MULLIKEN BANDS IN THE SOLAR SPECTRUM

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1. INTRODUCTION

The lower $X^1\Sigma_g$ state of the Phillips and of the Mulliken band system of C_2 molecule lies very close to the $X^1\ {}^3\pi_u$, the lower electronic state of the Swan system observed in the photospheric spectrum. Consequently, if the oscillator strengths are comparable and also if LTE prevails, the Phillips and the Mulliken band systems should show up in the photospheric spectrum. The presence of the Phillips bands has been investigated earlier (Sinha 1973; Lambert and Mallia 1974; Sinha and Pande 1976). Here we report the results of the calculations of the equivalent widths for eleven lines of the R-branch of the (0-0) band of Mulliken system for the HSRA model (Gingerich et al. 1971) under the assumption of LTE.

2. FORMULATION AND CALCULATION

The weak line approach (Waddell 1958) is used for the equivalent width calculations. Using the molecular constants given by Ballik and Ramsey (1963), a value 0.972 was obtained for the Franck-Condon factor, q_{00} through a technique outlined by Jarmain and Fraser (1953). The oscillator strength $f_{0\text{-}0}$ =(1.66×10^{-2}) is obtained from the formulation and the value for the electronic transition moment given by Cooper and Nicholls (1975). The factors S_J are borrowed from Schadee (1964). The dissociation constants and the partition functions are taken from Tatum (1966).

The following sources were included in the continuous opacity calculations :

(i) AlI, SiI and MgI (Travis and Matsushima 1968).

(ii) the unknown source of opacity (Matsushima 1968).

(iii) H and H^- ion (Tsuji 1968).

The opacities resulting from the Thomson and the Rayleigh scatterings were found to be negligibly small.

3. RESULTS AND DISCUSSIONS

Table 1 lists the results of the equivalent width calculations. Here, we have given the wavenumbers measured in vacuum as cited in the work of Landsverk (1939). At J (max) = 30, the best populated level at photospheric temperatures, an equivalent width of ~ 5m Å is predicted for the centre of the disk. From table 1 one can get T_{rot} = 5000 °K as the rotational temperature for the Mulliken bands in a log W_J/S_J versus $J(J+1)$ plot.

The only other electronic transition moment measure for this band, as known to us is due to Smith (1969). It is greater by a factor of about 3 than the value used here. So, if this value is taken up, the above equivalent widths would go up by the same factor.

However, the uncertainties in the model and the UV opacity should be borne in mind, though the UV opacity sources included here satisfactorily explain the limb-darkening curves in the region of our interest (Matsushima 1968).

Lacking an atlas for this spectral region we could not make an attempt for the identification of Mulliken bands. Keeping in view the crowded nature of this region of the spectrum, we suggest that construction of a synthetic spectrum for this region will be desirable for identification of the said bands.

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TABLE 1

Wavenumber (ν cm $^{-1}$)	Rotational quantum number (J)	Equivalent width W (mA)
43308.4	20	4.3
16.7	22	4.4
25.0	24	4.5
33.4	26	4.7
41.6	28	4.8
50.1	30	4.9
58.6	32	4.8
67.4	34	4.7
75.8	36	4.7
84.6	38	4.6
93.3	40	4.3

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