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THE ELECTRON-IMPACT BROADENING PARAMETERS FOR ASTROPHYSICALLY IMPORTANT LINES IN Co II SPECTRA

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1. INTRODUCTION

The spectral lines for singly ionized cobalt are present in stellar spectra, as e.g. in Hg-Mn star spectra (Bolcal and Didelon, 1987). The abundance of cobalt is derived by fitting-synthesis analysis of co-added high-resolution *International Ultraviolet Explorer (IUE) spectra*. The investigation of cobalt abundance in Hg-Mn stars shows that the most of the Hg-Mn stars are evidently largely cobalt-deficient ([Co/H]≤ -2dex), but exceptions for mildly cobalt-rich stars, νCnc and φHer, and cobalt-normal stars 87 Psc and 36 Lyn are notable (Smith and Dworetsky, 1993). Also, in hot star atmospheres Stark broadening mechanism is the main pressure broadening mechanism (Dimitrijević, 1989). Consequently, in order to investigate and modeling the Hg-Mn star and other type of hot star atmospheres, the Stark broadening parameters for Co II spectral lines are needed.

There is not measured Stark broadening parameters for Co II lines. However for the resonant $3d^8\ ^3F$-$3d^7 4p\ ^3G^0$ (λ=2058.9Å) Co II line the Stark broadening data have been estimated based on regularities and systematic trends by Lakićević (1983).

In order to provide to astrophysicist the needed data, we have calculated Stark broadening parameters for 12 Co II spectral lines, from the a^5F-z^5G^0 multiplet. Calculations were performed by using the modified semiempirical approach (Dimitrijević and Konjević, 1980; Dimitrijević and Konjević, 1981; Popović and Dimitrijević, 1996). Also, considering that Co II (λ=2307.85Å) line has been used for cobalt abundance determination (see e.g. Smith and Dworetsky, 1993) in HgMn stars, we have tested the influence of Stark mechanism on width of this line in layers of A type stars, as well as DA and DB white dwarfs. This has been done with the help of Kurucz's model atmospheres (Kurucz, 1979) of an A type star (T_{eff}=10000K, logg=4), and with Wickramasinghe's models of DA (T_{eff}=10000K, logg=6) and DB (T_{eff}=15000K, logg=7) white dwarf atmospheres (Wickramasinghe, 1972).

2. RESULTS AND DISCUSSION

As an example of our results, we present here the electron-impact broadening parameters for $a^5F_4 - z^5G_5^0$ Co II line as a function of temperature, calculated by using the modified semiempirical approach. The energy levels were taken from Pickering et al (1998). Oscillator strength data have been calculated by using the Bates-Damgaard method (Bates and Damgaard, 1949).

In Table 1, Stark widths and shifts for $a^5F_4 - z^5G_5^0$ Co II spectral line, for an electron density of $10^{23}m^{-3}$ and temperature range 5000-50000K, are shown. The configuration mixing has been taken into account in calculation.

It is no possible to compare our data with other, since experimental data do not exist and we have not calculated Stark broadening data for the line treated by Lakićević (1983).

We have considered the influence of the Stark broadening mechanism on Co II (λ=2307.85 Å) line in stellar plasma, by using the Kurucz's model atmospheres of an A type star (T_{eff}=10000K, log g=4), and with Wickramasinghe's models of DA (T_{eff}=10000K, log g=6) and DB (T_{eff}=15000K, log g=7) white dwarf atmospheres. The results of our investigation are presented in Table 2 and Figs. 1 and 2.

Thermal Doppler and Stark widths as functions of optical depth, for the considered Co II line, are compared in Figs.1. and 2. for an A type star and DA and DB white dwarf, respectively. As one can see from Fig. 1, in photospheric layers of hot A type stars the Stark line width is one order of magnitude larger than thermal Doppler one. In higher layers of stellar atmospheres ($\tau \approx$-4) however, the thermal Doppler mechanism is more important. In Fig. 2 one can see, that in the case of DA and DB white dwarf atmospheres Stark broadening mechanism is important in all atmospheric layers, especially in deeper layers, where the Stark width is two or three orders of magnitude larger than the thermal Doppler width.

Table 1. Stark (full) widths and shifts for the Co II λ=2307.85Å spectral line. The electron density is 10^{23}m^{-3}.

Transition	T(K)	Stark FWHM (Å)	d(Å)
$a\,^5F_4 - z\,^5G^0_5$ λ=2307.85 Å	5000	0.751E-01	-0.182E-01
	10000	0.524E-01	-0.130E-01
	20000	0.363E-01	-0.928E-02
	30000	0.293E-01	-0.768E-02
	40000	0.253E-01	-0.675E-02
	50000	0.227E-01	-0.608E-02

Table 2. Thermal Doppler and Stark full widths for the Co II λ=2307.85Å line as a function of optical depth for a DA white dwarf model (T_{eff}=10000K, log g=6).

τ	T(K)	log(p_e)	Stark FWHM (Å)	Thermal Doppler FWHM (Å)
0.00	7009	1.068	0.762E-04	0.342E-03
0.05	8034	2.599	0.210E-02	0.366E-03
1.25	11501	4.211	0.498E-01	0.438E-03
2.00	12474	4.413	0.701E-01	0.457E-03
6.00	14914	4.657	0.935E-01	0.499E-03
10.00	16102	4.716	0.953E-01	0.519E-03

Table 3. Thermal Doppler and Stark full widths for the Co II λ=2307.85Å line as a function of optical depth for a DB white dwarf model (T_{eff}=15000K, log g=7).

τ	T(K)	log(p_e)	Stark FWHM (Å)	Thermal Doppler FWHM (Å)
0.00	8998	2.465	0.130E-02	0.388E-03
0.05	9158	3.815	0.253E-01	0.406E-03
1.25	13859	4.877	0.173	0.481E-03
2.00	14847	5.062	0.239	0.498E-03
6.00	18222	5.699	0.758	0.552E-03
10.00	19934	6.000	1.320	0.577E-03

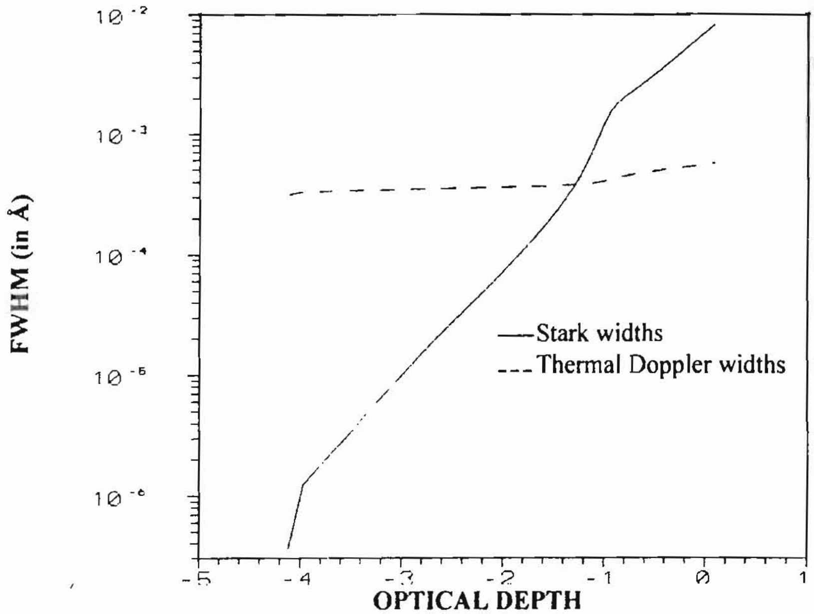

Fig. 1. Thermal Doppler and Stark full widths for the Co II λ=2307.85 Å line as functions of optical depth for an A type star (T_{eff}=10000K, log g=4).

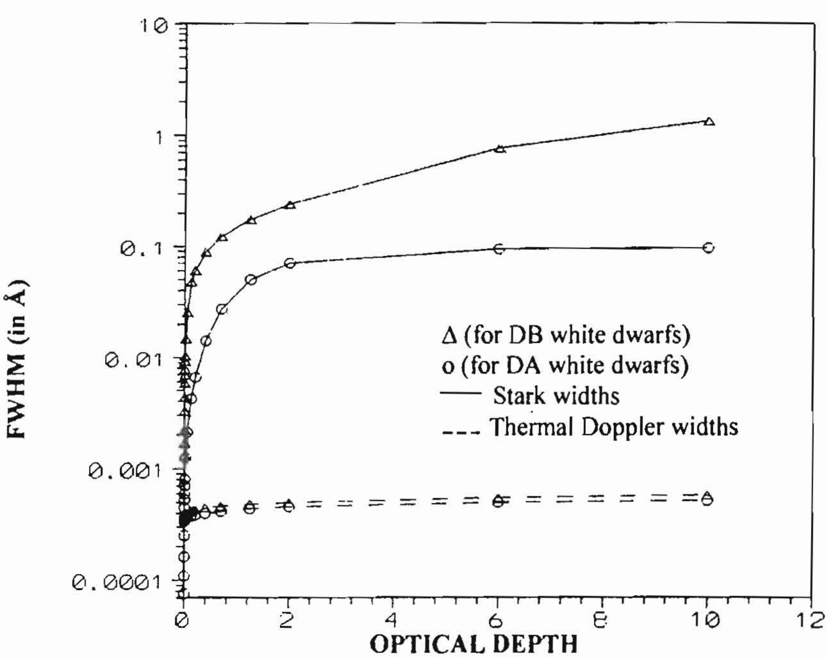

Fig. 2. Thermal Doppler and Stark full widths for the Co II λ=2307.85 Å line as functions of optical depth for DA (T_{eff}=10000K, log g=6) and DB (T_{eff}=15000K, log g=7) models.

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