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# STARK BROADENING PARAMETERS OF THREE O II LINES

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**Abstract.** Stark widths and shifts of 3 singly ionized oxygen (O II) spectral lines (327.0856 nm, 327.3434 nm and 327.7561 nm) in the 3p $^2$F$^o$- 4s $^2$D$^0$ and 3p $^4$P$^o$- 4s $^4$P transitions have been measured in a linear, low-pressure, pulsed arc discharge operated in helium-oxygen mixture (1: 1.1) at a 26 000 K electron temperatures and 1.1 $10^{23}$ m$^{-3}$ electron density. The Stark widths of these lines are the first measured values. The Stark shift of the 327.7561 nm is also the first measured value.

## 1. INTRODUCTION

The spectral lines of the singly ionized oxygen (O II) are of a great interest in the astrophysical plasma diagnostics (Finn et al., 2004; Kobulnicky and Phillips, 2003, as recent examples). At the electron densities (N) higher than 10 $^{21}$ m$^{-3}$ the Stark broadening begins to play an important role in the O II line shapes and line center position formation. Thus, the knowledge of the Stark width (FWHM, full-width at half intensity maximum, $W$) and shift ($d$) are of an interest. We have measured Stark widths ($W$) and shifts ($d$) of 3 singly ionized oxygen (O II) spectral lines (327.0856 nm, 327.3434 nm and 327.7561 nm) in the 3p $^2$F$^o$- 4s $^2$D$^0$ and 3p $^4$P$^o$ – 4s $^4$P transitions in a linear, low-pressure, pulsed arc discharge operated in helium-oxygen mixture (1: 1.1) at a 26 000 K electron temperatures and 1.1 $10^{23}$ m$^{-3}$ electron density. The Stark widths of these lines are the first measured values. The Stark shift of the 327.7561 nm is also the first measured value.

## 2. EXPERIMENT

The linear pulsed arc, used as plasma source, was described in detail in our previous publications (Djeniže et al., 1992; 2002; Srećković et al., 2001). Thus, only a few details will be given here. A pulsed discharge was occurred in a Pyrex discharge tube of 5 mm inner diameter and had plasma length of 14 cm. The tube had quartz windows. The working gas was helium-oxygen mixture (1: 1.1) at 267 Pa filling pressure with constant flux flowing regime (10 ml/min). A capacitor of 14 $\mu$F was charged up to 1.5 kV. Spectroscopic observations of isolated spectral lines were made end-on along the axis of the discharge tube. The complete experimental procedure

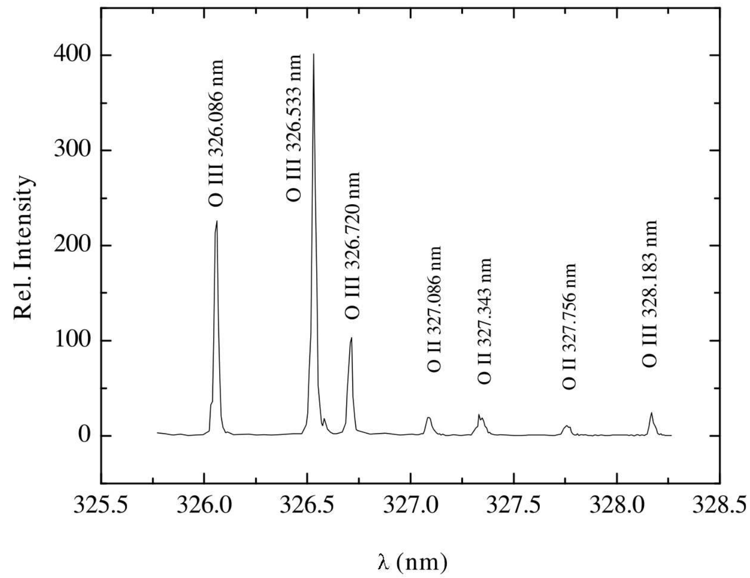


**Figure 1:** Recorded spectrum with investigated O II lines.

is described in Djeniže et al. (2002). Recorded spectrum, with the investigated O II lines, is presented in Fig. 1.

The plasma parameters are obtained using known diagnostics methods. The electron temperature ($T$) was determined from the ratios of the relative intensities of the 326.0857, 326.5329 and 326.7204 nm O III to 327.0856, 327.3434 and 327.7561 nm O II spectral lines, assuming the existence of LTE, with an estimated error of ± 6%. The necessary atomic data were taken from Wiese et al. (1966) and NIST (2000).

The electron density ($N$) was measured using a well-known single laser interferometry technique (Ashby et al., 1965) for the 632.8 nm He-Ne laser wavelength with an estimated error of ± 7%.

## 3. STARK WIDTHS MEASUREMENTS

The measured profiles were of the Voigt type due to the convolutions of the Lorentzian Stark and Gaussian profiles caused by Doppler and instrumental broadening. For the electron density and temperature in our experiments the Lorentzian fraction was dominant. Van der Waals (Griem, 1974) and resonance (Griem, 1974) broadening were estimated to be smaller by more than one order of magnitude in comparison to Stark, Doppler and instrumental broadening. The standard deconvolution procedure (Davies and Vaughan, 1963) was applied using the least square-algorithm. The absence og the self-apsorption was checked using a method described in Djeniže and Bukvić, (2001). The Stark widths were measured with ± 12% error at a given $N$ and $T$.

## 4. STARK SHIFTS MEASUREMENTS

The Stark shifts were measured relative to the unshifted spectral lines emitted by the same plasma using a method established and applied as first by Purić and Konjević (1972). According to this method the Stark shift of a spectral line can be measured experimentally by evaluating the position of the spectral line center ($X_C$) recorded at two different electron density values during plasma decay. In principle, the method requires recording of the spectral line profile at high electron density ($N_1$) that causes an appreciable shift and then later when the electron concentration has decreased to a value ($N_2$) lower by at last an order of magnitude. The difference of the line center positions in these two cases is Δd, so that the shift $d_1$ at the higher electron density $N_1$ is

$$d_1 = N_1 \Delta d/(N_1 - N_2). \tag{1}$$

Our Stark shift values have been obtained for line center positions corresponding to the $18^{th}$ $\mu$s and $45^{th}$ $\mu$s after the beginning of the discharge. The Stark shift data are corrected for the electron temperature decay (Popović et al., 1992). The Stark shifts were measured with a ± 0.6 pm error at a given $N$ and $T$.

## 5. RESULTS AND DISCUSSION

Measured Stark FWHM ($W_m$) and shift ($d_m$) values at various electron temperatures ($T$) and densities ($N$) together with other authors data are given in Table 1.

**Table 1:** Measured Stark FWHM ($W_m$) and shift ($d_m$) values at various electron temperatures ($T$) and densities ($N$) together with other authors data. The letters **a** and **b** denote results in this work and from Djeniže at al. (1991), respectively.

| Ion | Transition | Multiplet | $\lambda$ (nm) | T ($10^4$ K) | N ($10^{23}$ m$^{-3}$) | W$_m$ (pm) | d$_m$ (pm) | Ref. |
|---|---|---|---|---|---|---|---|---|
| O II | 2p$^2$3p - 2p$^2$($^1$D) 4s | $^2$F$^o$–$^2$D (39) | 327.0856 | 2.60 | 1.10 | 23.9 | - | a |
| | | | | 6.00 | 0.81 | - | 2.0 | b |
| | | | 327.3434 | 2.60 | 1.10 | 23.3 | 1.1 | a |
| | 2p$^2$3p - 2p$^2$($^2$P) 4s | $^4$P$^o$–$^4$P (23) | 327.7561 | 2.60 | 1.10 | 23.7 | 1.0 | a |

## 6. CONCLUSION

Our $W$ data are the first measured values for mentioned O II lines. It turns out that the previously published $d$ value (Djeniže et al., 1991) of the 327.0856 nm O II line have also positive sign.

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