The Reversal of Lines in the Explosion-Spectrum of Lead.

(Continuation of the former report[1])

By

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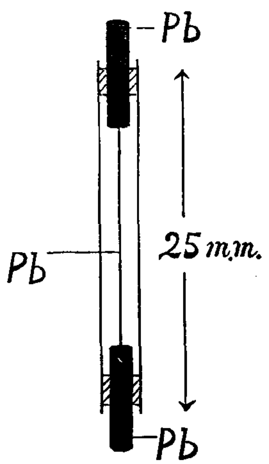
In the previous paper the writer reported the results on the self reversals of the spectral lines of lead appearing when a lead-wire is made to explode suddenly in the air of reduced pressure by passing a heavy electric current through it. Since then the writer has investigated the same phenomenon in the air of higher pressures.

As the explosion-chamber described in the former paper did not work well with the air of higher pressure, various preliminary devices were tried, and at last the experiment were carried out with the following device shown in Fig. 1. A piece of thin lead wire to be exploded with a diameter of about 0·2mm. is stretched between two thick leading-in-wires of lead. This is inserted in a transparent quartz tube of various size, and the two leading-in-wires are sealed air tight by hard sealing wax or by soldering at the ends of the tube. As in the previous experiment, the lead wire is exploded by short circuiting suddenly the secondary circuit of 200 volts of a step-down-transformer, and the emitted light is observed by a small quartz spectrograph made by Hilger. When



1. These Memoirs, **10**, 31(1926).

the sealing of the tube does not break, the spectrum lines show marked reversals in the intense continuous background as shown in the photograph reproduced in the Plate.

By keeping the diameter and the lengh of the wire to be exploded as constant the density of the vapour of lead formed by the explosion was made to vary by using enclosing quartz tube of various diameters, and the higher vapour pressure was attained by reducing the size of the quartz tube. When the enclosing quartz tube was 3 cms. in length and 5 mms. in diameter, the appearance of the explosion-spectrum showed no marked difference compared with that observed in the case when the wire was exploded in the open air.

But when tubes of the same length, and 3 mms., 2 mms. in diameter are usel successively in this order the continuous background in the explosion-spectrum gets thicker and thicker and wider, extending even up to the region of the visible spectrum, and at the same time a remarkable change occurs among the emission and reversed lines; some emission and reversed lines which have previously appeared become weaker and weaker, while many reversal-lines get clearer and broader at the same time so that the whole spectrum becomes, at last, to consist of these reversal lines in the continuous background. The reversed lines which have thus survived up to this final stage are abulated in the Table, and the characteristic behavior of each line is described below.

The five lines $\lambda 4057$ ($2p_2-2s$), $\lambda 3740$, $\lambda 3684$ ($2p_5-2s$), $\lambda 3640$ ($2p_3-2s$) and $\lambda 3573$, which were difficult previously, though not impossible, to observe as reversed ones, become now broad and clear absorption lines. Of the lines relating to $2p_1$ which showed no reversal previously at all, the two lines $\lambda 4168$ ($2p_1-3d_3$) and $\lambda 4020$ ($2p_1-3d_1$) represent now weak reversal. The appearance of the reversed lines $\lambda 4057$ ($2p_2-2s$), $\lambda 3684$ ($2p_5-2s$), $\lambda 3640$($2p_3-2s$) and $\lambda 2833$ ($2p_4-2s$) are worthy of remark in that they diffuse toward the red side with the sharp violet side.

Among the lines belonging to the diffuse series the reversed lines $\lambda 2802$($2p_2-3d_1$) and $\lambda 2614$ ($2p_3-3d_2$), which were strong in emission, are broadened remarkably and symmetrically on both sides, while the other reversed lines of this series are tolerably sharp. When a drop of mercury is present in the explosion tube these peculiarities of the lines are still more enhanced as shown in the Plate. This will probably be due to the increased density of the ionized vapour.

Generally the aspects of the reversed lines are quite similar to those of their emission lines, and the reasoning given in the previous paper to explain the width of the absorption as well as of the emisson lines by the Stark-effect seems to be verified further by the present investigati n.

Lastly, it seems worth while to mention the manner of development of the continuous background with increasing vapour pressure. With the explosion in a partially evacuated chamber a faint continuous band was detected in the region of λ2500, and as the air pressure in the chamber increased this band become strong and wide by extending its region on both sides. Moreover, it seems probable that there is another centre of the continuous background in the extreme ultra-violet region of wave-lengths shorter than λ2240, because the lines λ2253, 2247, etc. appeared, already in the stage of low pressure, as mere absorption lines in the continuous background. Finally, there is another continuous background whose centre lies between λ4058 and λ3684. This background was very weak at the stage of lowest pressure. As the pressure was increased this became stronger and wider and at the stage of highest pressure exami:ed this was the most intense sontinuous background. Thus considering, though it may not be conclusive, it seems to be probable that the continuous spectrum has many centres of development. So far as the present experiment is concerned the development begins with that lying in the region of the shortest wave-length and then proceeds to the one lying in the region of longer wave-lengths successively as the vapour pressure is increased.

The writer expresses his sincere thanks to Prof. M. Kimura, who kindly interested himself in this experiment; the author's thanks are also due to Professor U. Yoshida, who kindly discussed the results of this work.

Table

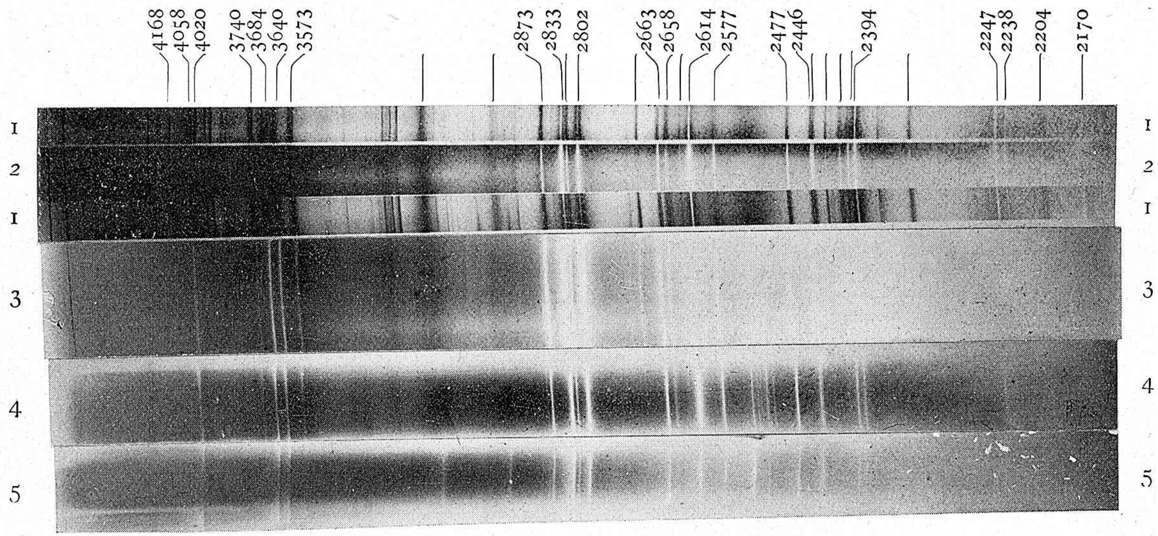
Wave Length.	Series.	Nature of the Emission Lines.	Nature of the Absorption Lines.
4058	$2p_2 - 2s$	Broad. VS. RD.	The same as the emission
3740	———	D. RD.	Sharp. slightly RD.
3684	$2p_5 - 2s$	B. VS. RD.	The same as the emission
3640	$2p_3 - 2s$	B. VS. RD.	〃
3573	———	D. RD.	S. RD.
2837	$2p_2 - 3d_3$	(D. ?)	S.
2833	$2p_4 - 2s$	S.	B. VS. RD.
2823	$2p_3 - 3d_2$	S.	S.
2802	$2p_2 - 3d_1$	B. D.	B. D.

Wave Length	Series.	Nature of the Emission Lines.	Nature of the Absorption Lines.
2663	$2p_2 - X_2$	S.	S. RD.
2657	$2p_3 - 3d_3$	D.	Faint. D.
2628	————	S.	Faint. S.
2614	$2p_3 - 3d_2$	B. D.	B. D.
2577	$2p_2 - X_1$	S.	S. RD.
2476	$2p_3 - X_2$	S. weak.	S. RD. weak.
2446	$2p_3 - 3s$	S. weak.	S. faint.
2444	————	B. to both side.	S. faint.
2412	$2p_2 - 4d_3$	weak S.	S. faint.
2402	$2p_3 - X_1$	....	....
2394	————	....	S.
2333	$2p_2 - 4s$	....	....
2247	$2p_3 - 4d_2$	....	....
2238	$2p_3 - 4d_1$	....	....

S. : Sharp.
B. : Broad.
D. : Diffuse.
RD. : Diffuse toward red.
VS. : Sharp on violet side.

Arakatsu.

Reversal of Lines in the Explosion Spectrum of Lead.
(Negative Plate).



1. Explosion in open air.
2. Explosion in a closed tube.
3. Explosion in a closed tube.
4. Explosion in a closed tube at the presence of a drop of mercury.
5. Explosion in a closed tube at the presence of a drop of mercury.