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

PART III.

By

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In earlier communications[1], one of the present writers in conjunction with Mr. Yoshida has reperted on the Stark effect on hydrogen lines examined by Lo Surdo's[2] method.

In the present experiment, the arrangement was essentially the same, excepting that a tantalum cathode was used instead of one of aluminium. This proved to be advantageous since the sputtering of the cathode was considerably decreased. Further, by reducing the pressure in the discharge tube until the end of the Crookes' dark space became quite indistinct, the maximum field strength ($E_{max.}$) was greatly increased. Assuming the proportionality between the amount of separation and the field strength, the exterpolated value of $E_{max.}$ was about 150000 volt/cm. The data given by Stark in the case of the "Grobzerlegung" of the hydrogen line H_γ were relied on as in our former experiments.

A. Balmer Lines.

(1) H_γ

One remarkable feature newly observed in the present experiment was the *shift* of the central line in the perpendicular component of H_γ in a strong electric field.

As shown in Fig. 1, Pl. II, the lowest portion of the said line is clearly bent toward the positive side. For reference, the light from a

1 Takamine and Yoshida, Mem. Coll. of Sci., Kyoto, **2**, 137, 321 (1917).

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

hydrogen Geissler tube was projected on the slit afterwards without touching the spectrograph.

The amount of the shift was found to be about +1 Å at the field of 130000 volt/cm. Owing to the diffuseness of the outer components, accurate measurement with respect to the symmetry of separations was difficult, but the phenomenon evidently shows one-sided property of the central line.

In his monograph[1], Stark states that, with the arrangement used in his experiment, the position of the initial line cannot be accurately determined owing to the Doppler effect in canal rays. We think, the above cited shift of the H_γ line is free from the ambiguity of this kind.

In our recent study of the Stark effect on helium lines[2], an altogether similar feature was observed for the lines 4026 and 4388, belonging to the diffuse series of helium and parhelium. These lines corresponds to the same term number $n=5$ as the H_γ line.

The similarity in the appearance of the central s-component of H_γ and that of the helium line 4388 is shown in Fig. 2, Pl. II.

In a few cases, the shift of the central s-component was observed also for the line H_ε; but owing to the insufficient data, we mention it here only with reserve.

(2) H_α.

In the monograph of Stark, only 2 p- and 1 s-components are given for this line, but later[3], he observed 6 p- and 3 s-components. Using a 6 inch plane grating, mounted in Littrow type, photographs as shown in Fig. 3a and 3b, Pl. II, were obtained in the second order spectrum. The dispersion was about 18 Å per mm. at this line. Although much detail is lost in printing, we could distinguish 6 p and 3 s-components just as noted by Stark.

B. Secondary Spectrum of Hydrogen.

In addition to the 43 affected lines previously reported by Takamine and Yoshida[4], and also by Nitta[5], we have found 11 more in the region below 4000 Å.

1 Stark, Elektrische Spektralanalyse chemischer Atome. Leipzig, S. Hirzel (1914).
2 Takamine and Kokgbu, Mem. Coll. of Sci., Kyoto, 381 (1918).
3 Stark, Ann. Phys., **48**, 183 (1915).
4 Takamine and Yoshida, loc. cit.
5 Nitta, Mem. Coll. of Sci., Kyoto, **2**, 349 (1917).

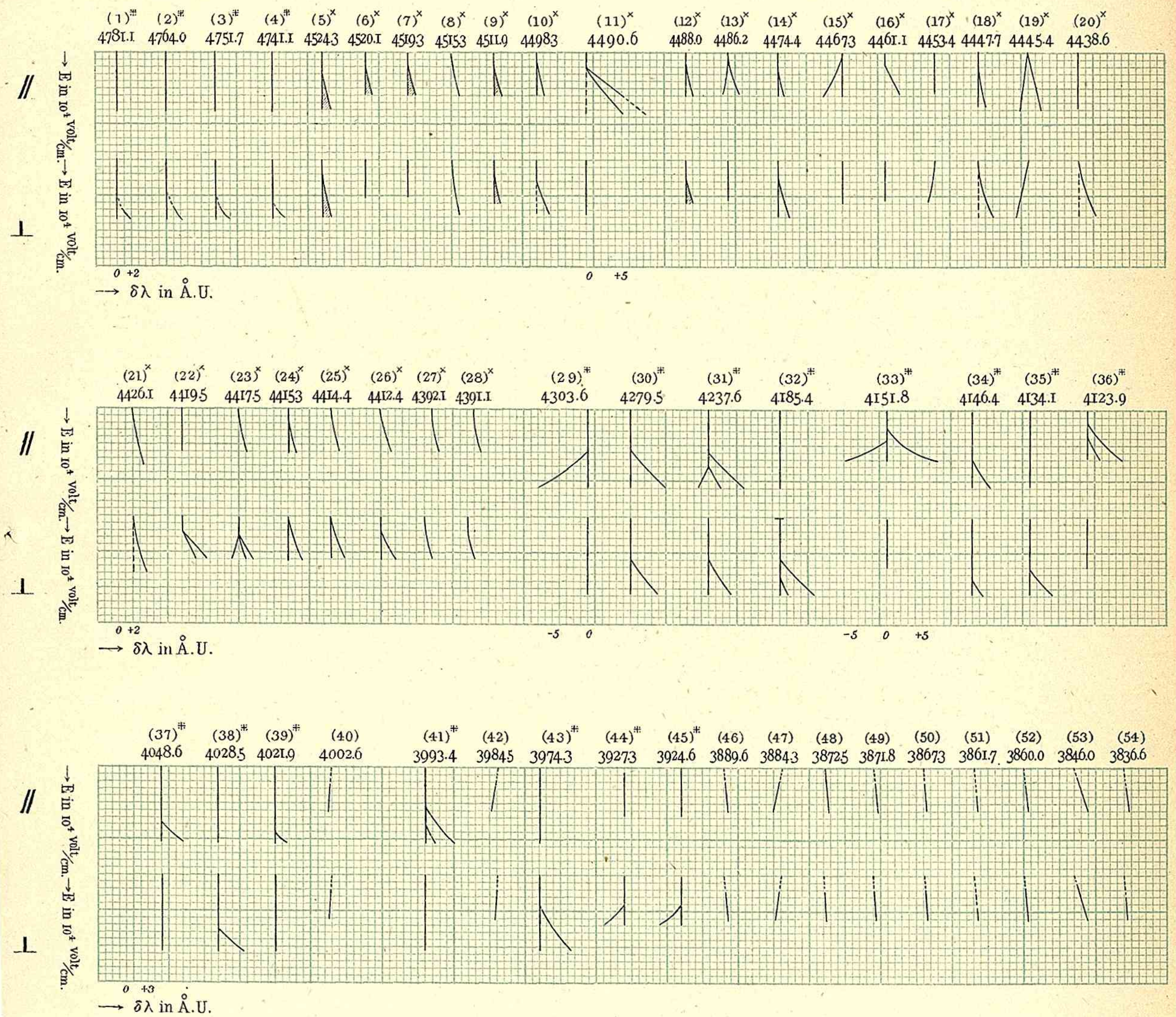
In order to facilitate a glance at the results hitherto obtained in our Institute, the diagrams including the former data are given in Pl. I.

As noted by Stark[1], the great difference in the Stark effect on Balmer lines and on secondary lines seems to suggest that they are due to different sorts of carriers. It is remarkable that all the affected lines given in Pl. I are of rather weak intensity. In fact, with a dispersion sufficient for detecting a displacement of 0.3 or 0.4 Å, no influence of the electric field was observed for the group of strong lines 4634, 4632, 4583 and 4580, even in the strong field of 150000 volt/cm. In connection with this, it may be noted here that no electric effect was observed for the nitrogen bands in such a strong field.

In conclusion, the writers wish to express their thanks to Prof. Mizuno for the interests he has taken in the work.

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

Pl. I.



× ………… Takamine and Yoshida, Mem Coll. of Sci., Kyoto, 2, 137, 321 (1917).

………… Nitta, Mem. Coll. of Sci., Kyoto, 2, 349 (1917).

Fig. 1. Shift of the central s-comp. of H_γ.

Hg 4359 H_γ

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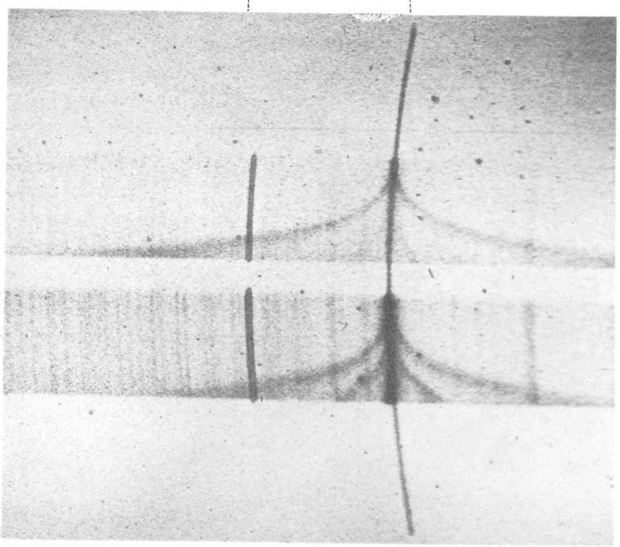

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----End of the dark space

----Cathode

----End of the dark space

----Cathode

$E_{max.}$: 130000 volt/cm,

Exposure : 1^h 30^m

Magnification : 16

Fig. 2. H_γ and He 4338.

He 4388 Hg 4359 H_γ

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$E_{max.}$: 113000 volt/cm

Exposure: 2^h

Magnification : 13

Fig. 3a.
Fine resolution of H_α

Fig. 3b. do.

H_α

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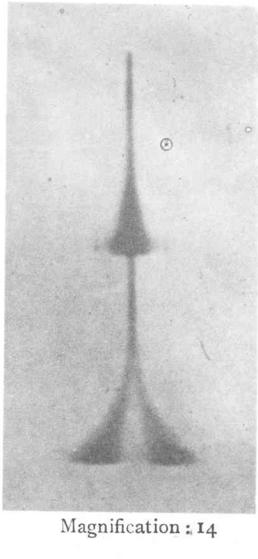

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Magnification : 14

H_α

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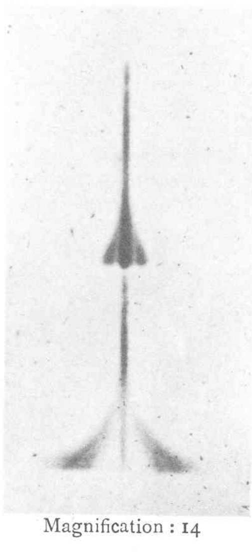

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Magnification : 14

Fig. 3a.

$E_{max.}$: 69000 volt/cm.

Exposure : 4^h

Fig. 3b.

$E_{max.}$: 94000 volt/cm.

Exposure : 1^h 50^m