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ON THE STARK BROADENING OF AR VIII SPECTRAL LINES

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Abstract. Within the semiclassical perturbation approach, we have considered electron-, proton-, and He III-impact line widths and shifts for 9 Ar VIII transitions, for perturber densities 10^{18} - 10^{22} cm^{-3} and temperatures T = 200,000 − 3,000,000 K.

1. INTRODUCTION

Stark broadening data for argon in different ionization stages are of interest for a number of problems in research of astrophysical, laboratory, laser produced and fusion plasmas, like *e.g.* plasma diagnostic and modelling. Stark broadening of Ar VIII spectral lines has been considered experimentaly (Hegazy *et al.* 1997) and theoreticaly (Purić *et al.* 1988, Hegazy *et al.* 1997, Djeniže and Srećković 1998, Konjević and Konjević 1998). In Hegazy *et al.* (1997) Stark broadening of 5f-6g and 5g-6h Ar VIII line profiles has been experimentaly investigated in gas-liner pinch. Obtained experimental results have been compared with the theoretical calculations performed in the same paper. These results has been discussed in Konjević and Konjević (1998). In Purić *et al.* (1988) and Djeniže *et al.* (1998), regularities and systematic trends have been used to estimate Ar VIII Stark broadening parameters. Moreover, Stark width for Ar VIII $4s^2S$-$4p^2P^o$ multiplet has been calculated in Djeniže *et al.* (1998) by using the symplified modified semiempirical approach (Dimitrijević and Konjević 1986).

As a continuation of our project (Dimitrijević 1996) to provide an as much as possible large set of reliable Stark broadening data for laboratory, laser produced, fusion and astrophysical plasma research, we have calculated within the semiclassical-perturbation formalism (sahal-Bréchot 1969ab, electron-, proton-, and ionized helium-impact line widths and shifts for 9 Ar VIII transitions.

2. RESULTS AND DISCUSSION

All relevant details concerning the obtained results and the calculation procedure will be published in Dimitrijević and Sahal–Bréchot (1999a). Here, we present only tables of Stark broadening parameters. Atomic energy levels needed for calculations have been taken from Bashkin and Stoner (1975). Our results for electron-, proton-, and He III-impact line widths and shifts for 9 Ar VIII transitions for perturber densities 10^{18}cm^{-3} – 10^{22}cm^{-3}, and the temperature range T = 200,000 – 3,000,000 K, will be published in Dimitrijević and Sahal-Bréchot (1999ab).

Table 1

Table 1. This table shows electron-, proton-, and He III-impact broadening parameters for Ar VIII for perturber density of 10^{18} cm^{-3} and temperatures from 200,000 up to 3,000,000 K. Transitions and corresponding wavelengths (in Å) are also given in the table. By dividing C by the corresponding full width at half maximum (Dimitrijević *et al.*, 1991), 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+18cm-3

PERTURBERS ARE :		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
Ar VIII3S 3P	200000.	0.930E-02	-0.137E-03	0.150E-03	-0.973E-04
714.0 Å	500000.	0.614E-02	-0.156E-03	0.374E-03	-0.208E-03
C=0.71E+21	1000000.	0.464E-02	-0.149E-03	0.557E-03	-0.304E-03
	1500000.	0.400E-02	-0.149E-03	0.656E-03	-0.368E-03
	2000000.	0.362E-02	-0.145E-03	0.701E-03	-0.403E-03
	3000000.	0.317E-02	-0.141E-03	0.780E-03	-0.448E-03
Ar VIII3S 3P	200000.	0.899E-02	-0.130E-03	0.146E-03	-0.918E-04
700.4 Å	500000.	0.593E-02	-0.148E-03	0.362E-03	-0.197E-03
C=0.69E+21	1000000.	0.448E-02	-0.142E-03	0.538E-03	-0.288E-03
	1500000.	0.386E-02	-0.142E-03	0.633E-03	-0.349E-03
	2000000.	0.350E-02	-0.138E-03	0.675E-03	-0.382E-03
	3000000.	0.307E-02	-0.134E-03	0.750E-03	-0.425E-03
Ar VIII3S 4P	200000.	0.119E-02	0.977E-05	0.702E-04	0.100E-04
159.0 Å	500000.	0.815E-03	0.147E-04	0.112E-03	0.199E-04
C=0.13E+20	1000000.	0.638E-03	0.125E-04	0.131E-03	0.276E-04
	1500000.	0.562E-03	0.119E-04	0.140E-03	0.316E-04
	2000000.	0.516E-03	0.119E-04	0.148E-03	0.342E-04
	3000000.	0.462E-03	0.113E-04	0.158E-03	0.380E-04

Table 1 continued

PERTURBER DENSITY = 1.E+18cm-3

PERTURBERS ARE :		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
Ar VIII4S 4P	200000.	0.210	-0.497E-02	0.106E-01	-0.586E-02
1887.0 Å	500000.	0.147	-0.561E-02	0.174E-01	-0.960E-02
C=0.19E+22	1000000.	0.117	-0.547E-02	0.209E-01	-0.120E-01
	1500000.	0.103	-0.527E-02	0.230E-01	-0.134E-01
	2000000.	0.952E-01	-0.512E-02	0.248E-01	-0.145E-01
	3000000.	0.852E-01	-0.447E-02	0.276E-01	-0.161E-01
Ar VIII3P 4S	200000.	0.161E-02	0.108E-03	0.535E-04	0.110E-03
229.4 Å	500000.	0.112E-02	0.130E-03	0.136E-03	0.176E-03
C=0.28E+20	1000000.	0.880E-03	0.122E-03	0.208E-03	0.216E-03
	1500000.	0.773E-03	0.118E-03	0.243E-03	0.239E-03
	2000000.	0.708E-03	0.115E-03	0.269E-03	0.257E-03
	3000000.	0.628E-03	0.104E-03	0.314E-03	0.282E-03
Ar VIII3P 4S	200000.	0.164E-02	0.110E-03	0.542E-04	0.111E-03
230.9 Å	500000.	0.114E-02	0.131E-03	0.137E-03	0.178E-03
C=0.28E+20	1000000.	0.893E-03	0.124E-03	0.211E-03	0.219E-03
	1500000.	0.784E-03	0.119E-03	0.245E-03	0.242E-03
	2000000.	0.718E-03	0.117E-03	0.272E-03	0.260E-03
	3000000.	0.637E-03	0.105E-03	0.318E-03	0.285E-03
Ar VIII3P 3D	200000.	0.573E-02	-0.637E-04	0.148E-03	-0.359E-04
519.2 Å	500000.	0.379E-02	-0.616E-04	0.314E-03	-0.798E-04
C=0.38E+21	1000000.	0.287E-02	-0.816E-04	0.438E-03	-0.120E-03
	2000000.	0.225E-02	-0.711E-04	0.513E-03	-0.165E-03
	3000000.	0.198E-02	-0.682E-04	0.551E-03	-0.183E-03
Ar VIII3P 3D	200000.	0.591E-02	-0.665E-04	0.153E-03	-0.379E-04
526.6 Å	500000.	0.391E-02	-0.648E-04	0.324E-03	-0.841E-04
C=0.40E+21	1000000.	0.296E-02	-0.849E-04	0.453E-03	-0.127E-03
	1500000.	0.255E-02	-0.727E-04	0.498E-03	-0.154E-03
	2000000.	0.232E-02	-0.741E-04	0.530E-03	-0.173E-03
	3000000.	0.204E-02	-0.711E-04	0.569E-03	-0.192E-03
Ar VIII3D 4P	200000.	0.547E-02	0.102E-03	0.346E-03	0.785E-04
337.6 Å	500000.	0.376E-02	0.127E-03	0.547E-03	0.141E-03
C=0.60E+20	1000000.	0.295E-02	0.124E-03	0.636E-03	0.194E-03
	1500000.	0.260E-02	0.116E-03	0.683E-03	0.215E-03
	2000000.	0.239E-02	0.116E-03	0.721E-03	0.233E-03
	3000000.	0.214E-02	0.111E-03	0.770E-03	0.258E-03

As a sample of our results, the Stark broadening parameters for Ar VIII spectral lines broadened by electron and proton impacts, for a perturber density of 10^{18} cm^{-3},

are shown in Table 1. We also specify a parameter C (Dimitrijević and Sahal–Bréchot 1984), which gives an estimate for the maximum perturber density for which the line may be treated as isolated when it is divided by the corresponding full width at half maximum. 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).

There is not an enough complete set of reliable atomic data to perform an adequate semiclassical perturbation calculation of the Stark broadening of Ar VIII 5f-6g and 5g-6h line profiles, experimentaly and theoreticaly investigated in Hegazy *et al.* (1997). This is similar for Ar VIII 4p-4d and 4p-5s Stark widths estimated on the basis of regularities and systematic trends in Djeniže *et al.* (1998). In Purić *et al.* (1988), full Stark width at half maximum (W) for $4s^2S$-$4p^2P^o$ multiplet has been estimated on the basis of the regular dependence on the upper level ionization potential to be 0.0244 Å at the temperature T=80,000 K and for an electron density of $10^{17}cm^{-3}$. For the same multiplet and electron density, W=0.018Å has been obtained in Djeniže *et al.* (1998) on the basis of established regularities along the argon isonuclear sequence, for T=150,000 K. Our result for T=200,000 K is 0.0210Å which is a good agreement.

The new experimental data will be very useful for further development and rafinement of the theory of multicharged ion lines and for the investigation of regularities and systematic trends.

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