MEASURED,CALCULATED AND ESTIMATED STARK WIDTH OF THE 381.135 nm O VI SPECTRAL LINE

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1. INTRODUCTION

Spectral lines of multiply ionized emitters, like O VI, were discovered in the spectra of stellar atmospheres of hot stars (Bruhweiler 1985; Kostyakova 1981).Thus, the necessity of knowledge of Stark widths of these lines was imposed. 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 electron density (N),important in the modeling of the stellar atmospheres (Lesage 1994) or other laboratorical plasmas (Griem 1974).After Hubble space telescope was launched to orbit, the UV radiation detection has became reality. It is of interest to find intensive spectral lines with well-known Stark width values, convenient in a plasma diagnostics. In this view, the 381.135 nm O VI spectral line would be recommended for a plasma diagnostics. Namely, the existing measured, calculated and estimated Stark width values of this line shows mutually agreement in a wide range of the electron temperatures.

2. MEASUREMENTS

Three experiments deal with the Stark width investigation of the 381.135 nm O VI spectral line. This was measured by Böttcher et al.(1988) at 145 000 K electron temperature, and by Glenzer et al. (1992) for an electron temperatures compused between 90 000 K and 200 000 K. Measurements of Blagojević et al.(1999) were realized in the temperature range between 61 900 K and 79 700 K. The observed electron densities in the mentioned experiments lies between 0.86 10^{23} m^{-3} and 24 10^{23} m^{-3}.

3. CALCULATIONS

The previous calculation the Stark width values of the 381.135 nm.O VI spectral line was performed by Dimitrijević & Konjević on the basis of the simplified semiclassical approximation after Griem (1974) (GM) and of the modified semiempirical formulae (SEM) (Dimitrijević & Konjević 1980). Seaton's calculations, using the close-coupling theory (CC),have been presented in 1988. Böttcher et al.(1988) have calculated the Stark width value of this line at 145 000 K electron temperature using the impact and classical path approximations (Hey & Breger 1980,1982) and Baranger's (1962) theory for nonhydrogenic ions.Blagojević et al.(1999) have calculated the newly values of the Stark widths in a wide range of the electron temperatures (20 000 K - 300 000 K) in the semiclassical perturbation formalism (SCPF) (Sahal-Bréchot 1969a, 1969b). This is a extension the calculations performed by Dimitrijević & Sahal-Bréchot (1992).

4. ESTIMATIONS

The simplest way to estimate the value of a Stark HWHM (w) is to use established regularities of w along the isonuclear (INS) isoelectronic (IES) sequences for given type of quantum transition. It was found (Djeniže et al.1988 ; Purić et al.1988) that a simple analytical relationship may exist, for same transition, between w and the corresponding upper-level ionization potential (I) of a particular spectral line.The found relationship, normalized to a $N = 10^{23}$ m^{-3} electron density, is of a form:

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

The upper-level ionization potential I (in eV) and net core charge z (z=1,2,3,4,... for neutral, singly, doubly, triply,... ionized atoms, respectively) 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. In the case of the lithium-like isoelectronic sequence (IES) (Li I, Be II, B III, CIV, N V, O VI, F VII, Ne VIII) for the 3s - 3p transition, this dependence is expressed (Purić et al.1988) as :

$$w(rad/s) = 5.31x10^{14}\ z^2\ T^{-1/2}\ I^{-1.74} \quad . \qquad (2)$$

In the case of the oxygen isonuclear sequence (INS), (O I, O II, O III, O IV, O V, O VI, O VII, O VIII), for the 3s - 3p transition, the following form was found (Djeniže & Labat 1996,and references therein):

$$w(rad/s) = 6.6\ x10^{13}\ z^2\,T^{-1/2}\ I^{-1.15} \quad . \qquad (3)$$

Using the Eqs.(2-3) it is possible to predict the Stark width values for: z = 1,2,3,4,5,6,7 at various electron temperatures. The estimated Stark FWHM (2w) values of the 381.135 nm O VI (z=6) spectral line are presented in Tab.1. The necessary atomic data were taken from Wiese et al.(1966).

$T(10^3 K)$	INS	IES	$T(10^3 K)$	INS	IES
40	0.0180	0.0135	110	0.0109	0.0082
50	0.0161	0.0122	120	0.0104	0.0078
60	0.0147	0.0111	130	0.0100	0.0075
70	0.0136	0.0103	140	0.0096	0.0073
80	0.0128	0.0096	150	0.0093	0.0070
90	0.0120	0.0091	200	0.0081	0.0061
100	0.0114	0.0086	300	0.0066	0.0050

Table 1

Estimated Stark FWHM values (2w in nm) on the basis of the regularities along a isonuclear (INS) and isoelectronic (IES) sequences at various electron temperatures and 10^{23} m^{-3} electron density.

5. DISCUSSION

In order to make easy comparison among measured, calculated and estimated Stark width values, in the Fig.1, the dependence of 2w (FWHM) values on the electron temperatures is given. Theoretical values present only electronic contribution to the Stark width, because the ion contribution is negligible (Blagojević et al. 1999).

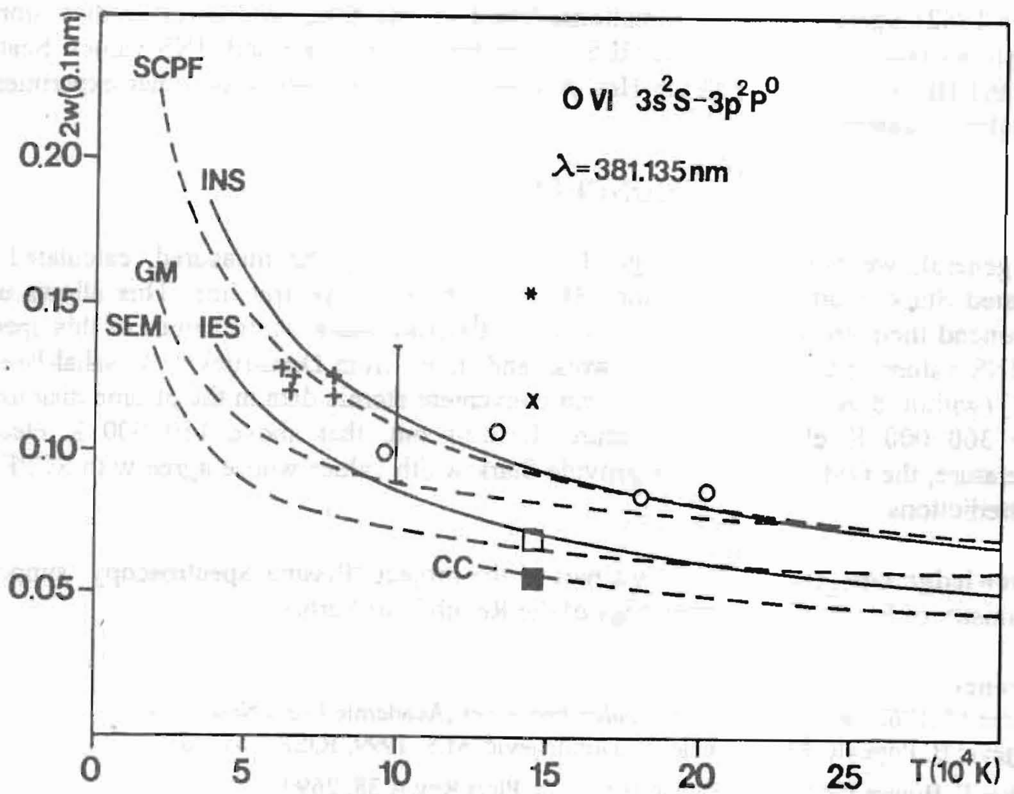

Fig.1
Stark FWHM dependence on the electron temperature at 10^{23} m^{-3} electron density
Measured values: o,Glenzer et al.(1992),+ ,Blagojevic et al.(1999);*,Böttcher et al.(1988).Calculated values; ■,Hey & Breger (1980); □,Hey & Breger (1982); x,Baranger (1962). For other symbols see the text. Error bar corresponding to 20% uncertainties is given for indication.

It is evident that excellent agreement among calculated Stark width values (based on the semiclassical perturbation formalism, SCPF) and our estimated values (based on the isonuclear sequence, INS), exist in the wide range of the electron temperatures (40 000 K - 300 000 K). On the other hand, the existing experimental data agree, within a few percent of accuracies,with these calculated and estimated values. Only exception makes data from Böttcher et al.(1988).This lies above the all other Stark width values up to 60 % . Here would be pointed out, that the results of the: GM, SEM and Hey's calculations (□ in Hey &

Breger 1982) agree with the estimations, based on the Stark width regularities along a lithium-like isoelectronic sequence (IES).These lies under SCPF and INS values. Seaton's (CC) and Hey's determinations (in Hey & Breger 1980) are below the other experimental, calculated and estimated data.

6. CONCLUSION

In general, we noticed a very good agreement among the measured, calculated and estimated Stark width values of the 381.135 nm O VI spectral line. This allows us to recommend their use for plasma spectroscopy.Existing Stark width values of this spectral line: INS values in the Tab.1 in this work and those from Dimitrijević & Sahal-Brechot (1992) (within 8 % uncertainties) present convenient atomic data in the plasma diagnostics up to 300 000 K electron temperature. It turns out, that above 150 000 K electron temperature, the GM aproximation provide Stark width values whose agree with SCPF and INS predictions.

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