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STARK BROADENING OF Sn III LINES IN A TYPE STELLAR ATMOSPHERES

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Abstract. Here we present Stark broadening parameters for Sn III 6s $^1S_0 - 6p\ ^1P_1^o$ spectral line obtained by using semiclassical perturbation approach and Stark widths for this transition obtained by using modified semiempirical approach. Results obtained have been compared with available experimental data and used for the consideration of the influence of the Stark broadening effect in A type stellar atmospheres.

1. INTRODUCTION

With the development of new space tehniques, the quality and quantity of spectroscopic data for trace elements as tin has increased. Spectral lines of neutral tin are present in the spectra of A type stars, for example γ Equ (Adelman et al. 1979). Also, a Sn II spectral line is observed in Przybylski's star by Cowley et al. (2000).

For the considered Sn III 6s $^1S_0 - 6p\ ^1P_1^o$ spectral line, Kieft et al. (2004) measured Stark width and they also, obtained the first theoretical result by using semiempirical (Griem, 1968) approach.

Here we present Stark broadening parameters for Sn III 6s $^1S_0 - 6p\ ^1P_1^o$ as a function of temperature, obtained by using semiclassical perturbation (Sahal-Bréchot, 1969ab) approach and Stark widths for this transition as a function of temperature, obtained by using modified semiempirical (Dimitrijević & Konjević, 1980) approach.

2. RESULTS AND DISCUSSION

For Sn III spectral line Stark broadening parameters, the full semiclassical perturbation approach (Sahal−Bréchot, 1969ab) has been applied. A summary of the formalism for ionized emitters is given in Dimitrijević et al. (1991) and Dimitrijević & Sahal - Bréchot, (1996). Also, for Sn III spectral line Stark width, modified semiempirical approach (Dimitrijević & Konjević, 1980) has been applied. The needed energy levels have been taken from Moore (1971). The oscillator strengths have been calculated by using the method of Bates & Damgaard, (1949), and the tables of Oertel & Shomo (1968). For higher levels, the method of Van Regemorter et al. (1979) has been used.

Our results for Sn III line are shown in Tables 1 and 2. We also specify a parameter C (Dimitrijević & 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.

One can see from Table 3, a good agreement with experimental value of both our results for Stark width for Sn III 6s $^1S_0 - 6p\ ^1P^o_1$ obtained by using semiclassical and modified semiempirical approach. Obviously, this ratio is better for our values than for semiempirical one obtained by Kieft et al. (2004) using Griem (1968) method, not applicable for multiply charged ions (see Dimitrijević & Konjević, 1980).

Table 1: Electron- and proton-impact broadening parameters for Sn III 5226.2 Å obtained by using semiclassical perturbation approach for perturber density of $10^{17}\mathrm{cm}^{-3}$ and temperatures from 10000 up to 150000 K.

Transition	T(K)	W_{e^-} (Å)	d_{e^-} (Å)	W_{p^+} (Å)	d_{p^+} (Å)
	10000	1.39	-0.149	0.391E-01	-0.207E-01
Sn III	20000	1.05	-0.987E-01	0.615E-01	-0.339E-01
6s $^1S_0 - 6p\ ^1P^o_1$	30000	0.907	-0.886E-01	0.758E-01	-0.426E-01
5226.2 Å	50000	0.788	-0.900E-01	0.869E-01	-0.513E-01
C= 0.24E+21	100000	0.676	-0.846E-01	0.102	-0.619E-01
	150000	0.626	-0.788E-01	0.111	-0.686E-01

Table 2: Stark widths for Sn III 5226.2 Å obtained by using modified semiempirical approach for perturber density of $10^{17}\mathrm{cm}^{-3}$ and temperatures from 2500 up to 50000 K.

Transition	T(K)	W(Å)
	2500	2.217
	5000	1.567
6s $^1S_0 - 6p\ ^1P^o_1$	10000	1.108
5226.2Å	20000	0.784
	30000	0.640
	50000	0.514

Table 3: Comparison between W_m-experimental Stark width with theoretical: W_{se}-semiempirical, W_{sc}-semiclassical and W_{mse}-modified semiempirical.

Transition	W_m(Å)	Rel. error	$\frac{W_m}{W_{se}}$	$\frac{W_m}{W_{sc}}$	$\frac{W_m}{W_{mse}}$
Sn III 6s $^1S_0 - 6p\ ^1P^o_1$ 5226.2 Å	1.22	50%	1.70	0.92	1.15

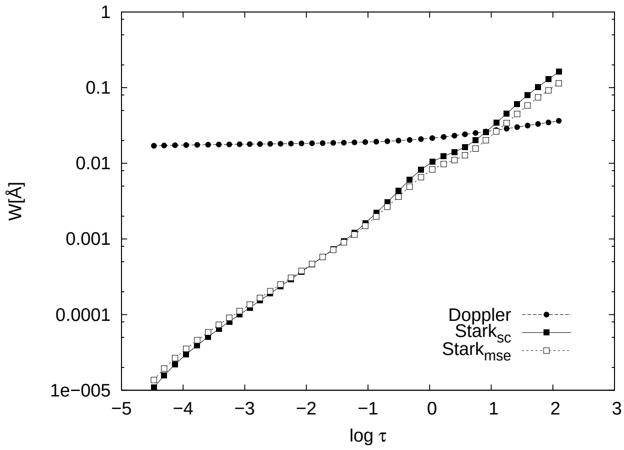

Figure 1: Thermal Doppler and Stark widths (sc-semiclassical, mse-modified semiempirical) for Sn III 6s $^1S_0 - 6p\ ^1P_1^o$ line as functions of optical depth for an A type star ($T_{\rm eff} = 10000$ K, $\log g = 4.5$).

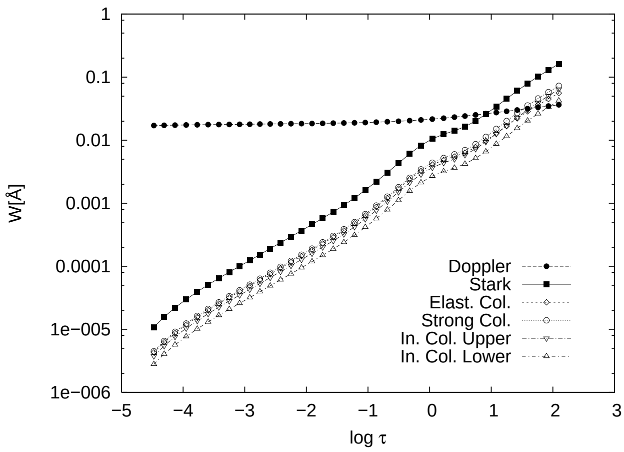

Figure 2: Thermal Doppler, Stark and contributions of different collision processes to the total Stark width of Sn III 6s $^1S_0 - 6p\ ^1P_1^o$ line as functions of optical depth for an A type star ($T_{\rm eff} = 10000$ K, $\log g = 4.5$).

In order to see the influence of Stark broadening mechanism for Sn III spectral line in stellar plasma conditions, we have calculated Stark widths for a Kurucz's (1979) A type star ($T_{\rm eff} = 10000$ K, $\log g = 4.5$) atmosphere model and compared them with Doppler ones. Obtained results in function of the Rosseland optical depth are presented in Fig. 1. One can see, that exist photospheric layers where Doppler and Stark widths are comparable and even where the Stark width is dominant and must be taken into account. Also, in Fig. 2, for the same atmosphere model, we presented Stark widths and contributions of different collision processes to the total Stark width in comparison with Doppler one. In this case, elastic and strong collisions and inelastic collision from upper levels have a similar contribution to the full Stark width as well as the similar behaviour with temperature.

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