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EXPERIMENTAL STARK SHIFTS IN THE F II 3s' - 3p' TRANSITION

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Abstract. Stark shifts (d) of four singly ionized fluorine (F II) spectral lines (410.917 nm, 354.177 nm, 429.918 nm and 320.274 nm) in $2p^3 3s' - 2p^3(^2D^0)3p'$ transition have been measured in a linear, low–pressure, pulsed arc discharge created in SF6 plasma at 33 600 K electron temperatures and at $2.80\text{x}10^{23}$ m^3 electron densities. The measured Stark widths are compared with the existing experimental values.

1. INTRODUCTION

Atomic data such as Stark shift (d) are useful for plasma diagnostical purposes in a wide range of electron temperatures (T) in the case of astrophysical and laboratory plasmas. Three experiments (Platiša el al., 1977; Djeniže et al., 1991; Blagojević et al., 1999), known to the authors (Lesage and Fuhr, 1999; Konjević at al., 2002), have dealt with investigations of Stark broadening parameters (widths and shifts) of singly ionized fluorine lines. Only one experiment (Djeniže et al., 1991) has dealt with investigations of Stark shift of singly ionized fluorine lines. No calculated F II d values for 3s'-3p' transition existing, to the knowledge of the authors. The aim of this paper is to present the measured Stark shifts values at 33 600 K electron temperatures and at $2.80\text{x}10^{23}$ m^3 electron densities for 4 F II spectral lines belonging to the $2p^3 3s'$ – $2p^3(^2D^0)3p'$ transition. The measured Stark shifts are compared with existing experimental values.

2. EXPERIMENT

The linear, low–pressure, pulsed arc used as a plasma source, operated in SF_6, was described in detail in earlier publications (Djeniže et al., 1992, 2002; Srećković et al., 2001ab). Applied experimental set–up system, recording procedure and diagnostics methods are presented in our earlier publication (Djeniže et al., 2002). Here we present only necessary information related to the plasma parameters considered in this paper. Stark shift data (d) are taken at electron temperature T = 33 600 K and electron density N = $2.80\text{x}10^{23}$ m^3.

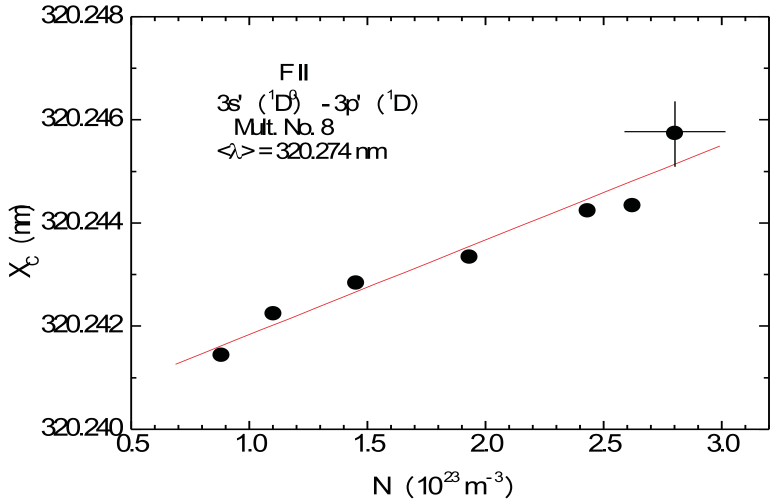

Fig. 1: The observed line center (X_C) position dependence on the electron density (N) during the plasma decay

3. STARK SHIFT MEASUREMENT

The measured profiles were of the Voigt type due to the convolutions of the Lorentzian Stark and Gaussian profiles caused by Doppler and instrumental broadening. For the electron density and temperature presented in our experiment, the Lorentzian fraction was dominant. Van der Waals (Griem, 1974) and resonance (Griem, 1974) broadening were estimated to be smaller by more than one order of magnitude in comparison to Stark, Doppler and instrumental broadening. The standard deconvolution procedure (Davies and Vaughan, 1963) has been computed using the least squares algorithm.

The Stark shifts were measured relative to the unshifted spectral lines emitted by the same plasma using a method established and applied first by Purić and Konjević (1972). According to that method the Stark shift of a spectral line can be measured experimentally by evaluating the position of the spectral line center (X_C) recorded at different electron density values during plasma decay (Srećković et al., 2000). In principle, the method requires recording of the spectral line profile at the higher electron density (N_1) that causes an appreciable shift and then, latter, when the electron concentration has dropped to a value (N_2) lower by at least an order of magnitude. The difference of the line center position in these two cases is Δd, so that the shift d_1 at the higher electro density N_1 is

$$d_1 = N_1 \Delta d / (N_2 N_1). \quad (1)$$

Our Stark shift values have been obtained for line center positions corresponding to the 15^{th} μs and 45^{th} μs after the beginning of the discharge. The observed line

Table 1: Our measured Stark shifts values (d_m in pm) at a given N and T.

Emiter	*Transition*	*Multiplet*	λ (nm)	T (10^4 K)	N (10^{23} m^{-3})	d_m (pm)
F II	$2p^3 3s'$ – $2p^3(^2D^0)3p'$	$^3D^0$ – ^3D (5)	410.917	3.36	2.80	-1.8±1.2
		$^3D^0$ – ^3P (6)	354.177	3.36	2.80	-1.7±0.5
		$^1D^0$ – ^1F (7)	429.918	3.36	2.80	-0.6±1.6
		$^1D^0$ – ^1D (8)	320.274	3.36	2.80	5.0±0.6

center (X_C) position dependence on the electron density (N) during the plasma decay of investigated 320.650 nm F II spectral line, as an example, is presented in Fig. 1. The Stark shift data are corrected for the electron temperature decay (Popović et al., 1992). Stark shifts data are determined with ±0.8 pm error at a given N and T. Measured (d_m) Stark shifts are presented in Table 1.

4. RESULTS AND DISCUSSION

Our experimental Stark shifts (d_m) values at a given electron temperature (T) and density (N) are given in Table 1. The necessary atomic data were taken from NIST (2003).

The measured d_m values are generally negative and very small. The positive Stark shift values are obtained in the $^1D^0$ - ^1D multiplet . The positive shift is toward the red. Our measured Stark shift values agree well with earlier experimental data at 45 000 K (Djeniže et al., 1991) except in case of the multiplet No. 8. where our d values overvalue the earlier data.

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