the excited ions have no magnetic moment at all during a time $T$, if we suppose that the absorbed light of a wave-length of 6000 A. is transformed into heat after the same time $T$. It appears that for a saturated solution of chromic chloride, in a time so short as $4{\cdot}5\ T$, the influence of the temperature effect will already be equal to the effect due to the presence of the excited atoms.

The result of this calculation suggests that the observed change of the susceptibility is entirely due to the rise in temperature.

I have tested this latter hypothesis in the following way: Two equal bulbs, filled with a saturated solution of chromic chloride, were suspended by a torsion wire symmetrically in an inhomogeneous magnetic field, so that the magnetic forces exerted on the bulbs were in equilibrium. The periods of the torsion balances used were rather short: 15 and 30 seconds.

When the light of a high-pressure mercury arc was concentrated on one of the bulbs, a change in the susceptibility could be observed, which increased with the time, and could be interpreted, assuming Curie's law, as due to a rise in temperature of 0·0010° per second. The red and infra-red rays were filtered off by a solution of cupric chloride, and as the arc was calibrated with a flicker photometer, it could be estimated that the energy of the visible light falling on the bulb was sufficient to cause a rise of temperature of about 0·0013° per second. Afterwards the rise of temperature was measured directly in the same arrangement with a thermo-element and proved to be 0·0011° per second, the rise being linear with regard to time during the experiment.

The agreement with the measurements on the change of the susceptibility is satisfactory, and it may be concluded that the effect observed by Bose and Raha really exists, but is very probably due to a rise of the temperature of the substance. No conclusions about magnetic moments in excited states can thus be drawn from such experiments.

I wish to express my thanks to Prof. A. D. Fokker and to Dr. A. C. S. van Heel for the active interest they showed in this research, and to Prof. W. J. de Haas, who kindly put the mercury arc at my disposition.

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[1] NATURE, **127**, 520, April 4, 1931.
[2] O. Specchia, *Il Nuovo Cimento*, **8**, 179, 291; 1931.
[3] C. J. Gorter, *Arch. du Musée Teyler*, **37**, 182; 1932.

## Infra-Red Bands in the Aurora

IN his letter in these columns [1] regarding the infra-red aurora spectrum observed by Vegard, Jevons failed to say anything about an intensity phenomenon in the first positive bands of nitrogen to which I first directed attention in a note in the *Physical Review*.[2] I called this phenomenon the variation of intensity within a progression, the progression in this case being a '$v'$' progression. It is strikingly demonstrated in Lord Rayleigh's [3] experiments on the afterglow in mixtures of nitrogen and the rare gases. In this paper Lord Rayleigh suggested that the auroral radiation of wave-length 6323 A. was probably the first positive nitrogen band (10, 7). In directing attention to Lord Rayleigh's experiments, I pointed out that his results could be interpreted as either real or apparent violations of the Franck-Condon rule for band intensities. Recently, a similar result in iodine, namely, the observations of Ramsauer on the quenching of a fluorescence series in an iodine-oxygen mixture, was explained by Loomis and Fuller,[4] who