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Stark broadening of spectral lines of multicharged ions of astrophysical interest

XVI. S V spectral lines*

M.S. Dimitrijević[1] and S. Sahal-Bréchot[2]

[1] Astronomical Observatory, Volgina 7, 11050 Belgrade, Yugoslavia
[2] Laboratoire "Astrophysique, Atomes et Molécules", Département Atomes et Molécules en Astrophysique, Unité associée au CNRS No. 812, Observatoire de Paris-Meudon, 92190 Meudon, France

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Abstract. Using a semiclassical approach, we have calculated electron−, proton−, and He III−impact line widths and shifts for 34 S V multiplets for perturber densities $10^{17} - 10^{21}$ cm^{-3} and temperatures $T = 20\,000 - 1\,000\,000$ K. For lower perturber densities, the obtained results are linear with perturber density.

Key words: lines: profile — atomic data

1. Introduction

Stark widths and shifts of S V lines are of interest not only for the laboratory plasma research and for testing and developping of the Stark broadening theory for shapes of multicharged ion lines, but as well for the consideration of subphotosperic layers and atmospheres of hot stars. They are also of importance for the considerations of regularities and systematic trends particularly along isoelectronic sequences. Recently, S V spectral lines have been observed in spectra of some sdO stars (Rauch 1996). The relevant parameter range for the spectrum synthesis is for the electron density up to $N_{\rm e} = 10^{17}$ cm^{-3} and the effective temperature 20 000 K $\leq T_{\rm eff} \leq$ 160 000 K. For such conditions, Stark broadening is the main pressure broadening mechanism, and toward the density of $N_{\rm e} = 10^{17}$ cm^{-3} it becomes comparable with Doppler width or even dominant. Consequently, data on the shape of S V spectral lines are of interest for the modelling and interpretation of sdO star spectra, as well as for consideration and modelling of subphotospheric layers in other stars.

This paper is the sixteenth of a series devoted to the investigation of Stark broadening parameters of spectral lines of multicharged ions (see Dimitrijević & Sahal-Bréchot 1995 and references therein, as well as Dimitrijević & Sahal-Bréchot 1996a,b). In order to continue the attempt to provide to astrophysicists and plasma physicists Stark broadening parameters needed for the research of astrophysical and laboratory plasmas as well as plasmas in various plasma devices in technology, we have calculated within the semiclassical-perturbation formalism (Sahal-Bréchot 1969a,b), electron-, proton-, and He III-impact line widths and shifts for 34 S V multiplets.

2. Results and discussion

The original computer code (Sahal-Bréchot 1969a,b), has been modernized, updated and optimized several times (Sahal-Bréchot 1974; Fleurier et al. 1977; Dimitrijević & Sahal-Bréchot 1984; Dimitrijević et al. 1991; Dimitrijević & Sahal-Bréchot 1996b). A summary of the formalism is given in Dimitrijević & Sahal-Bréchot (1996b), and will not be repeated here. Atomic energy levels needed for calculations have been taken from Martin et al. (1990). Oscillator strengths have been calculated within the Coulomb approximation (Bates & Damgaard 1949, and the tables of Oertel & Shomo 1968). For higher levels, the method of Van Regemorter et al. (1979) has been used.

Our results for 34 S V multiplets are shown in Table 1 (accessible only in electronic form), for perturber densities $10^{17} - 10^{21}$ cm^{-3} and temperatures $T = 20\,000 - 1\,000\,000$ K. The complete set of data is given for the perturber density of 10^{18} cm^{-3}. For perturber density of 10^{17} cm^{-3}, only data for higher transitions, needed for better interpolation with perturber density are given. Stark broadening parameters for densities lover than tabulated, are linear with perturber density. We also specify a parameter c (Dimitrijević & Sahal-Bréchot 1984), which

* Table 1 is only available in electronic form: The material published electronically can be accessed: by ftp at cdsarc.u-strasbg.fr or 130.79.128.5 or on WWW at: http//cdsweb.u-strasbg.fr/abstract.html

gives an estimate for the maximum perturber density for which the line may be treated as isolated when it is divided by the corresponding full width at half maximum. For each value given in Table 1, the collision volume (V) multiplied by the perturber density (N) is much less than one and the impact approximation is valid (Sahal-Bréchot 1969a,b). Values for $NV > 0.5$ are not given and values for $0.1 < NV \leq 0.5$ are denoted by an asterisk. When the impact approximation is not valid, the ion broadening contribution may be estimated by using quasistatic approach (Sahal-Bréchot 1991 or Griem 1974). In the region between where neither of these two approximations is valid, a unified type theory should be used. For example in Barnard et al. (1974), a simple analytical formulas for such a case are given. The accuracy of the results obtained decreases when broadening by ion interactions becomes important.

We hope that presented results will be useful for the interpretation and modelling of sdO stars spectra as well as for subphotospheric layers research and for laboratory plasma considerations. For further development and rafinement of the Stark broadening theory for multicharged ion lineshapes, as well as for the investigation of regularities and systematic trends of Stark broadening parameters along isoelectronic sequences, the corresponding experimental data will be very useful.

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References

Barnard A.J., Cooper J., Smith E.W., 1974, J. Quant. Spectrosc. Radiat. Transfer 14, 1025
Bates D.R., Damgaard A., 1949, Trans. Roy. Soc. London Ser. A 242, 101
Dimitrijević M.S., 1988a, Bul. Obs. Astron. Belgrade 139, 31
Dimitrijević M.S., 1988b, A&AS 76, 53
Dimitrijević M.S., Konjević N., 1980, J. Quant. Spectrosc. Radiat. Transfer 24, 451
Dimitrijević M.S., Konjević N., 1981, in Spectral Line Shapes, Wende B., de Gruyter W. (eds.). Berlin, New York, p. 211
Dimitrijević M.S., Sahal-Bréchot S., 1984, J. Quant. Spectrosc. Radiat. Transfer 31, 301
Dimitrijević M.S., Sahal-Bréchot S., Bommier V., 1991, A&AS 89, 581
Dimitrijević M.S., Sahal-Bréchot S., 1995, A&AS 109, 551
Dimitrijević M.S., Sahal-Bréchot S., 1996a, A&AS 115, 351
Dimitrijević M.S., Sahal-Bréchot S., 1996b, Phys. Scr. 54, 50
Fleurier C., Sahal-Bréchot S., Chapelle J., 1977, J. Quant. Spectrosc. Radiat. Transfer 17, 595
Griem H.R., 1968, Phys. Rev. 165, 258
Griem H.R., 1974, Spectral Line Broadening by Plasmas. Academic Press, New York
Martin W.C., Zalubas R., Musgrove A., 1990, J. Phys. Chem. Ref. Data 10, 821
Oertel G.K., Shomo L.P., 1968, ApJS 16, 175
Rauch T., 1996 (private communication)
Sahal-Bréchot S., 1969a, A&A 1, 91
Sahal-Bréchot S., 1969b, A&A 2, 322
Sahal-Bréchot S., 1974, A&A 35, 321
Sahal-Bréchot S., 1991, A&A 245, 322
Van Regemorter H., Hoang Binh Dy, Prud'homme M., 1979, J. Phys. B 12, 1073