**Proc. IV Serbian-Bulgarian Astronomical Conference,**
**Belgrade 21–24 April 2004,**
**eds. M. S. Dimitrijević, V. Golev, L. Č. Popović, M. Tsvetkov,**
**Publ. Astron. Soc. "Rudjer Bošković" No 5, 2005, 271 - 274** *Contributed paper*

# ON THE STARK BROADENING OF Cd I LINES

Z. SIMIĆ[1], M. S. DIMITRIJEVIĆ[1] and S. SAHAL-BRÉCHOT[2]
[1]*Astronomical Observatory, Volgina 7, 11160 Belgrade 74, Serbia*
*E–mail zsimic@aob.aob.bg.ac.yu*
*E–mail mdimitrijevic@aob.aob.bg.ac.yu*

[2]*Observatoire de Paris-Meudon, 92190 Meudon, Cedex, France*
*E–mail Sylvie.Sahal-Brechot@obspm.fr*

**Abstract.** We have calculated within the semiclassical perturbation theory Stark broadening parameters (width and shift) for 13 Cd I multiplets in UV and V, and for 24 multiplets in infrared spectral ranges, for temperatures between 2500 K and 50000 K, of interest for stellar plasma investigations.

## 1. INTRODUCTION

Investigation of Stark broadening parameters of neutral cadmium spectral lines is of interest for a number of problems as e.g. for the determination of chemical composition and plasma diagnostic of stellar atmospheres, as well as for radiative transfer, plasma modelling and stellar spectra interpretation and synthesis. The electron-impact broadening mechanism is the main pressure broadening mechanism in hot star atmospheres, and it is of interest especially for A type stars and some white dwarfs, or pre dwarfs like PG-1195 type ones.

Stark broadening parameters of cadmium lines are also of interest for the consideration of regularities and systematic trends, which are useful for interpolation of new data and critical evaluation of existing ones.

The first experimental investigations of the influence of the Stark broadening mechanism on cadmium lines have been performed by Nagibina (1958), and by Gorodnichyute and Gorodnichyus (1961). In our case will be of interest experimental results obtained by Kusch and Oberschelp (1967).

Here, we have calculated within semiclassical approach, Stark broadening parameters of 13 Cd I multiplets in UV and V, and 24 multiplets in infrared spectral ranges, for temperatures between 2500 K and 50000 K.

## 2. RESULTS AND DISCUSSION

Stark broadening parameters (the full line width at half maximum and the line shift) of neutral cadmium have been determined by using the semiclassical perturba-

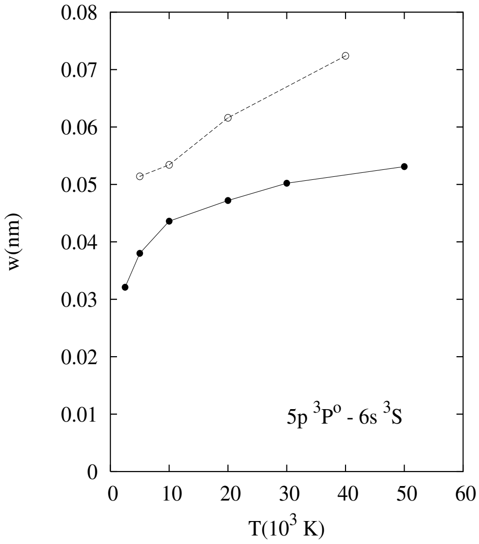


**Figure 1:** Stark widths due to electron impacts for Cd I 5p $^3P^o$ - 6s $^3S$ (494.13 nm) spectral multiplet as a function of temperature. Values of Dimitrijević and Konjević (1983) are presented by white points, and values of Simić, Dimitrijević and Sahal-Bréchot (present results) by black points.

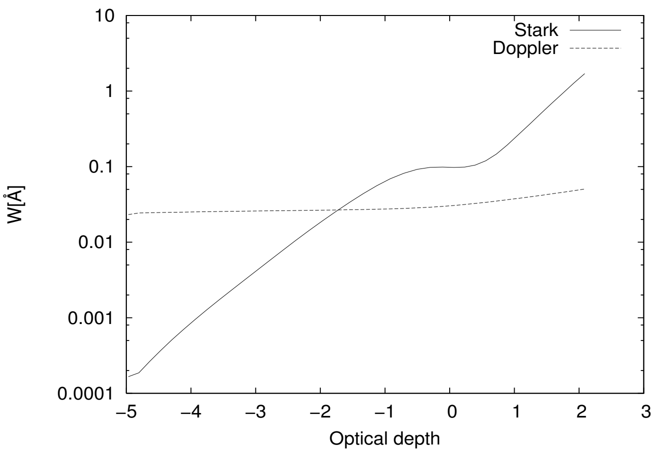


**Figure 2:** Stark and Doppler widths for Cd I 6s $^3S^o$ - 7p $^3P^o$ (740.09 nm) spectral line as a function of optical depth.

**Table 1:** Experimental ($w_{KO}$ - Kusch and Oberschelp, 1967) and theoretical values of Stark widths ($w_{DK}$ - Dimitrijević and Konjević, 1983; $w_{SDS}$ - present work) for Cd I 5p $^3P^o$ - 6s $^3S$ spectral lines. The electron density is $10^{17}$ cm$^{-3}$ and temperature 11100 K.

| Wavelength (nm) | $w_{KO}/w_{DK}$ | $w_{KO}/w_{SDS}$ |
|---|---|---|
| 508.58 | 6.34 | 6.41 |
| 479.99 | 6.63 | 7.53 |
| 467.82 | 3.00 | 3.59 |

tion formalism (Sahal-Bréchot, 1969ab). The discussion of updatings and validity criteria has been briefly reviewed e.g. in Dimitrijević (1996).

Energy levels for Cd I lines have been taken from Moore (1971). Oscillator strenghts have been calculated by using the method of Bates and Damgaard (1949). For higher levels, the method of Van Regermorter et al. (1979) has been used.

In Table 1, we present comparison between existing experimental results of Kusch and Oberschelp (1967), with theoretical results of Dimitrijević and Konjević (1983) and our results for Cd I 5p $^3P^o$ - 6s $^3S$. With $w_{KO}$ are denoted experimental full width at half maximum of Kusch and Oberschelp (1967), with $w_{DK}$ - theoretical ones determined in Dimitrijević and Konjević (1983) by GBKO (Griem et al., 1962) theory, and with $w_{SDS}$ - our results for the mentioned multiplet of Cd I. The first column represents wavelenghts for this multiplet of neutral cadmium in [nm] for perturber density of $10^{17}$ cm$^{-3}$ and temperature 11100K.

Both theoretical results are in a disagreement with experimental ones, and self absorption is indicated as a possible reason in Konjević et al. (1984).

In Fig. 1 are shown both theoretical results for Cd I 5p $^3P^o$ - 6s $^3S$ (494.13 nm). In our calculations have been included symmetrization of perturber velocity before and after impact, in distinction from calculations of Dimitrijević and Konjević (1983), as well as a different treatement of elastic collisions and impact parameter cut-offs. In future new experimental results will be of help for a detailed analysis.

In order to see the influence of Stark broadening mechanism for neutral cadmium spectral lines in stellar plasma conditions, we have calculated the Stark widths for Cd I (740.09 nm) spectral line for a Kurucz's (1979) A type star atmosphere model with $T_{eff}$=10000 K and log g=4.0. From Fig. 2. one can see the existence of atmospheric layers where Stark width is dominant and that Stark broadening effect should be taken into account in abundance determination, spectra synthesis and modeling of stellar plasmas.

### Acknowledgements

This work is a part of the project GA-1195 "Influence of collision processes on astrophysical plasma line shapes", supported by Ministry of Science and Environmental Protection of Serbia.

## References

Bates, D.R., Damgaard, A.: 1949, *Phyl. Trans. Roy. Soc.*, **A242**, 101.
Dimitrijević, M.S.: 1996, *Zh. Prikl. Spektrosk.*, **63**, 810.
Dimitrijević, M.S., Konjević, N.: 1983, *J. Quant. Spectrosc. Radiat. Transfer*, **30**, 45.
Gorodnichyute, M.G., Gorodnichyus, G.A.: 1961, *Litov. Fiz. Sb.*, **1**, 163.
Griem, H.R., Baranger, M., Kolb, A.C., Oertel, G.K.: 1962, *Phys. Rev.*, **125**, 177.
Konjević, N., Dimitrijević, M.S., Wiese, W.L.: 1984, *J. Phys. Chem. Ref. Data*, **13**, 619.
Kurucz, R.L.: 1979, *Astrophys. J. Suppl. Series*, **40**, 1.
Kusch, H.J., Oberschelp, E.: 1967, *Z. Astrophys.*, **67**, 77.
Moore, C.E.: 1971, *Atomic Energy Levels*, Vol. III, NSRDS-NBS, **35**, 55.
Nagibina: 1958, *Opt. Spek.*, **4**, 430.
Sahal-Bréchot, S.: 1969a, *Astron. Astrophys.*, **1**, 91.
Sahal-Bréchot, S.: 1969b, *Astron. Astrophys.*, **2**, 322.
Van Regemorter, H., Hoang Binh D., Prud′homme, M.: 1979, *J. Phys.*, **B12**, 1053.