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STARK SHIFTS OF N III AND O IV LINES

B. BLAGOJEVIĆ, M. V. POPOVIĆ, N. KONJEVIĆ
Institute of Physics, 11080 Belgrade, P.O. Box. 68, Yugoslavia

M. S. DIMITRIJEVIĆ
Astronomical Observatory, Volgina 7, 11050 Belgrade, Yugoslavia

Abstract. The Stark shifts of several lines belonging to analogous multiplets, $3s^2S$-$3p^2P^o$ and $3p^2P^o$-$3d^2D^2$, of doubly ionized nitrogen and triply ionized oxygen (boron isoelectronic sequence) have been calculated and measured in a plasma of a low pressure pulsed arc. Plasma electron densities are determined from the width of the HeII P_α line. Electron temperatures are measured from relative intensities of NIII lines while temperatures in oxygen mixture are determined from relative intensities of IV lines. Experimental NIII Stark shifts are in reasonable agreement with our semiclassical calculations. In the case of OIV lines theory predicts shifts of the opposite sign. Possible causes of this discrepancy are discussed.

1. INTRODUCTION

While broadening of NIII and OIV spectral lines in plasmas was a subject of several experimental and theoretical studies (see e.g. Konjević and Wiese 1990 and Blagojević et al 1994 and references in both papers) only two experimental results for the shifts of 3s-3p lines are reported (Purić et al 1987). Therefore, here we present the results of experimental and theoretical plasma shift study of the analogous transitions of NIII and OIV (the isoelectronic sequence of boron). These types of studies are very convenient for the testing of theory (similar energy level structure of the emitter with gradual increase of the ionic charge), allowing also determination of the Stark shift and/or width dependence upon ionic charge Z of the emitter which is of importance for the estimation of the broadening parameters for the ions with no available data. Recent experimental study of the Stark shifts along P isoelectronic sequence (4s-4p transition of SII, ClIII and ArIV) shows, as in the case of Stark widths, gradual shift decrease with increasing ionic charge (Kobilarov and Konjević 1990 and Wiese and Konjević 1992). Furthermore, the change of the sign of the shift along the S sequence (4s'-4p' transition of ClII and ArIII) is detected. This shift behavior can be explained by the irregular change of the perturbing energy levels disposition around upper and/or lower level of the transition along the sequence. In this case simple theory (Dimitrijević and Kršljanin 1986) predicted well the sign of the shift. The aim of this paper is to supply the theoretical and experimental data for the Stark shifts for several lines of the analogous transitions of NIII and OIV.

2. THEORY

By using the semiclassical formalism (Sahal-Bréchot 1969, see also Dimitrijević et al 1992) we have calculated electron- and ion-impact Stark line shifts for NIII and OIV 3s S-3p P and 3p P -3d D multiplets, All necessary data for these calculations are taken from Bashkin and Stonner 1975.

3. EXPERIMENT

Experimental apparatus and procedure are described in details elsewhere (Blagojević et al 1994 and Blagojević et al this conference). The light source was a low pressure pulsed arc operated with gas mixtures : 2% nitrogen in helium and 1.4% oxygen in helium. During the spectral line recordings continuous flow of gas mixture was maintained at a pressure of 3 torr. For the line-shift measurements we used line profiles at the different times of the plasma existence (Purić and Konjević 1972). For this technique of shift measurement it is necessary to know plasma parameters (electron density and temperature) at the times when both profiles are recorded. For the electron density measurements we use the width of the HeII P_α 4686 Å line Pittman and Fleurier 1986). Electron temperatures are determined in nitrogen-helium plasma from the relative intensities of four lines, 4103.43-, 4097.33-, 4634.16- and 4640.64-Å, which belong to NIII. Electron temperatures in oxygen- helium plasma are determined from the Boltzmann plot of the relative intensities of several OIV lines.

4. RESULTS

The experimental results for the Stark shifts Δd_m of NIII and OIV lines are given in Table I together with plasma parameters and estimated errors for the various measured quantities. Table I also contains spectroscopic data for the investigated lines and comparison with our theoretical results Δd_{DSB} (electrons + ions). The shifts of another Comparison of experimental and theoretical data for NIII lines shows a reasonable agreement which is well within estimated uncertainties of both, experiment and theory, see Table I. For OIV lines theory predicts opposite sign of the shift. Possible causes for this discrepancy are eventual configuration mixing.

Table 1.

Ion	Transition	λ_{tab} (A)	N_{e1} ($10^{17}cm^{-3}$)	T_1 (K)	N_{e2} ($10^{17}cm^{-3}$)	T_2 (K)	$\Delta d_m/\Delta N_e$	$\Delta d_m/\Delta d_{DSB}$ (10^{-17} A cm^3)	Ref.
N III	$3s^2S_{1/2}-3p^2P^o_{3/2}$	4097.33	1.38	33000	2.52	44300	-3.5[-2]±54%	117	a
	$3s^2S_{1/2}-3p^2P^o_{3/2}$	4097.33	~ 0		1.78	50000	-2.3[-2]±36%	3.56	b
	$3s^2S_{1/2}-3p^2P^o_{1/2}$	4103.43	1.38	33000	2.52	44300	-3.5[-2]±54%	117	a
	$3s^2S_{1/2}-3p^2P^o_{1/2}$	4103.43	~ 0		1.78	50000	-2.3[-2]±36%	3.56	b
	$3p^2P^o_{1/2}-3d^2D_{3/2}$	4634.16	1.38	33000	2.52	44300	-3.5[-2]±54%	129	a
	$3p^2P^o_{3/2}-3d^2D_{5/2}$	4640.64	1.38	33000	2.52	44300	-2.6[-2]±62%	96	a
O IV	$3s^2S_{1/2}-3p^2P^o_{3/2}$	3063.43	2.06	62600	5.07	93600	1.0[-2]±62%	*	a
	$3s^2S_{1/2}-3p^2P^o_{1/2}$	3071.60	2.06	62600	5.07	93600	1.0[-2]±62%	*	a
	$3p^2P^o_{1/2}-3d^2D_{3/2}$	3403.60	2.06	62600	5.07	93600	1.0[-2]±62%	*	a
	$3p^2P^o_{3/2}-3d^2D_{5/2}$	3411.76	2.06	62600	5.07	93600	1.0[-2]±62%	*	a

*, Theory predicts opposite sign of the shift
a, Our work,
b, Purić et al 1988

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