Journal of Research in Physics Vol.28, No. 3, 243-246 (1999)

MEASURED STARK WIDTHS OF SINGLY IONIZED OXYGEN SPECTRAL LINES

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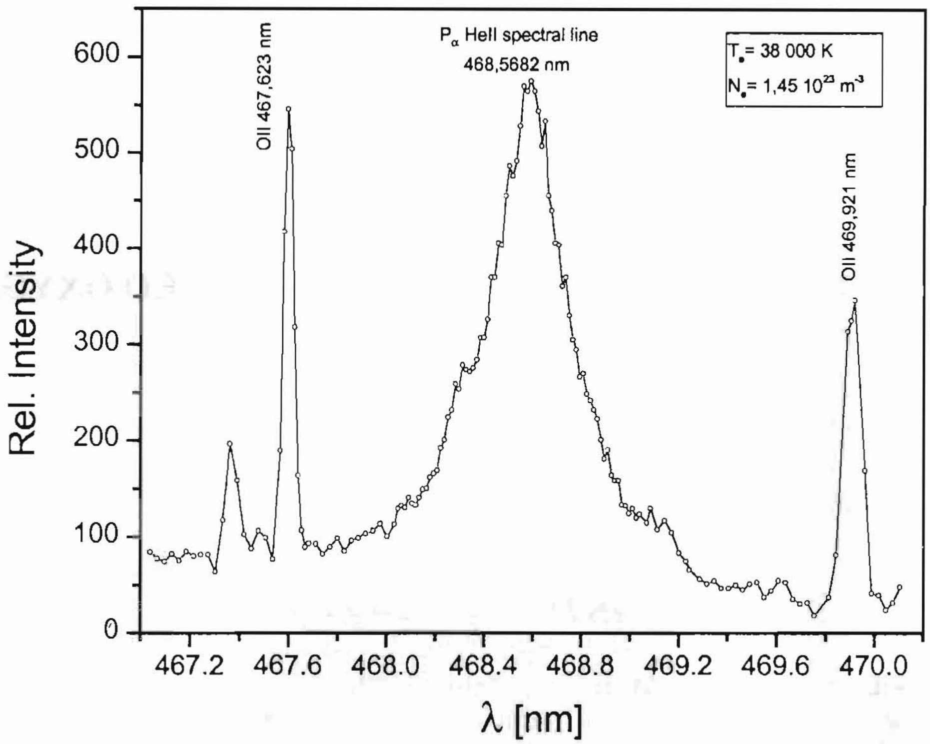
1. INTRODUCTION

The knowledge of the OII spectral lines characteristics, like Stark width, is important for the determination of chemical abundance's of elements, and also for the estimation of the radiative transfer through stellar plasmas, as well as for opacity calculations. A number of experimental papers have dealt with Stark broadening of OII spectral lines (Platiša et al. 1975; Purić et al. 1988; Djeniže et al. 1991; Djeniže et al. 1998).

The aim of this work is to present measured Stark FWHM (full width at half maximum intensity, w) of two OII spectral lines that belong to 3s-3p and 3p-3d transitions. No experimental Stark FWHM data exist for these investigated spectral lines, to the knowledge of the authors. Measurements have been performed in the low pressure linear pulsed arc at $1.45 \cdot 10^{23}$ m^{-3} electron density and 38 000 K electron temperature

2. EXPERIMENT

The Modified version of the linear low pressure pulsed arc (Djeniže et al. 1998; Milosavljević & Djeniže 1998) has been used as a plasma source. A pulsed discharge driven in a quartz discharge tube of 5 mm i.d. and has an effective plasma length of 5.8 cm. The tube has end-on quartz windows. On the opposite side of the electrodes the glass tube was expanded in order to reduce erosion of the glass wall and also sputtering of the electrode material onto the quartz windows (Djeniže et al. 1998). The working gas was helium-nitrogen - oxygen mixture (90% He + 8% N_2 + 2% O_2) at 267 Pa filling pressure in flowing regime. Spectroscopic observation of isolated spectral lines was made end-on along the axis of the discharge tube. A capacitor of 8 μF was charged up to 4.5 kV. The line profiles were recorded by a shot-by-shot technique using a photomultiplier and a grating spectrograph system (Milosavljević et al. 1999). The exit slit (10 μm) of the spectrograph with the calibrated photomultiplier was micrometrically traversed along the spectral plane in small wavelength steps (0.0073 nm).

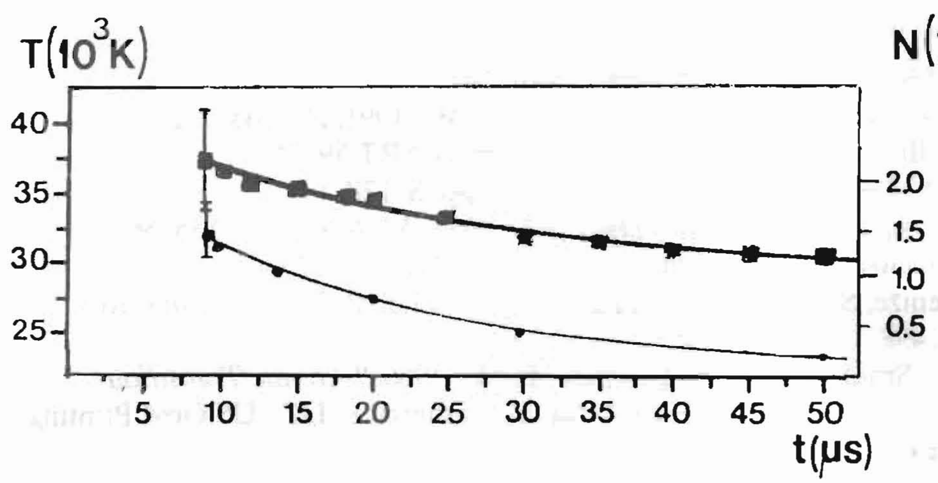


Recorded spectrum at 20 μs after the beginning of the discharge with the investigated OII lines.

The photomultiplier signal was digitized using oscilloscope, interfaced to a computer. Plasma reproducibility was monitored by the OII lines 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. For electron density and temperature obtained in our experiment the Lorentzian fraction in the Voigt profile was dominant (over 80%). Van der Waals and resonance broadening were estimated to be smaller by more than an order of magnitude in comparison to Stark, Doppler and instrumental broadening. A standard deconvolution procedure (Davies & Vaughan, 1963) was used. The deconvolution procedure was computerized using the least squares algorithm. The Stark widths were measured with ±15% error. Great care was taken to minimize the influence of self-absorption on Stark width determinations. The opacity was checked by measuring line-intensity ratios within multiplet (No. 1). The values obtained were compared with calculated ratios of the products of the spontaneous emission probabilities and the corresponding statistical weights of the upper levels of the lines (Wiese et al. 1966). It turns out that these ratios differed by less than ±14%.

The plasma parameters were determined using standard diagnostic methods. The electron temperature (T) was determined from the rations of the relative intensities of the four N III spectral lines (409.74 nm; 410.34 nm; 463.42 nm and 464.06

nm) to the 463.054 nm N II spectral line with an estimated error of ±10 %. All the necessary atomic parameters were taken from Wiese et al. (1966). The electron density (N) decay was measured using a single wavelength He-Ne laser interferometer for the 632.8 nm transition and convenient Stark width of the P_α HeII line, with an estimated error of ±7%.



Temporal evolution of the electron temperature (T) ■, and electron density (N) •, with error bars in the decaying plasma.

3. RESULTS

The results of the measured w_m values (FWHM) at the $T=3.8\cdot10^4$ K electron temperature and $N= 1.45\cdot10^{23}$ m^{-3} electron density are given in the Table 1 together with transition arrays and multiplets.

Emitter	Transition	λ(nm)	w_m(nm)
OII	$3s^4P$-$3p^4D^0$ (1)	467.623	0.0514
	$3p^2D^0$-$3d^2F$ (25)	469.921	0.0555

Table 1

In turns out that our measured w_m values agree (within 25% accuracies) with experimental Stark widths data of other spectral lines that belong to multiplet No. 1 (Djenize et al. 1998 and references therein) and to multiplet No. 25 (Djenize et al. 1991).

Acknowledgment

This research was supported by Ministry for Science and Technology of the Republic of Serbia.

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