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STARK WIDTHS AND SHIFTS OF NIII SPECTRAL LINES OF 2p3p-2p3d TRANSITION

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Abstract. Stark parameters (width and shift) of four doubly ionized nitrogen spectral lines have been measured in the linear pulsed low pressure arc discharge in the nitrogen plasma at 53 000 K electron temperature and $2.8 \cdot 10^{23} m^{-3}$ electron density. The measured values were compared to the existing experimental and calculated data.

1. INTRODUCTION

A number of experimental and theoretical papers have dealt with Stark broadening and shift of NIII spectral lines (Fuhr and Lesage, 1993 and references therein). However,only three papers (Källne *et al.*, 1979; Purcell and Barnard, 1984; Purić *et al.*, 1987) dealt with the experimental investigation of the Stark widths of seven NIII spectral lines that belong to 2s2p3p-2s2p3d transition and only one contribution (Purić *et al.*, 1988) was devoted to the Stark shift measurements of four spectral lines from this transition. The relative small electron density ($1.78 \cdot 10^{23} m^{-3}$) in the latter work makes the measured shift values obtained unreliable,especially in the case of the multiplet No.9 .

The aim of this work is to present Stark shift and width values of the NIII spectral lines belonging to 2p3p-2p3d transition at $2.8 \cdot 10^{23} m^{-3}$ electron density and 53 000 K electron temperature. Stark shift of 486.72 nm spectral line from multiplet No.9 has not been measured before and the Stark shift of the 298.36 nm spectral line is the first data for the multiplet No.25uv in NIII spectra.

The measured values of Stark widths were compared with existing theoretical predictions based on the various approximations.

2. APPARATUS AND PROCEDURE

The linear pulsed arc,that has been used as a plasma source,has been described elsewhere (Djeniže *et al.*, 1990; Djeniže *et al.*, 1991). A pulsed discharge occured in a Pyrex discharge tube of 5 mm i.d. and had an effective plasma length of 5.8 cm.In order to obtain highest possible electron density,we have used discharge of the condenser battery of 14 μF capacity charged up to 63 J energy. The working gas was nitrogen at a 70 Pa filling pressure in flowing regime. We have determined the following electrical characteristics of the discharge from the Rogowski coil signal : circuit inductance = 1.7 μH, equivalent circuit resistance = 0.2 Ω, period = 32 μs and the peak current =7.7 kA.

We have obtained a good reproducibility (>90 %) of the investigated spectral line radiation intensities.Great care was taken to minimize the influence of selfabsorption on Stark width determination. The opacity has been checked by measuring line intensity ratios within multiplets (No.9). 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.*, 1966). These ratios were found to differ by less than ±10%.

The spectroscopic observations were made end-on,along the axis of the discharge tube.Scanning of the spectral line profiles was done by using a shot-to -shot technique,while advencing the exit slit-photomultiplier combination in small wavelength steps (Djeniže *et al.*, 1991). The photomultiplier signal was digitized using HAMEG 205-2 digital scope interfaced to a computer. The standard deconvolution procedure (Davies and Vaughan, 1963) was computerized using the least square algoritm. The measured profiles were of 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. The estimated error of the measured Stark FWHM (full-width at half intensity maximum) (w_m) was within ±13 %.

The Stark shifts (d_m) were measured relative to the unshifted spectral lines emitted by the same plasma (Purić and Konjević, 1972). The Stark shifts were determined with ±15 % error.

The plasma parameters were determined using standard diagnostic methods. The electron temperature (T) decay was found from the ratios of the relative intensities of 347.45 nm NIV and 375.47 nm NIII spectral lines with an estimated error of ±11% assuming the existence of LTE. The electron density (N) decay was obtained using a single wavelength He-Ne laser interferometer at the 632.8 nm with an estimated error of ±7%. Atomic parameters required for the diagnostic purposes (for NIV and NIII spectra) have been taken from Wiese et al. (1966).

3. RESULTS

Table 1 Measured w_m and d_m values

multiplet	λ (nm)	w_m	d_m
$^2P-^2P^0$ (25uv)	298.358	0.40	0.01
$^4D-^4F^0$	486.715	0.62	0.04
(9)	486.133	0.59	0.02
$^4S-^4P^0$ (13)	454.636	0.51	-0.05

The results of measured Stark FWHM (w_m in $\AA$) and shift (d_m in $\AA$) values at 53 000 K electron temperature and $2.8 \cdot 10^{-23} m^{-3}$ electron density are presented in Table 1. The positive shift is toward the red.

4. DISCUSSION

To the knowledge of the authors only one paper (Dimitrijević and Konjević, 1981) contains calculated values of the Stark width for the 2p3p-2p3d transition.In Fig.1 we have presented Stark FWHM as a function of electron temperature for multiplet No.9 predicted by theoretical calculations at $1 \cdot 10^{23} m^{-3}$ electron density. G and GM denote Stark FWHM values calculated on the basis of the semiclassical and modified semiclassical formulae,respectively (Griem, 1974), both SC and SEM denote values calculated on the basis of the semiclassical theory and modified semiempirical formulae, respectively,performed by Dimitrijević and Konjević (1981). The existing experimental data were also given : Δ, Purcell and Barnard (1984); $\circ$, Purić *et al.* (1987); $\square$, Källne *et al.* (1979) and $\bullet$, our results. $\bar{\lambda}$ is the average wavelength in the multiplet No.9. The error bars include the uncertainties of the width and electron density measurements. We can conclude that in the case of the multiplet No.9 our measured w_m values agree well (within 10%) with predictions of the modified semiclassical theory. The agreement with SEM theoretical values is also acceptable (within 26%), while the theoretical G and SC values are higher than our results up to factors 1.30 and 1.56, respecively. Our experimental data agree well with those from Purić *et al.* (1987).

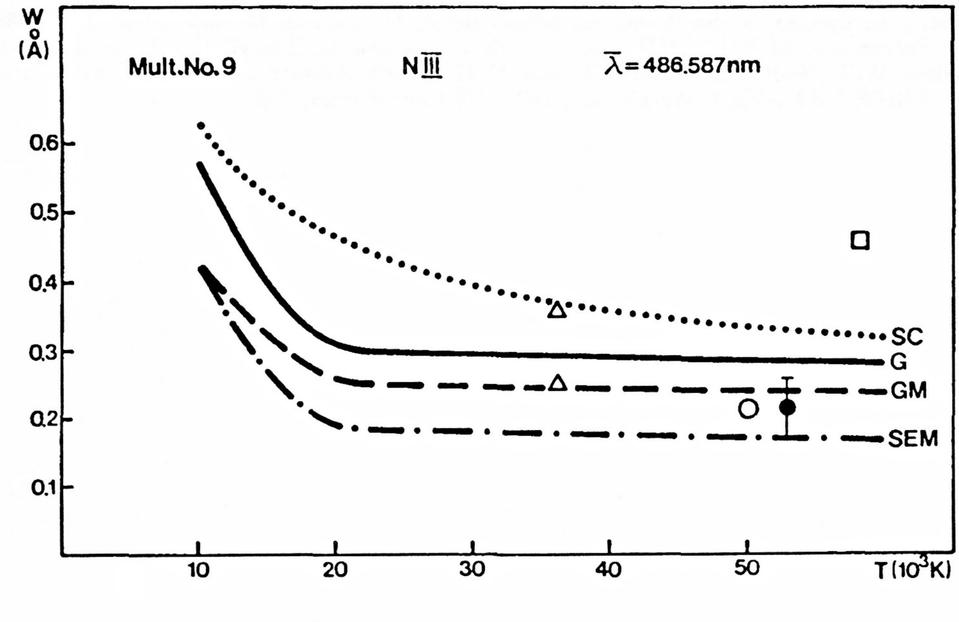

Fig. 1. Calculated Stark FWHM dependence on the electron temperature for the multiplet No.9.

For the Stark shift sign. we confirm earlier obtained conclusion made by Purić *et al.* (1988) for the multiplet No.13, both in the case of the multiplet No.9, we found positive shift.

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