ON AlF LINES IN SUNSPOTS

(Research Note)

P. S. MURTY

Indian Institute of Astrophysics, Kodaikanal-624103, India

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Abstract. Intensity factors for bands of the C-A transition of the AlF molecule are calculated. A reinvestigation for the lines of (0, 0) band of the C-A system in sunspot spectra is suggested, so as to resolve the questionable existence of AlF absorption lines in sunspots.

The existence of AlF lines in the spectra of umbrae of sunspots seemed to be questionable following the identification of Wöhl (1971). One aspect that limited the search of the identification of molecules in sunspot spectra is the lack of accurate experimental and theoretical data (determination of molecular constants and oscillator strengths from intensity measurements) of many molecules, from laboratory spectra.

Recently, Barrow *et al.* (1974), reported a comprehensive study of the electronic spectrum of gaseous AlF, in the region between 3800 and 11 000 Å, under high resolution. They reported the results of a detailed rotational analysis involving the assignment of some 14 500 lines and the observed bands have been ascribed to transitions between nine singlet states and between seven triplet states. Of these transitions, the $C^1\Sigma^+$-$A^1\Pi$ is of particular interest, as a search for the lines of this system, has already been made (Wöhl, 1971), using the data of Naude and Hugo (1953).

The present report deals with the calculation of Franck–Condon factors, which control the intensity distribution in the emission of a band system and *r*-centroids, which are useful for a study of the variation of electronic transition moment, with internuclear separation. Using the accurate molecular constants (Barrow *et al.*, 1974) for the $C^1\Sigma^+$ and $A^1\Pi$ states, the Franck-Condon intensity factors ($q_{v'v'}$) are calculated for the bands up to $v' = v'' = 0$ to 5, by the method outlined by Fraser and Jarmain (1953). The *r*-centroids ($\bar{r}_{v'v''}$) are evaluated by the quadratic equation method of Nicholls and Jarmain (1956). The results are included in Table I, along with the band assignments and wavelengths of P heads taken from Barrow *et al.* (1974). The following are the conclusions drawn from the results.

(1) From the magnitude of the Franck-Condon factors, it is seen that the bands 0,4 and beyond, in the v'' progression ($v' = 0$) and similarly, bands 4,0 and beyond, in the v' progression ($v'' = 0$), are unlikely to be observed experimentally. This conclusion is in keeping with the experimental results.

(2) The 0,0 band at 7245.9 Å is the most intense band of the system followed by the sequence members of $\Delta v = +1$ and $\Delta v = -1$ sequences.

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TABLE I

Data of the C-A transition of AlF molecule

v'	v''	λ	$q_{v'v''}$	$\bar{r}_{v'v''}$
0	5	–	0.000	1.282
0	4	–	0.001	1.346
1	4	8590.8	0.020	1.394
2	5	8461.7	0.043	1.425
0	2	8175.4	0.043	1.483
1	3	8068.8	0.102	1.499
2	4	7963.3	0.159	1.515
3	5	7858.7	0.199	1.531
0	1	7686.2	0.234	1.560
1	2	7599.2	0.320	1.573
2	3	7512.8	0.310	1.586
3	4	7426.9	0.247	1.599
4	5	7341.5	0.166	1.611
0	0	7245.9	0.717	1.628
1	1	7174.9	0.312	1.640
2	2	7104.2	0.096	1.651
1	0	6789.9	0.241	1.705
2	1	6732.1	0.343	1.715
3	2	6674.5	0.350	1.725
4	3	6616.8	0.299	1.735
5	4	6559.5	0.222	1.745
2	0	6392.3	0.038	1.780
3	1	6345.3	0.096	1.789
4	2	6298.1	0.157	1.799
5	3	6251.4	0.210	1.808
3	0	6036.9	0.004	1.857
4	0	–	0.000	1.938
5	0	–	0.000	2.025

In conclusion, as the *W*-index for this molecule (Wöhl, 1971) is in the range 0.1–0.14, it appears reasonable to conclude that a reinvestigation for the lines of the 0,0 band of the C-A system, in the sunspot spectra, would resolve the questionable presence of the lines of AlF molecule, in the sunspots.

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