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Xe III SPECTRAL LINES WIDTH MEASUREMENTS

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Abstract. Stark halfwidths of 10 Xe III spectral lines have been measured and compared with experimental results by other authors, as well as with modified semiempirical calculations. The measurements were performed in a pulsed arc plasma.

1. INTRODUCTION

Investigation of ionized xenon spectra is of interest for many physics areas: laser physics, fusion diagnostics, spectroscopy, astrophysics etc. Stark parameters of spectral lines are usually used for plasma diagnostic purposes and also for testing the theoretical calculations. Stark width data are also very important for higher electron density plasmas, because in this regime Stark broadening is dominant in comparison with other broadening mechanisms. In this work, we examined ionized xenon lines, most of them belonging to the UV region. The Stark halfwidths of 10 Xe III spectral lines from 5d – 6p, 6s – 4f, 5d – 4f, 6s – 6p and 6p – 6d transition arrays were measured. Present results were compared with other experimental results (Konjević and Pittman 1987, Iriarte et al. 1997, Romeo et al. 1998). Comparison with modified semiempirical calculations based on (Dimitrijević and Konjević 1980) were also performed in some cases.

2. EXPERIMENTAL DATA AND DIAGNOSTICS

Experimental apparatus and diagnostic methods are described elsewhere (Mar et al. 2000, Djurović et al. 2006). Herein, only minimal details will be given. Excitation unit contains capacitor bank of 20 μF, charged up to 9.2 kV. The mixture of He-Xe at a pressure of $3.0 \cdot 10^3$ Pa continuously flows through the discharge lamp. Plasma electron density $(0.2 - 1.86) \cdot 10^{23}$ m^{-3} was determined by two-wavelength interferometrical method, with an error band lower than 10%. The electron temperature (17000 – 29000) K was determined by Boltzmann plot. Estimated error for temperature determination is lower than 15%.

3. RESULTS AND DISCUSSION

An example of recorded spectrum containing Xe III 376.585 nm and 377.253 nm lines is shown in Fig. 1. The spectra were fitted to a sum of Lorentzian functions (for spectral lines) and a linear function (for continuum emission).

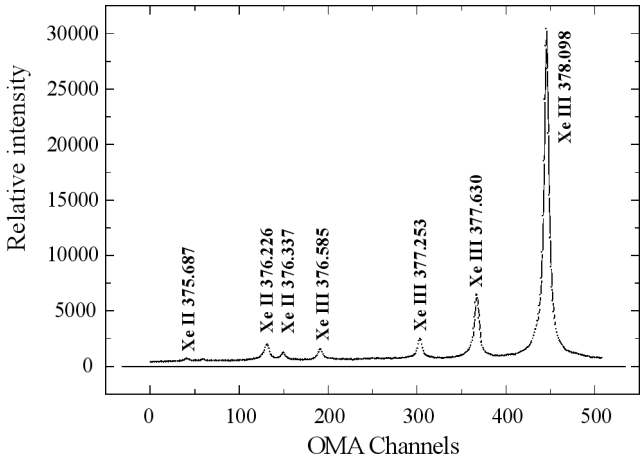

Figure 1: Example of one part of Xe spectrum and its fit.

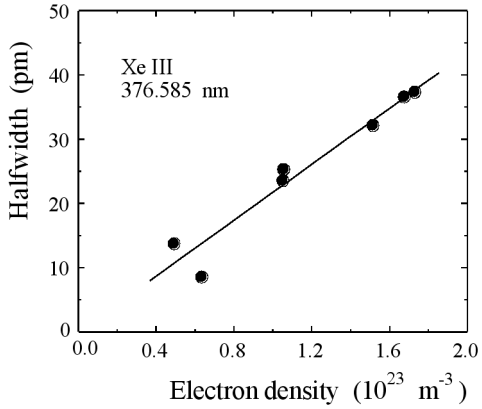

Figure 2: Example of line halfwidth vs. electron density and its linear fit.

The measured Stark halfwidth data are given in Table 1. In the two first columns, transitions and wavelengths of the lines are given. Next two columns present measured Stark halfwidths and comparison with calculations based on modified semiempirical formula (Dimitrijević and Konjević 1980) for the lines where all necessary data for the calculations were available. For semiempirical calculations jK-coupling scheme was used. The agreement is satisfactory.

Table 1: Experimental Stark halfwidths of Xe III lines (w_m) for T_e = 22000 K. Estimated accuracy is A (15-25%) and B (25-30%). The data are compared with modified semiempirical calculations (Dimitrijević and Konjević 1980, w_{th}) and with other experimental results (w) (1- Konjević and Pittman 1987, 2- Iriarte et al. 1997, Romeo et al. 1998). These data are given for corresponding electron temperatures. All data are normalized to the electron density of $N_e = 10^{23}$ m^{-3}.

Transitions	λ (nm)	w_m (pm)	Acc.	$\frac{w_m}{w_{th}}$	Other authors results		
					T (10^3K)	w (pm)	Ref.
(^{2}D^o)5d ^{3}F^o - (^{2}D^o)6p ^{3}F	308.353	15.36	B		29	32.09	3
(^{2}D^o)6s ^{3}D^o - (^{4}S^o)4f ^{5}F	360.702	16.95	B		27	16.40	1
					29	31.98	3
	360.946	17.23	A				
(^{2}P^0)5d ^{1}D^o - (^{4}S^o)4f ^{5}F	333.165	18.38	A		29	25.90	3
(^{2}P^o)5d ^{3}P^o - (^{2}D^o)6p ^{3}P	365.461	21.22	A		29	24.49	3
(^{2}D^o)6s ^{1}D^o - (^{2}D^o)6p ^{1}F	467.367	36.07	B	0.77	29	36.10	2
(^{2}P^o)6s ^{3}P^o - (^{2}P^o)6p ^{3}P	363.214	23.13	B	0.91	29	32.98	2
	376.585	23.85	B	0.86	29	37.26	2
(^{2}P^o)6s ^{1}P^o - (^{2}P^o)6p ^{1}P	377.253	24.46	A		29	39.80	2
(^{2}D^o)6p ^{3}P - (^{2}D^o)6d ^{3}P^o	328.791	41.14	B				

The estimated errors for Stark widths given in Table 1, might seem a bit high, but one should bear in mind that we have investigated low intensity lines. There is a very good agreement with Konjević and Pittman 1987 result. On the other hand, there is an obvious disagreement with the two other experimental results (Iriarte et al. 1997, Romeo et al. 1998). The reason of this discrepancy is discussed in (Peláez et al. 2006). Two results, for 360.946 nm and 328.791 nm, are new and there were no available data for comparison.

Stark width of Xe III 376.585 nm line as a function of electron density is plotted, as an example, in Fig. 2. It is obvious that there is a clear linear trend.

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