THE ELECTRON-IMPACT WIDTHS FOR 4s-4p OF Sr III LINES

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Abstract. In this paper we present Stark widths for five $5s - 5p$ transitions of Sr III calculated by using the modified semiempirical approach and jK coupling approximation.

1. INTRODUCTION

The electron-emitter/absorber collisions are cause of the main pressure broadening mechanism in atmospheres of hot stars. Consequently, the knowledge of the Stark broadening parameters is needed for the stellar atmosphere investigations and modeling. Also, Stark broadening data are needed for investigations and diagnostic of laboratory plasma.

In the case of emitters with complex spectra, where the usual LS coupling scheme is not applicable, as well as the more sophisticated methods as the semiclassical approach (Sahal-Bréchot 1969ab) due to the lack of atomic data, the simpler methods should be used. One of such methods for Stark broadening parameter calculations is the modified semiempirical approach (Dimitrijević & Konjević 1980, Popović & Dimitrijević 1996). It was shown in several papers (Popović & Dimitrijević 1996ab, 1997) that for an emitter with the complex spectrum, the modified semiempirical approach gives a good average accuracy.

Here we present Stark broadening parameters for five Sr III 5s-5p transitions, calculated by using the modified semiempirical approach and assuming jK coupling approximation.

2. THEORETICAL REMARKS

According to the MSE approach (Dimitrijević & Konjević 1980, Popović & Dimitrijević 1996) the electron impact full width (FHWM) of an ion line is given as

$$w_{MSE} = N\frac{8\pi}{3}\frac{\hbar^2}{m^2}\Big(\frac{2m}{\pi kT}\Big)^{1/2}\frac{\pi}{\sqrt{3}}\cdot\Big\{\sum_{\ell_i\pm 1}\sum_{K_{i'}}\vec{\Re}^2[n_i\ell_iK_i, n_i(\ell_i\pm 1)K_{i'}]\widetilde{g}\Big(\frac{E}{\Delta E_{\ell_i,\ell_i\pm 1}}\Big)+$$

$$+\sum_{\ell_f\pm 1}\sum_{K_{f'}}\vec{\Re}^2[n_f\ell_fK_f, n_f(\ell_f\pm 1)K_{f'}]\widetilde{g}\Big(\frac{E}{\Delta E_{\ell_f,\ell_f\pm 1}}\Big)+ \qquad (1)$$

$$+\Big(\sum_{i'}\vec{\Re}^2_{ii'}\Big)_{\Delta n\neq 0}g(x_{n_i,n_i+1})+\Big(\sum_{f'}\vec{\Re}^2_{ff'}\Big)_{\Delta n\neq 0}g(x_{n_f,n_f+1})\Big\},$$

where the initial level is denoted with i and the final one with f and the square of the matrix element $\{\vec{\Re}^2[n_k\ell_k K_{k'}, (\ell_k \pm 1)K_{k'}], \quad k = i, f\}$ is

$$\vec{\Re}^2[n_k\ell_k K_k, n_k(\ell_k \pm 1)K_{k'}] = \frac{\ell_>}{2J_k + 1} Q(j_p K\ell', \ell K')[R^{n_k(\ell_k\pm1)}_{n_k\ell_k}]^2 \qquad (2)$$

and

$$(\sum_{k'} \vec{\Re}^2_{kk'})_{\Delta n \neq 0} = (\frac{3n_k}{2Z})^2 \frac{1}{9}(n_k^2 + 3\ell_k^2 + 3\ell_k + 11) \qquad (3)$$

where $\ell_> = \max(\ell_k, \ell_k \pm 1)$.

In Eqs. (1 – 3) N and T are electron density and temperature, respectively.

$$Q(j_p K\ell', \ell K') = (2K + 1)(2K' + 1)[W(j_p K\ell' 1; \ell K')]^2$$

is the multiplet factor for jK coupling approximation (see e.g. Sobelman 1992). The $[R^{n_k\ell_k\pm1}_{n\ell}]$ is the radial integral, $g(x)$, and $\tilde{g}(x)$ are the semiempirical (Griem 1968) and the modified semiempirical (Dimitrijević & Konjević 1980) Gaunt factors for Stark width and shift, respectively.

3. RESULTS AND DISCUSSION

Calculation of Stark widths for five Sr III lines was performed by using Eqs. 1-4. The atomic energy levels have been taken from Persson and Valind (1972). The necessary matrix elements have been calculated by using Eqs. 2 and 3. The data for the multiplet factor for jK coupling approximation were taken from Popović (1994).

Table 1. Stark width (FWHM) Sr III (5s – 5p) transitions for electron density of $10^{23}m^{-3}$ as a function of temperature. The averaged wavelength of the multiplet is denoted as $\overline{\lambda}$. The jK coupling approximation was assumed.

Transition	T (K)	W (nm)
$(^2P_{3/2})\ 5s[3/2] - 5p[5/2]$	5000.	.172E-01
	10000.	.120E-01
	50000.	.530E-02
	100000.	.420E-02
$\overline{\lambda} = 309.62$ nm	250000.	.393E-02
	500000.	.387E-02
$(^2P_{3/2})\ 5s[3/2] - 5p[3/2]$	5000.	.153E-01
	10000.	.107E-01
	50000.	.471E-02
	100000.	.373E-02
$\overline{\lambda} = 287.08$ nm	250000.	.349E-02
	500000.	.344E-02

Table 1. continued

Transition	T (K)	W (nm)
$(^2P_{3/2})\ 5s[3/2] - 5p[1/2]$	5000.	.183E-01
	10000.	.128E-01
$\overline{\lambda} = 321.63$ nm	50000.	.563E-02
	100000.	.446E-02
	250000.	.418E-02
	500000.	.412E-02
$(^2P_{1/2})\ 5s[1/2] - 5p[3/2]$	5000.	.154E-01
	10000.	.108E-01
$\overline{\lambda} = 286.82$ nm	50000.	.473E-02
	100000.	.374E-02
	250000.	.349E-02
	500000.	.344E-02
$(^2P_{1/2})\ 5s[1/2] - 5p[1/2]$	5000.	.154E-01
	10000.	.107E-01
$\overline{\lambda} = 286.82$ nm	50000.	.472E-02
	100000.	.373E-02
	250000.	.348E-02
	500000.	.344E-02

In Table 1 we present results of our calculation of Stark widths and shifts for Sr III 5s – 5p transitions assuming jK coupling approximation, respectively.

In the case of Sr III there is not measured and calculated data. Here we give first results, and we hope that the data will be of interest for stellar as well as laboratory plasma spectroscopy.

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