

## LETTERS TO THE EDITOR

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## Magnetism of Phosphors

A STUDY of the magnetic susceptibility by the Curie balance of a few commercial samples of phosphorescent powders indicates an increase of diamagnetism when the powder is rendered luminiscent. As long as the composition of the phosphors remains unknown, the observed variation may be attributed to the existence of some paramagnetic components, whose susceptibility depends on temperature. With the view of eliminating the uncertainty regarding the composition, the calcium "sulphide"—bismuth phosphor was prepared from chemically pure ingredients. 7 gm. of sulphur and 10 gm. of calcium oxide were ground together and heated to redness for about 15 minutes in an electric furnace. 5 gm. of this calcium "sulphide" was mixed with 0.25 gm. of sodium sulphate, 0.15 gm. of sodium tetraborate, 0.10 gm. of calcium fluoride and 0.0012 gm. of bismuth; the mixture, after heating to bright redness for about 25 minutes, yielded the CaS-Bi phosphor which phosphoresces with a blue colour when exposed to light. In fact the luminescence is so strong that the spectrum of the phosphorescent light is clearly visible in a direct vision spectroscop.

A magnetic study of this phosphor has revealed that the process of the decay of phosphorescence can be followed from observations on the variation of susceptibility during the decay. Fig. 1 gives the variation with time of the

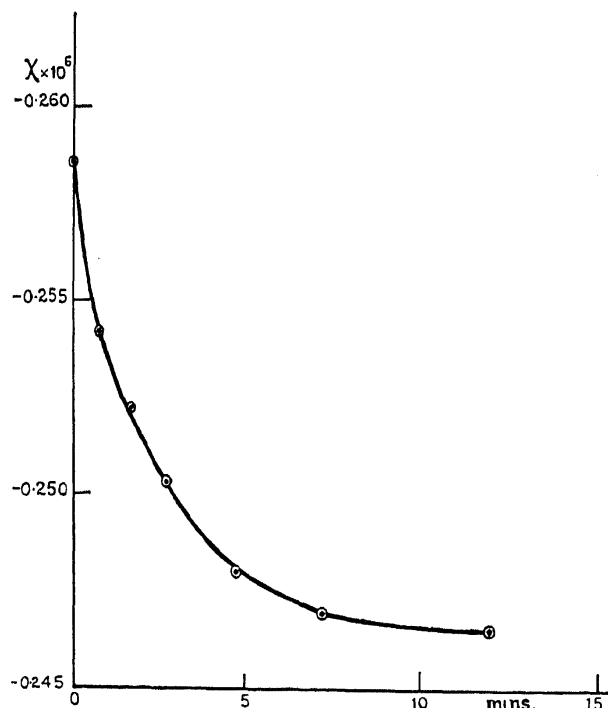


FIG. 1

The variation of magnetic susceptibility of CaS-Bi phosphor during phosphorescent decay

susceptibility of the CaS-Bi phosphor initially illuminated strongly. As the materials utilised in the preparation of the phosphor are all diamagnetic, the observed increase of diamagnetism while luminescent cannot be ascribed to a temperature effect. An independent test has shown that the temperature effect on the magnetism of the powder is inappreciable. According to the view put forward by Lenard,<sup>1</sup> the phosphorescent centre consists of the atom of the heavy metal (Bi) attached to a sulphur atom in the ringlike arrangement of the alkaline earth sulphide (CaS). The increase in the observed diamagnetism while luminescent is on this basis explicable as arising from the larger electron orbits which circumscribe the phosphorescent centre on irradiation; our results therefore lend support to Lenard's view regarding the mechanism of phosphorescence. The earlier results of Rupp<sup>2</sup> cannot however be reconciled with the expectations of the Lenard theory.

L. SIBAIYA.

H. S. VENKATARAMIAH.

University of Mysore,  
Central College, Bangalore,  
April 11, 1940.

<sup>1</sup> Lenard, *Ann. der Physik*, 1910, **31**, 641.

<sup>2</sup> Rupp, *ibid.*, 1925, **78**, 505. (*Vide Physical Principles and Applications of Magnetochemistry* by Bhatnagar and Mathur, p. 158.)

### A New Band $\lambda$ 2963 of the OD Molecule

IN a previous letter<sup>1</sup> the rotational structure of the (2,1) band  $\lambda$ 2916 of the OD molecule has been reported. Further work on the emission band spectrum of heavy water has revealed the existence of a new band with its head at  $\lambda$ 2963, showing doublet P, Q, R branches, characteristic of the electronic transition  ${}^2\Sigma^+ \rightarrow {}^2\pi_{inv}$ . The values of the rotational term differences and the calculated constants indicate that the band corresponds to the vibrational states  $\nu' = 3$  and  $\nu'' = 2$ . Attempts are being made to detect the analogous (3,2) band of the OH molecule, which does not appear

to have been identified so far in spite of numerous investigations on the emission spectrum of ordinary water vapour.

The calculated constants for  $\lambda$ 2963 referred to above are  $B_3' = 8.09$ ,  $B_2'' = 9.31$ .

The wave numbers of the lines  $Q_1(1)$  and  $P_1(1)$  are 33702.8 and 33686.9  $\text{cm.}^{-1}$  respectively. The analysis has led further to estimate the vibrational constants for the lower electronic state of the OD molecule. From the data for the bands (2,0), (2,1) and (3,1), (3,2) the intervals  $\Delta\nu_{\frac{1}{2}}''$  and  $\Delta\nu_{1\frac{1}{2}}''$  have been found to be 2632.0 and 2544.5  $\text{cm.}^{-1}$  respectively. Hence it is easy to deduce the following values for the vibrational constants,

$$\omega_e'' = 2719.5, \quad x_e''\omega_e'' = 43.75.$$

The mass ratio of the hydrogen isotopes estimated from  $\omega_e''$  (OD) and  $\omega_e''$  (OH) is obtained as  $\rho = 0.7281$ .

Details of the rotational structure will be published shortly.

K. R. RAO.

M. G. SASTRY.

Andhra University,  
Waltair,  
April 8, 1940.

<sup>1</sup> *Curr. Sci.*, 1940, **4**, 172.

### Variation of Intensity along an Electron Reflection Ring

IN examining the structure of a polycrystalline surface by electron reflection, the patterns obtained consist of rings in the form of semi-circles. The reflected rays lie on a cone with the incident beam as the axis. The electrons reflected along a generator of this cone which lies in the plane of incidence, leave the material by the shortest path; while the electrons moving along any other generator have to travel over a longer distance. Those electrons which travel over a longer distance in the material are absorbed more than those which have a shorter path in it. Thus we can see that the intensity of a ring in a reflection pattern—which is merely the section of cones