IDENTIFICATION OF SiH LINES IN THE
SOLAR DISK SPECTRUM

A. J. SAUVAL

Royal Belgian Observatory, Uccle-Brussels, Belgium

(Received 20 June, 1969)

Abstract. A new investigation of the presence of SiH lines in the solar disk spectrum has been performed. It may be concluded that molecular absorption lines of SiH are present in the disk spectrum with maximum equivalent widths of about 2 mÅ. A value of the oscillator strength of SiH has been derived \( f_{00} = 0.0008 \pm 0.0004 \).

1. Introduction

The laboratory analysis of the \( A^2\Delta - X^2\Pi \) transition of SiH has been performed by several investigators. The analysis of the (0,0) band has been given by Jackson (1930) and somewhat modified by Mulliken (1931) and more recently by Douglas (1957). The (1,1), (1,0), (2,1) and (2,2) bands have been analyzed by Rochester (1936), Douglas (1957) and Klynning and Lindgren (1967).

Without any doubt absorption lines of SiH are present in the sunspot spectrum (Pearse, 1931).

A preliminary identification of SiH lines of the (0,0) band in the solar disk spectrum has been investigated by Schadee (1964). This research was based on the laboratory analysis by Jackson (1930), on the Photometric Atlas of the Solar Spectrum (1940) and on the Preliminary Catalogue of Fraunhofer Lines (1960). Schadee investigated the strongest lines of the Q1cd, Q1o~, Q2r and Q2ac branches; not all 33 SiH lines appeared to coincide with solar lines, but 14 lines were indicated as present (with or without another blending contributor); Schadee concluded to the very probable presence of SiH lines in the solar disk spectrum.

Over a longer range of wavelength, Moore-Sitterly (1966) found about 60 SiH lines that are possibly present in the disk spectrum and suggested further study to settle this borderline case.

2. Laboratory Data

According to Douglas (1957), a characteristic feature for the SiH bands is the predominance of the \( \Delta v=0 \) sequence. Thus the (0,0), (1,1) and (2,2) bands are by far the most intense ones: the approximate intensity ratios for these bands, as observed by Douglas (1957), are 10/3/1, whereas the (1,0) and (2,1) bands are just visible.

The upper state \( (2\Delta) \) is a Hund's case (b) and the lower state \( (2\Pi) \) is intermediate between the Hund's cases (a) and (b). According to Rochester (1936), the intensity distribution over the branches is very close to that of a \( 2\Pi \) (intermediate)–\( 2\Sigma \) transition. In a first approximation, we found for the rotational line strengths of the main branches

(Q_{1cd}, Q_{1dc}, Q_{2cd}, Q_{2dc}, P_{1ce}, P_{1de}, P_{2ce}, P_{2de}, R_{1ce}, R_{1de}, R_{2ce} and R_{2de}) of the (0,0) band:

\[ S(Q_1, Q_2) = J; \]
\[ S(P_1, P_2, R_1, R_2) = \frac{J}{2}; \]

with

\[ \Sigma_j S_j = 2(2J + 1) \] (Schadee, 1967).

The line strengths of the satellite branches of the (0,0) band are less than one fourth of that of the main branches.

It is the reason why this investigation mainly concerns 167 lines of the main branches of the (0,0) band. However, we have also roughly investigated the strongest lines of the satellite branches of the (0,0) band and of the main branches of the (1,1) and (2,2) bands.

From a rough calculation according to the Boltzmann law at \( T = 4500^\circ K \), the strongest lines of each branch correspond to \( J \)-values around 14.5.

The two first columns of Table I give the designation and the laboratory wavelengths of SiH lines of the (0,0) band. The wavelengths are mainly derived from Douglas (1957): the wavenumbers are converted into wavelengths by means of the 'Table of Wavenumbers' (De Witt Coleman et al., 1960). The wavelengths of the missing lines, between brackets in Table I (not observed or not measured by Douglas), have been derived from the term values computed by Klynning and Lindgren (1967). An asterisk in the wavelength column is used to indicate a blend with one or more lines of the satellite branches of the (0,0) band or of the main branches of the (1,1) and (2,2) bands.

3. Solar Data

The wavelengths and equivalent widths of solar lines are mainly taken from 'The Solar Spectrum 2935 Å to 8770 Å' (1966), (Rowland Table).

Furthermore we have observed very recently the spectral region \( \lambda \lambda 4096-4204 \) Å with the double pass solar spectrometer of the Institut d'Astrophysique of Liège, at the Scientific Station of Jungfraujoch (Delbouille et al., 1963; Delbouille and Roland, 1969). In order to detect and measure very faint lines, new techniques have recently been developed to increase the signal-to-noise ratio. It appeared to be a very great advantage if one obtains as many rapid scans as possible, taking their mean value as the final tracing of a spectral region. Now the spectrometer is directly connected with an online electronic computer in order to get recordings that are really mean values of at least 50 individual scans. Moreover, to reduce the remaining low noise content, the smoothing of data is accomplished by convoluting the data with a normalized filter function, \( \sin x/x \). A graph-plotter gives drawings of the smoothed data at a large scale.

With this new recording system, the determination of line profiles appears to be