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ON THE STARK WIDTH REGULARITIES IN THE DOUBLY IONIZED OXYGEN SPECTRUM

S.Djeniže
Faculty of Physics, University of Belgrade, P.O.B.368, Serbia, Yugoslavia

1. INTRODUCTION

Extensive studies of the star atmospheres (and other cosmic emitters) on the basis of the shape and position of spectral lines ,emitted by atomic or ionic emitters, have enhanced the effort to develop a fast and reliable method to find the Stark widths of spectral lines. If the Stark broadening is the principal pressure broadening mechanism in plasmas (with 10^{22} -10^{27} m^{-3} electron density), on the basis of Stark HWHM (half-width at half intensity maximum,w) values it is possible to obtain the other basic plasma parameters e.g. electron temperature (T) and density (N),essential in the modeling of the stellar atmospheres or other laboratorical plasmas (Dimitrijević 1989; Lesage 1994).The simplest way to quick and reliable estimation of the values of w is to use an established regularities for a given type of quantum transition in a particular ionic spectrum.The main objective of this study is to establish regularities of Stark HWHM values using existing experimental results and,on that basis,to predict the w values for spectral lines of the doubly ionized oxygen atoms (O III),that have been not measured or calculated before.Trends of the Stark HWHM values within four types of transitions (3s-3p, $2p^2$ 3s-$2p^2$ 3p, 3p-3d , $2p^2$ 3p-$2p^2$ 3d) have been established in doubly ionized oxygen spectrum. On that basis Stark width values for 25 intensitive spectral lines, not measured or calculated before, have been predicted. These can be applied in the plasma spectroscopy.

2. REGULARITIES

The simplest way to estimate the value of a Stark HWHM (w) is to use established regularities of w along the same type of quantum transition in the ionic spectra (Djeniže et al.1989, and references therein). Namely,on the basis of the existing experimental results of a Stark HWHM of the spectral lines that belong to the 4p-4d transition in the Ar II spectrum it was found that simple analytical relationship exist between w and corresponding upper-level ionization potential (I) of a particular spectral line for the same type of transitions. This relationship, normalized to a N= 10^{23} m^{-3} electron density, is of a form:

$$w(rad/s) = a\,T^{-1/2}\,I^{-b}. \qquad (1)$$

The upper-level ionization potential I (in eV) specifies the emitting ion,while the electron temperature T (in K) characterizes the assembly.The coefficients a and b are independent of I and T.Successful application of Eq.(1) (including the all existing experimental w data) in the cases of nine singly ionized spectra is presented by Djeniže et al.(1999).Inclusion the all existing experimental Stark HWHM data for O III spectral lines in the Eq.(1), in the cases of the investigated transitions, leads to the coefficients a and b which are presented in Fig.1. The found Stark HWHM trends along various type of the transition are graphically presented in the Fig.1.The error bars of 15%,in the Fig.1, shows the magnitude of the scatter of the experimental data of the reduced Stark HWHM ($wT^{1/2}$) values.Stark width values,predicted on the basis of the Eq.(1),at T= 40 000 K electron temperature (as example) and $N=10^{23}$ m^{-3} electron density,are presented in Tab.1. The necessary atomic data are taken from Wiese et al.(1966).

Transition	Multip.	lλ(nm)	2w(nm)	Acc(%)
$2p^2\,3s - 2p^2\,3p$	$^5P - {}^5D^0$ (21)	370.34	0.0182	12
	$^5P - {}^5S^0$ (22UV)	268.61	0.0126	12
		267.46	0.0125	12
		266.57	0.0124	12
	$^3P - {}^3P^0$ (23)	407.39	0.0279	12
	$^3P - {}^3P^0$ (24)	355.69	0.0237	12
3p - 3d	$^3S - {}^3P^0$ (12)	313.29	0.0119	22
		312.17	0.0118	22
	$^3P - {}^3D^0$ (14)	370.72	0.0154	22
	$^3P - {}^3P^0$ (15)	344.41	0.0144	22
	$^1D - {}^1D^0$ (16)	550.01	0.0311	22
	$^1D - {}^1P^0$ (18)	381.68	0.0199	22
$2p^2\,3p - 2p^2\,3d$	$^3S - {}^3P$ (23 UV)	268.75	0.0124	18
	$^5D^0 - {}^5F$ (25)	345.51	0.0165	18
		345.09	0.0164	18
		344.81	0.0163	18
	$^5D^0 - {}^5D$ (26)	308.36	0.0149	18
	$^5P^0 - {}^5D$ (27)	338.49	0.0180	18
		338.27	0.0179	18
	$^3D^0 - {}^3F$ (30)	372.88	0.0250	18
		372.85	0.0248	18
		372.97	0.0248	18
	$^5S^0 - {}^5P$ (33)	446.16	0.0315	18
	$^3P^0 - {}^3D$ (35)	363.87	0.0286	18
		364.68	0.0287	18

Tab.1 Predicted Stark FWHM (2w) values at T=40 000 K electron temperature and $N=10^{23}$ m^{-3} electron density with theire estimated accuracies.

3. RESULTS

3s - 3p transition

Ten spectral lines from six multiplets (parenthesis on the Fig.1) in the 3s-3p transition have been investigated in four experiments (Platiša et al.1975; Purić et al.1988; Djeniže et al.1996; Blagojević et al.1998).Measured Stark HWHM values satisfy our Eq.(1).

$2p^2\,3s - 2p^2\,3p$ transition

Three spectral lines from three multiplets in the $2p^23s$ - $2p^23p$ transition have been investigated in only one experiment (Purić et al.1988).Measured Stark HWHM values satisfy our Eq.(1).Predicted Stark width data for six spectral lines,not measured or calculated before (Lesage & Fuhr 1998), are presented in Tab.1.

3p - 3d transition

Ten spectral lines from six multiplets in the 3p - 3d transition have been investigated in two experiments (Platiša et al.1975; Purić et al.1988). Measured Stark HWHM values satisfy our Eq.(1).Predicted Stark width data for six spectral lines,not measured or calculated before,are presented in Tab.1.

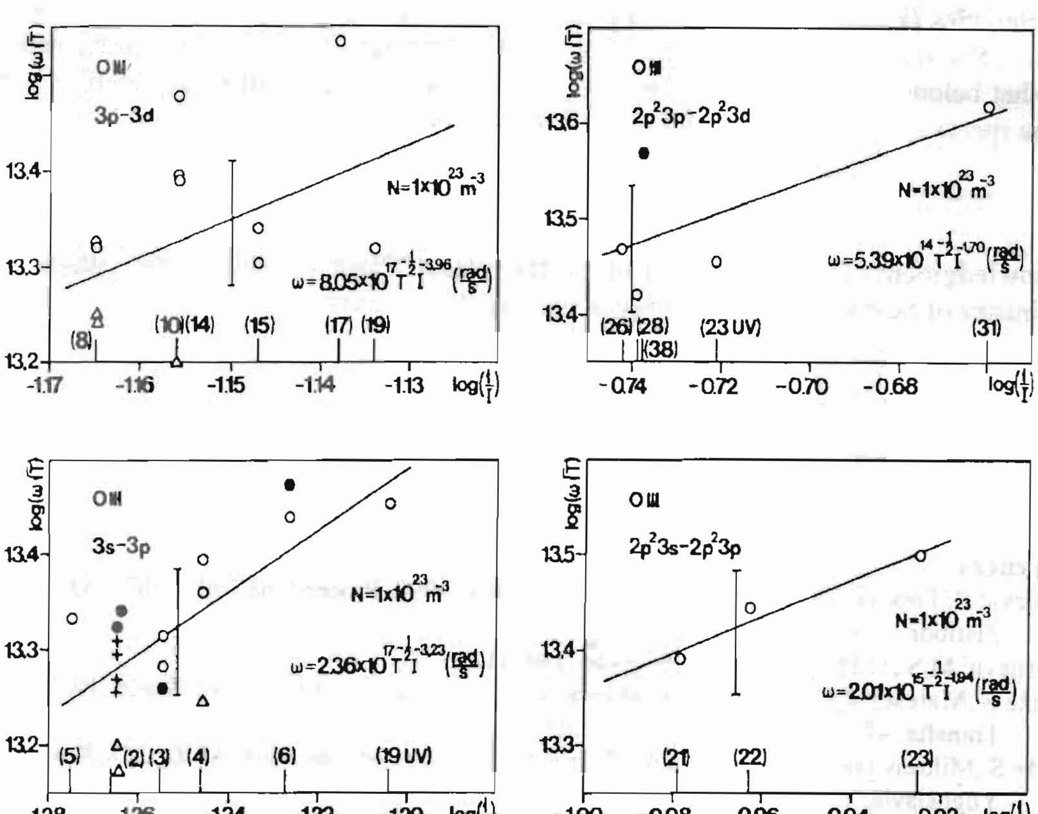

Fig.1

Reduced Stark HWHM ($wT^{1/2}$) versus inverse value of the upper-level ionization potential for various transitions. Δ,Platiša et al.(1975);o,Purić et al.(1988); •,Djeniže et al.(1996) and +,Blagojević et al.(1998).

$2p^2\,3p$ - $2p^2\,3d$ transition
Five spectral lines from five multiplets in the $2p^2\,3p$ - $2p^2\,3d$ transition have been investigated in two experiments (Purić et al.1988; Djeniže et al.1996). Measured Stark HWHM values satisfy our Eq.(1). Predicted Stark width data for thirteen spectral lines,not measured or calculated before,are presented in Tab.1.

4. CONCLUSION

On the basis of existing experimental data, trends of Stark HWHM values for spectral lines from doubly ionized O III spectrum have been established in four types of transitions. They confirm the correct form of the dependence of w on the upper-level ionization potential. It should be pointed out that the investigated spectral lines origin from the upper levels (i) whose energies lies in the wide energy interval (ΔE_i) :2.83 eV; 1.126 eV, 1.006 eV and 0.95 eV for the 3s - 3p, $2p^2\,3s$-$2p^2\,3p$, 3p - 3d and $2p^2\,3p$-2p2 3d transitions, respectively. The ΔE_i values is in order the magnitude of the plasma characteristics (kT) of the investigated plasma sources (kT; 2 eV - 4 eV).The minor scatter (within 15% accuracy) among reduced Stark HWHM values in the cases of the spectral lines that belong to the 3s-3p and $2p^2\,3s$-$2p^2\,3p$ transitions makes them applicatible in the plasma spectroscopy (Djeniže 1999).

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