Physics. — "*Change of wavelength of the middle line of triplets.*" (Second Part). By Prof. P. ZEEMAN.

6. We will now return to the observations of § 4. Arranging these according to strength of field it appears that the distance $a'—a''$ changes considerably with increasing magnetic intensity. The displacement of line 5791 is not a linear function of the strength of the field but increases more rapidly than would follow from this simple relation. However it is impossible without further consideration to deduce the law of displacement, because, as remarked in § 4, the distance of the lines of comparison does not remain invariable. This is the reason why somewhat different values of $a'—a''$ are obtained, when these are calculated from the change of $a—a'$, than when the change of $b—a'$ is considered.

The direction however of the displacement of 5791 is easily determined. It is towards the *red* end of the spectrum. A shift towards the side of increasing wavelengths corresponds in the figure of § 3 to a displacement in the direction from a' towards a''. The less refrangible side of line 5791 is easily distinguished upon the negatives by the observation of the two weak less refrangible companion lines and the one weak more refrangible companion line [1]).

7. The shift of the middle line of the triplet may be demonstrated also by our method of the non-uniform field, if an echelon-spectroscope is made use of. A curvature of the middle line will be the immediate effect of the shift. If we use ROWLAND's grating such a curvature would be invisible nor have I observed it in that case.

The visibility of the curvature will be much increased by taking care that in the image points corresponding to very different intensities of field lie closely together. In order to attain this an eleven times reduced image of the vacuum tube, charged with mercury and placed into the field, was projected on the slit of the auxiliary spectroscope. The lens used was a photographic objective of 10 cm. focus.

The Plate gives somewhat enlarged reproductions of negatives relating to line 5791 resp. line 5770. The middle line is given in two succeeding orders. Between these the other components of the triplets are seen. With increasing magnetic force the components deviate further and further from their own middle line. In the central part of the field of view the maximum distance is reached.

[1]) JANICKI. Feinere Zerlegung der Spektrallinien von Quecksilber u.s.w. Inaugural. Diss. Halle a. S. 1905, Annalen der Physik. Bd. 19, 36. 1906.

The component towards the red in the figures is always at the left of its middle line, being concave to it in the central part; the second manifestly curved line is the component towards the violet belonging to the other order.

The curvature of the middle lines, the demonstration of which is the object of our present experiment, is undoubtedly visible in the figure for 5791. It is still more easily seen by comparison with a straight bit of paper.

In the figure for 5770 this kind of curvature is absent.

The asymmetry of the magnetic resolution of line 5791 is at once evident by the fact that one of the middle lines is approached more nearly by the outer component than the other.

If we denote by a_v and a_r the distances of the components to their middle lines, then what I called on a former occasion[1]) the amount of the asymmetry is equal to $a_v - a_r$. This difference is also equal to the difference of the distances separating the plainly curved lines from the middle lines to which they do not belong, and to which they are convex.

The two negatives were taken with the same field intensity of about 34000 Gauss.

The question now arises whether the difference $a_v - a_r$ is equal to twice the shift of the middle line or not. In the first case the asymmetry is brought about solely by the motion of the middle line towards the less refrangible wavelengths, the outer components having undergone a symmetrical displacement relatively to the unmodified line. The other, more general case one would rather expect without hypothesis or without the results of measurements.

8. In order to test the question by experiment, I have taken on the same negative as well the figures described in § 7 as the unmodified lines. It appeared however rather soon that, in the case of line 5791, only in the most intense fields the separation of the middle lines, taken with field on and with field off, was sufficient to allow measurements.

I therefore refrain from communicating these experiments. Only one detail of the vacuum tube, charged with mercury and used in all my experiments with strong fields, may perhaps be mentioned. This vacuum tube of the form indicated by PASCHEN, has a rather wide capillary. That part however of the capillary which is placed in the magnetic field is drawn out. Only over this short distance the

[1]) ZEEMAN, These Proceedings 30 November 1907.

capillary has a small diameter. Now the gap-width of the electromagnet may be considerably diminished; at the same time the electrical resistance of the vacuum tube is moderate.

9. Measurements were made in the following manner. The slit of the auxiliary spectroscope performing the preliminary analysis of the light, was widened in order to obtain in the echelon spectroscope light of the *two* yellow mercury lines simultaneously. The steps of the echelon were placed parallel to the slit of the auxiliary spectroscope. The image of the vacuum tube projected on the slit was now chosen in such a manner that only light from the uniform part of the field was analyzed. By means of a suitable small screen placed before the photographic plate its middle part could be exposed first to light under magnetic influence; then the unmodified lines were taken in the upper and lower parts of the plate. The plates taken confirmed the result obtained in § 6 as to the shift of line 5791 towards the red.

As to line 5770 the amount and even the existence of the shift is not quite certain at present [1]). All these measurements were not further pursued however, because after the publication of the first part of this paper [2]) and during my measurements there appeared a communication by GMELIN in the 1 April number of the physikalische Zeitschrift.

Independently of my paper and in another way our present subject was taken up by GMELIN. The enormous resolving power of the echelon spectroscope used by GMELIN apparently permits of greater accuracy in the measurements than would have been possible for me.

It may be remarked finally that, so far as the present results can settle the question, the observation of the asymmetry in a direction parallel to the lines of force, [3]) which first induced me to this investigation, but which was given with some reserve, must have been correct.

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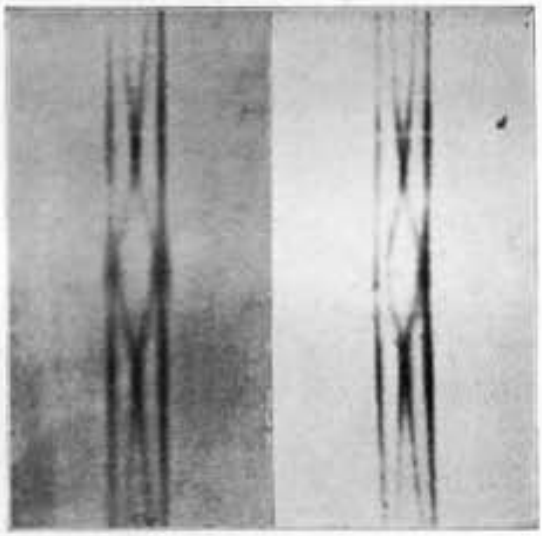
[1]) The first part of this communication contains an error, which I only noticed after the printing off. In the last division of § 4 the change of wavelength has been calculated from the measured displacement in the same manner as must be done, when the distance of two adjacent orders with the field off, is compared with the distance separating the components towards red and towards violet with the field on. Of course this proceeding is faulty in the case of § 4. Hence the last sentence of § 4 and the last column of the table in § 5 have lost significance. The further consideration of the peculiar change of the distance of orders noticed in § 5 must be reserved for a future paper.

[2]) ZEEMAN, These Proceedings 29 Febr. 1908.

[3]) ZEEMAN, § 7 in New Observations etc. These Proceedings 29 Febr. 1908.

P. ZEEMAN. "Change of wavelength of the middle line of triplets."
(Second part).



Hg. 5770 5791 1 mm = 0.12 A.E.

resolution: symmetrical. asymmetrical.

middle lines: straight. curved.

ERRATA.

In the Proceedings of the meeting of December 1907:

In Pl. I belonging to the communication of Prof. H. KAMERLINGH ONNES and C. BRAAK (p. 413) the numbers I and II are to be interchanged.

p. 422 to footnote 1 add: In this communication the resistance thermometer of Comm. No. 95 *c* (Sept. '06), which is called Pt_I, was used.

p. 423 to footnote 1 add: The thermometer till now called Pt_I was named Pt'_I after the breaking of the wire.

p. 447 l. 20 from the top: for 79 *read* 78.

In the proceedings of the meeting of February 1908:

Pl. II belonging to the communication of JEAN BECQUEREL and H. KAMERLINGH ONNES in the subscript of Fig. 1 for 1.71 mM. in 1, 2, 3, 4 read 1.71 mM. in 1, 3, 4.

p. 597 l. 5 from the bottom: for we *read* they.

p. 604 l. 1 „ „ „ „ 106 and 107 *read* 147.

l. 15 „ „ „ „ on *read* of

p. 606 l. 19 „ „ „ „ observations *read* deviations

p. 610 l. 1 „ „ top, for down to *read* as far as.

l. 7 „ „ bottom: for 170 *read* 117.

In the proceedings of the meeting of Februari 1908.

p. 591 l. 14 from the bottom: for 0°.10 read 0°.06.

p. 522 l. 1 from the top: for 0.0000013 read 0.0000009.

l. 2 „ „ „ : „ 0.0036614 read 0.0036617.

In the paper by Dr. DE SITTER "On Jupiter's Satellites" (Meeting of March 28).

p. 721 the value of $log\, a_4$ should read

$$log\, a_4 = 8.0998360,$$

p. 727 the signs of a_{21} and a_{21}' should be inverted.

(May 26, 1908)