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ON THE SOLAR OSCILLATOR STRENGTH OF SiH^+

Chetna Trivedi and K. Sinha
U. P. State Observatory, Manora Peak, Naini Tal 263 129.

ABSTRACT

The contrasting values of the oscillator strengths for the (0,0) band of SiH^+ molecules for the $A\ ^1\Pi - X\ ^1\Sigma^+$ transition reported in literature, motivated us to reinvestigate the same with the help of a new set of well accepted solar photospheric models, elemental abundances and dissociation energy.

Key Words : Oscillator strengths - Photospheric spectrum - SiH^+

I. INTRODUCTION

SiH^+, the first molecular ion to be detected and studied in the solar photospheric spectrum was used by GS (Grevesse and Sauval 1970) to derive $f_{00} = 5 \times 10^{-4}$ and $f_{01} = 4 \times 10^{-4}$ for the $A\ ^1\Pi - X\ ^1\Sigma^+$ transition of the molecule. Laboratory estimates for f_{00} are $(2.4 \pm 1) \times 10^{-3}$ (Carlson et. al. 1980) and $(1.4 \pm 0.2) \times 10^{-3}$ (Hishikawa and Karawajczyk 1993) with a remark that the former result is discrepant because of an ambiguity in life time measurements. Theory predicts $f_{00} = 1.2 \times 10^{-3}$ (Matos et. al. 1988).

The laboratory as well as theoretical investigations appear to be in conflict with the solar studies and the practice of deriving oscillator strengths from the solar spectrum might seem questionable. In view of this circumstance and the availability of better photospheric models and reliable Si abundance than those available to GS, a re-examination of the oscillator strengths for the (0,0) and the (0,1) bands for SiH^+ obtainable from the solar spectrum was attempted by us.

II. METHOD AND CALCULATION

The photospheric models M1 and M2 by (Maltby et. al. 1986) and (Holweger and Müller 1974) respectively, and the procedure for $EW/f_{v'v''}$ calculation (Sortiovski 1971) were used. The solar lines, solely due to SiH^+ in the investigations by GS, were chosen along with their EWs for the present study. Dividing the observed photospheric EW by the corresponding calculated ratio $EW/f_{v'v''}$ yields average values of f_{00} and f_{01}. N(Si) was taken as 7.63 (Lambert and Luck 1978) and D_0^0 was taken as 3.17 eV (Huber and Herzberg 1979). The atomic partition functions and the dissociation constants were evaluated using coefficients by Irwin (1981), and Sauval and Tatum (1984) respectively. The opacity sources are from Tsuji (1966).

III. RESULTS AND DISCUSSIONS

Results derived are given in Table 1. which shows that our results are model independent and are in conformity with those by GS. Average oscillator strengths obtained in present study, for models M1 and M2 are $f_{00} = 6.3 \pm 1.7 \times 10^{-4}$, $f_{01} = 4.2 \pm 1.5 \times 10^{-4}$ and $f_{00} = 6.7 \pm 1.8 \times 10^{-4}$ $f_{01} = 4.4 \pm 1.6 \times 10^{-4}$ respectively. Results obtained utilizing the same set of abundance and dissociation energy as used by GS and by Matos et. al. (1988) make us state that our results do not alter appreciably .

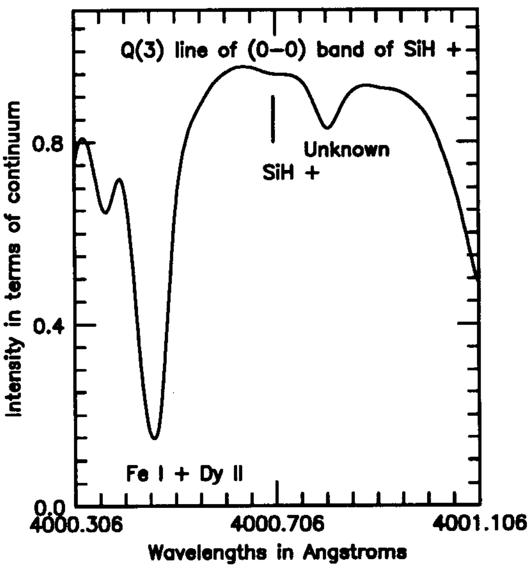

Fig. 1.— Solar photospheric spectrum around 4000.706 Å taken from the Liège atlas.

It must be pointed out that work by Carlson et al. (1980) may not be relied upon because of a breakdown of the r-centroid approximation Larsson(1987, personal communication).

Examination of the solar SiH^+ features (*cf.* figure given below) in the Liège atlas (Delbouille et. al. 1973) suggests that a judicious fixation of the continuum is difficult and we suspect that EW measurements by GS may be systematically underestimated and so are the oscillator strengths . In view of the mutually consistent new results quoted above $f_{00} = 1.186 \times 10^{-3}$ (Larsson, 1987), $f_{00} = 1.2 \times 10^{-3}$ and $f_{00} = (1.4 \pm 0.2) \times 10^{-3}$, it appears possible that because of the under estimated

Table 1. Derived oscillator strengths ($\times 10^4$) for the (0,0) and the (0,1) bands of SiH^+.

Line	λ (Å)	$EW_{(obs)}$ (mÅ)	Present study M1	Present study M2
(0,0)				
P (6)	4024.209	0.7	5.63	6.01
P (11)	4079.046	1.0	4.79	5.10
Q (3)	4000.706	1.1	6.02	6.43
Q (4)	4004.659	1.8	7.82	8.34
Q (7)	4022.946	1.5	4.23	4.51
Q (9)	4041.005	3.5	8.36	8.91
Q (13)	4094.114	2.0	4.01	4.27
R (6)	4005.921	1.5	7.63	8.14
R (7)	4011.841	1.7	7.91	8.43
(0,1)				
P (8)	4412.536	0.6	5.80	6.13
P (12)	4470.770	0.8	5.73	6.05
Q (8)	4399.321	0.8	3.23	3.42
Q (12)	4452.138	0.6	1.93	2.04
Q (14)	4489.532	1.2	3.67	3.87
R (3)	4358.337	0.4	4.86	5.14

solar EWs, the GS oscillator strengths and those obtained here by us should be scaled up by a factor of 2. We are still of the opinion that the solar spectrum can still be used to derive the oscillator strengths.

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REFERENCES

Carlson T. A., Copley J., Duric N., Elander N., Erman P., Larsson M., Lyrra M. 1980, A&A, 83, 238.

Delbouille L., Roland G., Neven L. 1973, Photometric Atlas of the Solar Spectrum from λ3000 to λ10000, Institut d'Astrophysique de 1' Université de Liège, Belgium.

Grevesse N., Sauval A. J. 1970, A&A, 9, 232.

Hishikawa A., Karawajczyk A. 1993, J. Mol. Spectrosc., 158, 479.

Holweger H., Müller E. A. 1974, Sol. Phys., 39, 19.

Huber K. P., Herzberg G. 1979, Molecular spectra and molecular structure IV. Constants of diatomic molecules, Van Nostrand.

Irwin A. W. 1981, ApJS, 45, 621.

Lambert D. L., Luck R. E. 1978, MNRAS, 183, 79.

Maltby P., Avrett E. H., Carlson M., Kjeldseth - Moe O., Kurucz R. Z., Loeser R. 1986, ApJ, 306, 284.

Matos J. M. O., Kello V., Roos B. O., Sadlej A. J. 1988, J. Chem. Phys., 89, 423.

Sauval A. J., Tatum J. B. 1984, ApJS, 56, 193.

Sotriovski P. 1971, A&A, 14, 319.

Tsuji T. 1966, PASJ, 18, 127.