Publ. Obs. Astron. Belgrade No. 50 (1995), 61 – 64

STARK WIDTHS OF ArIII SPECTRAL LINES FROM 4s' - 4p' TRANSITION

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Abstract. Stark widths of three ArIII spectral lines that belong to $4s' - 4p'$ transition have been measured at the electron density of $3.5 \cdot 10^{23} m^{-3}$ and electron temperature of 38 000 K in a pulsed linear arc discharge in argon plasma . The measured values were compared to existing theoretical data calculated on the basis of various approaches.

1. INTRODUCTION

Knowledge of the Ar III spectral line charecteristics is important for the determination of chemical abundances of elements and for the estimation of the radiative transfer through the stellar plasmas as well as for opacity calculalations (Iglesias *et al.*, 1990). A number of experimental and theoretical papers have dealt with Stark broadening of ArIII spectral lines (Fuhr and Lesage, 1993). However, only 16 spectral lines from five multiplets (Platiša *et al.*, 1975; Konjević and Pittman, 1987; Purić *et al.*, 1988; Kobilarov and Konjević, 1990) and 6 lines from 1(UV) multiplet (Baker and Burgess, 1979) have been investigated. Only two papers (Platiša *et al.*, 1975; Konjević and Pittman, 1987) are devoted to the experimental investigation of the ArIII spectral lines from the $4s' - 4p'$ ($^3D^0 -^3 F$) transition.In both of them Stark widths were measured in plasma with electron temperature up to 26 000 K.

In this work we present measured Stark FWHM (full width at half maximum intensity) (w) values of three Ar III spectral lines originating from $4s' - 4p'$ transition (Mult.No.3) at 38 000 K electron temperature. The measured values of Stark widths were compared with existing theoretical predictions based on various theoretical approximations calculated by Dimitrijević and Konjević (1981).

2. EXPERIMENT

The linear pulsed arc,that was used as a plasma source,has been described in detail in our previous publication (Djeniže *et al.*, 1991), so only a few details will be given here. A pulsed discharge occured in a Pyrex discharge tube of 5 mm i.d. and had an effective plasma length of 5.8 cm. The tube had quartz windows. The working gas was argon-helium mixture (Ar72+He28%) at 130 Pa filling pressure in flowing regime. Spectroscopic observation of isolated spectral lines were made end-on along the axis of the discharge tube. A capacitor of 8.0 μF was charged up to 5.2 kV and supplied discharge current up to 6.6 kA. From the coil Rogovski signal follows that the discharge duration is 30 μs. The line profiles were recorded by a shot-by-shot technique using photomultiplier(EMI 9789 QB)-spectrograph (Zeiss PGS-2, inverse linear dispersion 0.73 nm/mm in the first order) combination. The exit slit of the spectrograph with the calibrated photomultiplier was micrometrically traversed along the spectral plane in small (0.0073 nm) wavelength steps. The photomultiplier signal was digitized using HAMEG 205-2 digital scope interfaced to a computer.A sample output, as an example, is shown in Fig.1.

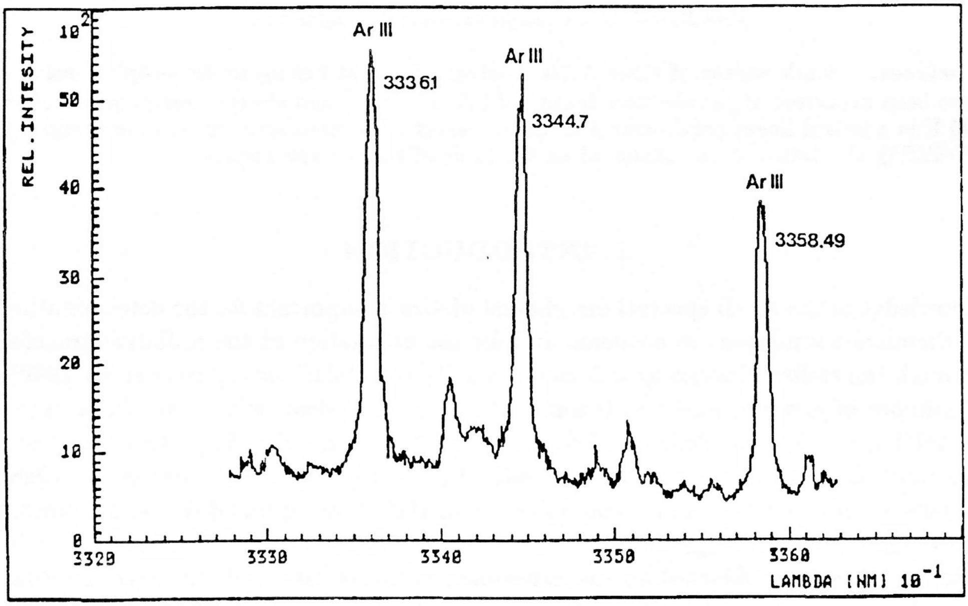

Fig. 1. The recorded spectrum at 15 μs after the beginning of the discharge with the investigated ArIII spectral lines.

Plasma reproducibility was monitored by the ArIII line radiation and also by the discharge current (it was found to be within ±6%). The measured profiles were of the Voigt type due to the convolution of the Lorentzian Stark and Gaussian profiles caused by Doppler and instrumental broadening. Van der Waals and resonance broadening are estimated to be smaller by more than an order of magnitude in comparison to Stark,Doppler and instrumental broadening. A standard deconvolution procedure (Davies and Vaughan, 1963) was used. The deconvolution procedure was computerized using the least square algoritm . Great care was taken to minimize the influence of self-absorption on Stark width determination. The opacity has been checked by measuring line - intensity ratios within multiplets (No.3). The values obtained were compared with calculated ratios of the products of the spontaneous emission probabilities and the corresponding statistical weigths of the upper levels of the lines (Wiese *et al.*, 1969). These ratios were found to differ by less than ±12%. The Stark width data were determined with an error of ±15% The plasma parameters were determined using standard diagnostic methods. So, the electron temperature (T) decay was determined from the Boltzmann slope of nine ArIII lines (330.2, 328.6, 349. 97, 350.4, 348.6, 335.8, 334.5, 333.6, 302.4 nm with a corresponding upper level energy interval of 4.8 eV), with an estimated error of ±13%. All the atomic parameters that were necessary were taken from Wiese *et al.* (1969). Electron density (N) decay was measured using a single wavelength He-Ne laser interferometer (Aschby *et al.*, 1965) for the 632.8 nm transition with an estimated error of ±6%.

3. RESULTS AND DISCUSSION

The measured Stark FWHM (w_m) values are presented in Table 1 at given electron temperature (T in 10^4 K) and density (N in 10^{23}m^{-3}). In the same Table we give, also, values w_m/w_{th}, where w_{th} are the Stark FWHM values calculated on the basis of various theoretical calculations performed by Dimitrijević and Konjević (1981). w_{SE} and w_{SEM} denote semiempirical and modified semiempirical results,respectively and w_G and w_{GM} denote values obtained on the basis of the semiclassical (Griem, 1974) approximation.

Table 1 Measured Stark FWHM values

λ (Å)	Transition	T	N	w_m (Å)	$\frac{w_m}{w_G}$	$\frac{w_m}{w_{GM}}$	$\frac{w_m}{w_{SE}}$	$\frac{w_m}{w_{SEM}}$
3336.1	4s' - 4p'	3.8	3.5	0.56	0.99	1.31	2.35	1.44
3344.7	4s' - 4p'	3.8	3.5	0.54	0.95	1.26	2.27	1.39
3358.5	4s' - 4p'	3.8	3.5	0.46	0.81	1.07	1.93	1.18

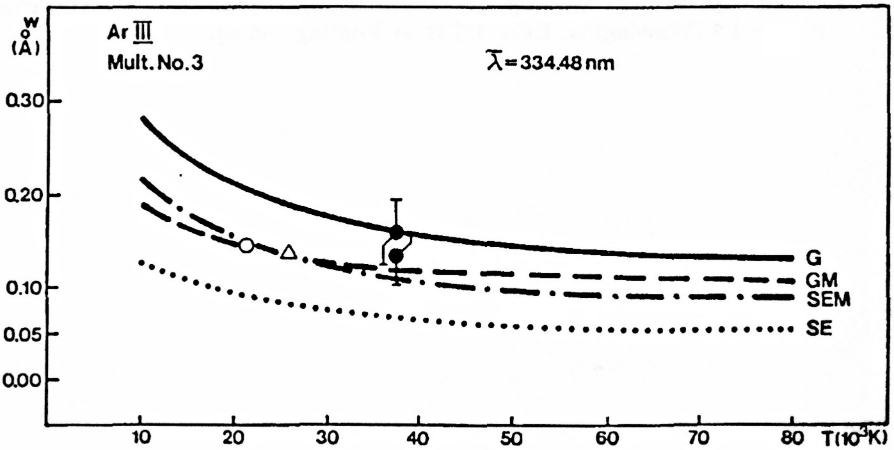

Fig. 2. Stark FWHM dependence on the electron temperature.

The theoretical Stark FWHM (w_{th}) dependence on the electron temperature together with the values of other authors (o, Platiša *et al.*, 1975; Δ, Konjević and Pittman, 1987) and our experimental results (•) at the electron density $N = 1 \cdot 10^{23}m^{-3}$ are presented graphically in Fig.2. $\overline{\lambda}$ is the average wavelength in the multiplet. The error bars include the uncertainties of the width and electron density measurements.

We can conclude that our experimental w_m values well agree, within experimental accuracy, with theoretical predictions (w_G and w_{GM}) based on the semiclassical approximation. The average ratio w_m/w_{SEM}=1.34 (three measurements) shows, also, acceptably agreement between w_m and w_{SEM} values at 38 000 K electron temperature while w_{SE} values are lower than our w_m data up to the factor 2.2 .

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