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ON THE STARK WIDTH REGULARITIES IN THE Ar II SPECTRUM: 4s-4p AND 3d-4p TRANSITIONS

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1. INTRODUCTION

The great number of the papers (Fuhr and Lesage 1993, and references therein; Pellerin *et al.* 1997) devoted to the Stark width of the singly ionized argon (Ar II) spectral lines testify to their topicality in the plasma diagnostic. The aim of this paper is to establish regularities of Stark HWHM (half-width at half intensity maximum, w) along a one type of the quantum transition in the Ar II spectrum. Namely, with the established regularities a quick and reliable estimation of the Stark HWHM values is possible that have not yet been measured or calculated. We have established trends of the Stark HWHM within 4s-4p and 3d-4p type of transitions. In view of these regularities new measurements of these Stark HWHM values can be recommended.

2. REGULARITIES

The simplest way to estimate values of Stark HWHM is to use the established regularities of w along the same type of quantum transition in the ionic spectra (Djeniže *et al.* 1989 and references therein). On the basis of the existing experimental Stark HWHM values of the spectral lines that belong to 4p-4d transition in the Ar II spectrum it was found (Djeniže *et al.* 1989) that simple analytical relationship exists between w and corresponding upper-level ionization potential (I) of a particular spectral line for the same type of the transition. The found relationship, normalized to a $N = 1 \times 10^{23}\ \mathrm{m}^{-3}$ electron density, is of the form:

$$w = aT^{-1/2}I^{-b} \quad (\mathrm{rad/s}). \tag{1}$$

The upper-level ionization potential I (in eV) specifies the emitting ions, while the electron temperature T (in K) characterizes the assembly. The coefficients a and b are independent of I and T. The found form in the case of the 4p-4d transition is presented in Djeniže *et al.* (1989). This relationship was confirmed by new w experimental results (Srećković and Djeniže 1998). On the basis of Eq. (2) in Djeniže *et al.* (1989) it was possible to predict w values for the spectral lines that have not been measured

or calculated before. These predictions were summarized in Srećković and Djeniže (1998). In the meantime, since 1989, the results of the new Stark HWHM values have been published for various transitions of the singly ionized argon. These values, and those before 1989, enable establishing the trend of the Stark HWHM values along the 4s-4p and 3d-4p transitions. In Figs. 1 and 2 we present, graphically, the reduced Stark widths ($wT^{1/2}$) vs the inverse value of the upper-level ionization potential ($1/I$) for: 4s-4p and 3d-4p type of transitions, respectively. The necessary atomic data were taken from Wiese *et al.* (1969).

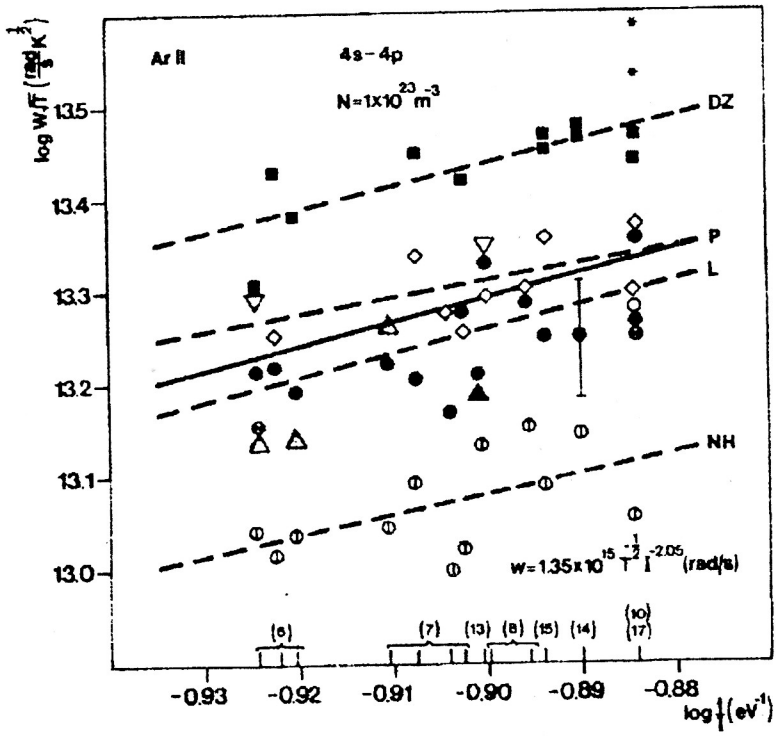

Fig. 1. Reduced Stark HWHM ($wT^{1/2}$) vs inverse value of the upper-level ionization potential at 1×10^{23} m^{-3} electron density. —, established trend; •, Labat *et al.* 1974 (L); Φ, Nick and Helbig 1986 (NH); ■, Dzierżega and Musiol 1994 (DZ); ◇, Pellerin *et al.* 1997 (P); ○, Djeniže *et al.* 1989; ▲, Konjević *et al.* 1970; ▽, Chapelle *et al.* 1968; Δ, Vitel and Skowronek 1987; ⊗, Aparicio *et al.* (1997); *, Mazing and Vrubljovskaia (1962).

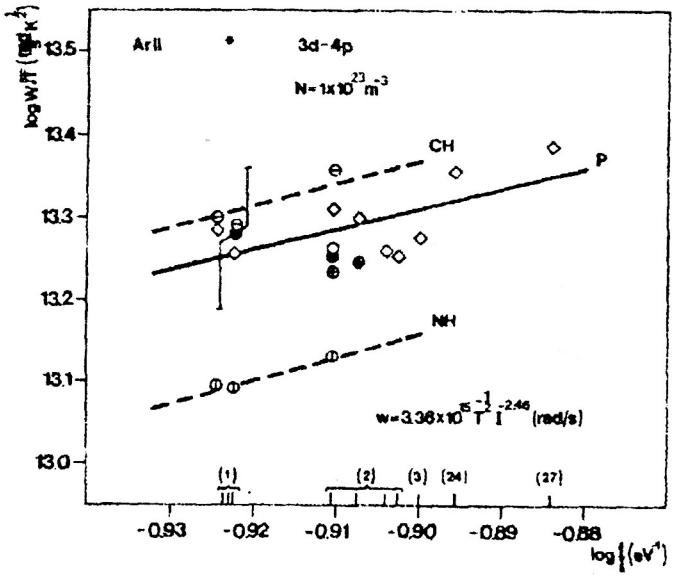

Fig. 2. Same as in Fig. 1. Complement: Θ, Chapelle *et al.* 1967 (CH); $\oplus$, Lhuissier (1987).

An evident scatter exists between experimental Stark HWHM values. However, one can conclude that in the selected particular experiments (L, NH, DZ, P, CH) (Labat *et al.* 1974; Nick and Helbig 1986; Dzierżega and Musiol 1994; Pellerin *et al.* 1997, Chapelle *et al.* 1967) the measured Stark HWHM values follow also regularities described by Eq. (1) (dashed lines in Figs. 1 and 2). The full lines show their averaged values. In order to ilustrate the magnitude of the scatter of the reduced Stark HWHM values we have their uncertainties ($\pm$ 20%), like error bars, presented in Figs 1 and 2. The averaged values can be expressed by formulae:

$$w_{4s-4p} = 1.35 \times 10^{15} T^{-1/2} I^{-2.05} \quad \text{(rad/s)}. \tag{2}$$

$$w_{3d-4p} = 3.36 \times 10^{15} T^{-1/2} I^{-2.46} \quad \text{(rad/s)}. \tag{2}$$

3. CONCLUSION

On the basis of the existing experimental data we have established trends for Stark HWHM values for spectral lines that belong to 4s-4p and 3d-4p transitions. The evident scatter between results of particular experiments can be explained on the basis of various uncertainties of the electron density and temperature measurements in these experiments. It should be pointed out that these experiments were performed with various plasma sources and the plasma parameters were obtained using various diagnostics methods. In any case, new measurements of the Stark HWHM values for spectral lines that belong to 4s-4p and 3d-4p transitions would be helpful.

Acknowledgements

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