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EXPERIMENTAL STARK WIDTHS IN THE Ne II SPECTRUM

S. DJENIŽE and V. MILOSAVLJEVIĆ
Faculty of Physics, University of Belgrade,
P.O.B.368, 11000 Belgrade, Serbia, Yugoslavia
E-mail: steva@rudjer.ff.bg.ac.yu

Abstract. Stark widths of three Ne II spectral lines (372.708, 341.482 and 341.777 nm) belonging to the $3s^2P - 3p^2D^0$ and $3p^2D^0 - 3d^2F$ transitions have been measured in the linear, low pressure, pulsed neon arc plasma at 31 000 K and 34 500 K electron temperatures and corresponded electron densities of 0.95 10^{23} m^{-3} and 1.83 10^{23} m^{-3}, respectively. Our experimental Stark widths data have been compared to the existing experimental and theoretical Stark width values.

1. INTRODUCTION

In the papers published by Blagojević et al. (1999) and Djeniže (2000) the existing experimental, theoretical and estimated Stark FWHM (full-width at half intensity maximum, W) values have been mutual compared. This comparison show satisfactory agreement between experimental (Platiša et al. 1978; Purić et al. 1987; Konjević & Pittman 1986; Blagojević et al. 1999) and theoretical (Griem 1974) W values, especially in the case of the $3s\ ^3P - 3p\ ^2D^0$ transition. However, the experimental W values lie only little over the SC theoretical predictions based on the semiclassical approaches (Griem 1974). The estimated INS values evaluated from the Stark width regularities along neon isonuclear sequence (Djeniže et al. 1990; Dejniže & Labat 1996) agree with SC and other experimental W values. Contrary, in the case of the $3p^2D^0 - 3d^2F$ transition the INS estimations provide higher W values in comparison to the SC values. In both case of the transitions, modified semiempirical (SEM) approaches (Dimitrijević & Konjević 1980; Blagojević et al. 1999) provide smaller W values.

We have measured Stark FWHM values of three Ne II spectral lines at two discharge conditions in neon plasma using the linear low pressure pulsed arc as a plasma source.

2. EXPERIMENT AND RESULTS

The modified version of the linear low pressure pulsed arc (Djeniže et al. 1991,1998) has been used as a plasma source. A pulsed discharge was driven in a quartz discharge tube of 5 mm inner diameter and effective plasma length of 7.2 cm (Fig. 1 in Djeniže et al. (1991,1998)). The tube has end-on quartz windows. The working gas was neon at 130 Pa filling pressure in constant flux flowing regime. A capacitor of 14 μF was charged up to 1.5 kV and 2.5 kV, respectively. Spectroscopic observation of isolated spectral lines were made end-on along the axis of the discharge tube. The line profiles were recorded using a step-by-step technique, described in our earlier publications. The spectrograph exit slit (10 μm) with the calibrated photomultiplier was micrometrically traversed along the spectral plane in small wavelength steps (0.0073 nm). The averaged photomultiplier signal (five shots at each position) was digitized using a oscilloscope, interfaced to a computer.

Plasma reproducibility was monitored by the Ne II and Ne III lines radiation and, also, by the discharge current (it was found to be within 3%). Recorded line profiles can be fitted to the Voigt function as a superposition of the Gauss (instrumental and Doppler broadening) and Lorentz (Stark broadening) functions. The standard deconvolution procedure (Davies & Vaughan 1963) was computerized using the least square algorithm. Stark widths have been obtained with $\pm 10\%$ accuracy at given T and N. 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 $(^2D^0 - ^2F)$. The values obtained were compared with calculated ratios of the products of the spontaneous emission probabilities and the corresponding statistical weight of the upper levels of the lines. These ratios differed by less than $\pm 9\%$, testifying absence of the self-absorption. The necessary atomic data were taken from Wiese et al. (1966).

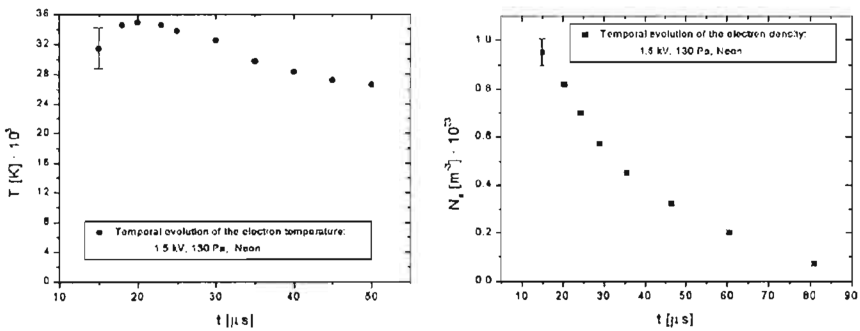

Fig.1. Electron temperature (T) and density (N) decay at 1.5 kV bank energy

The plasma parameters were determined using standard diagnostic methods (Rompe & Steenbeck 1967). Thus, the electron temperature (T) was determined from the Boltzmann-plot of 14 Ne II lines (331.98, 336.06, 337.18, 341.48, 341.69, 341.77, 350.36, 356.83, 366.41, 369.42, 429.04, 439.19, 440.93 and 441.32 nm) with a corresponding upper-level energy interval of 7.52 eV with an estimated error of $\pm$ 7%, assuming the existence of LTE, according to criterion from Griem (1974). All necessary atomic data were taken from Wiese et al. (1966).The electron density (N) decay was measured using a well known single laser interferometry technique for the 632.8 nm He-Ne laser wavelength with an estimated error of $\pm 7\%$. The electron density and temperature decay's are presented in Fig. 1 (for the 1.5 kV bank energy). Our experimental W data are given in the Tab.1.

Table 1. Measured W values at various plasma parameters.

Transition	λ (nm)	W (nm)	
		31 000 K 0.95 10^{23} m^{-3}	34 500 K 1.83 10^{23} m^{-3}
$3s^2P - 3p^2D^0$	372.708	0.0128	0.0225
$3p^2D^0 - 3d^2F$	341.482	0.0145	0.0262
	341.777	0.0140	0.0251

3. DISCUSSION AND CONCLUSION

In order to allow easy comparison among measured and calculated Stark width values, we report in Fig.2. variations of W (FWHM) with the electron temperatures for a given electron density equal to 10^{23} m^{-3}. Theoretical predictions are calculated on the basis of the modified semiempirical formulae (SEM) and semiclassical theory (SC). INS denote estimated W values calculated on the basis of the obtained regularities along a neon isonuclear sequence (Djeniže et al. 1990; Djeniže & Labat 1996; Djeniže 2000).

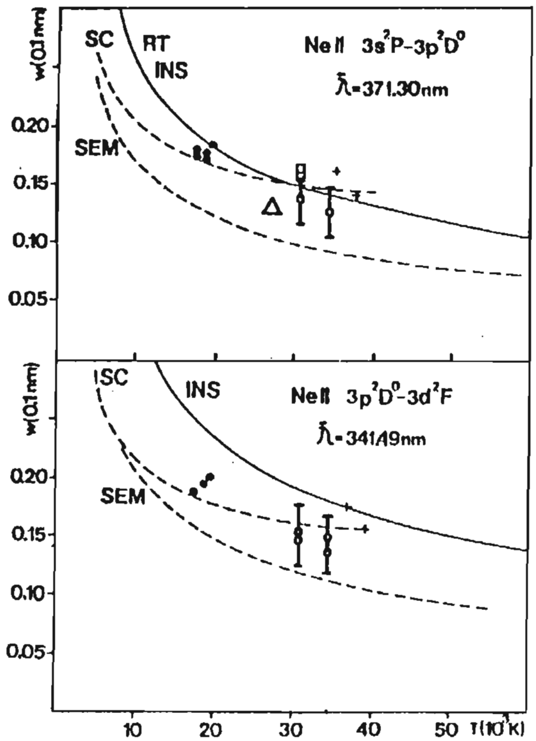

Fig.2. Stark FWHM values vs. electron temperature at an 10^{23} m^{-3} electron density. o, this work; •, Blagojević et al. (1999); □, Platiša et al. (1978); △, Konjević & Pittman (1986); +, Purić et al. (1987); SC,Griem (1974); SEM, Blagojević et al. (1999); INS, Djeniže et al. (1990) and Djeniže & Labat (1996) for the 3s-3p, and Djeniže et al. (1990) for the 3p -3d transition. Error bars include uncertainty estimates in width (±10%) and electron density (±7 %) measurements. $\bar{\lambda}$ is the mean wavelength in multiplet.

One can conclude that our new experimental W data confirm the earlier observed experimental W values around 30 000 K electron temperature and lie between SC and SEM (within experimental accuracy's) theoretical values. It should be pointed out that the estimated INS values agree satisfactory with experimental data in the case of the 3s-3p transition, but in the case of the 3p-3d transition the INS estimations definitively overvalue the existing Ne II Stark width values. From this statement follow that new determination of the INS regularities is necessary taking into account newly experimental Stark FWHM values of the Ne II, Ne III, Ne IV, ... spectral lines in the case of the 3p-3d transition.

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