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STARK WIDTHS AND SHIFTS OF THE Ar I 427.2 nm LINE

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1. INTRODUCTION

The preliminary results presented here are the part of an systematic and high precision experimental study of the widths and shifts of argon spectral lines. Experimental results are compared with the theoretical ones (Griem, 1974) in the range of electron density $(1.0\text{-}3.3)\cdot 10^{22}\ m^{-3}$. This comparison shows discrepancy between measured and theoretical widths and shifts. In the case of shifts this discrepancy is smaller.

2. EXPERIMENTAL

As the plasma source a wall stabilized electric arc operating at atmospheric pressure is used. For diagnostic purposes the mixture containing 96 % of argon and 4 % of hydrogen was introduced in the central part of the arc with the flow rate of 0.03 l/min. The flow rate of the working gas - argon, was 3 l/min). The current of 30 A was supplied to the arc by a current-stabilized power supply with stability of 0.3 %. The plasma observations were performed side-on with a 1m mono-chromator and photomultiplier tube. Monochromator was equipped with a 1200 g/mm grating and stepping motor (36000 step/rev). The signals from the photomultiplier were led to the digitizing oscilloscope working in the averaging mode. For the shift measurements, the Geissler tube containing argon is used as a source of unshifted line. The light from the arc plasma and from the reference source is focused onto the entrance slit of the monochromator alternatively by means of light chopper. The stepping motor of the monochromator, light chopper and oscilloscope are controlled by the personal computer. The same computer is used for data acquisition.

An electron density (N_e) in the range (1.0 - 3.3) · 10^{22} m^{-3} is determined from the width of Balmer H_β line (Vidal *et al.* 1973). The electron temperature (T_e) in the range (9600 - 11000) K is obtained from plasma composition data evaluated as described in (Popenoe and Shumaker, 1965).

3. RESULTS

The Abel inversion procedure described in Djurović (1997) were applied on side-on recorded spectral line profiles. After that the deconvolution procedure of Gaussian (Doppler and instrumental) profile and $j_{A,R}(x)$ profile described in Mijatović et al. (1993) were applied in order to obtain Stark full-halfwidths (w_m). The spectral line profiles from the reference source are fitted by least square method to Gaussian profiles. The shift of plasma broadened lines (d_m) is measured at the halfwidth of line profile. The experimental results of w_m and d_m are given in Table 1 together with theoretical (semiclassical) (Griem, 1974) full-halfwidths w_t and shifts d_t.

Table 1. Measured and theoretical values for Stark widths and shifts.

N_e (10^{22} m^{-3})	T_e (K)	w_m (nm)	w_t (nm)	d_m (nm)	d_t (nm)
3.30	10920	0.043	0.072	0.023	0.028
3.25	10900	0.042	0.071	0.022	0.028
3.15	10880	0.041	0.068	0.021	0.027
3.00	10830	0.039	0.065	0.020	0.026
2.70	10700	0.036	0.058	0.018	0.023
2.40	10550	0.031	0.052	0.017	0.021
2.16	10400	0.028	0.046	0.015	0.019
1.88	10250	0.024	0.040	0.014	0.017
1.64	10100	0.023	0.033	0.012	0.014
1.38	9880	0.019	0.029	0.010	0.012
1.18	9700	0.013	0.025	0.009	0.011
1.00	9570	0.012	0.021	0.007	0.009

The measured widths and shifts are corrected for Van der Waals broadening (Griem, 1974), while resonance broadening is found negligible. The theoretical widths and shifts are corrected for the Debye shielding effect (Griem, 1974). The error for both, halfwidth and shift measurements is estimated to < 10 %.

Theoretical (w_t) and measured (w_m) Stark full-halfwidths upon electron density are given in Fig. 1. Ratio w_m/w_t (for corresponding electron densities and temperatures) is almost constant, with mean value of 0.61 with standard deviation

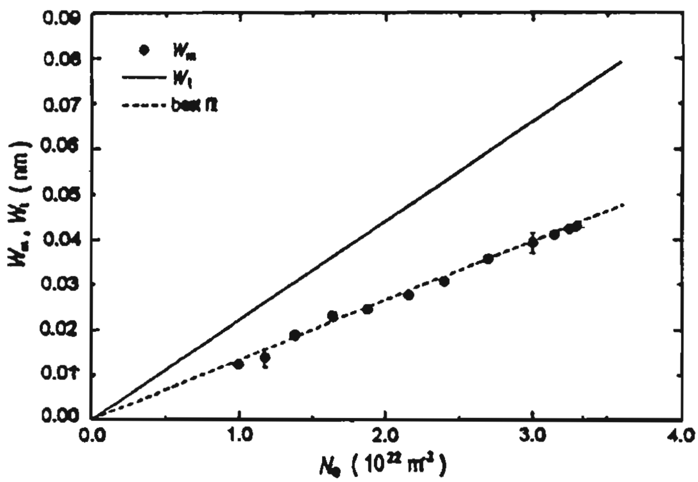

Figure 1. Theoretical (W_t) and measured (W_m) full-halfwidths versus electron density N_e.

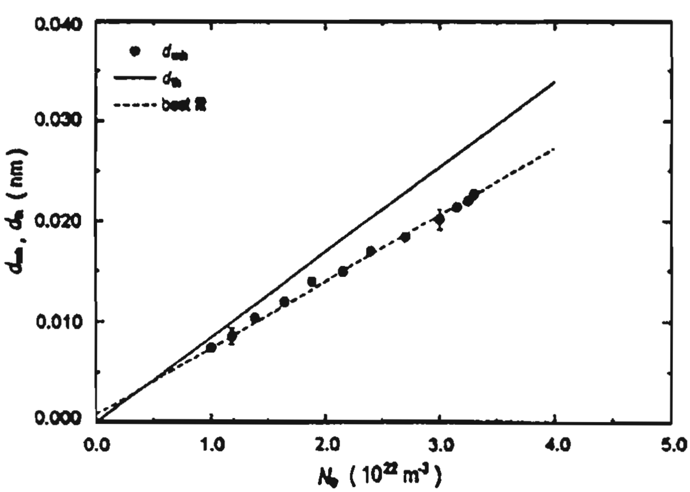

Figure 2. Theoretical (d_{th}) and measured (d_{mh}) shifts versus electron density N_e.

of 0.04. This ratio determined by other authors (Musilok *et al.*, 1976; Chapelle et al., 1967; Bues *et al.*, 1969; Morris and Morris, 1970; Jons *et al.*, 1986) is ranging from 0.79 to 1.15 with error in widths measurements ranging from below 15 % to 50 % according to classification in Konjević et al. (1976, 1984, 1990). In paper of Musielok, (1994) the measurements of widths are reported. The values w_m/w_t ranged from 0.62 to 0.98.

Figure 2 is the same as Fig. 1 but for shifts. The mean value of the ratio of measured d_m and theoretical d_t shifts is, as in the case of widths, almost constant and to be 0.81 with standard deviation of 0.02. In papers of Konjević et al. (1976, 1984, 1990) (until the end of 1988) we found only three papers which reported measured shifts (Chapelle et al., 1967; Bues *et al.*, 1969; Morris and Morris, 1970). Their values of d_m/d_t ranges from 0.93 to 1.02 with 15% - 50% uncertainty in shift measurement (Konjević *et al.*, 1976, 1984, 1990).

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