125. *Anomalous Zeeman Effect of the Mercury Line 5791 and its Satellite-0.124.*

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The anomalous behaviour of the central component of the mercury line 5791 was studied by Gmelin¹⁾ and Zeeman,²⁾ while that of the neighbouring line, distant by $-1 \text{ \AA}$ was examined by Gmelin.³⁾ The singular character of these lines resembles that of the satellites of other mercury lines, already studied by one of us⁴⁾ with Prof. T. Takamine. Echelon grating or Lummer-Gehrcke plates were used in former experiments, but the interferential spectroscope⁵⁾ we have lately constructed seemed quite fit for the purpose. On account of high intensity of interference fringes, those formed by the yellow lines 5770 and 5791 with their satellites can be photographed in 15 to 50 sec., by using a Geissler tube as a source of light. The tube was made of pyrex glass with a capillary in the middle, and heated electrically to have constant supply of mercury vapour; the light was excited by a small transformer. The capillary part of the tube was placed between the poles of a large electromagnet with water circulation, the interferendum being 9 mm. Pole-pieces of 110° or 80° having end faces of 0.7 and 1.1 cm. diam. resp. were used. Owing to small heterogeneity⁶⁾ of the field, slight broadening of fringes was noticed with strong magnetising current. Only 5 mm. of the capillary near the axis of the magnet was used as a source of light; a Wollaston prism was inserted between the tube and the slit of the spectroscope.

The interferometer had air-plates 4.037 mm. and 6.397 mm. thick, the fringe interval corresponding to $0.415 \text{ \AA}$ and $0.262 \text{ \AA}$ resp., and the fringes formed by different lines were analysed by means of a single

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1) GMELIN: Phys. Zeit. 9 (1908) 212.

2) ZEEMAN: Amsterdam Proc. (1908) 473.

3) GMELIN: Phys. Zeit. 11 (1910) 1193.

4) NAGAOKA and TAKAMINE: Phil. Mag. 27 (1914) 333; 29 (1915) 244.

5) NAGAOKA and MISHIMA: Proc. Imp. Acad. 2 (1926) 116.

6) NAGAOKA and UCHIYAMA: Proc. Imp. Acad. 2 (1926) 158.

constant deviation prism made by Hilger. The small dispersion was convenient for the comparison of the yellow lines, although the fringes were quite apart to allow of accurate measurements by a micrometer. Out of a number of photograms taken with different fields and exposures, the fringes produced by the principal and the satellites were studied by measuring their positions with a Hilger micrometer. The line 5791 is accompanied by six satellites of various intensities¹⁾ extending over a range of about $\pm 300 \text{ m}\text{\AA}$; they seem to be separated in a complex manner and appear all crowded together as fringes. On account of the intricacy of such systems of fringes, we were unable to examine the mode of separation of each satellite. In spite of this difficulty, the separation of the strongest satellite -0.124 was followed closely up to field of 32.6 kilogauss, and this only for the p -components, the n -components being extremely complex. Strength of the fields was evaluated by the separation of the principal, which can be considered as a normal triplet, as already investigated by Gmelin.²⁾

The shift of the principal central line was distinctly noticed and found to be nearly the same as the measurements of Gmelin and Zeeman; curve (P) in the diagram shows its displacement towards the red. The satellite -0.124 (S) is similarly affected, and the amount of the shift is nearly equal to that of the principal. The singularity is its appearance both in p - and n - components, so that the central component

1) NAGAOKA a. TAKAMINE: Proc. Phys. Soc. (London) 25 (1912) 1; Mem. Imp. Acad. 1 (1913) 1.

2) GMELIN: Ann. Phys. 28 (1909) 1084; 33 (1910) 26.

is not polarised ; in this respect it resembles the neighbouring line $-1 \text{ \AA}$ apart. In addition to this component, there are four other components a, a', b, b' , two on each side of the central. The separation of these components is not proportional to the field referred to the *initial* position of S, so that the graphs of the separation turn out to be slightly curved and concave to the side of longer wave-length. They are not however irregularly separated ; for the same strength of the field, the interval between the branches a and a' is nearly equal to that between a and b or between a' and b' ; thus they are similar to a quartet usually observed in Zeeman effect. Denoting the mean difference of wave-length between the central component S and b or b' by δx , we find that it is proportional to the field.

$\delta x \text{ (m\AA)}$	142	214	287	361	433	471	
H (kilogauss)	10	15	20	25	30	32.6	
$\delta x/H$	14.2	14.3	14.3	14.4	14.3	14.0	Mean 14.3

Thus the separation and the field are linearly related ; for normal triplet, the above ratio is 15.7, so that the shift is little less $\left(= \frac{9}{10} \right)$ than the normal value found in the components of the principal.

The above relation seems to have an important bearing on the separation of the line $-1 \text{ \AA}$ from the principal. Gmelin has measured the displacement of the component toward violet from the initial position in zero field, and found it to be only approximately proportional to the field ; the central component was not measured. From the above observation, it seems likely that the central component is also similarly affected, so that its distance from 5791 remains constant ; or what is the same thing, if the displacement be referred to 5791 subject to shifts in different fields, then we have to increase the displacement observed by that corresponding to that of P. As the line is only $-1 \text{ \AA}$ distant and belong to the same series as 5791, it is probable that the displacement of the central component is the same. The actual shift δx would be equal to the observed value plus correction to the central.

H (kilogauss)	15.12	24.19	30.13	32.46	33.56	33.47	33.63
Obs. shift (m\AA)	151	237	269	295	292	298	307
Correction (m\AA)	11	25	42	45	47	47	48
Act. shift (m\AA)	162	262	311	340	339	345	355
$\delta x/H$	10.7	10.8	10.2	10.5	10.1	10.3	10.6

The mean value of the above ratio $= 10.4$; $3/2$ of this is 15.6, which is very near to 15.7 given by normal triplet ; consequently the separation of $-1 \text{ \AA}$ counted from the central component is most probably $2/3$ of the normal value. This fact seems to have remained unnoticed previously.

Plotting Gmelin's observed value against the field, there is curvature in the line joining the points; if we add the shift of the central component P of 5791, the line becomes straight.

In our experiments, it was difficult to discriminate the fringes produced by the line studied by Gmelin on account of its faintness. The shifts can only be determined by a concave grating of high dispersion, or by interferometers after isolating the line by a monochromator of tolerably good resolving power.

In the photograms of the lines 5791 and 5770 in strong magnetic fields, we noticed small separation of each component of the triplet of the latter line; probably the lines are multiplets in high fields, as one of us¹⁾ has noticed many years before. This point is now being examined with new appliances.

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1) NAGAOKA: *Phys. Zeit.* **11** (1910) 789.