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EXPERIMENTAL STARK WIDTHS OF SINGLY IONIZED OXYGEN SPECTRAL LINES

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Abstract. Stark widths of four singly ionized oxygen spectral lines belonging to 3s-3p transitions have been measured. Measurements have been performed in the low pressure linear pulsed arc at a 2.8×10^{23} m^{-3} electron density and at a 54000 K electron temperature.

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 and theoretical papers have dealt with Stark broadening of OII spectral lines (Griem, 1974), (Platiša et al., 1975), (Purić et al., 1988) and (Djeniže et al., 1991).

The aim of this work is to present measured Stark HWHM (half width at half maximum intensity, w) of four OII spectral lines, 3s-3p transition, at electron temperature of an 54000 K. No experimental Stark HWHM data exist for these lines over 26000 K electron temperature, to the knowledge of the authors.

2. EXPERIMENT

The Modified version of the linear low pressure pulsed arc (Djeniže et al., 1990) 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 (see Fig. 1).

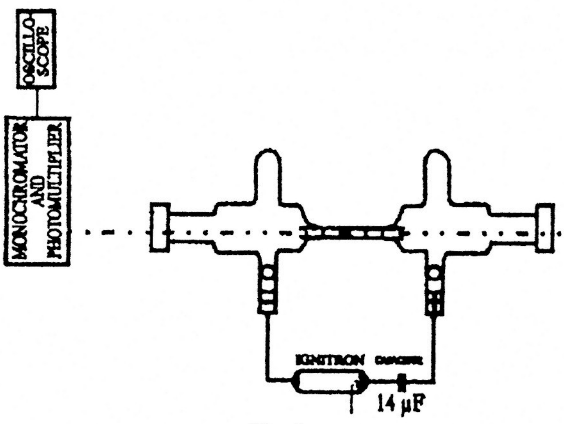

Fig. 1.

The working gas was nitrogen and oxygen mixture (83% N_2 + 17% O_2) at 70 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 14 μF was charged up to 3 kV and supplied discharge currents up to 7.7 kA. The line profiles were recorded by a shot-by-shot technique using a photomultiplier and a grating spectrograph system. 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). The photomultiplier signal was digitized using oscilloscope, interfaced to a computer. Plasma reproducibility was monitored by the OII 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. 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 and 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 selfabsorption 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 ratios of the relative intensities of the 348.49 nm NIV to 393.85 NIII and the previous NIII to 399.50 nm NII spectral lines, assuming the existence of LTE, with an estimated error of ±12%. 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 with an estimated error of ±7%.

3. Results and discussion

The results of the measured w_m values (HWHM) at the $T=5.4\times10^4$ K electron temperature and at the $N=2.8\times10^{23}$ m^{-3} electron density are given in the Table 1 together with transition arrays an multiplet numbers.

Transition	Multiplet	λ(nm)	w_m(nm)
3s-3p	$^4P-^4D^0$	463.88	0.032
	(1)	464.18	0.031
	$^4P-^4S^0$	374.95	0.019
	(3)		
	$^2P-^2P^0$	395.44	0.027
	(6)		

Table 1

In order to compare existing experimental and theoretical values of the Stark HWHM the electron temperature (T) dependence of w, at $N=1x10^{23}$ m^{-3} electron density, is given in Fig. 2.

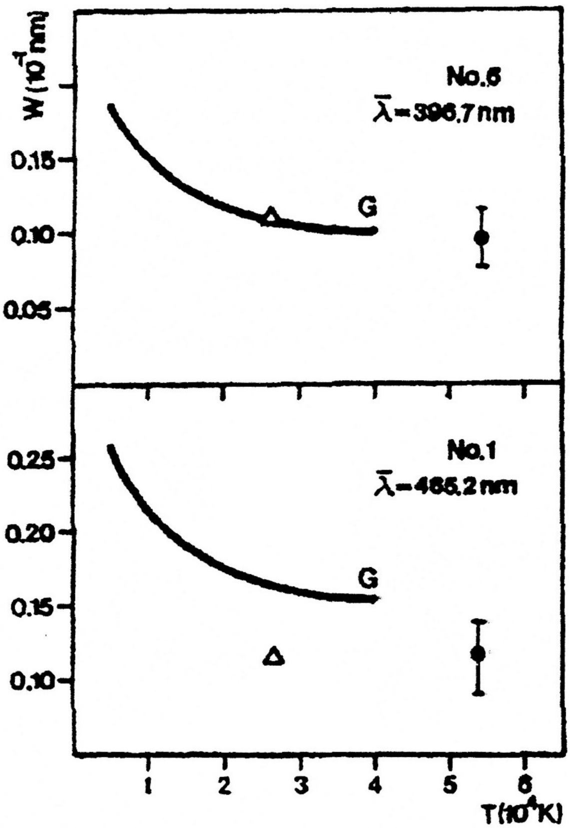

Fig. 2.

Our experimental data (•), for the multiplets No. 1 and No. 6, confirm the trends predicted with Griems theory (Griem, 1974). The triangle (Δ) is experimental data from Platiša et al. (1975). G denote Stark HWHM values calculated on the basis of the semiclassical formula (Griem, 1974).

The error bars include the uncertainties of the width and electron density measurements.

Acknowledgments

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