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STARK SHIFTS OF ArI SPECTRAL LINES

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Introduction

Stark shift measurements of spectral lines are very interesting, because they can be successfully applied to diagnostic purposes. In order to estimate Stark shifts of ArI spectral lines in this experiment, we have used a special source of plasma, allowing combined measurements of glow and pulsed discharge (Djeniže and Labat, 1983). In such case we can believe that the spectral lines in glow discharge are almost unshifted.

Apparatus and procedure

The glow and pulsed discharge occurred in a Pyrex tube. The tube had two quartz windows at both its ends (fig. 1). Details of the experimental apparatus are given in Djeniže *et al* (1993). The effective plasma length was 70 mm, while the iner diameter of linear part of discharge tube was 5 mm. As a working gas we used the argon-helium mixture (72% + 28%) at the pressure of 266 Pa. Spectroscopic observations of isolated spectral lines were made along the axis of the discharge tube. By using this source it was possible to get a reproducable and homogenous plasma.

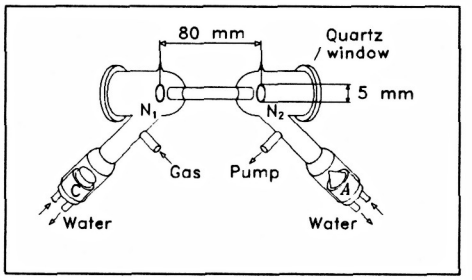

Fig. 1. The discharge tube.

The glow discharge was driven between water-cooled copper electrodes (C and A). The current was 50 mA. Auxiliary ring-shape nickel electrodes (N_1 and N_2) were positioned at the optical axis, 80 mm from each other. They were used to drive the pulse discharge, by repetitive discharge of 0.3 μF condenser initially charged to 10 kV.

The electron density in the positive column of the glow discharge was about $2 \times 10^{18} m^{-3}$, hence it does not contribute to the Stark shift of spectral lines.

Parameters of the pulse plasma were determined by standard diagnostic methods. Electron temperature was found from the ratio of relative intensities of ArII 500.93 nm and ArI 696.54 nm spectral lines. The maximal value of the electron temperature was 13000 K with ±15% error. Atomic parameters required were taken from Wiese *et al* (1969). It was found that the electron temperature decayed slowly during the first 40 μs after the beginning of the discharge.

The electron density was measured by a single wavelength laser interferometry, using the 632.8 nm He-Ne laser line. The maximal value of the electron density was $3.8 \times 10^{22}\mathrm{m}^{-3}$ corresponding to 10 μs after the beginning of the discharge. The errors of these measurements are estimated to be within $\pm 10\%$. All Stark shifts of spectral lines have been measured in this domain.

Recording of spectral lines profiles was done as described in details in Djeniže *et al* (1993). The line shift was found by the new method described in the same paper. The Stark shifts were measured relative to almost unshifted spectral lines emitted by the glow discharge at considerably lower electron densities. This measuring method could be very successful for Stark shift measurements of neutral lines.

Results

Experimentally determined Stark shifts (d_m) of the ArI lines are given in Table 1 together with the plasma parameters, i.e. electron density and temperature (N_e, T_e). The uncertainties in our experimentally measured Stark shift data are within $\pm 15\%$.

Transition	Multiplet	λ (nm)	T_e (K)	N_e ($10^{22}\mathrm{m}^{-3}$)	d_m (nm)
4s – 4p	$[1\frac{1}{2}]^0 - [1\frac{1}{2}]$ (1)	763,51	13000	3,3	0,021
4s – 4p′	$[1\frac{1}{2}]^0 - [\frac{1}{2}]$	696,54	13000	3,3	0,010
4s′ – 5p′	$[\frac{1}{2}]^0 - [\frac{1}{2}]$ (9)	425,94	14000	2,6	0,023

Table 1. Measured Stark shifts of the ArI spectral lines.

Only experimental results exist for the ArI 763.51 nm and ArI 696.54 nm lines while there are some theoretical calculations also for the ArI 425.94 nm line. For this line our experimental result is about 39% less than the theoretical value based on the semiclassical Griem's theory (Konjević and Roberts, 1976). Similar results were obtained by other authors.

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