NEW TERMS IN THE SPECTRA OF AL I, GA I, AND IN I

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ABSTRACT

The spectra of Al, Ga, and In were investigated in a tungsten vacuum furnace. Lines arising from the term $sp^2\ ^2D$ were discovered in Al I. A $^2P-^4P$ combination was found in In I from previous data.

FURNACE spectra offer a very useful means of classifying spectra due to neutral atoms. Temperature excitation is perhaps preferable to electron bombardment because of the large amount of energy involved, requiring only short exposures. The excitation may be varied by changing the temperature, and in addition absorption lines aid in the identification of low terms.

The spectrum of aluminum in the furnace has been investigated by Frayne and Smith[1] and by Sur and Majumdar.[2] Since they list only absorption lines and do not agree even on that, it was thought desirable to repeat the work.

The furnace was a tungsten strip furnace described by Paton and Rassweiler.[3] The under-water spark of copper was used as the continuous source. At a temperature of 1400°C the first two members of the sharp and diffuse series were absorbed. Higher members of these series were out of the range studied. At 1500°C the first members of the sharp series (3961 and 3944A), which are the resonance lines, were emitted. At 1800°C the sharp and diffuse series were emitted, and in addition two lines at 3057.16 and 3050.08A. At about 2200°C the following unclassified lines were emitted.

TABLE I. *Unclassified lines of Al. Tungsten strip furnace at 2200°C.*

Int.	λI.A.	ν (vac.)	Int.	λI.A.	ν (vac.)
6	3066.16	32604.6	10	3057.16	32700.6
4	3064.31	32624.1	3	3054.69	32727.1
0−	3060.56	32664.3	8	3050.08	32776.5
2	3060.00	32670.3			

These lines are all due to Al I. At 1800°C no known lines of Al II were radiated, and at 2200°C only those lines of Al II belonging to transitions between low terms were observed, and these were weak.

The furnace spectra of gallium and indium were also tried. Absorption of the first few members of the sharp and diffuse series of Ga were observed. No emission of Ga and only very faint emission of the resonance lines of

[1] Frayne and Smith, Phys. Rev. **27**, 23 (1926).
[2] Sur and Majumdar, Phil. Mag. **1**, 451 (1926).
[3] Paton and Rassweiler, Phys. Rev. **33**, 16 (1929).

In was observed. This was probably due to the rapid escape of the heated vapor from the furnace.

Frayne and Jarvis[4] have observed five unclassified lines excited in indium vapor by 6.9v electrons. These lines are obviously low-excitation lines, since they come out with the lines due to low terms.

These lines in Al and In are undoubtedly due to transitions between low terms in the atom. The only low terms having sufficient energy and not already discovered are the b^4P, b^2D, b^2S, and b^2P terms arising from the sp^2 configuration. In Al I the bP terms are known,[5] and the irregular doublet law predicts that the lines $aP-bS$ should lie about 1950A.[6] The separations of the lines are not right for the a^2P-b^4P combination. Three of the lines seem to form a diffuse doublet, and the irregular doublet law confirms the classification which is given below.

TABLE II. *Classification of three Al I lines.*

Int.	λI.A.	ν (vac.)	Δν		Classification
0	3060.56	32664.3			$a^2P_2-b^2D_2$
			36.3		
10	3057.16	32700.6			$a^2P_2-b^2D_3$
				112.2	
8	3050.08	32776.5			$a^2P_1-b^2D_2$

The five indium lines come from the b^4P terms, as shown in the table below. The wave-lengths and intensities are taken from Exner and Haschek and corrected to I. A.

TABLE III. *Classification of five In lines.*

	b^4P_1		b^4P_2		b^4P_3
a^2P_1	2858.19 (1) 34976.9	1043.8	2775.36 (1) 36020.7		—
	2212.2		2212.7		
a^2P_2	3051.19 (1) 32764.7	1043.3	2957.02 (2*R*) 33808.0	1431.4	2836.90 (3*R*) 35239.4

A strong unclassified line due to In I at 2306.07A probably belongs to one of the other terms coming from the configuration sp^2. No such terms of Ga I have yet been observed An unclassified line at 3020A given by Exner and Haschek may come from one of these terms. It is expected that the work on Ga and In will be continued using a tube furnace to prevent escape of the metallic vapor.

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[4] Frayne and Jarvis, Phys. Rev. **29**, 673 (1927).

[5] Bowen and Millikan, Phys. Rev. **26**, 150 (1925).

[6] Selwyn (Phys. Soc. London **41**, 402 (1929)) has discovered a pair of lines in the arc between Al electrodes in nitrogen with wave-lengths 1936.45 and 1932.25. This pair has the separation 112 of Al I exactly, and he rightly attributes it to the $aP-bS$ combination.