PROCEEDINGS

OF THE

NATIONAL ACADEMY OF SCIENCES

Volume 3 JUNE 15, 1917 Number 6

THE STARK EFFECT IN HELIUM AND NEON

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Communicated by H. A. Bumstead, April 20, 1917

Stark[1] and Koch[2] have studied the effect of an electric field on the spectral lines of helium by a method which was designed by Stark. Brunetti[3] and Evans and Croxson[4] nave studied the effect in the same substance by a method devised by Lo Surdo.[5] The results obtained by the two methods agree in the main, but hitherto the method of Stark has proved capable of greater refinement than that of Lo Surdo.

In the present investigation a method has been employed which is essentially a modification of Lo Surdo's but avoids the greatest disadvantages of that method. Lo Surdo's discharge tube is about 3 mm. in diameter and has a cylindrical cathode nearly filling it. The positive rays in the space before the cathode are in a strong field and are suitable for the study of the effect. The disadvantages of the method are, first, that the walls of the tube are quickly covered with a metallic film due to sputtering and, second, the tube breaks easily on account of the heating. In the present apparatus these difficulties are overcome by having within the discharge tube proper an inner tube made of aluminum through which the discharge takes place, and which has a slit through which the light passes. Opposite this slit there is a side tube having a window at its end. The aluminum is not seriously affected by the heat and the trouble from sputtering is eliminated.

The optical apparatus consists of a six prism spectrograph and a double image prism so arranged that photographs of the parallel and perpendicular components of the lines can be obtained simultaneously.

The source of current is a 13,200 volt transformer, the current from which is rectified by two kenotrons and a suitable arrangement of condensers and inductances.

The following is a brief summary of the results obtained in helium and neon:

1. The equation connecting the displacement of a component and the electric field is of the form

$$\delta\lambda = a + bE$$

where a differs from 0 for many components.

2. When $a = 0$, b is positive. Only two exceptions have been found to this rule, viz., He 4686 and He 3965.

3. There are simple numerical relations connecting the values of a for the different components of a given line. Such numerical relations exist to a less degree between the values of b.

4. The effect in the line He 4686 agrees qualitatively with that predicted by Evans and Croxson on Epstein's theory. The numerical

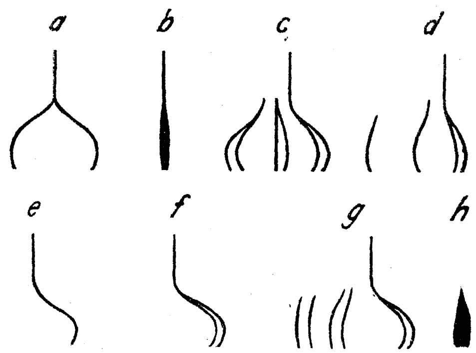

FIG. 1.

value of the ratio of the distance between the outer components of H_β to that of He 4686, however, was found to be $\frac{24}{3^2 - 2^2}$ instead of $\frac{24}{4^2 - 3^2}$ as predicted by them.

5. Two new lines of the same type as those discovered by Koch were observed in helium. In neon, 34 such lines were observed.

6. In the accompanying figure are shown some illustrations of the lines as they occur on the photographic plate. In these drawings the wave-length increases from left to right. The upper part of the illustrations shows the line as it appears when the field is zero, the lower part shows the effect of the field.

In the modified discharge tube used, the maximum value of the field occurs some distance above the cathode, instead of in its immediate vicinity. This causes the displaced lines to have the form shown instead of the simple Y shape given by Lo Surdo's tube.

The pair of symmetrical components illustrated at (*a*) is typical of the Balmer series of hydrogen. The separation of such components has been taken as a measure of the field, the constant obtained by Stark being used in each case to calculate the field intensity. The form illustrated in (*b*) is typical of lines which show no appreciable Stark effect. While it is distinctly broadened in its lower portion, there is no doubt that the greater part of that broadening is due to increased intensity in the stronger field. The illustration (*c*) represents those components of He 4388 whose electric vector is perpendicular to the field. It shows, in order from left to right, two components having $a < 0$ and $b < 0$, one component having $a<0$ and $b = 0$, one having $a<0$ and $b>0$, and finally two having $a = 0$ and $b>0$. The line sketched at (*d*) is He 4922. The type (*e*) is very common in neon as is also type (*f*). A few lines in neon are of the general type illustrated at (*g*). At (*h*) is shown the appearance of a typical new line. It is very broad and intense in the field but does not exist where the field is zero, or at least is so faint that it produces no effect on the photographic plate.

A detailed statement of the results together with a full description of the apparatus and method will be published shortly.

[1] Stark, J., *Elektrische Spektralanalyse chemischer Atome*, Hirzel, Leipzig, 1914; *Ann. Physik, Leipzig*, **48,** 1915, (193).

[2] Koch, J., *Ann. Physik, Leipzig*, **48,** 1915, (98), Cf. J. Stark, *Elektrische Spektralanalyse chemischer Atome*, 73.

[3] Brunetti, R., *Nuovo Cimento, Pisa*, **10,** 1915, (34).

[4] Evans, E. J., and Croxson, C., *Phil. Mag., London*, 32, 1916, (327).

[5] Lo Surdo, A., *Roma Atti Acc. Nuovi Lincei*, **22,** 1913, (664); **23,** 1914, (82); *Physik. Zs., Leipzig*, **15,** 1914, (122).

NEW ANALYSES OF ECHINODERMS

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Communicated April 18, 1917

In a recent publication of the United States Geological Survey[2] Clarke and Wheeler have reported 250 analyses of the shells and skeletons of marine invertebrates; analyses which were made in order to determine what each class of organisms contributes to the formation of marine limestones. In that investigation the echinoderms and alcyonarians were peculiarly interesting, not only because they were notably magnesian, but also because the proportion of magnesia in them was found to be related to temperature. The warm water forms were all relatively rich in magnesium carbonate, while the cold water forms were much