LII. The secondary spectrum of hydrogen

C.F. Hogley A.R.C.Sc. B.Sc.

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at 10,000 amperes, which he considers a low estimate. The effect of the lightning may be partly a heating one, the rock being heated so far as to transform a non-magnetic into a magnetic constituent, which is then magnetized by the earth's field. A second possibility is to attribute the chemical change to the sun's heat, and the magnetization to the lightning flash, since the experiments of Folgheraiter and Messrs. Platania* have proved that both the earth's field and lightning are operative in producing magnetization in rock material.

Experiments on hæmatite ores are in progress, but sufficient has been done to find that the second allotropic form of magnetite, into which they change on being heated at 400°, behaves similarly to the more common form as regards loss of magnetic power about 550° C.

The experiments described in this paper were made in the Natural Philosophy Buildings of Glasgow University, and I have to thank Professor Gray for valuable suggestions made during their progress.

Glasgow, 30 Nov. 1908.

LII. *The Secondary Spectrum of Hydrogen.*

By C. F. HOGLEY, A.R.C.Sc., B.Sc.†

IT is well known that vacuum-tubes filled with hydrogen emit two spectra. One of these consists of the well-known lines which are seen reversed in the spectrum of the sun and in the spectra of some stars. The other spectrum is known as the secondary spectrum, and consists of a multitude of fine lines crowding the visible region, being especially conspicuous in the neighbourhood of the yellow. These lines have not been observed in stellar or solar spectra, and it has been regarded as doubtful whether they are due to hydrogen at all.

It seems almost certain that if this spectrum is not due to hydrogen, it is due to some more easily condensible substance. Sir James Dewar has shown that all gases except hydrogen, neon, and helium, are readily condensed by charcoal at the temperature of liquid air. This method of condensation seems to afford an opportunity of testing whether or not the secondary spectrum is in reality due to hydrogen.

* G. & G. Platania, *Comptes Rendus*, cxli. p. 974 (1905).

† Communicated by the Hon. R. J. Strutt, F.R.S.

To carry out the experiment the apparatus shown in the diagram was constructed.

A, vacuum tube; B, bulb containing charcoal; C_1 , C_2 , drying-tubes containing phosphoric oxide. The hydrogen was prepared from sulphuric acid and pure zinc.

The apparatus was exhausted and filled with hydrogen from the generator attached. This was repeated until the lines due to oxygen and nitrogen could no longer be seen in the spectrum of the gas. The charcoal had been heated previous to sealing on to the apparatus to drive off all moisture, and whilst the exhaustion was in progress it was again heated to expel any gases which might be condensed in its pores. The heating was not prolonged sufficiently to drive off all the carbon dioxide present in the charcoal. The amount of this gas was small, and would not interfere with the absorbing properties of the charcoal when cooled by liquid air. When a suitable vacuum had been obtained giving a spectrum of maximum brightness, the bulb B was immersed in liquid air. On observing the spectrum the intensity of the lines was seen to decrease, and the appearance of the discharge in the tube indicated a decrease in pressure of the gas. The relative intensities of the two spectra, however, remained unchanged up to the total disappearance of the whole spectrum, when a discharge would no longer take place through the gas owing to the high vacuum. A little more hydrogen was allowed to enter, and the spectrum reappeared with its original brightness, but after a time the same decrease in intensity as before was observed, though the condensation did not proceed sufficiently to stop the discharge.

Two attempts were made, the first using only a small bulb

containing about 1 gram, and the second with a larger bulb containing about 5 grams of charcoal. The change in the spectrum was only that due to the change in pressure of the gas, as was demonstrated by simply exhausting the apparatus and observing the spectrum.

So far, then, as this method can decide, the evidence points to the conclusion that hydrogen is really the source of the secondary spectrum.

I am indebted to Prof. Strutt, of the Royal College of Science, for his various suggestions during this research, and I take this opportunity of acknowledging my thanks to him.

LIII. *The Action of Electrolytes on Copper Colloidal Solutions.*

By E. F. BURTON, B. A., *Demonstrator in Physics, University of Toronto* *.

1. INTRODUCTION.

THE problem of the effect of the presence of very small traces of electrolytes on the stability of colloidal solutions is one of the most important unsolved questions relating to colloids. The recent paper by Jacques Duclaux † tends to throw doubt on the theory of the isoelectric point first suggested by Hardy ‡; while a later contribution by Lottermoser § dealing with Duclaux's results shows, at least, that we have yet much to learn regarding the interaction of the colloidal particles and the dissolved salts.

The experiments detailed in the present communication are a continuation of those performed by the writer || on the action of small traces of electrolytes on silver and gold colloidal solutions prepared by Bredig's method. In this former work it was found that, as minute quantities of aluminium sulphate were added in increasing amounts to either silver or gold solutions, the velocities with which the particles moved in a given electric field were at first reduced to zero and then reversed. As the particles in each case were negatively charged in the pure solution, according to Hardy's theory, the positively charged aluminium ions, and

* Communicated by Professor J. C. McLennan.

† *Jour. de Ch. phys.* vol. v. 1-2-3, p. 29.

‡ *Proc. Roy. Soc.* vol. lxvi. p. 110; *Jour. of Physiol.* vol. xxix. p. 26.

§ *Zeits. für phys. Chem.* vol. lx. 4, p. 451.

|| *Phil. Mag.* ser. 6, vol. xii. Nov. 1906.