Publ. Astron. Obs. Belgrade No. 54 (1996), 31 – 34 *Contributed paper*

ON THE STARK BROADENING OF Se I SPECTRAL LINES

M. S. DIMITRIJEVIĆ[1] and S. SAHAL-BRÉCHOT[2]
[1]*Astronomical Observatory, Volgina 7, 11050 Belgrade, Yugoslavia*
E-mail mdimitrijevic@aob.aob.bg.ac.yu

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

Abstract. Using a semiclassical approach, we have calculated electron-, proton-, and ionized argon- impact line widths and shifts for 31 Se I multiplets. The results have been compared with existing theoretical estimates.

1. INTRODUCTION

In order to try to provide an as much as possible more complete set of semiclassical Stark-broadening parameters needed for research of astrophysical, laboratory and laser produced plasma we obtained such data for large number of different emitter lines (see Dimitrijević, 1996 and references therein). Such set of data is not only of interest *e.g.* for stellar plasma diagnostic, opacity calculations or the investigation/modelling of stellar spectra or a particular line, but as well for different examinations of regularities and systematic trends for e.g. homologous atoms (Dimitrijević and Popović, 1989) or in general (Purić *et al.* 1991). Moreover, we do not know *a priori* the chemical composition of a star and with the developement of space born techniques the astrophysical importance of up to now often astrophysically meaningless lines increases.

By using the semiclassical-perturbation formalism (Sahal-Bréchot, 1969ab), we have calculated electron-, proton-, and ionized argon- impact line widths and shifts for 31 multiplets of neutral selenium. The obtained results will be presented elsewhere (Dimitrijević and Sahal-Bréchot, 1996). Here, only a part of the results will be shown as an illustration, as well as the comparison with simple estimates (Lakićević, 1983).

2. RESULTS AND DISCUSSION

The semiclassical perturbation method used here, has been discussed in detail in Sahal - Bréchot (1969ab) and a brief summary is given in Dimitrijević *et al.* (1991). Energy levels for Se I lines have been taken from Moore (1971). Oscillator strengths have been calculated by using the method of Bates and Damgaard (1949) and tables of Oertel and Shomo (1968). For higher levels, the method described in Van Regemorter *et al.* (1979) has been used. For $4p^4\ {}^3P$ - $4p^3({}^4S^o)5s{}^3S^o$, $4p^4\ {}^3P$ - $4p^3({}^2D^o)5s'{}^3D^o$ and $4p^4$ ${}^3P$ - $4p^3({}^2P^o)5s''{}^3P^o$ the oscillator strengths calculated by Gruzdev (1969) Ref. 15

Table 1. This Table shows electron-, and proton- impact broadening parameters for Se I for a perturber density of 10^{16} cm^{-3} and temperatures from 2,500 up to 50,000 K. Transitions and averaged wavelengths for the multiplet (in Å) are also given. If one divides c value with the linewidth value, we obtain an estimate for the maximum perturber density (in cm^{-3}) for which the line may be treated as isolated and tabulated data may be used. The asterisk identifies cases for which the collision volume multiplied by the perturber density (the condition for validity of the impact approximation) lies between 0.1 and 0.5.

PERTURBER DENSITY= 1xE+16cm-3

PERTURBERS ARE:		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
4P - 5S	2500.	0.294E-02	0.256E-02	0.786E-03	0.690E-03
1997.9Å	5000.	0.352E-02	0.298E-02	0.882E-03	0.796E-03
C= 0.39E+19	10000.	0.418E-02	0.350E-02	0.990E-03	0.910E-03
	20000.	0.466E-02	0.395E-02	0.111E-02	0.103E-02
	30000.	0.481E-02	0.406E-02	0.119E-02	0.111E-02
	50000.	0.508E-02	0.387E-02	0.129E-02	0.121E-02
4P - 6S	2500.	0.117E-01	0.851E-02	0.263E-02	0.206E-02
1522.6Å	5000.	0.137E-01	0.103E-01	0.295E-02	0.249E-02
C= 0.69E+18	10000.	0.153E-01	0.121E-01	0.331E-02	0.292E-02
	20000.	0.161E-01	0.125E-01	0.372E-02	0.337E-02
	30000.	0.168E-01	0.121E-01	0.398E-02	0.364E-02
	50000.	0.175E-01	0.105E-01	0.433E-02	0.401E-02
4P - 7S	2500.	0.411E-01	0.293E-01	*0.886E-02	*0.553E-02
1409.5Å	5000.	0.474E-01	0.344E-01	*0.999E-02	*0.741E-02
C= 0.23E+18	10000.	0.506E-01	0.382E-01	*0.112E-01	*0.917E-02
	20000.	0.549E-01	0.375E-01	*0.126E-01	*0.109E-01
	30000.	0.560E-01	0.332E-01	*0.135E-01	*0.119E-01
	50000.	0.614E-01	0.278E-01	0.147E-01	0.132E-01
5P - 6S	2500.	1.36	0.904	0.323	0.215
16773.0Å	5000.	1.57	1.11	0.351	0.258
C= 0.84E+20	10000.	1.79	1.19	0.384	0.302
	20000.	2.13	1.17	0.421	0.347
	30000.	2.36	1.02	0.446	0.375
	50000.	2.76	0.849	0.479	0.412
5P - 7S	2500.	1.64	1.13	*0.350	*0.218
8905.4Å	5000.	1.88	1.40	*0.394	*0.291
C= 0.92E+19	10000.	2.01	1.43	*0.442	*0.360
	20000.	2.19	1.40	*0.496	*0.427
	30000.	2.35	1.22	*0.530	*0.467
	50000.	2.65	1.03	0.577	0.519

PERTURBER DENSITY= 1xE+16cm-3

PERTURBERS ARE:		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
4P - 4D	2500.	0.433E-02	-0.160E-02	0.186E-02	-0.405E-03
1553.6Å	5000.	0.458E-02	-0.185E-02	0.188E-02	-0.468E-03
C= 0.10E+19	10000.	0.500E-02	-0.192E-02	0.189E-02	-0.534E-03
	20000.	0.561E-02	-0.178E-02	0.190E-02	-0.606E-03
	30000.	0.603E-02	-0.157E-02	0.192E-02	-0.652E-03
	50000.	0.656E-02	-0.134E-02	0.193E-02	-0.712E-03
4P - 5D	2500.	0.150E-01	-0.643E-02	*0.627E-02	-0.156E-02
1424.9Å	5000.	0.168E-01	-0.629E-02	*0.647E-02	-0.188E-02
C= 0.31E+18	10000.	0.195E-01	-0.451E-02	0.659E-02	-0.220E-02
	20000.	0.235E-01	-0.311E-02	0.669E-02	-0.253E-02
	30000.	0.258E-01	-0.278E-02	0.675E-02	-0.273E-02
	50000.	0.282E-01	-0.218E-02	0.685E-02	-0.300E-02
4P - 6D	2500.	0.806E-01	0.514E-01		
1371.7Å	5000.	0.910E-01	0.535E-01		
C= 0.73E+17	10000.	0.106	0.448E-01		
	20000.	0.125	0.350E-01	*0.274E-01	*0.195E-01
	30000.	0.133	0.300E-01	*0.288E-01	*0.215E-01
	50000.	0.139	0.220E-01	*0.308E-01	*0.241E-01
5P - 5D	2500.	0.769	-0.359	*0.300	-0.815E-01
9556.1Å	5000.	0.866	-0.394	*0.310	-0.986E-01
C= 0.14E+20	10000.	1.01	-0.389	0.317	-0.116
	20000.	1.22	-0.335	0.323	-0.134
	30000.	1.35	-0.305	0.327	-0.144
	50000.	1.50	-0.259	0.333	-0.159
5P - 6D	2500.	2.47	1.54		
7583.5Å	5000.	2.80	1.60		
C= 0.22E+19	10000.	3.27	1.27		
	20000.	3.90	0.952	*0.837	*0.591
	30000.	4.16	0.807	*0.881	*0.653
	50000.	4.39	0.559	*0.941	*0.732

have been used, by using a semiempirical approximation based on the intermediate coupling scheme and the quantum deffect method. In addition to electron-impact full halfwidths and shifts, Stark-broadening parameters due to proton- and ionized argon-impacts have been calculated. As the illustration, one part of our results is shown in Table 1 for a perturber density of 10^{16} cm^{-3} and temperatures T = 2,500 - 50,000 K. For each value given in Table 1, the collision volume (V) multiplied by the perturber density (N) is much less than one and the impact approximation is valid (Sahal - Bréchot, 1969ab). Values for $0.1 < NV \leq 0.5$ are denoted with an asterisk.

With the help of regularities and systematic trends the Stark width and shift for the resonant Se I $4p^4\ ^3P$ - $4p^3(^4S^o)5s^3S^o$ multiplet have been estimated to be W = 0.058 Å and |d| = 0.033 Å for T = 20,000 K and an electron density of 10^{17} cm^{-3} (Lakićević, 1983). Our calculations give W = 0.047 Å and |d| = 0.040 Å, which is an encouraging agreement.

We hope that the presented Stark broadening data will be of help for consideration of various scientific problems.

References

Bates, D.R. and Damgaard, A.: 1949, *Trans.Roy.Soc. London, Ser. A* **242**, 101.
Dimitrijević, M.S.: 1996, *Zh. Prikl. Spektrosk* in press.
Dimitrijević, M.S. and Popović, M.M.: 1989, *Astron. Astrohys.* **217**, 201.
Dimitrijević M.S. and Sahal-Bréchot, S.: 1996, *Zh. Prikl. Spektrosk.*, in press.
Dimitrijević, M.S., Sahal-Bréchot, S., and Bommier, V.: 1991, *Astron. Astrophys. Suppl. Series* **89**, 581.
Gruzdev, P.F.: 1969, *Opt. Spectrosc.* **27**, 479.
Lakićević, I.S.: 1983, *Astron.Astrophys* **127**, 37.
Moore, C.E.: 1971, Atomic Energy Levels Vol. II, NSRDS-NBS 35, U.S. Govt. Print. Office, Washington.
Oertel, G.K. and Shomo, L.P.: 1968, *Astrophys. J. Suppl. Series* **16**, 175.
Purić, J., Dimitrijević, M.S. and Lesage,A.: 1991, *Astrophys. J.* **382**, 353.
Sahal-Bréchot, S.: 1969a, *Astron.Astrophys.* **1**, 91.
Sahal-Bréchot, S.: 1969b, *Astron.Astrophys.* **2**, 322.
Van Regemorter, H., Hoang Binh Dy, and Prud'homme, M.: 1979, *J.Phys.B* **12**, 1073.