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ON THE STARK BROADENING OF Y III SPECTRAL LINES

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Abstract. Using a semiclassical approach, we have considered electron-, proton-, and ionized helium-impact line widths and shifts for 32 Y III multiplets, for perturber densities 10^{14}– 10^{19} cm^{-3} and temperatures T = 10,000 – 300,000 K.

1. INTRODUCTION

Yttrium spectral lines are observed in spectra of hot stars, as e.g. in the spectrum of ϕ Her (T_{eff} = 11,500K, log$g$ = 3.5) and o And (T_{eff} = 9,500K, log$g$ =3.5) (Adelman and Lanz 1987). Sadakane and Ueta (1989) have found its overabundance in the spectrum of Sirius, and Van't Veer-Mennert, Coupry and Burkhart (1985) in the spectrum of Am star HR 178. Savanov (1985) reports high yttrium abundance in hot Am stars, where Stark broadening is the principal pressure broadening mechanism. Yttrium is additionally of interest for astrophysics, since it is commonly associated with slow-neutron-capture nucleosynthesis in stellar interiors (see e.g. Leckrone et al. 1993). Consequently, Y III lines are of interest for the diagnostic and modelling not only for laboratory plasma, but as well for stellar plasmas research.

Popović and Dimitrijević (1996) have published recently, electron - impact broadening parameters for astrophysically important ns-np transitions of singly charged yttrium ion, calculated within the modified semiempirical approach (Dimitrijević and Konjević, 1980). In order to provide the corresponding Stark broadening data for yttrium III spectral lines, we have calculated within the semiclassical-perturbation formalism (Sahal-Bréchot 1969ab) electron-, proton-, and ionized - helium-impact line widths and shifts for 32 Y III multiplets.

2. RESULTS AND DISCUSSION

Energy levels for yttrium III have been taken from Epstein and Reader (1975). Details of calculations will be published in Dimitrijević and S.Sahal-Bréchot (1997). Our results for electron-, proton-, and helium ion-impact line widths and shifts for 32 Y III multiplets, for perturber densities 10^{14}– 10^{19} cm^{-3} and temperatures T = 10,000 – 300,000 K, will be published elsewhere (Dimitrijević and Sahal-Bréchot, 1997). A sample of results is presented in Table 1.

Table 1

This table shows electron- and proton-impact broadening parameters for Y III for a perturber density of 10^{15} cm^{-3} and temperatures from 10,000 up to 300,000 K. Transitions and averaged wavelengths for the multiplet (in $\AA$) are also given. If one divides C value with the linewidth value, we obtain an estimate for the maximum perturber density (in cm^{-3}) for which the line may be treated as isolated and tabulated data may be used.

PERTURBER DENSITY = 1.E+15cm-3

PERTURBERS ARE:		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
Y III 6d-6f	10000.	0.758E-01	-0.308E-02	0.627E-02	0.370E-02
5585.7 A	20000.	0.700E-01	-0.192E-02	0.745E-02	0.450E-02
C= 0.34E+18	50000.	0.657E-01	-0.123E-02	0.901E-02	0.568E-02
	100000.	0.619E-01	-0.804E-03	0.102E-01	0.655E-02
	150000.	0.588E-01	-0.111E-02	0.111E-01	0.714E-02
	300000.	0.521E-01	-0.950E-03	0.117E-01	0.794E-02
Y III 4f-5d	10000.	0.331E-01	0.193E-02	0.119E-02	0.561E-03
7942.3 A	20000.	0.249E-01	0.185E-02	0.179E-02	0.846E-03
C= 0.71E+19	50000.	0.191E-01	0.188E-02	0.238E-02	0.122E-02
	100000.	0.165E-01	0.159E-02	0.274E-02	0.146E-02
	150000.	0.153E-01	0.156E-02	0.298E-02	0.163E-02
	300000.	0.135E-01	0.144E-02	0.320E-02	0.186E-02
Y III 4f-6d	10000.	0.285E-01	0.105E-01	0.204E-02	0.146E-02
5585.7 A	20000.	0.235E-01	0.766E-02	0.277E-02	0.196E-02
C= 0.15E+19	50000.	0.206E-01	0.563E-02	0.352E-02	0.249E-02
	100000.	0.189E-01	0.432E-02	0.409E-02	0.290E-02
	150000.	0.180E-01	0.388E-02	0.437E-02	0.316E-02
	300000.	0.162E-01	0.315E-02	0.508E-02	0.360E-02
Y III 4f-7d	10000.	0.153E-01	0.791E-02	0.178E-02	0.131E-02
3016.8 A	20000.	0.137E-01	0.637E-02	0.216E-02	0.160E-02
C= 0.24E+18	50000.	0.126E-01	0.463E-02	0.273E-02	0.200E-02
	100000.	0.121E-01	0.364E-02	0.307E-02	0.231E-02
	150000.	0.116E-01	0.315E-02	0.320E-02	0.244E-02
	300000.	0.105E-01	0.240E-02	0.376E-02	0.282E-02
Y III 5f-6d	10000.	0.611	0.109	0.378E-01	0.853E-02
20955.3 A	20000.	0.533	0.747E-01	0.460E-01	0.120E-01
C= 0.91E+19	50000.	0.489	0.587E-01	0.545E-01	0.159E-01
	100000.	0.453	0.432E-01	0.594E-01	0.190E-01
	150000.	0.430	0.384E-01	0.613E-01	0.210E-01
	300000.	0.383	0.342E-01	0.663E-01	0.234E-01

Table 1 continued

PERTURBER DENSITY = 1.E+15cm-3

PERTURBERS ARE:		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
Y III 5f-7d	10000.	0.192	0.727E-01	0.184E-01	0.116E-01
9548.4 A	20000.	0.176	0.572E-01	0.219E-01	0.141E-01
C= 0.19E+19	50000.	0.165	0.417E-01	0.269E-01	0.179E-01
	100000.	0.158	0.326E-01	0.299E-01	0.203E-01
	150000.	0.152	0.286E-01	0.320E-01	0.217E-01
	300000.	0.137	0.218E-01	0.349E-01	0.253E-01
Y III 6f-7d	10000.	4.37	0.876	0.342	0.118E-02
37626.1 A	20000.	4.13	0.699	0.387	0.223E-02
C= 0.15E+20	50000.	3.92	0.508	0.437	0.408E-02
	100000.	3.76	0.399	0.459	0.562E-02
	150000.	3.59	0.364	0.471	0.623E-02
	300000.	3.21	0.271	0.508	0.749E-02
Y III 4f-5g	10000.	0.162E-01	-0.255E-03	0.825E-03	-0.518E-03
4041.0 A	20000.	0.127E-01	-0.363E-03	0.115E-02	-0.717E-03
C= 0.34E+18	50000.	0.101E-01	-0.207E-03	0.145E-02	-0.918E-03
	100000.	0.887E-02	-0.248E-03	0.169E-02	-0.109E-02
	150000.	0.825E-02	-0.164E-03	0.179E-02	-0.117E-02
	300000.	0.731E-02	-0.416E-04	0.208E-02	-0.134E-02
Y III 4f-6g	10000.	0.257E-01	0.917E-03	0.436E-02	0.418E-02
2711.2 A	20000.	0.217E-01	0.803E-03	0.573E-02	0.507E-02
C= 0.71E+16	50000.	0.178E-01	0.569E-03	0.771E-02	0.604E-02
	100000.	0.154E-01	0.385E-03	0.963E-02	0.689E-02
	150000.	0.140E-01	0.335E-03	0.114E-01	0.733E-02
	300000.	0.118E-01	0.236E-03	0.137E-01	0.807E-02
Y III 5f-5g	10000.	3.45	-0.121	0.205	-0.134
48267.9 A	20000.	2.92	-0.167	0.264	-0.173
C= 0.48E+20	50000.	2.51	-0.122	0.334	-0.222
	100000.	2.27	-0.115	0.381	-0.258
	150000.	2.13	-0.902E-01	0.413	-0.278
	300000.	1.88	-0.589E-01	0.459	-0.316

Table 1 continued

PERTURBER DENSITY = 1.E+15cm-3					
PERTURBERS ARE:		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(Å)	SHIFT(Å)	WIDTH(Å)	SHIFT(Å)
Y III 5f-6g	10000.	0.196	0.413E-02	0.293E-01	0.278E-01
7037.7 A	20000.	0.168	0.288E-02	0.382E-01	0.337E-01
C= 0.48E+17	50000.	0.142	0.184E-02	0.519E-01	0.403E-01
	100000.	0.124	0.891E-03	0.648E-01	0.459E-01
	150000.	0.114	0.832E-03	0.761E-01	0.486E-01
	300000.	0.963E-01	0.462E-03	0.927E-01	0.540E-01
Y III 5g-6f	10000.	0.203	0.159E-01	0.177E-01	0.129E-01
9042.4 A	20000.	0.185	0.133E-01	0.215E-01	0.157E-01
C= 0.88E+18	50000.	0.169	0.120E-01	0.269E-01	0.198E-01
	100000.	0.158	0.971E-02	0.314E-01	0.224E-01
	150000.	0.149	0.786E-02	0.328E-01	0.246E-01
	300000.	0.131	0.593E-02	0.397E-01	0.273E-01

There is not measured or calculated Y III Stark broadening parameters. The corresponding experimental data will be very useful for further development and rafinement of the theory of multicharged ion lines.

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