Proc. VI Serbian-Bulgarian Astronomical Conference, Belgrade 7-11 May 2008,
Eds. M. S. Dimitrijević, M. Tsvetkov, L. Č. Popović, V. Golev
Publ. Astr. Soc. "Rudjer Bošković", No. 9, 2009, 311-314

STARK BROADENING OF NEUTRAL TELLURIUM SPECTRAL LINES IN WHITE DWARF ATMOSPHERES

MILAN S. DIMITRIJEVIĆ[1], ZORAN SIMIĆ[1],
ANDJELKA KOVAČEVIĆ[2], MIODRAG DAČIĆ[1],
SYLVIE SAHAL-BRÉCHOT[3]

[1]*Astronomical Observatory, Volgina 7, 11060 Belgrade 38, Serbia*
e-mail: mdimitrijevic@aob.bg.ac.yu
[2]*Department of Astronomy, Faculty of Mathematics, Studentdski Trg 16, 11000 Belgrade, Serbia*
[3]*Observatoire de Paris, 92195 Meudon Cedex, France*

Abstract. We determined Stark widths and shifts for four Te I multiplets, of interest for modellisation, investigation and diagnostic of stellar plasma, by using the semiclassical perturbation method. Results were applied for the investigation of the influence of Stark broadening mechanism in ultraviolet, optical and infrared part of the spectrum of white dwarf star atmospheres.

1. INTRODUCTION

With the development of astronomical observations from space, even elements like tellurium are found in stellar atmospheres, so that the broadening parameters of its spectral lines are needed for the better analyzis and synthesis of stellar spectra.

Chayer et al. (2005) observed Te I spectral lines in ultraviolet range of spectra of the cool DO white dwarf HD149499 B and HZ 21. In order to provide needed line broadening data, we have calculated recently, the Stark broadening parameters for four Te I multiplets for plasma conditions, of interest for white dwarfs. We will present here the results for Te I 6s $^5S^o$ - 7p ^5P multiplet and use them for the analysis of Stark broadening influence for white dwarfs plasma conditions by comparing Stark and Doppler widths in white dwarf atmospheres.

There are no other theoretical and experimental data for Stark broadening of these four Te I multiplets.

2. RESULTS AND DISCUSSION

Calculations have been performed within the semiclassical perturbation formalism, developed and discussed in Sahal-Bréchot (1969ab). For updates see e.g. Dimitrijević (1996). Atomic energy levels needed for calculations have been taken from Moore (1971). The oscillator strengths have been calculated within the Coulomb approximation (Bates and Damgaard, 1949; and the tables of Oertel and Shomo, 1968). For higher levels, the method of van Regemorter et al. (1979) has been used.

Here, as an example, are presented in Table 1, electron-, and proton-impact broadening parameters for Te I 6s $^5S^o$ - 7p ^5P (5125.2 Å) multiplet for a perturber density of 10^{16}cm^{-3} and temperatures from 2500 up to 150000 K. The quantity C (given in Å cm^{-3}), when divided by the corresponding full width at half maximum, gives an estimate for the maximum perturber density for which 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. For higher densities, the isolated line approximation used in the calculations breaks down.

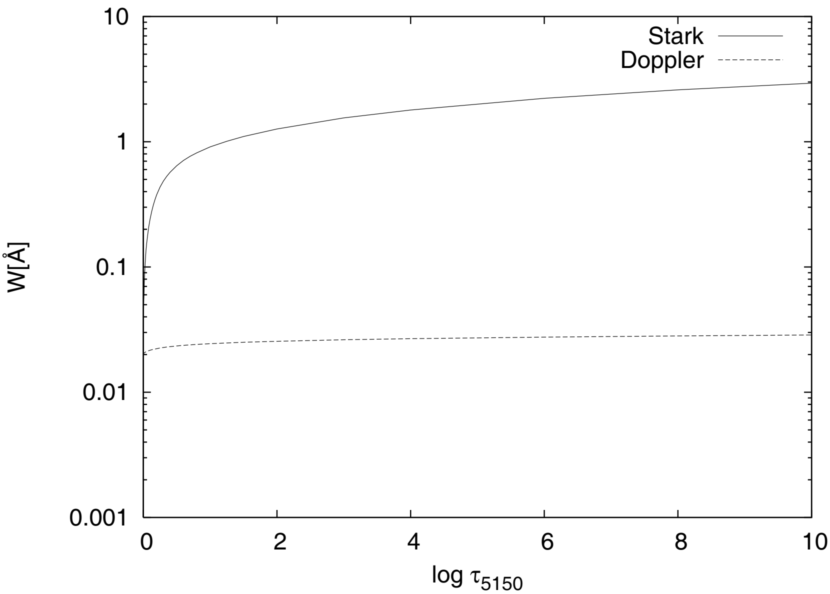

Figure 1: Thermal Doppler and Stark widths for Te I 6s $^5S^o$ - 7p ^5P (5125.2 Å) multiplet as a functions of optical depth T_{eff} = 15000 K and log *g* = 8 for DA type of white dwarf.

Table 1. Electron-, and proton-impact broadening parameters for Te I 6s $^5S^o$ - 7p ^5P multiplet obtained by using the semiclassical perturbation method.

Transition	T(K)	W_e-(Å)	d_e-(Å)	W_{p+}(Å)	d_{p+}(Å)
TeI 6s $^5S^o$ - 7p ^5P 5125.2 Å C=0.57E+19	2500	0.125	0.758E-01	*0.818E-01	*0.180E-01
	5000	0.146	0.912E-01	*0.842E-01	*0.215E-01
	10000	0.170	0.944E-01	0.855E-01	0.251E-01
	20000	0.196	0.894E-01	0.865E-01	0.288E-01
	30000	0.212	0.770E-01	0.871E-01	0.311E-01
	50000	0.230	0.638E-01	0.880E-01	0.341E-01
	100000	0.244	0.515E-01	0.895E-01	0.387E-01
	150000	0.243	0.435E-01	0.906E-01	0.414E-01

We used the obtained results for the investigation of the influence of Stark broadening in DA and DB type of white dwarf atmospheres. Stark widths for Te I 6s $^5S^o$ - 7p ^5P (5125.2 Å) multiplet have been compared in Fig. 1. with Doppler widths for a model (Teff=15000 K, log g= 8) of DA type of white dwarf (Wickramasinghe, 1972). For the considered model atmosphere of the DA white dwarfs, the prechosen optical depth points at the standard wavelength λ_s = 5150 Å (τ = 5150) are used in Wickramasinghe (1972) and here. As one can see in Fig. 1. for the DA white dwarf atmosphere plasma conditions, thermal Doppler broadening has much less importance in comparison with the Stark broadening mechanism. The mentioned model with the same parameters (Teff=15000 K, log g= 8) but for

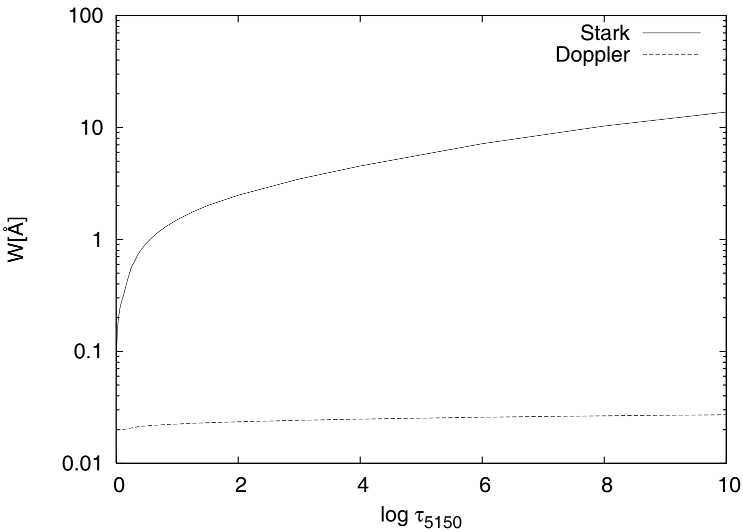

Figure 1: Thermal Doppler and Stark widths for Te I 6s $^5S^o$ - 7p ^5P (5125.2 Å) multiplet as a functions of optical depth T_{eff} = 15000 K and log g = 8 for DB type of white dwarf.

DB type of white dwarf atmospheres has been used for Te I 6s $^5S^o$ - 7p ^5P (5125.2 Å) multiplet (see Fig. 2.). It is interesting to see, in Fig. 2, that the Stark broadening mechanism is larger more than two magnitudes in comparison with the termal Doppler mechanism throughout the considered layers of white dwarf atmospheres.

For the considered atmosphere model Stark broadening effect should be taken into account in abundance determination and other investigations of stellar plasmas. Our results for all four Te I multiplets will be submitted in Dimitrijević et al. 2008.

References

Bates, D. R. and Damgaard, A.: 1949, *Phil. Trans. Roy. Soc.*, London, Ser. A, **242**, 101.
Chayer, P., Vennes, S., Dupuis, J. and Kruk, J. W.: 2005, *Astrophys. J.*, **630**, L169.
Dimitrijević, M. S.: 1996, *Zh. Priklad. Spektrosk*, **63**, 810.
Moore, C. E.: 1971, Atomic Energy Levels, Vol. III, NSRDS-NBS.
Oertel, G. K. and Shomo, L. P.: 1968, *ApJS*, **16**, 175.
Sahal-Bréchot, S.: 1969a, *Astron. Astrophys.*, **1**, 9.
Sahal-Bréchot, S.: 1969b, *Astron. Astrophys.*, **2**, 322.
van Regemorter, H., Hoang Binh Dy and Prud'homme, M.: 1979, *J. Phys.B*, **12**, 1073.
Wickramasinghe, D. T.: 1972, *Mem. R. Astron. Soc.*, **76**, 129.