Publ. Astron. Obs. Belgrade No. 57 (1997), 91 - 93 *Contributed paper*

ELECTRON IMPACT BROADENING PARAMETERS FOR IONIZED RARE-EARTHS: La II AND La III

L. Č. POPOVIĆ and M. S. DIMITRIJEVIĆ
Astronomical Observatory, Volgina 7, 11000 Belgrade, Yugoslavia
E-mail lpopovic@aob.aob.bg.ac.yu
E-mail mdimitrijevic@aob.aob.bg.ac.yu

Abstract. The atomic data for ionized rare-earth elements are important for many astrophysical problems. Here we present the calculated electron impact parameters for three La II and six La III lines. Calculation was performed by using the modified semiempirical approach.

1. INTRODUCTION

The spectral lines of rare-earth elements are present in Solar as well as in stellar spectra (see e.g. Grevesse & Blanquet 1969, Molnar 1972, Adelman 1987, Mathys & Cowley 1992, Sadakane 1993, etc.). Principally, these lines are originated in layers (photosphere or subphotosphere) of stellar atmospheres with higher electron density. Consequently, electron impact broadening mechanism can be important, especialy for hot stars (A and B stars) as well as white dwarfs. La II lines in stellar spectra are discussed e.g. in Sadakane (1993) who suggested overabundance of La in α CM and o Peg, two hot Am stars. On the basis of regularities and systematic trends Lakićević (1983) estimated stark widths and shifts for La II $5d^2\ {}^3F - 4f^3F^0$ transition. Due to the lack of known energy levels as well as transition probabilities for these elements, for Stark broadening calculations only the approximative method can be applied. Here we have applied the modified semiempirical approach (Dimitrijević & Konjević 1980).

In order to provide a set of atomic data needed for different astrophysical problems, as e.g. opacity calculations, we have calculated the Stark broadening for many astrophysically important elements (see e.g. Popović & Dimitrijević 1996ab, 1997ab). Here we present our calculation of three La II and six La III lines. The calculations were performed by using the modified semiempirical approach (Dimitrijević & Konjević 1980, for emiters with complex spectra see also Popović & Dimitrijević 1996a)

2. RESULTS AND DISCUSSION

The results our calculation are presented in Table 1.

Table 1. Stark full widths (FWHM) for La II and La III lines. The electron density is $10^{23}m^{-3}$. The avaraged wavelength of the multiplet is denoted by $\overline{\lambda}$.

Transition	T (K)	W (nm)
La II	5000.	.219E-01
$a^3F - y^3D^0$	10000.	.152E-01
	20000.	.104E-01
	30000.	.853E-02
$\overline{\lambda} = 379.44$ nm	40000.	.756E-02
	50000.	.707E-02
La II	5000.	.493E-01
$a^3D - y^3D^0$	10000.	.348E-01
	20000.	.246E-01
	30000.	.201E-01
$\overline{\lambda} = 403.58$ nm	40000.	.174E-01
	50000.	.148E-01
La II	5000.	.336E-01
$a^3P - y^3D^0$	10000.	.232E-01
	20000.	.160E-01
	30000.	.131E-01
$\overline{\lambda} = 463.20$ nm	40000.	.116E-01
	50000.	.109E-01
La III	5000.	.260E-01
$6s^2S - 6p^2P^0$	10000.	.182E-01
	20000.	.126E-01
	30000.	.103E-01
$\overline{\lambda} = 328.01$ nm	40000.	.892E-02
	50000.	.807E-02
La III	5000.	.105E-01
$6s^2S - 7p^2P^0$	10000.	.734E-02
	20000.	.522E-02
	30000.	.440E-02
$\overline{\lambda} = 124.28$ nm	40000.	.400E-02
	50000.	.376E-02
La III	5000.	.231E-01
$6p^2P^0 - 6d^2D$	10000.	.161E-01
	20000.	.115E-01
	30000.	.978E-02
$\overline{\lambda} = 259.32$ nm	40000.	.889E-02
	50000.	.839E-02

The atomic energy levels needed for calculations were taken from Moore (1971). Oscillator strengths have been calculated by using the method of Bates & Damgaard (1949) and the tables of Oertel & Shomo (1968). The results of our calculation are presented in Table 1. Besides the estimate of Lakićević (1983) based on regularities, this is the first quantitative atempt to calculate rare-earth's Stark broadening parameters.

Table 1 (continued)

Transition	T (K)	W (nm)
La III	5000.	.453E-01
$6p^2P^0 - 7s^2S$	10000.	.317E-01
	20000.	.226E-01
	30000.	.191E-01
$\bar{\lambda} = 261.31$ nm	40000.	.173E-01
	50000.	.162E-01
La III	5000.	.747
$7s^2S - 7p^2P^0$	10000.	.522
	20000.	.374
	30000.	.320
$\bar{\lambda} = 854.39$ nm	40000.	.295
	50000.	.281
La III	5000.	.556
$6d^2D - 6p^2P^0$	10000.	.388
	20000.	.278
	30000.	.238
$\bar{\lambda} = 876.37$ nm	40000.	.220
	50000.	.210

References

Adelman S. J., 1987, *in Elemental Abundance Analyses*, Proc. of the IAU working group on Ap stars Workshop (Eds. S.J. Adelman and T. Lanz).
Bates,D.R., & Damgaard A., 1949, *Phil. Trans. Roy. Soc. London*, Ser. A, **242**, 101.
Dimitrijević, M.S., Konjević, N., 1980, *J. Quant. Spectrosc. Radiat. Transfer*, **24**, 451.
Grevesse N. & Blanquet G., 1969, *Solar Phys.* **8**, 5.
Lakićević I. S., 1983, *Astron. Astrophys.* **127**, 37.
Mathys G. Cowley C. R., 1992, *Astron. Astrophys.* **253**, 199.
Molnar H. 1972, *Astron. Astrophys.* **20**, 69.
Moore, C., E., 1971, *Atomic Energy Levels*, NSRDS-NBS, Vol. **2**, Washington D.C.
Oertel,G.K., Shomo,L.P., 1968, *ApJS*, **16**, 175.
Popović L. Č. and Dimitrijević M. S., 1996a, *Phys. Scr.* **53**, 325.
Popović, L. Č., Dimitrijević, M. S., 1996b, *A&AS*, **120**, 373.
Popović L. Č. and Dimitrijević M. S., 1997a, *Astron. Astrophys.* (in press).
Popović L. Č. and Dimitrijević M. S., 1997b, *Astron. Astrophys.* (in press).
Sadakane K., 1993, in Peculiar Versus Normal Phenomena in A-type and Related Stars, *ASP Conf. Series*, **44** (Eds. M. M. Dworetsky, F. Gastelli, R. Forragiona), 72.