92. *Instantaneous Spectrograms of Copper, Silver, and Gold.*

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After studying the course of spectral lines excited by disruptive discharge with special reference to those of alkaline elements and alkaline earths,¹⁾ elements belonging to Group Ib of the periodic table were examined. The condenser battery of $1.3\mu\text{F}$ was charged to 25 K.V. and discharged through the electrodes of the metal placed in point contact with spark gap in the circuit. The half-period of oscillation was nearly 10^{-5} sec., the peak value of the discharge current being about 10^4 A.

Cu.:—The necessity of working with electrodes at point contact is evident on trials, especially with elements having many lines showing reversal. When the electrodes touch each other the heavy current passing through them generates large quantity of vapour, so that the light passing through it suffers reversal; if there is a gap between the electrodes, the vapour is insufficient to call forth reversal in most of the lines. This fact is well exemplified in lines of copper, magnesium, and especially thallium. When a ribbon or fine wire of various metals are exploded, the spectral lines do not show the oscillatory character so distinctly as with disruptive discharge through electrodes placed in contact. This is quite remarkable in copper and mercury stream, the explosion generally taking place in two stages. The reason for using disruptive discharge in the manner above specified rests on these experiences.

The spectrograms obtained in different gases do not show much deviations from each other; the reversals observed in oxygen are somewhat greater than in air, nitrogen or carbon dioxide. The following lines belong to sharp series.

3248	$2p_1 - 1s$	reversal strong and diverging
3274	$2p_2 - 1s$	„ „ „ „
3599	$2p_1 - 5s$	continuous emission

1) Nagaoka, Nukiyama a. Futagami: Proc. 3 (1927) No. 61, 62, 75, 76.

It is to be noticed that lines given by $2p_{1,2} - 2s$, $2p_{1,2} - 3s$, and $2p_{1,2} - 4s$ are outside the photographed region. No lines belonging to diffuse series were observed.

Recently Sommer¹⁾ and Shenstone²⁾ published classification of lines of Cu; following the notation of the first mentioned author, the lines distinctly observed are³⁾

4275	$^4P_3 - ^4D_4$	c.e. by explosion
4063	$^2p_1 - ^4d_{2,1}$	c.e. ,, ,,
3602	$^4\bar{D}_4 - ^4D_4'$	c.e.
3599	$^2P_2 - 5^2S_1$	c.e.
3064	$^2D_2 - ^2P_2$	c.e.
2961	$^2D_3 - ^2F_4$	c.e.
2824	$^2D_3 - ^2\bar{D}_3$	o.e.
2618	$^2D_3 - 3^2P_2$	c.e.
2370	$^2D_2 - 4^2F_3$	o.e.
2294	$^2D_1 - a_3$	o.c.
2243	$1^2S_1 - ^4D_2$	c.o.e.
2218	$^2D_2 - ^2P_2'$	c.e.
2179	$1^2S_1 - ^2P_2$	?

Besides these we notice the presence of the following lines which mostly belong to spark lines.

3308A	c.e.	2507S	c.o.e.
3770A	c.o.e.	2486S	o.e.
2722S	c.o.e.	2474S	c.e.
2719S	c.o.e.	2469S	o.e.
2714S	c.o.e.	2445S	o.e.
2703S	c.o.e.	2404S	o.e.
2701S	c.o.e.	2400S	c.e.
2690S	c.o.e.	2276S	c.e.
2667S	c.e.	2264A	c.e.
2600S	c.o.e.	2247S	o.e.
2599S	c.e.	2210S	o.e.
2545S	c.o.e.	2192S	o.e.
2530S	c.o.e.	2190S	?
2527S	c.o.e.	2175S	?

1) Sommer : Zeit. f. Phys., **39** (1926), 711.

2) Shenstone : Phys. Rev., **28** (1926), 449.

3) The following abbreviations are used :—

c.e. for continuous emission,

o.e. ,, oscillatory

c.o.e. ,, emission, which is first continuous and later oscillatory.

i.e. ,, emission at the initial moment only.

It is to be remarked that the length of the slit in these experiments was 0.2 mm; the distinction between c.e. and o.e. refers to this slit. When the length is diminished to 0.03 mm many lines marked c.e. become o.e., so that c. and o. are only relative.

By subjecting an alloy of copper and zinc to the same method of treatment, most of copper lines appear, but the reversal is effaced, plausibly due to the intimate mixture of two metallic vapours.

Ag :—The character of the spectral lines of silver obtained by the process here mentioned is similar to that of copper. Two lines of the sharp series corresponding to ultimate rays appear.

3281 $1\pi_1 - 1\sigma$ reversal sharp
3383 $1\pi_2 - 1\sigma$ „

One line of the diffuse series

4055 $1\pi - 3\delta'$ broadened

is also distinctly found.

The following lines of Ag^+ are also found.

3181 o.e.
2938 c.o.e.
2815 o.e.

Of the unclassified lines mostly belonging to spark lines may be mentioned

3986S	c.e.	2481S	o.e.
3332S	i.e.	2477S	o.e.
2934S	o.e.	2474S	o.e.
2902S	o.e.	2453S	o.e.
2897S	o.e.	2448S	c.o.e.
2874S	o.e.	2438S	c.o.e.
2800S	o.e.	2430S	o.e.
2768S	c.o.e.	2413S	o.e.
2757S	o.e.	2411S	o.e.
2712S	o.e.	2391S	o.e.
2681S	o.e.	2375A	c.e.
2661S	o.e.	2359S	o.e.
2657S	o.e.	2358S	o.e.
2615S	c.o.e.	2331S	o.e.
2606S	c.e.	2325S	o.e.
2581S	o.e.	2320S	o.e.
2535S	c.e.	2317S	o.e.
2507S	o.e.		

Generally speaking the difference in the character of the lines with the nature of the surrounding gas is not so marked in silver as with other elements.

Au :—The character of lines observed with gold resembles that of silver in many respects. No reversed lines were noticed. Of the lines classified by McLennan and McLay¹⁾ may be mentioned

4793	$1^2P_2 - 2^2D_3$	c.e.
4065	$1^2P_2 - 2^2D_2$	c.e.
3802	$1^2P_2 - 3^2D_2$	c.e.
4643	$1^2\bar{D}_3 - a_4$	c.e.
4438	$1^2\bar{D}_3 - a_3$	c.e.
4084	$1^2\bar{D}_3 - a_2$	c.e.
4488	$1^4F_4 - a_4$	c.e.
4315	$1^4F_4 - a_3$	c.e.
3898	$1^4F_4 - a_2$	c.e.
3874	$1^4D_4 - \beta_5$	c.e.
3654	$1^2P_1 - 3^2S_1$	o.e.
3205	$1^4F_4 - a_5$	c.e.
3195	$1^4F_4 - \beta_5$	c.e.
3123	$1^2D_3 - 1^2P_2$	c.e.
3029	$1^2D_3 - 1^2F_4$	c.e.
2894	$1^3F_4 - a_5$	o.e.

Of the unclassified lines we observe

4582S	o.e.	3165S	c.e.
4549S	o.e.	3157S	c.e.
4175S	o.e.	3015S	c.e.
4053S	c.e.	2995S	o.e.
4016S	c.e.	2990S	o.e.
3959S	c.e.	2955S	o.e.
3707S	c.e.	2932A	i.e.
3635S	c.e.	2914A	o.e.
3587S	c.e.	2907S	o.e.
3554A	c.e.	2838S	o.e.
3404S	o.e.	2826S	o.e. (triplet)
3231A	c.e.	2802S	o.e.

The observations hitherto recorded of the character of emission may have some important bearing on the process of emission, but it seems still premature to give any theory on this point.

1) McLennan a. McLay : Proc. Roy. Soc., 108 (1925), 571 ; 112 (1926), 95.

Cu wire

Cu in air with gap

4275.
4063.
3388.
g

3274.
48.
3602.

3274.
48.

3064.
2961.

2824.

2770.

2722.

2690.

2667.

2618.

2600.

2545.

2507.

Cu in air

3602.

3274.
48.

3064.

2961.

2824.

2770.

2722.

2690.

2667.

2618.

2600.

2545.

2507.

2486.

2445.

2404.

2390.

2274.

2260.

2243.

Ag in coal gas

Ag in O₂

2359.
2325.

4055.
3986.

3393.

3281.

3181.

2934.

2902.

2874.

2800.

2757.

2712.

2661.

2615.

2581.

2535.

2507.

2477.

2413.

Au in air

4790.

4582.

4488.

4315.

4175.

4065.

3878.

3804.

3707.

3635.

3587.

354.

3404.

3231.

3205.

3133.

3029.

2975.

2955.

2914.

2838.

2826.

2802.