BALLIK-RAMSEY BAND IN SOLAR SPECTRUM

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Equivalent width calculations for a line 1·83 μ of the 0—0 vibrational band of the Ballik-Ramsey band system has been carried out in two photospheric models — BCA and HSRA. Centre-to-limb variation of the above line is given for BCA. Calculations show that this band may be observable in the photospheric spectrum.

Баллик-Рамсейевская полоса в солнечном спектре

Расчет эквивалентной ширины для линии 1.83 μ 0—0 вибрационной полосы Баллик-Рамсейевской системы полос был выполнен в двух фотосферических моделях — BCA и HSRA. Изменение от центра к краю Солнца вышеприведенной линии приводится для BCA. Вычисления показывают, что эта полоса может наблюдатся в спектре фотосферы.

1. Introduction

In an earlier investigation (Sinha, 1973) the absence of Phillips bands in the solar photospheric spectrum was reported. The same reasons as given in the reffered paper prompted us to investigate theoretically the possible presence or absence of Ballik-Ramsey 0—0 band in the photospheric spectrum.

For this selected a line at 1·83 μ ($N = 35$), because it is expected to be the strongest line under photospheric temperatures. Centre-to-limb variation of equivalent width of this line was obtained for the BCA photosphere (Gingerich and De Jager, 1968). To check the results, the equivalent width of this line was calculated for the centre of the disk in HSRA (Gingerich et al., 1971). Here we report the results of this investigation.

2. Equivalent Width Calculations

The equivalent width calculations are carried out with the same technique as outlined in Gaur et al. (1971). The oscillator strength ($= 2{\cdot}783 \times 10^{-4}$) is calculated in the same manner as given in Sinha (1973).

The molecular constants and the wavelength are taken from Ballik-Ramsey (1963). The concentration-optical depth run in BCA is taken from Pande and Gaur (1972). The same run in HSRA is obtained with the help of the following equations:

$$P(\mathrm{C}) = p(\mathrm{C})\left[1 + \frac{K(\mathrm{C})}{p(e)} + \frac{p(\mathrm{O})}{K(\mathrm{CO})}\right] \tag{2.1}$$

$$P(\mathrm{O}) = p(\mathrm{O})\left[1 + \frac{K(\mathrm{O})}{p(e)} + \frac{p(\mathrm{C})}{K(\mathrm{CO})}\right] \tag{2.2}$$

and

$$p(\mathrm{C}_2) = \frac{p(\mathrm{C}) \cdot p(\mathrm{C})}{K(\mathrm{C}_2)}, \tag{2.3}$$

where K's denote the dissociation constants, P's the fictitious pressures, p's the free partial pressures and the terms within brackets refer to the relevant species with usual notations.

3. Results and Discussions

The equivalent width in HSRA for the 1·83 μ line turns out to be 1·88 mA at the centre of the disk. The results in BCA are presented in Table 1.

Table 1

Sr. No.	cos Θ	Equivalent width (mA)
1.	1·00	1·45
2.	0·75	2.10
3.	0·50	2·66
4.	0·30	2·62

An inspection of Table 1 suggests that cos $\Theta = 0{\cdot}5$ may be the best centre-to-limb position for detecting the lines of the 0—0 Ballik-Ramsey band. This is also supported by the following argument. The 1·782 μ line arising from the rotational level $J = 10$, will be about half as intense as the 1·83 μ line originating from the level $J = 34$ under photospheric temperatures. The equivalent widths of the two lines are respectively 0·72 mA and 1·45 mA at cos $\Theta = 1$ for BCA. If the same center-to-limb variation is assumed for both the lines then the maximum equivalent widths attained at cos $\Theta = 0{\cdot}5$ will be 1·32 mA & 2·66 mA respectively. In brief, we suggest that the observations for detecting the Ballik-Ramsey 0—0 band lines should be made at center-to-limb positions around cos $\Theta = 0{\cdot}5$.

Presently a controversy is going on about the presence or absence of the C_2 Swan bands in sunspots.

For example, Branch (1969) and Schadee (1970) consider that the C_2 Swan band lines are considerably weakened in the umbral spectrum, while Wöhl (1972) thinks that these lines get strengthened in spots as compared with the photosphere. If the C_2 Swan band lines get strengthened in sunspot spectrum then it is reasonable to expect that the Ballik-Ramsey 0−0 band lines will also be strengthened. This gives us an additional criterion for resolving the present controversy about C_2 in sunspots. The strongest C_2 lines belonging to the Swan and Ballik-Ramsey bands should be studied at various center-to-limb positions so as to locate the place on the disk at which spot/photosphere contrast in these lines attains maximum. Of course, very careful location of the continuum in sunspot spectra and judicious corrections for scattered photospheric light will be needed in such an investigation.

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FORMATION OF C_2 MOLECULES IN SOLAR ATMOSPHERE

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It is shown that while the triplet states of Swan bands are populated through an LTE path, the singlet states of Phillips bands are not. The problems regarding the observations of the various bands of C_2 molecules in the solar photospheric and umbral spectra are discussed in the light of this result.

Образование молекул C_2 в солнечной атмосфере

Показано, что в то время как триплетные состояния полос Свана заселяются посредством LTE, сингулентные состояния полос Филлипса не заселяются. Проблемы, касающиеся наблюдений различных полос молекул C_2 в спектрах солнечной фотосферы и пятна, обсуждаются в свете этих результатов.

1. Introduction

While considering the abundances and the excitation equilibrium of C_2 molecules in the photosphere and sunspots one encounters the following problems:

(i) The absence of Phillips bands coupled with the presence of Swan bands in the photospheric spectrum (Sinha, 1973).

(ii) The absence or presence of the uninvestigated Ballik-Ramsey bands in the photospheric and spot spectra (Pande and Sinha, 1974).

(iii) Centre-to-limb variations of profiles of C_2 Swan band lines in the photospheric and sunspot spectra. For the photospheric case, the observations and model based theoretical predictions do not match near the limb if homogeneous models and LTE are assumed (Raghavan, 1968).

(iv) Observational evidence for the absence (Branch, 1969; Schadee, 1970; Sotirovski, 1971), presence (Wöhl, 1972) or weakening (Harvey, 1972) of C_2 Swan band lines in the spectra of umbrae of spots is conflicting. Theoretical LTE calculations of the equivalent widths of C_2 Swan band lines lead to the absence of these bands in the umbral spectrum (Sotirovski, 1971; Branch, 1969).

These problems cannot be lucidly interpreted unless one clarifies whether the processes of formation and disappearance of C_2 molecules in the solar atmosphere correspond to LTE or not. With this in view, we have investigated the problem of photodissociation and radiative association of C_2 molecules in the photosphere and sunspots (cf. section 2) and have discussed the implications of the results obtained.

2. Absence of C_2 Molecules in Singlet States

The radiative association probabilities for the bands of the Swan and Phillips systems are calculated by