16th SPIG

XVI SUMMER SCHOOL and INTERNATIONAL SYMPOSIUM on the PHYSICS OF IONIZED GASES

September 25 -28, 1993. Belgrade, Yugoslavia

CONTRIBUTED PAPERS

&
ABSTRACTS OF INVITED LECTURES AND PROGRESS REPORTS

edited by
M. Milosavljević

Zbornik se objavljuje u čast
45. godina postojanja
Instituta „Vinča"

On the occasion of
45th anniversary of
the VINČA Institute

Institute of Nuclear Sciences "Vinča"
Belgrade, Yugoslavia

Institute "Braća Karić"
Belgrade, Yugoslavia

STARK BROADENING OF Be II SPECTRAL LINES: COMPARISON OF DIFFERENT THEORETICAL CALCULATIONS

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

[1]Astronomical Observatory, Volgina 7, 11050 Beograd, Yugoslavia

[2]Laboratoire "Astrophysique, Atomes et Molécules"Unité associée au C.N.R.S. No 812, Département Atomes et Molécules en Astrophysique, Observatoire de Paris-Meudon, 92190 Meudon, France

1. INTRODUCTION

Besides the interest for plasma spectroscopy [1-4], the Be II Stark-broadening parameters are important to astrophysicists since the surface content (abundance) of light elements, especially Li and Be, involves problems correlated with nucleogenesis, mixing between the atmosphere and the interior, and stellar structure and evolution [5]. Moreover, Be II profiles are of importance for opacity calculations [6], as well as for modelisation of stellar atmospheres and stellar plasma research.

By using the semiclassical-perturbation formalism [7-8] we have calculated electron-, proton-, and ionized helium-impact line widths and shifts for 30 Be II multiplets, in order to provide Stark broadening data for cases of all principal perturbes in stellar atmospheres. A summary of the formalism is given in Ref. [9]. Here, we present and discuss a comparison of our results for Be II with other theoretical results [6,10-11].

2. RESULTS AND DISCUSSION

Table 1. Comparison between the semiclassical calculation of width (FWHM) W and shift d, at electron density of 10^{17} cm^{-3} and T = 5000 K and 20,000 K. DSB - present results; JBG - Jones, Benett and Griem [10-11]; S - Seaton [6].

Transition	T(K)	WDSB (A)	WJBG (A)	WS (A)	dDSB (A)	dJBG (A)	dS (A)
2s-2p	5000	0.0801	0.144	0.0407	-0.0101	-0.0604	-0.0191
	20000	0.0445	0.0832	0.0286	-0.00499	-0.0347	-0.0121
2s-3p	5000	0.0555	0.0912	0.0598	0.00283	0.0358	0.00278
	20000	0.0420	0.0608	0.0397	0.00414	0.0214	0.00157
2p-3s	5000	0.133	0.155	0.127	0.0621	0.0789	0.0409
	20000	0.0723	0.102	0.0766	0.0371	0.0525	0.0220
2p-3d	5000	0.123	0.144	0.0978	0.00809	-0.0521	0.0104
	20000	0.0708	0.0870	0.0541	0.00183	-0.0278	0.00630
3s-3p	5000	11.0	12.2	8.54	-1.66	2.23	-0.522
	20000	7.56	8.84	6.21	-0.783	1.83	-0.332
3s-4p	5000	1.90	2.72		0.190	1.13	
	20000	1.57	2.18		0.151	0.753	
3p-4s	5000	3.60	3.84		1.50	1.77	
	20000	2.68	3.22		1.08	1.36	
3p-5s	5000	2.65	3.08		1.49	1.76	
	20000	2.14	2.92		1.12	1.48	
3p-3d	5000	336.	432.	280.	-22.6	-180.	-7.22
	20000	234.	302.	188.	-23.2	-113.	-4.34
3p-4d	5000	5.14	8.24		-0.507	1.32	
	20000	4.74	5.38		-0.139	0.360	
3d-4f	5000	3.33	6.60		0.583	-1.65	
	20000	2.49	3.96		0.231	-0.756	

Our results as a function of perturber density and temperature will be published elsewhere [12-13].

In Table 1, the present results are compared with semiclassical calculations of Jones, Benett and Griem [10-11] and with strong coupling calculations of Seaton [6]. We see that widths fall within the error bars of different methods with the exception of the resonance multiplet 2s - 2p and of the transitions 3p - 4d and 3d - 4f influenced by close perturbing levels. For shifts disagreements become larger and even the sign of shift is different for the last two of the mentioned multiplets

We may devide the cases of large desagreements in three groups.

(1) The case of close perturbing levels (Multiplets 3p - 3d; 3p - 4d; 3d - 4f).

In such a case it is crucial to take into account Debye screening which will reduce width and might change the sign of shift. In Jones, Benett and Griem [10-11] Debye screening has not been taken into account. If we compare results of Jones et al [10-11] at electron density (N) of 10^{17} cm^{-3} with our results at N = 10^{13} cm^{-3} where the influence of Debye shielding is lower the agreement is better. For 3p - 4d multiplet e.g., we obtain shift of + 0.125 Å at T = 20000 K and N = 10^{13} cm^{-3} while at N = 10^{17} cm^{-3} our result is - 0.139 Å.

(2) The case when shifts are much smaller than widths (2p - 3d and 3s - 3p multiplets). In such case cancelations between important contributions with different signs occur and the accuracy is smaller.

(3) The case of resonance lines (2s - 2p multiplet). In such a case short range effects are important so that expected accuracy is lower than usually.

It should be noted also that shifts are generally of lesser accuracy than widths [14-16] and reliable experimental data for the shifts would be very helpful.

REFERENCES

1. J.Purić and N.Konjević, Z.Phys. 249, 440 (1972).
2. M.Platiša, J.Purić, N.Konjević, and J.Labat, Astron. Astrophys 15, 325 (1971).
3. D.Hadžiomerspahić, M.Platiša, N.Konjević, and M.Popović, Z.Phys. 262, 169 (1973).
4. A.Sanchez, M.Blaha, and W.W.Jones, Phys.Rev.A 8, 774 (1973).
5. A.M.Boesgaard, Vistas in Astronomy 31, 167 (1988).
6. M.J.Seaton, J.Phys.B 21, 3033 (1983).
7. S.Sahal-Bréchot, Astron.Astrophys 1, 91 (1969).
8. S.Sahal-Bréchot,Astron.Astrophys 2, 322 (1969).
9. M.S.Dimitrijevic and S.Sahal-Bréchot, JQSRT 31, 301 (1984).
10. W.W.Jones, S.M.Benett, and H.R.Griem, "Calculated Stark Broadening Parameters for Isolated Spectral Lines from the Atom Helium through Calcium and Cesium", Univ. Maryland, Tech. Rep. No 71-097, College Park, Maryland (1971).
11. H.R.Griem, Spectral Line Broadening by Plasmas, Academic Press, New York (1974)
12. M.S.Dimitrijevic and S.Sahal-Bréchot, JQSRT (1992) in press.
13. M.S.Dimitrijevic and S.Sahal-Bréchot, Bull.Obs.Astron. Belgrade 145, 65 (1991).
14. H.R.Griem and C.S.Shen, Phys.Rev. 125, 196 (1962).
15. D.E.Roberts, J.Phys.B 1, 53 (1968).
16. M.S.Dimitrijevic, N.Feautrier and S.Sahal-Bréchot, J.Phys.B 14, 2559 (1981).