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Kr III STARK HALFWIDTHS MEASURED IN PULSED ARC PLASMA

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Abstract. This work reports new measured Stark halfwidths of several spectral lines from the 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

Stark broadening data of nonhydrogenic spectral lines are of interest for both laboratory and astrophysical plasmas. They are usually used for plasma diagnostics purposes. In addition, Stark parameters data of Kr III lines can be useful for verification of theoretical calculations and investigation of regularities and systematic trends (Wiese and Konjević 1982) in case of doubly ionized noble gases. Kr III spectral lines data are also very important for industry, where krypton is used in the manufacturing of spectral light sources (Cayless and Marsden 1983) and lasers (Shimoda 1984).

In this work we report 12 measured Stark halfwidths 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) × 10^{23} m^{-3} and electron temperature 16000 - 22000 K.

For obtaining the Stark halfwidths, special attention was paid to both experimental and data treatment procedures. Other broadening mechanisms were taken into account, as well.

These data are quite new in the literature and they can increase the present database of measured Kr III Stark halfwidths. Only a few papers report Kr III Stark halfwidth data (Konjević and Pittman 1987, Dimitrijević and Konjević 1987, Ahmad et al. 1998 and Milosavljević et al. 2000), but all the observed lines were above 300 nm. The presented Stark halfwidth data can be used for plasma diagnostics purposes, theory testing and applications.

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 halfwidths of some 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 halfwidths, w_m, and estimated accuracy, Acc., are presented. The data are normalized to electron density $N_e = 1 \times 10^{23}$ m^{-3} and electron temperature T_e = 18000 K. The multiplets are arranged in the same way as in the NIST atomic spectra database. The transition

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

#	Configurations	Terms	Wavelength (nm)	w_m (pm)	Acc. (%)
1	$4s^24p^3(^4S^o)4d – 4s^24p^3(^4S^o)5p$	$^5D_1{}^o – {}^5P_2$	267.962	9.28	29
2		$^5D_2{}^o – {}^5P_2$	268.032	10.06	27
3	$4s^24p^3(^2D^o)4d – 4s^24p^3(^2D^o)5p$	$^3F_3{}^o – {}^3D_2$	255.316	11.80	29
4		$^3F_3{}^o – {}^3F_3$	255.513	11.61	29
5	$4s^24p^3(^2D^o)5s – 4s^24p^3(^2D^o)5p$	$^3D_1{}^o – {}^3P_0$	281.448	20.96	36
6		$^3D_2{}^o – {}^3P_2$	290.004	19.86	38
7		$^1D_2{}^o – {}^3P_1$	299.660	19.93	39
8	$4s^24p^3(^2D^o)5s – 4s^24p^3(^2P^o)5p$	$^1D_2{}^o – {}^3P_1$	260.435	19.07	27
9	$4s^24p^3(^2P^o)4d – 4s^24p^3(^2D^o)5p$	$^3P_1{}^o – {}^3S_1$	280.607	11.17	17
10	$4s^24p^3(^2P^o)4d – 4s^24p^3(^2P^o)5p$	$^3F_4{}^o – {}^3D_3$	287.061	9.80	42
11	$4s^24p^3(^4S^o)5p – 4s^24p^3(^4S^o)6s$	$^5P_3 – {}^5S_2{}^o$	256.325	27.64	9
12	5p – 5d	$^5P_2 – {}^3D_3{}^o$	245.772	25.43	28

data for the last line given in Table 1 can be found in Striganov and Sventitskii (1968).

All spectral lines were checked to self-absorption effect, using an external mirror (Djurović et al. 2006). The chosen percentage of krypton in krypton-helium mixture ensured the plasma conditions, where self-absorption was absent for all lines in consideration.

Apart from taking care of experimental conditions and plasma diagnostics, attention was also paid to the proper fitting (Gigosos et al. 1994) and deconvolution procedure (Davies an Vaughan 1963). Under these experimental conditions Stark broadening was the dominant broadening mechanism. Two other pressure broadening mechanisms, resonance and van der Waals, were found to be negligible. Therefore, only Gaussian (instrumental + Doppler) and Stark broadening were considered in deconvolution procedure.

All possible errors in the line shape recording, transmittance correction, as well as fitting and deconvolution procedure were included in the final experimental accuracy estimation presented in Table 1. All measured halfwidths show linear dependence on electron density. An example is shown in Fig. 1. Relatively large experimental errors and dispersion of the measured halfwidths (see Fig. 1) are a consequence of low signal/noise ratio since we deal with low intensity spectral lines.

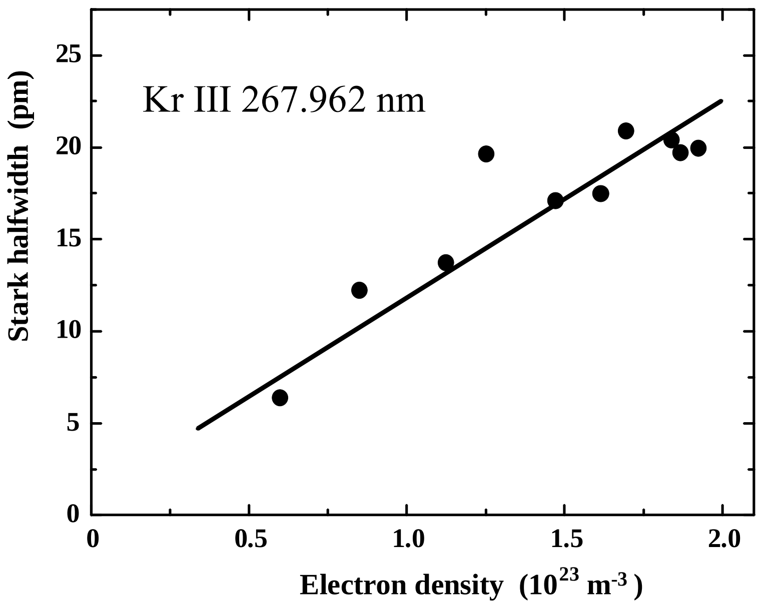

Figure 1: Example of Stark halfwidth measurements.

In the present results there is only one line per multiplet and regularity check of Stark halfwidths can be done only for supermultiplets or transition arrays. In Wiese and Konjević (1982) it was found that Stark halfwidths of the lines belonging to the same transition array normally have values within ±40%. Here, we have a variation of Stark halfwidths of about ±12% around the average value for 4d – 5p transition array and even less (±5%) for 5s – 5p transition array.

As it was already pointed out in the introduction, the presented data are new data and can not be found in the literature. Namely, there are some data in Di Rocco et al. (1989), but reliable plasma diagnostics parameters are not provided and comparison with those results is not possible.

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