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STARK SHIFTS IN THE S III SPECTRUM

A. SREĆKOVIĆ, S. DJENIŽE and S. BUKVIĆ

Faculty of Physics, University of Belgrade, P.O.B. 368, Belgrade, Serbia and Montenegro
E–mail srele@ff.bg.ac.yu

Abstract. The aim of this paper is to present the first measured Stark shifts (d) values for six prominent S III spectral lines belonging to the 3d–4p transition at 31 200 K electron temperature and 2.84 10^{23} m^{-3} electron density. The Stark shifts were measured in a SF_6 plasma created in the linear, low pressure, pulsed arc discharge.

1. INTRODUCTION

The doubly ionized sulfur (S III) spectral lines play an important role in astrophysics. Thus, the knowledge of the Stark broadened and shifted S III line characteristics are necessary for various cosmic plasma modelling or for diagnostical purposes. To the knowledge of the authors (Lesage & Fuhr 1999; NIST 2002) no experimental or theoretical Stark shifts (d) data of the S III lines exist.

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. 2001a,b). 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 = 31 200 K and electron density N = 2.84 10^{23} m^{-3}. The Stark shifts were measured relative to the unshifted spectral lines emitted by the same plasma using a method established and applied as first by Purić & 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 two different electron density values during plasma decay. In principle, the method requires recording of the spectral line profile at high electron density (N_1) that causes an appreciable shift and then later when the electron concentration has decreased to a value (N_2) lower by at last an order of magnitude. The difference of the line center positions in these two cases is Δd, so that the shift d_1 at the higher electron density N_1 is

$$d_1 = \frac{N_1 \Delta d}{N_1 - N_2} \quad . \tag{1}$$

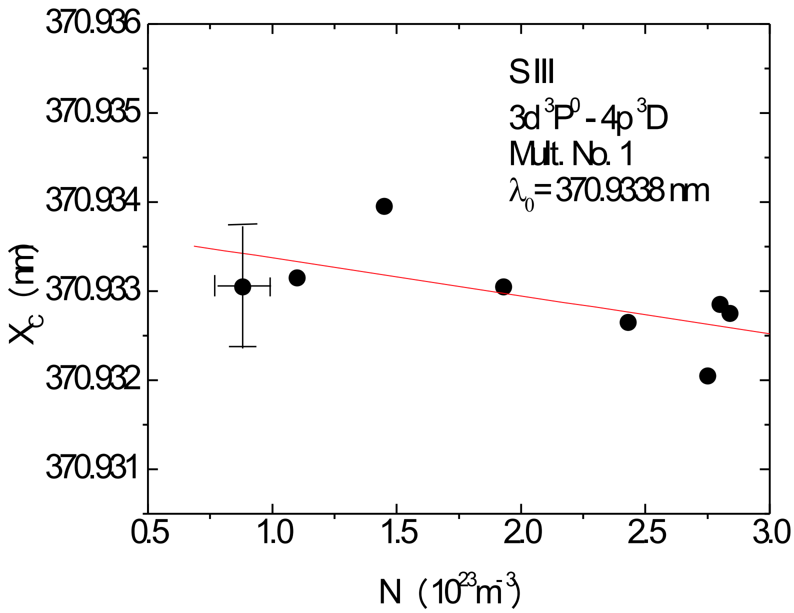

Figure 1: The observed line center (X_C) position dependence on the electron density (N) during the plasma decay.

Our Stark shift values have been obtained for line center positions corresponding to the 15^{th} μs and 40^{th} μs after the beginning of the discharge. The observed line center (X_C) position dependence on the electron density (N) during the plasma decay of investigated 370.9338 nm S III 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).

3. RESULTS

The measured Stark shift (d_m) are presented in Table 1 with their estimated accuracies. The necessary atomic data are taken from NIST (2002).

The measured d_m values are generally very small. We have obtained Stark shift (d_m) values with negative sign in the $^3P^0$ – ^3D multiplet. A positive Stark shift value has been obtained in the $^3P^0$ – ^3P and $^3D^0$ – ^3P multiplet. The positive shift is toward the red.

Table 1: Our measured Stark shift (d_m) values at given T and N

Transition	*Multiplet*	λ (nm)	T (10^3)	N (10^{23} m^{-3})	d$_m$ (pm)
3p3d – 3p(^{2}P^0)4p	^{3}P^0 – ^{3}D	370.9338	31.2	2.84	-1.1 ± 0.5
	(1)	371.0422	31.2	2.84	-1.4 ± 1.2
	^{3}P^0 – ^{3}P	337.0351	31.2	2.84	0.9 ± 0.6
	(2)	338.7092	31.2	2.84	0.0 ± 0.3
	^{3}D^0 – ^{3}P	392.8556	31.2	2.84	1.6 ± 0.6
	(8)				

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