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MEASURED STARK SHIFTS OF SOME Kr III UV LINES

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Abstract. In this work we report new Stark shift data of several lines from UV region (246 nm – 300 nm) of doubly ionized krypton spectrum. A low-pressure arc with mixture of 8% krypton and 92% helium was used as a plasma source.

1. INTRODUCTION

Investigation of ionized krypton spectra is always of interest for many reasons. Generally, spectra of inert gases are important for many physics areas, for example laser physics, fusion diagnostics, photoelectron spectroscopy, collision physics, astrophysics etc. Krypton plays an important role in applications, for example in development of the spectral lamps (Cayless and Marsden 1983) and development of lasers and laser techniques (Shimoda 1984). Furthermore, there is an interest in spectroscopic and atomic data of krypton ions. Stark shifts as well as halfwidths of spectral lines are usually employed for plasma diagnostic purposes and also for testing the theoretical calculations.

In this work, we report 17 measured Stark shifts of UV Kr III spectral lines. The measurements are performed in low pressure pulsed arc plasma under the following plasma conditions: electron density $(0.7 – 2.0) \times 10^{23}$ m^{-3} and electron temperature 16000 - 22000 K.

Present data are quite new in the literature and they can increase the present database of measured Kr III Stark shifts. Only two papers report Kr III Stark shift data (Di Rocco et al. 1989, Milosavljević et al. 2000). In Di Rocco et al. (1989) the plasma diagnostics data are missing and in Milosavljević et al. (2000) all observed lines were above 300 nm. The conclusion is that there are no other experimental data for comparison.

2. EXPERIMENTAL SETUP AND PLASMA DIAGNOSTICS

Measurements were performed in a pulsed plasma. Pulses were created by discharging a capacitor bank, charged up to 8.2 kV, through a cylindrical Pyrex tube. A mixture of krypton (8%) and helium (92%) was flowing continuously through the tube at a pressure of 2.6 kPa. The experimental set-up is described in detail in our previous work (Djurović et al. 2006). Electron density, determined by two wavelength interferometric method, was in the range ($0.7 – 2.0 \times 10^{23}$ m^{-3}). Electron temperature, determined by the Boltzmann-plot, was in the range 16000 – 22000 K.

3. RESULTS AND DICUSSION

Measured Stark shifts of several Kr III spectral lines are given in Table 1. In the first three columns Table 1 contains configurations, terms and wavelengths of the observed spectral lines. In the next two columns measured shifts, d_m, and estimated accuracy, Acc., are presented. The multiplets are arranged in the same way as in the NIST atomic spectra database. The data are normalized to electron den sity $N_e = 1 \times 10^{23}$ m^{-3} and electron temperature T_e = 18000 K.

Table 1. Experimental Stark shifts normalized to electron density $N_e = 1 \times 10^{23}$ m^{-3} and electron temperature T_e = 18000 K.

#	Configurations	Terms	Wavelength (nm)	d_m (pm)	Acc. (%)
1	$4s^24p^3(^4S^o)4d – 4s^24p^3(^4S^o)5p$	$^5D_1^o – ^5P_2$	267.962	1.58	58
2		$^5D_2^o – ^5P_2$	268.032	1.36	44
3		$^5D_3^o – ^5P_2$	268.119	0.65	48
4		$^5D_1^o – ^5P_1$	269.659	0.78	38
5		$^5D_2^o – ^5P_1$	269.730	0.77	53
6	$4s^24p^3(^2D^o)4d – 4s^24p^3(^2D^o)5p$	$^3F_4^o – ^3D_3$	253.757	1.00	80
7		$^3F_2^o – ^3D_1$	269.023	0.64	53
8		$^3F_2^o – ^3F_2$	255.425	1.66	32
9		$^3F_3^o – ^3F_3$	255.513	1.96	27
10		$^3F_4^o – ^1F_3$	257.119	1.04	48
11	$4s^24p^3(^2D^o)5s – 4s^24p^3(^2D^o)5p$	$^3D_1^o – ^3P_0$	281.448	-2.20	49
12		$^3D_2^o – ^3P_2$	290.004	-2.47	27
13		$^1D_2^o – ^3P_1$	299.660	2.34	38
14		$^1D_2^o – ^1D_2$	267.067	-1.74	40
15	$4s^24p^3(^2D^o)5s – 4s^24p^3(^2P^o)5p$	$^1D_2^o – ^3P_1$	260.435	$\|d\| < 0.5$	--
16	$4s^24p^3(^2P^o)4d – 4s^24p^3(^2D^o)5p$	$^3P_1^o – ^3S_1$	280.607	$\|d\| < 0.5$	--
17	$4s^24p^3(^2P^o)4d – 4s^24p^3(^2P^o)5p$	$^3F_4^o – ^3D_3$	287.061	3.04	16

An example of a part of recorded spectrum containing the first three Kr III lines in Table 1 is shown in Fig. 1. The spectra were fitted to the sum of Lorentzian functions (for spectral lines) and a linear function (for continuum emission).

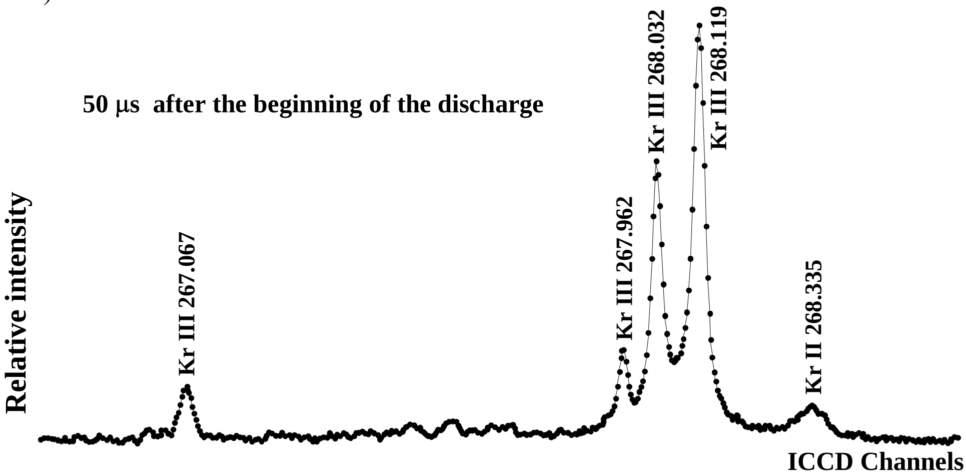

Figure 1: Part of the ionized krypton spectrum

Stark shift of Kr III 267.962 nm line as function of electron density is shown in Fig. 2. Stark shifts were obtained using a method described in Aparicio et al. (1998). Firstly, it was assumed that there is no Stark shift when electron density $N_e = 0$. Since the exact position of an observed spectral line at $N_e = 0$ is unknown, this value was obtained by extrapolating the linear fit of the lines centre positions versus electron density to zero electron density. Once this value was subtracted

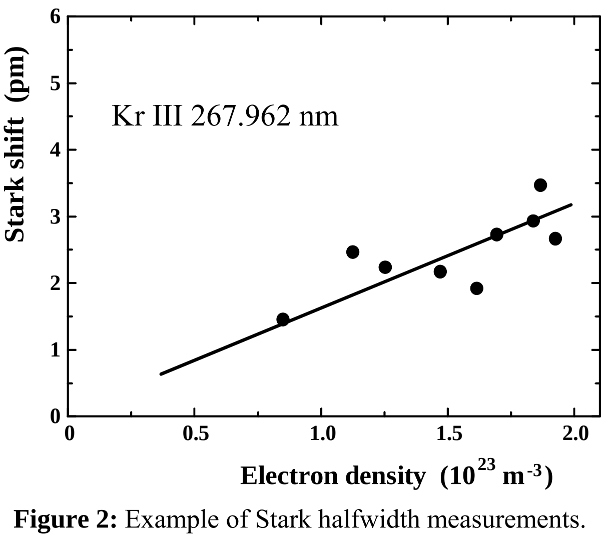

Figure 2: Example of Stark halfwidth measurements.

from the measured lines centre positions, the resulting differences multiplied by the inverse linear dispersion of the spectroscopic system gave us the desired Stark shift values (in pm).

From Table 1 one can see relatively large experimental errors. It is well known that Stark shift measurements are, in general, less accurate than Stark halfwidth measurements, especially in cases where shifts are very low. In 15th and 16th row of Table 1, shift results, for lines 260.435 nm and 280.607 nm, are given in the form $|d| < 0.5$. This means that the measured shift is very small, practically null, and dispersion of the points is within ± 0.5 pm. This value is actually the accuracy of the shift measurements in this work.

Present Stark data, in general, can be used for diagnostic purposes, demonstration of regularities and similarities of line halfwidths or shifts within the supermultiplets or transition arrays or, by combining them with other experimental results, within the multiplets (Wiese and Konjević 1992). In addition, these results can be used for theory testing and they are also of interest in astrophysics.

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