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ON THE STARK BROADENING OF F III SPECTRAL LINES

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Abstract. We have modeled the F III atom and calculated Stark broadening parameters using two methods, semiclassical perturbation method for resonance transition and modified semiempirical method for additional ten multiplets.

1. INTRODUCTION

Importance of trace elements in stellar atmospheres increased with the development of space and satellite technology. Spectral lines of fluorine were observed in Solar (Moore et al., 1966), as well as in stellar spectra (Merrill, 1956). Also these spectral lines were founded in the ejecta of SN 1987A supernova (Trimble, 1991).

The first, qualitative, experimental investigation of the Stark broadening of F III spectral lines was made by Sarma (1961). Quantitative experimental data were obtained in 1988 by Purić et al. (1988). Since then, two additional experimental works on the F III Stark broadening have been published (Djeniže et al., 1991a; Blagojević, et al, 2000). The first quantitative theoretical determination was made by Dimitrijević and Konjević (1981), by using four different theoretical methods: the semiempirical method (Griem, 1968), the modified semiempirical method (Dimitrijević and Konjević, 1980), the simplified semiclassical method (Griem, 1974) and its modification (Dimitrijević and Konjević, 1981).

In order to provide new Stark broadening parameters for F III spectral lines, we adopted first of all a model of F III ion, with simplified energy level structure, facilitating and optimizing our further considerations. Using such a model, Stark broadening data for the resonance transition and additional 10 F III multiplets, have been determined. These multiplets belong to the 3s-3p, 3s-4p, 3p-4s and 4s-4p transition arrays (quartets).

2. RESULTS AND DISCUSSION

We applied full semiclassical perturbation method (Sahal-Bréchot, 1969ab) only to the astrophysically most important, resonance line, since for other lines there is no enough complete set of atomic data for such calculations. Consequently, for additional

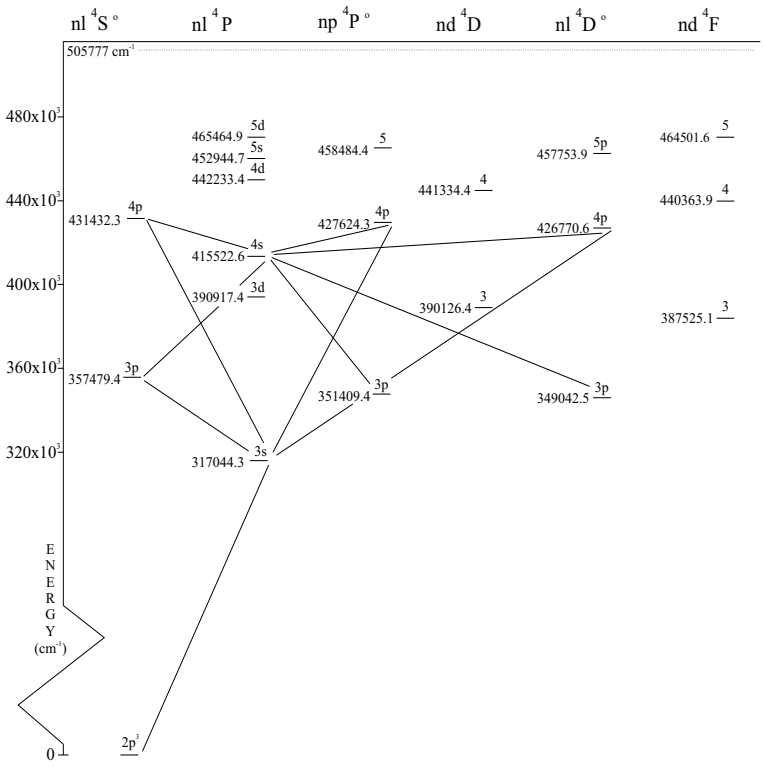

Figure 1: F III ion model adopted for Stark broadening parameters calculation. The resonance line $2p^3\ {}^4S^o$ - $3s\ {}^4P$ has been calculated by using this model within the semiclassicl approach (Sahal- Bréchot, 1969ab) and other lines within the modified semiempirical approach (Dimitrijević and Konjević, 1980). The ionization potential is presented by a dotted line at 505777 cm^{-1}.

Table 1: Stark broadening parameters for electron impact broadening for the resonance F III spectral line (Full width at half maximum and shift) determined within the semiclassical theory, for a perturber density of 10^{17} cm^{-3} and the temperature range from 10000 K up to 300000 K.

Transition	T(K)	W(0.1 nm)	d(0.1 nm)
$2p^3\ {}^4S^o$ - $3s\ {}^4P$ 31.54 nm	10000	0.123E-02	0.143E-03
	20000	0.771E-03	0.648E-04
	50000	0.465E-03	0.635E-04
	100000	0.341E-03	0.681E-04
	150000	0.291E-03	0.669E-04
	300000	0.230E-03	0.615E-04

Table 2: Stark widths (Full width at half maximum) for F III spectral lines obtained by using the modified semiempirical approach for a perturber density of 10^{17} cm^{-3} and the temperature range from 10000 K up to 300000 K.

Transition	T(K)	W(0.1 nm)	Transition	T(K)	W(0.1 nm)
	10000	0.886E-01		10000	0.348E-01
3s ^{4}P - 3p ^{4}S^o	20000	0.627E-01	3s ^{4}P - 4p ^{4}S^o	20000	0.246E-01
247.3 nm	50000	0.396E-01	87.4 nm	50000	0.178E-01
	100000	0.298E-01		100000	0.159E-01
	200000	0.253E-01		200000	0.148E-01
	300000	0.242E-01		300000	0.141E-01
	10000	0.399E-01		10000	0.343E-01
3s ^{4}P - 4p ^{4}P^o	20000	0.240E-01	3s ^{4}P - 3p ^{4}D^o	20000	0.242E-01
90.4 nm	50000	0.172E-01	91.1 nm	50000	0.147e-01
	100000	0.151E-01		100000	0.154E-01
	200000	0.139E-01		200000	0.142E-01
	300000	0.134E-01		300000	0.136E-01
	10000	0.113		10000	0.905E-01
4s ^{4}P - 3p ^{4}S^o	20000	0.795E-01	4s ^{4}P - 3p ^{4}P^o	20000	0.640E-01
172.3 nm	50000	0.576E-01	156.0 nm	50000	0.465E-01
	100000	0.507E-01		100000	0.409E-01
	200000	0.462E-01		200000	0.374E-01
	300000	0.438E-01		300000	0.354E-01
	10000	0.838E-01		10000	0.272E+01
4s ^{4}P - 3p ^{4}D^o	20000	0.593E-01	4s ^{4}P - 4p ^{4}S^o	20000	0.193E+01
150.4 nm	50000	0.431E-01	628.6 nm	50000	0.143E+01
	100000	0.380E-01		100000	0.131E+01
	200000	0.347E-01		200000	0.122E+01
	300000	0.329E-01		300000	0.116E+01
	10000	0.443E+01		10000	0.511E+01
4s ^{4}P - 4p ^{4}P^o	20000	0.313E+01	4s ^{4}P - 4p ^{4}D^o	20000	0.361E+01
826.3 nm	50000	0.232E+01	889.0 nm	50000	0.268E+01
	100000	0.209E+01		100000	0.243E+01
	200000	0.194E+01		200000	0.226E+01
	300000	0.186E+01		300000	0.215E+01

ten multiplets, the modified semiempirical method (Dimitrijević and Konjević, 1980) has been applied, and only Stark widths have been calculated.

Energy levels for F III transitions have been taken from Baskin and Stoner (1975). Oscillator strenghts have been calculated by using the method of Bates and Damgaard (1949) and the tables of Oertel and Shomo (1968). For higher levels, the method described by Van Regermorter et al. (1979) has been used.

Our calculations have been performed by using a model of F III atom, see Fig. 1.

In Tables 1. and 2. are shown Stark broadening parameters for F III spectral lines.

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