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INFLUENCE OF STARK BROADENING WITHIN Be III SPECTRAL SERIES

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Abstract. Using a semiclassical perturbation method, we have calculated electron−, proton−, and ionized helium −impact line widths and shifts for 52 Be III multiplets as a function of temperature and perturber density. The obtained results have been used for discussion of regularities and systematic trends along spectral series.

1. INTRODUCTION

The results of light element ions line profile study are obviously of astrophysical interest, since such lines are present in stellar atmospheres. Such results may be used e.g. for numerical modelling of stellar atmospheres or abundance determinations. The Be III Stark broadening parameters are additionally interesting as regards problems correlated with nucleogenesis, mixing between atmospheres and the interior, stellar structure and evolution (see e.g. Boesgaard 1988), and opacity calculations (Seaton 1988). Moreover, data on electron-impact (Stark) broadening of Be III spectral lines are of interest in the investigation and diagnostic of laboratory and laser-produced plasma, as well as for the consideration of regularities and systematic trends and for the comparison with experimental data. First experimental investigations of Be III plasma spectral line shapes, have been made by Fraenkel et al. (1968) and Malvezi et al. (1975). Rosznayi (1977) performed the first theoretical study of Be III lines Stark broadening. After him Dimitrijević and Konjević (1981) and Dimitrijević (1988ab) have published results of the Be III Stark widths determination within the semiempirical method (Griem 1968), the modified semiempirical method (Dimitrijević and Konjević 1980), the symplified semiclassical method (Griem 1974) and its modification (Dimitrijević and Konjević 1980). In Dimitrijević and Sahal-Bréchot (1996ab)

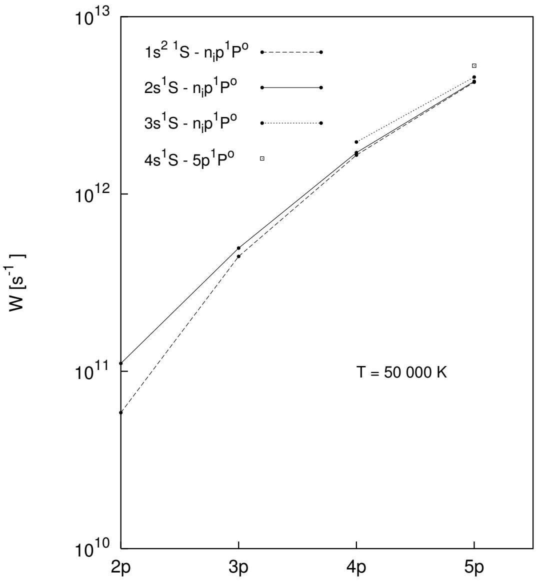

Figure 1: Electron-impact full half widths (in angular frequency units) for Be III n_fs^{1}S-n_ip^{1}P^o lines as a function of n_i for different n_f, for T = 50 000 K at N_e = 10^{17}cm^{-3}. Here, n_i is the principal quantum number of initial (upper), and n_f of the final (lower) level of the considered transition.

Stark broadening parameters of 12 Be III spectral lines have been obtained within the semiclassical perturbation approach, formulated in Sahal−Bréchot (1969ab), and updated later several times (Sahal - Bréchot 1974,1991, Fleurier et al. 1977, Dimitrijević and Sahal - Bréchot 1984, 1995, Dimitrijević et al. 1991). However, the recently published analysis of the spectrum and term system of Be III (Jupén et al. 2001) enables the determination of Stark broadening parameters for 52 additional multiplets, with the standard accuracy. We have determined them and used the obtained results for an investigation of regularities and systematic trends of Stark broadening parameters along spectral series. Results of such investigations are of interest as regards acquisition of new data by interpolation and a critical evaluation of existing experimental and theoretical data.

2. RESULTS AND DISCUSSION

The semiclassical perturbation formalism used here, has been reviewed briefly *e.g* in Dimitrijević and Sahal - Bréchot (1995, 1996c). Energy levels for Be III have been taken in Jupén et al. (2001). All details of the Stark broadening parameters determination as well as the complete results for 52 Be III multiplets will be published elsewhere (Dimitrijević et al. 2003).

In Figs. 1 and 2 the electron-impact full half widths and shifts for Be III n_fs^{1}S-n_ip^{1}P^o lines as a function of n_i for different n_f, for T=50 000 K at $N_e = 10^{17} cm^{-3}$ is shown. Here, n_i is the principal quantum number of initial (upper), and n_f of the final (lower) level of the considered transition. We can see gradual change of Stark broadening parameters within particular n_fs^{1}S-n_ip^{1}P^o spectral series, permitting the

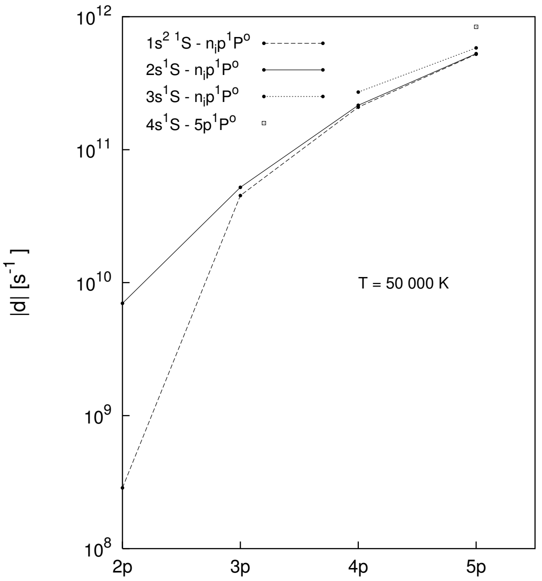

Figure 2: As in Fig. 1 but for electron-impact shift.

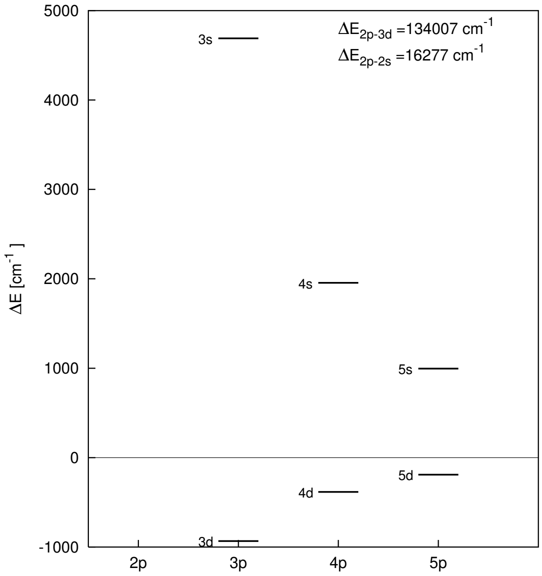

Figure 3: Energy separations between the upper level n_ip^{1}P^o and the principal perturbing levels for Be III n_fs^{1}S-n_ip^{1}P^o lines. Here, n_i is the principal quantum number of initial (upper), and n_f of the final (lower) level of the considered transition.

interpolation of new data or critical evaluation of mutual consistency of existing data as in our previous analyses (see e.g. Dimitrijević and Sahal−Bréchot 1996c). Exceptions of such behaviour have been analysed e.g. in Tankosić et al (2001). As an addition to previous analyses (e.g. Dimitrijević and Sahal−Bréchot 1996c), where only one Li II $2s^3S$-np^3P^o series has been analysed in Figs. 1-2 are considered all calculated transitions belonging to different Be III $n_f s^1S$-$n_i p^1P^o$ series. One can see that differences between corresponding members with the same initial (upper) level of different spectral series are not large and increase gradually with the increase of the principal quantum number of the final (lower) level. Consequently, rough estimation of the mutual consistency of existing data or of an approximate value for a member of a different spectral series is possible in considered case on the basis of considered regularities if the upper (initial) level of the investigated transition is the same as for members of other spectral series with known Stark broadening parameters. Such regular behaviour of Stark broadening parameters within considered spectral series is the consequence of the gradual change of the energy separations between the initial (upper) level and the principal perturbing levels, shown in Fig. 3. It is of interest to determine experimentally Stark broadening parameters for several members of a Be III spectral series in order to test experimentally the possibilities of established regularities within spectral series for prediction of new data and checking the reliability and mutual consistency of existing ones.

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