Publ. Astron. Obs. Belgrade No. 60 (1998), 22 – 25 *Poster*

ON THE STARK BROADENING OF Mg XI LINES

M. S. DIMITRIJEVIĆ[1] and S. SAHAL-BRÉCHOT[2]
[1]*Astronomical Observatory, Volgina 7, 11160 Belgrade-74, 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 He III-impact line widths and shifts for 18 Mg XI multiplets.

1. INTRODUCTION

Data on magnesium spectral lines as well as on its various ionization stages are of interest for investigation of a number of physical processes in stellar, laboratory and technological plasmas. Data on Mg XI spectral lines are as well of interest for the study of systematic trends along helium isoelectronic sequence and for testing and developing of the Stark broadening theory for multicharged ions.

We have calculated here within the semiclassical-perturbation formalism (Sahal-Bréchot 1969ab), electron-, proton-, and He III-impact line widths and shifts for 18 Mg XI multiplets. A summary of the formalism is given e.g. in Dimitrijević *et al.* (1991) and will not be repeated here.

2. RESULTS AND DISCUSSION

As a continuation of our project 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 Mg XI line widths and shifts have been calculated. Energy levels for Mg XI have been taken from Martin and Zalubas (1980). Our results for 18 Mg XI multiplets, for perturber densities 10^{18} - 10^{24} cm^{-3} and temperatures T = 500,000 - 5,000,000K will be published in Dimitrijević and Sahal-Bréchot (1998a,b).

Table 1
This table shows electron- and proton-impact broadening full half-widths (FWHM) and shifts for Mg XI (singlets) for a perturber density of 10^{19} cm^{-3} and temperatures from 500,000 up to 5,000,000 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. 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 = 1.E+19cm-3

PERTURBERS ARE:		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
Mg XI 1S 2P	500000.	0.250E-05	-0.347E-07	0.147E-07	-0.400E-07
9.2 A	750000.	0.205E-05	-0.163E-07	0.287E-07	-0.594E-07
C=0.57E+18	1000000.	0.179E-05	-0.158E-07	0.451E-07	-0.768E-07
	2000000.	0.129E-05	-0.111E-07	0.116E-06	-0.129E-06
	3000000.	0.108E-05	-0.931E-08	0.171E-06	-0.158E-06
	5000000.	0.862E-06	-0.427E-08	0.268E-06	-0.201E-06
Mg XI 1S 3P	500000.	0.843E-05	-0.379E-06	0.235E-05	-0.276E-05
7.9 A	750000.	0.714E-05	-0.352E-06	0.355E-05	-0.330E-05
C=0.23E+17	1000000.	0.637E-05	-0.335E-06	0.444E-05	-0.354E-05
	2000000.	0.486E-05	-0.299E-06	0.652E-05	-0.428E-05
	3000000.	0.418E-05	-0.255E-06	0.795E-05	-0.473E-05
	5000000.	0.347E-05	-0.202E-06	0.971E-05	-0.529E-05
Mg XI 2S 2P	500000.	0.819E-01	-0.257E-02	0.984E-03	-0.425E-02
1473.6 A	750000.	0.681E-01	-0.247E-02	0.223E-02	-0.599E-02
C=0.15E+23	1000000.	0.600E-01	-0.241E-02	0.339E-02	-0.734E-02
	2000000.	0.446E-01	-0.231E-02	0.800E-02	-0.106E-01
	3000000.	0.378E-01	-0.222E-02	0.122E-01	-0.128E-01
	5000000.	0.309E-01	-0.191E-02	0.178E-01	-0.147E-01
Mg XI 2S 3P	500000.	0.401E-03	-0.192E-04	0.107E-03	-0.126E-03
52.7 A	750000.	0.341E-03	-0.185E-04	0.162E-03	-0.151E-03
C=0.11E+19	1000000.	0.304E-03	-0.176E-04	0.201E-03	-0.161E-03
	2000000.	0.233E-03	-0.160E-04	0.298E-03	-0.196E-03
	3000000.	0.201E-03	-0.140E-04	0.361E-03	-0.215E-03
	5000000.	0.167E-03	-0.114E-04	0.447E-03	-0.242E-03
Mg XI 3S 3P	500000.	4.89	-0.355	1.26	-1.49
5065.9 A	750000.	4.19	-0.347	1.89	-1.75
C=0.98E+22	1000000.	3.77	-0.336	2.26	-1.89
	2000000.	2.94	-0.308	3.34	-2.26
	3000000.	2.55	-0.270	4.06	-2.48
	5000000.	2.14	-0.222	5.06	-2.76

Table 1 continued

PERTURBER DENSITY = 1.E+19cm-3

PERTURBERS ARE:		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
Mg XI 2P 3S	500000.	0.254E-03	0.246E-04	0.404E-04	0.676E-04
55.2 A	750000.	0.219E-03	0.244E-04	0.578E-04	0.830E-04
C=0.60E+19	1000000.	0.198E-03	0.239E-04	0.760E-04	0.940E-04
	2000000.	0.156E-03	0.222E-04	0.122E-03	0.113E-03
	3000000.	0.135E-03	0.198E-04	0.150E-03	0.125E-03
	5000000.	0.113E-03	0.166E-04	0.191E-03	0.142E-03
Mg XI 2P 4S	500000.	0.310E-03	0.432E-04	0.667E-04	0.952E-04
40.7 A	750000.	0.270E-03	0.427E-04	0.971E-04	0.112E-03
C=0.32E+19	1000000.	0.246E-03	0.422E-04	0.112E-03	0.121E-03
	2000000.	0.197E-03	0.389E-04	0.156E-03	0.144E-03
	3000000.	0.173E-03	0.344E-04	0.186E-03	0.159E-03
	5000000.	0.147E-03	0.289E-04	0.231E-03	0.177E-03
Mg XI 2P 5S	500000.	0.748E-03	0.109E-03	*0.440E-03	*0.426E-03
36.1 A	750000.	0.660E-03	0.105E-03	*0.530E-03	*0.485E-03
C=0.55E+18	1000000.	0.603E-03	0.979E-04	*0.601E-03	*0.520E-03
	2000000.	0.481E-03	0.896E-04	*0.793E-03	*0.602E-03
	3000000.	0.419E-03	0.789E-04	*0.928E-03	*0.659E-03
	5000000.	0.350E-03	0.641E-04	0.113E-02	0.734E-03
Mg XI 3P 4S	500000.	0.754E-02	0.816E-03	0.196E-02	0.224E-02
160.3 A	750000.	0.653E-02	0.803E-03	0.266E-02	0.252E-02
C=0.98E+19	1000000.	0.592E-02	0.788E-03	0.315E-02	0.273E-02
	2000000.	0.469E-02	0.723E-03	0.446E-02	0.326E-02
	3000000.	0.409E-02	0.637E-03	0.545E-02	0.360E-02
	5000000.	0.345E-02	0.530E-03	0.664E-02	0.391E-02
Mg XI 3P 5S	500000.	0.774E-02	0.102E-02	*0.409E-02	*0.388E-02
106.7 A	750000.	0.680E-02	0.978E-03	*0.494E-02	*0.441E-02
C=0.43E+19	1000000.	0.620E-02	0.914E-03	*0.560E-02	*0.473E-02
	2000000.	0.492E-02	0.836E-03	*0.757E-02	*0.554E-02
	3000000.	0.428E-02	0.735E-03	*0.895E-02	*0.591E-02
	5000000.	0.358E-02	0.597E-03	*0.110E-01	*0.658E-02
Mg XI 2P 3D	500000.	0.270E-03	0.103E-04	0.691E-04	0.806E-04
54.7 A	750000.	0.226E-03	0.999E-05	0.103E-03	0.994E-04
C=0.11E+19	1000000.	0.200E-03	0.924E-05	0.138E-03	0.111E-03
	2000000.	0.151E-03	0.930E-05	0.215E-03	0.134E-03
	3000000.	0.129E-03	0.857E-05	0.261E-03	0.148E-03
	5000000.	0.107E-03	0.718E-05	0.320E-03	0.167E-03

Here, only a sample of results is shown in Table 1. 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. For each Stark broadening parameter shown 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 NV $>$ 0.5 are not given and values for 0.1 $<$ NV $\leq$ 0.5 are denoted by an asterisk.

The presented values may be of interest for a number of problems concerning the stellar, laboratory, fusion and laser produced plasma, and soft x-ray lasers modeling and research. The obtained results are of interest as well 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.: 1998a, *Astron. Astrophys. Suppl. Series*, submitted.
Dimitrijević, M.S. and Sahal-Bréchot, S.: 1998b, *Bull. Astron. Belgrade*, **157**, in press.
Dimitrijević, M.S., Sahal-Bréchot, S. and Bommier, V.: 1991, *Astron. Astrophys. Suppl. Series*, **89**, 581.
Martin, W.C., Zalubas, R.: 1980, *J. Phys. Chem. Reference Data*, **9**, 1.
Sahal-Bréchot, S.: 1969a, *Astron.Astrophys.* **1**, 91.
Sahal-Bréchot, S.: 1969b, *Astron.Astrophys.* **2**, 322.