ART. XIX. —*Phosphorescence Produced by the Canal Rays*;
by JOHN TROWBRIDGE.*

IN most cases the phosphorescence caused by the canal rays is similar in color to that produced by the cathode rays. When, however, the canal rays fall upon lithium chloride there seems to be a marked difference. Professor J. J. Thomson, in his treatise on conduction of electricity through gases, describes a form of tube in which a layer of lithium chloride can be bombarded alternately by both kinds of rays, and he states that when the layer is struck by the canal rays it shines with a bright red light and the lines of the lithium spectrum are very bright; when, however, the direction of the discharge is reversed so that the layer is struck by the cathode rays, its color changes from bright red to steely blue, giving only a faint continuous spectrum but not the lithium lines. The layer steadily becomes black in hydrogen.

I have succeeded in producing the red phosphorescence by the cathode rays, thus annihilating the distinction in this case between the two kinds of rays. The method adopted seems to have a general application in the study of phosphorescence and is as follows;

The vacuum tube was of cylindrical form; the cathode was a concave aluminium mirror, the anode a circular iron electrode with a circular orifice at its center. A glass tube was inserted in this orifice and was welded to the walls of a tubular appendix, shutting out all rays except those which passed through the orifice. This cylindrical appendix 3^{cm} to 8^{cm} long was closed at the end by a ground glass stopper with a flat end; on this end could be sifted the layer of lithium chloride which was held by a suitable medium; a solenoid was slipped over the tube, the latter forming the core of the solenoid; the longitudinal magnetic

* University Press, Cambridge, 1906, p. 642.

line of the solenoid thus passed through the core. Fig. 1 shows the arrangement; *A* represents the circular iron terminal with its central orifice perforated by a glass tube; *S* the solenoid; *L* the stopper with the layer of lithium chloride at its end.

When the solenoid is excited the cathode rays can be brought to a sharp focus on the layer at *L*, and the apparatus can be called in popular language a magnetic lens. A very intense cathode beam can be made to converge at *L* by suitably adjusting the solenoid. The rays seek the weakest part of the magnetic field. Immediately on striking the layer of lithium chloride the red phosphorescence appears at the center of the focus, and is surrounded by the blue phosphorescence; either the red or the blue can be produced at pleasure.

It seems, therefore, that if n is the number of cathode particles, m their mass, v their velocity; and n' the number of positive particles, m' their mass, v' their velocity, that the equation

$$nmv^2 = n'm'v'^2$$

holds on the unit of area; and that the distinction in this case between the color produced by the cathode rays and the canal rays disappear. The production of the two colors is a question of energy on the unit of area.

I have examined the phosphorescence of the other metals of the same group as lithium. Cæsium gives a very bright blue color for both the cathode and the canal rays and the blue lines of the spectrum appear with the application of the cathode beam. Rubidium gives both a red and blue color; the red, however, is much less bright than in the case of lithium chloride. All of these salts are quickly decomposed. Calcium tungstate recovers from fatigue very quickly and is not decomposed appreciably even after long exposures. Its use for X-ray screens is, therefore, substantiated by these experiments.

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