Publ. Astron. Obs. Belgrade No. 57 (1997), 19 – 22 *Contributed paper*

ON THE STARK BROADENING OF Si XIII LINES

MILAN S. DIMITRIJEVIĆ[1] and SYLVIE SAHAL-BRÉCHOT[2]
[1]*Astronomical Observatory, Volgina 7, 11000 Belgrade, Yugoslavia*
E-mail mdimitrijevic@aob.aob.bg.ac.yu

[2]*Observatore de Paris, 92195 Meudon Cedex, France*
E-mail sahal@obspm.fr

Abstract. Using a semiclassical approach, we have calculated electron-, proton-, and He III-impact line widths and shifts for 61 Si XIII multiplets.

1. INTRODUCTION

Silicon is important for the consideration of physical processes in stellar plasmas, and the corresponding data on spectral lines from its various ionization stages are consequently of particular astrophysical interest. Stark broadening parameters of Si XIII spectral lines are important not only for astrophysics, as e.g. for the consideration of radiative transfer through subphotospheric layers, but also for the fusion plasmas and laser produced plasmas research. The development of soft x-ray lasers, where Stark broadening data are needed to calculate gain values, model radiation trapping and to consider photoresonant pumping schemes (see e.g. Griem and Moreno, 1990; Fill and Schöning, 1994), provided an additional interest for such results.

In order to provide the needed Si XIII Stark broadening parameters,we have calculated within the semiclassical-perturbation formalism (Sahal-Bréchot 1969ab), electron-, proton-, and He III-impact line widths and shifts for 61 Si XIII multiplets. A summary of the formalism is given in Dimitrijević *et al.* (1991).

2. RESULTS AND DISCUSSION

As the continuation of our programme to provide to astrophysicists and plasma physicists the needed Stark-broadening parameters (see Dimitrijević 1996, Dimitrijević and Sahal-Bréchot 1995 and references therein), electron-, proton-, and He III- impact Si XIII line widths and shifts have been calculated. Energy levels for Si III have been taken from Martin and Zalubas (1983). Our results for 61 Si XIII multiplets, for perturber densities 10^{16} - 10^{23} cm^{-3} and temperatures T = 500,000 - 6,000,000K will be published in Dimitrijević and Sahal-Bréchot (1997a,b).

Table 1

This table shows electron- and proton-impact broadening full half-widths (FWHM) and shifts for Si III for a perturber density of 10^{19} cm^{-3} and temperatures from 500,000 up to 6,000,000 K. By deviding C with the full linewidth, we obtain an estimate for the maximum perturber density for which the line may be treated as isolated and tabulated data may be used.

PERTURBER DENSITY = 1.E+19cm-3

PERTURBERS ARE:		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
Si XIII1S 2P	500000.	0.115E-05	-0.150E-07	0.265E-08	-0.103E-07
6.6 A	750000.	0.939E-06	-0.745E-08	0.519E-08	-0.156E-07
C=0.37E+18	1000000.	0.816E-06	-0.731E-08	0.847E-08	-0.206E-07
	2000000.	0.587E-06	-0.390E-08	0.261E-07	-0.376E-07
	4000000.	0.426E-06	-0.331E-08	0.625E-07	-0.587E-07
	6000000.	0.355E-06	-0.200E-08	0.897E-07	-0.713E-07
Si XIII1S 3P	500000.	0.363E-05	-0.137E-06	0.785E-06	-0.101E-05
5.7 A	750000.	0.306E-05	-0.124E-06	0.119E-05	-0.124E-05
C=0.12E+17	1000000.	0.271E-05	-0.120E-06	0.158E-05	-0.140E-05
	2000000.	0.205E-05	-0.105E-06	0.257E-05	-0.169E-05
	4000000.	0.156E-05	-0.841E-07	0.355E-05	-0.202E-05
	6000000.	0.134E-05	-0.699E-07	0.415E-05	-0.223E-05
Si XIII1S 4P	500000.	0.950E-05	-0.421E-06	0.646E-05	-0.548E-05
5.4 A	750000.	0.814E-05	-0.396E-06	0.835E-05	-0.624E-05
C=0.44E+16	1000000.	0.730E-05	-0.403E-06	0.977E-05	-0.674E-05
	2000000.	0.565E-05	-0.375E-06	0.136E-04	-0.804E-05
	4000000.	0.441E-05	-0.322E-06	0.175E-04	-0.912E-05
	6000000.	0.383E-05	-0.261E-06	0.197E-04	-0.981E-05
Si XIII2S 2P	500000.	0.454E-01	-0.103E-02	0.178E-03	-0.141E-02
1200.7 A	750000.	0.376E-01	-0.109E-02	0.455E-03	-0.208E-02
C=0.12E+23	1000000.	0.329E-01	-0.105E-02	0.829E-03	-0.266E-02
	2000000.	0.243E-01	-0.988E-03	0.263E-02	-0.429E-02
	4000000.	0.181E-01	-0.929E-03	0.548E-02	-0.597E-02
	6000000.	0.153E-01	-0.825E-03	0.810E-02	-0.679E-02
Si XIII2S 3P	500000.	0.169E-03	-0.659E-05	0.352E-04	-0.452E-04
37.8 A	750000.	0.143E-03	-0.632E-05	0.532E-04	-0.556E-04
C=0.55E+18	1000000.	0.127E-03	-0.613E-05	0.709E-04	-0.630E-04
	2000000.	0.958E-04	-0.552E-05	0.115E-03	-0.758E-04
	4000000.	0.733E-04	-0.454E-05	0.159E-03	-0.905E-04
	6000000.	0.631E-04	-0.385E-05	0.187E-03	-0.100E-03

Table 1 continued

PERTURBER DENSITY = 1.E+19cm-3

PERTURBERS ARE:		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
Si XIII2S 4P	500000.	0.263E-03	-0.118E-04	0.176E-03	-0.149E-03
28.2 A	750000.	0.226E-03	-0.113E-04	0.228E-03	-0.170E-03
C=0.12E+18	1000000.	0.203E-03	-0.114E-04	0.267E-03	-0.184E-03
	2000000.	0.157E-03	-0.107E-04	0.370E-03	-0.219E-03
	4000000.	0.122E-03	-0.923E-05	0.476E-03	-0.249E-03
	6000000.	0.107E-03	-0.753E-05	0.537E-03	-0.268E-03
Si XIII3S 3P	500000.	2.54	-0.152	0.511	-0.662
4122.7 A	750000.	2.17	-0.149	0.760	-0.819
C=0.65E+22	1000000.	1.94	-0.147	1.02	-0.915
	2000000.	1.50	-0.136	1.61	-1.10
	4000000.	1.16	-0.112	2.23	-1.31
	6000000.	1.00	-0.959E-01	2.64	-1.43
Si XIII3S 4P	500000.	0.425E-02	-0.224E-03	0.265E-02	-0.225E-02
108.3 A	750000.	0.365E-02	-0.217E-03	0.340E-02	-0.255E-02
C=0.17E+19	1000000.	0.328E-02	-0.219E-03	0.399E-02	-0.275E-02
	2000000.	0.256E-02	-0.206E-03	0.557E-02	-0.328E-02
	4000000.	0.200E-02	-0.176E-03	0.720E-02	-0.372E-02
	6000000.	0.174E-02	-0.145E-03	0.814E-02	-0.401E-02
Si XIII2P 3S	500000.	0.978E-04	0.787E-05	0.776E-05	0.200E-04
39.4 A	750000.	0.838E-04	0.795E-05	0.151E-04	0.257E-04
C=0.38E+19	1000000.	0.753E-04	0.788E-05	0.192E-04	0.294E-04
	2000000.	0.587E-04	0.746E-05	0.377E-04	0.383E-04
	4000000.	0.460E-04	0.630E-05	0.559E-04	0.460E-04
	6000000.	0.398E-04	0.547E-05	0.685E-04	0.509E-04
Si XIII2P 4S	500000.	0.137E-03	0.170E-04	0.397E-04	0.571E-04
29.0 A	750000.	0.120E-03	0.169E-04	0.583E-04	0.683E-04
C=0.86E+18	1000000.	0.109E-03	0.168E-04	0.708E-04	0.731E-04
	2000000.	0.875E-04	0.147E-04	0.102E-03	0.882E-04
	4000000.	0.694E-04	0.120E-04	0.142E-03	0.105E-03
	6000000.	0.603E-04	0.106E-04	0.169E-03	0.114E-03

In Table 1, only a sample of results is shown. Parameter C (Dimitrijević and Sahal-Bréchot 1984), given also in Table 1, provides an estimate for the maximum perturber density for which the line may be treated as isolated when it is divided by the corresponding electron-impact full width at half maximum.

We hope that the present results will be of interest for the investigation of various problems concerning the stellar, laboratory, fusion and laser produced plasma, and soft x-ray lasers modeling and research. We hope as well that the presented results will be of interest for the investigation of behaviour of Stark broadening parameters along isoelectronic sequences.

References

Dimitrijević, M. S., 1996, *Zh. Prikl. Spektrosk.* **63**, 810.
Dimitrijević, M.S., and Sahal-Bréchot,S.: 1984, *JQSRT* **31**, 301.
Dimitrijević, M.S. and Sahal-Bréchot, S.: 1995, *Astron. Astrophys. Suppl. Series* **109**, 551.
Dimitrijević M.S. and Sahal-Bréchot, S.: 1997a, *Astron. Astrophys. Suppl. Series* submitted.
Dimitrijević M.S. and Sahal-Bréchot, S.: 1997b, *Bull. Astron. Belgrade* **156**, in press.
Dimitrijević, M.S., Sahal-Bréchot, S. and Bommier,V.: 1991, *Astron. Astrophys. Suppl. Series* **89**, 581.
Fill, E. E., Schöning, T.: 1994, *J. Appl. Phys.* **76**, 1423.
Griem, H. R., Moreno, J. C.: 1990, in: *X-Ray Lasers*, ed.G. Tallents, Institute of Physics, Bristol, 301.
Martin, W. C., Zalubas, R.: 1983, *J. Phys. Chem. Reference Data* **12**, 323.
Sahal-Bréchot, S.: 1969a, *Astron.Astrophys.* **1**, 91.
Sahal-Bréchot, S.: 1969b, *Astron.Astrophys.* **2**, 322.