The Effect of an Electric Field on the Spectrum Lines of Hydrogen. Part II.

By

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§ 1. In a previous experiment[1], making use of Lo Surdo's[2] method, the writers examined the effect of an electric field on the spectrum lines of hydrogen.

In the course of further investigations, relating mainly to the secondary lines of hydrogen, much new data were obtained; and at the same time certain doubtful cases observed in the former experiment were decided.

No essential change was made in experimental method excepting that the fused silica tube was replaced by an ordinary hard glass tube. Experimenting with capillaries having various diameters, we attained an electrie field stronger than that in our previous experiment. For photographing the spectrum, the four prism spectrograph mentioned in the former paper was used throughout the experiment.

§ 2. In Fig. 1, a portion of the photograph obtained by this instrument is reproduced; the dispersion at H_γ was 14 Å.U. per mm, and in this case the maximum electric field just in front of the cathode was $7{\cdot}6 \times 10^4$volt/cm.

The various modes presented by the affected secondary lines are shown in Fig. 2. The curves are certainly of an approximate nature and we cannot be sure of the behaviour of those lines in the portion lying above the dotted lines.

Besides the lines above cited, there were many lines which showed

1 Mem. Coll. Sci., Kyoto, **2**, 137 (1917).

2 Rendiconti d. Lincei, **22**, 664 (1913).

considerable broadening toward the red side in the strong field. These are given in Table I.

TABLE I.

λ in Å.U.	Affected component.
4764·0	p and s
4524·3	s
4511·9	p and s
4490·6	s
4488·0	s
4486·2	s
4461·1	s

Of the lines newly examined, the line λ 4467.3 has already been observed by Stark in the field of 4.8×10^4volt/cm, but he carried out no precise measurement for this line.

The wide separation of the line λ 4490.6 has already been observed in our first experiment; but, owing to the faint image of the line, it was difficult to measure the amount of the separation at that time.

Including the broadened lines, 15 affected lines were newly found besides the 17 lines reported in the former communication.

In the present experiment, about 60 photographs were taken.

§ 3. In the course of measuring the photographs we noticed that the outer components of the Balmer lines often extended beyond the unaffected neighbouring lines belonging to the secondary spectrum; or, in other words, the branches of the affected Balmer lines crossed through the secondary spectrum lines lying near them.

In the following table we give a list of secondary lines through which the branches of $H\beta$, $H\gamma$, and $H\delta$ crossed.

λ of the secondary spectrum lines.	Balmer lines.
4856·7	p-component of Hβ
4335·7	p- and s-components of Hγ
4332·7	,, ,, ,, ,, ,,
4108·1	,, ,, ,, ,, H_δ
4106·4	,, ,, ,, ,, ,,
4097·6	,, ,, ,, ,, ,,

The problem concerning the origin of the emission of Balmer lines and of the secondary spectrum lines is of great importance. According to Stark,[1] the carriers of the former are the positive atomions, while those of the latter are the neutral atoms of hydrogen. Judging from above cited phenomenon, which seems to show no mutual influence between the secondary lines and the Balmer lines, it seems probable that they are due to different sorts of carriers.

It may be remarked here that, exterpolating the amount of separation of the outer components of H_ζ (λ 3889 Å.U.) by using the separations in the lower members of Balmer lines, we might expect to see the overlapping of the two opposite branches of H_ε and H_ζ at the field of 10^5volt/cm. To see the existence of mutual influence between the Balmer lines themselves in such a case, may be of no small importance in view of the theory of the atom; but as the intensity of the Balmer lines falls off rapidly with increasing term numbers, there are of course grave experimental difficulties.

Certain regularity in the lines belonging to the secondary spectrum of hydrogen is noted by Fulcher[2] in his investigation on the spectra of low potential discharges. Fulcher records several groups of lines having constant frequency differences lying in the yellow and red part of the spectrum.

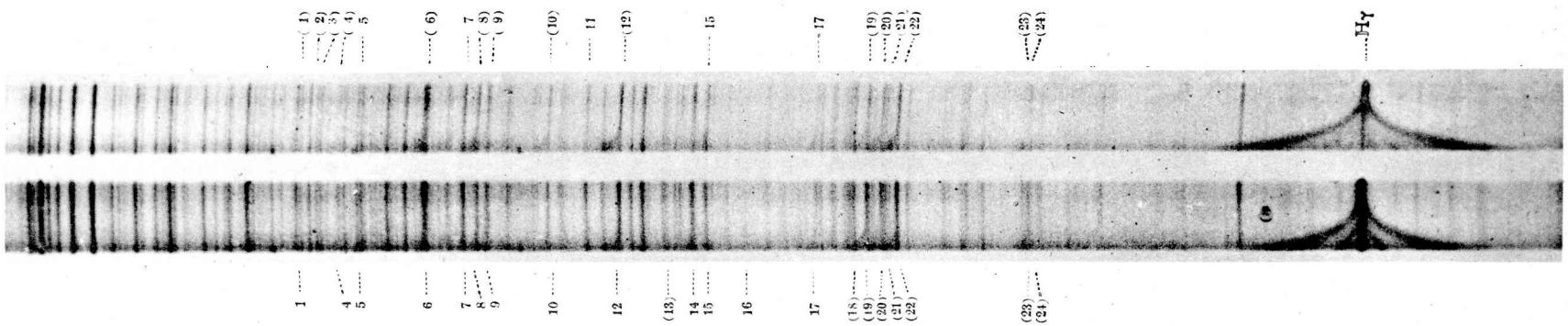
The results obtained in our experiments may be of some use in finding the regularities in the secondary spectrum lines.

In conclusion the writers wish to express their hearty thanks to Prof. T. Mizuno for his kind advice.

1 Ann. d. Phys., **49**, 179 (1916).

2 Phys. ZS., **13**, 1137 (1912).

Fig. 1.



No.	λ in Å.U.	No.	λ in Å.U.
1	4524·3	13	4453·4
2	4520·1	14	4447·7
3	4519·3	15	4445·4
4	4515·3	16	4438·6
5	4511·9	17	4426·1
6	4498·3	18	4419·5
7	4490·6	19	4417·5
8	4488·0	20	4415·3
9	4486·2	21	4414·4
10	4474·4	22	4412·4
11	4467·3	23	4392·1
12	4461·1	24	4391·1

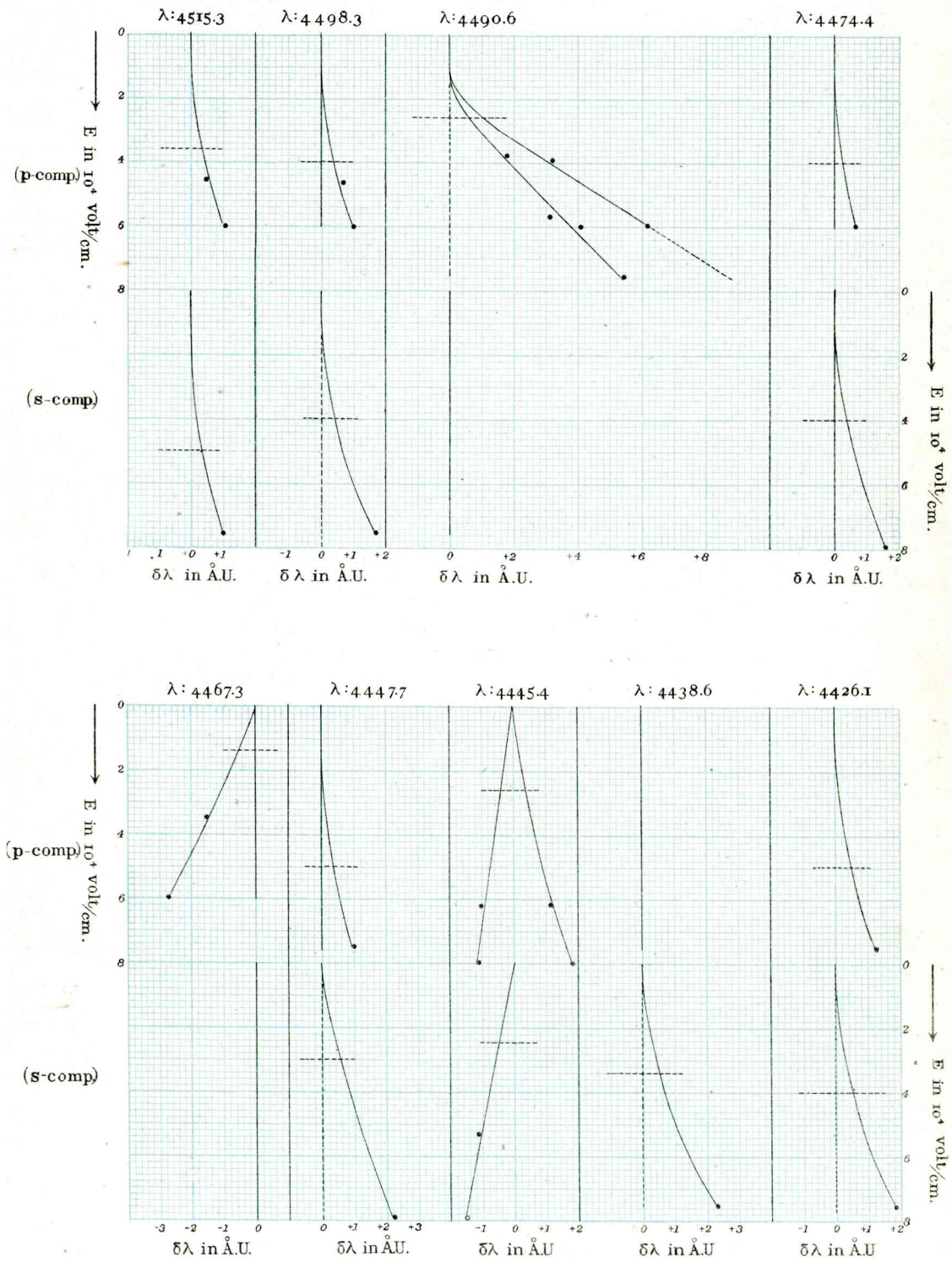
Magnification : 10

Exposure : $3^h\ 30^m$

$E_{max.}$: $7{\cdot}6 \times 10^4$ volt/cm.

( ) ..... Observed in our former experiment.

Fig. 2.


λ:4515.3
λ:4498.3
λ:4490.6
λ:4474.4
E in 10⁴ volt/cm.
(p-comp)
(s-comp)
δλ in Å.U.
λ:4467.3
λ:4447.7
λ:4445.4
λ:4438.6
λ:4426.1