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TESTING OF SIMPLE FORMULAE FOR EVALUATION OF STARK WIDTHS

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1. INTRODUCTION

For evaluation of Stark broadening parameters one can use the so-called semiclassical approach or a fully quantum mechanical theoretical approach (see e.g. Griem, 1974 and references therein), which require elaborate calculations even for a single line. For large-scale calculations, when high accuracy for each particular line is not required, simple approximations with good average accuracy are very useful. Furthermore, these simple formulae do not require complete set of atomic data which are sometimes missing, in particular for some multiply ionized atoms and in this case sophisticated calculations of the Stark broadening parameter are not feasible.

The aim of this paper is to test two popular simple approaches for evaluation of Stark widths, simple semiclassical formula derived by Griem (1974, Eq. 526) and modified semiempirical formula by Dimitrijević and Konjević (1980). Estimated Stark widths will be compared with most comprehensive experimental results for doubly ionized inert gases (Konjević and Pittman, 1980). In order to determine eventual systematic discrepancies along homologous ions only analogous transitions are selected for comparison.

2. RESULTS AND DISCUSSION

Both approximate formulae, simplified semiclassical and modified semiempirical are described in detail elsewhere (Griem, 1974; Dimitrijević and Konjević, 1980). Atomic data for evaluation of Stark widths are taken from : Bashkin and Stonner (1975) and (1978), Persson *et al.* (1991) for NeIII, Bashkin and Stonner (1975) and (1978), Hansen and Persson (1987) for ArIII, Sugar and Musgrove (1991) for KrIII and Persson *et al.* (1988), Tauheed and Joshi (1993) for XeIII. The results of the comparison with experimental results w_m (Konjević and Pittman, 1980) are given in Tables 1 and 2 in the form of ratios w_m/w_G and w_m/w_{DK} where w_G and w_{DK} are theoretical results obtained from Griem's simplified semiclassical formula (Griem, 1974) and the modified semiempirical formula (Dimitrijević and Konjević, 1980), respectively. Experimental results in these tables are given normalized to the electron density Ne $=10^{17}$ cm^{-3}.

TABLE 1. Comparison of experimental w_m (Konjević and Pittman, 1980) and theoretical Stark widths evaluated from simplified semiclassical formula w_G (Griem, 1974, Eq. 526) and modified semiempirical formula w_{DK} (Dimitrijević and Konjević, 1980). Experimental results w_m are given normalized to the electron density 10^{17} cm $^{-3}$.

ION	Transition array	Multiplet	Wavelength [Å]	Temperature [K]	w_m[Å]	w_m/w_G	w_m/w_{DK}
Ne III	$2p^3 3s - 2p^3(^4S^0)3p$	$^5S^0 -^5P$	2593.60	34000	0.050	0.84	1.04
			2595.68	34000	0.050	0.84	1.05
		$^3S^0 -^3P$	2677.90	34000	0.065	0.92	1.21
			2678.64	34000	0.065	0.92	1.21
Ar III	$3p^3 4s - 3p^3(^4S^0)4p$	$^5S^0 -^5P$	3285.85	26000	0.144	0.82	1.07
			3311.25	26000	0.144	0.81	1.05
		$^3S^0 -^3P$	3514.18	27500	0.148	0.71	0.95
			3509.33	27500	0.160	0.77	1.03
Kr III	$4p^3 5s - 4p^3(^4S^0)5p$	$^5S^0 -^5P$	3351.93	25000	0.163	0.86	1.11
			3325.75	25000	0.163	0.87	1.12
		$^3S^0 -^3P$	3564.23	25000	0.167	0.72	0.95
Xe III	$5p^3 6s - 5p^3(^4S^0)6p$	$^5S^0 -^5P$	3950.59	27000	0.239	0.69	0.94
			3624.08	27000	0.223	0.84	1.04
		$^3S^0 -^3P$	3781.02	27000	0.240	0.71	0.98

TABLE 2. Same as for Table 1.

ION	Transition array	Multiplet	Wavelength [Å]	Temperature [K]	w_m[Å]	w_m/w_G	w_m/w_{DK}
Ne III	$2p^3 3s' - 2p^3(^2D^0)3p'$	$^3D^0 -^3 D$	2777.65	34000	0.054	0.78	1.03
		$^3D^0 -^3 F$	2613.41	34000	0.047	0.75	1.00
			2615.84	34000	0.047	0.76	1.00
Ar III	$3p^3 4s' - 3p^3(^2D^0)4p'$	$^3D^0 -^3 D$	3503.58	27500	0.148	0.77	1.02
			3499.67	27500	0.142	0.74	0.98
		$^3D^0 -^3 F$	3336.13	26000	0.143	0.78	1.02
			3344.72	26000	0.142	0.77	1.00
Kr III	$4p^3 5s' - 4p^3(^2D^0)5p'$	$^3D^0 -^3 D$	3474.65	25000	0.157	0.78	1.03
			3439.46	25000	0.157	0.80	1.05
		$^3D^0 -^3 F$	3191.21	25000	0.165	0.98	1.29
Xe III	$5p^3 6s' - 5p^3(^2D^0)6p'$	$^3D^0 -^3 F$	3583.65	27000	0.184	0.63	0.87
			3579.70	27000	0.191	0.66	0.91

Theoretical results for w_{DK} for KrIII lines in Tables 1 and 2 are taken from Konjević and Konjević (1994).

From the comparison of the experimental and theoretical results in Tables 1 and 2 one may conclude that both sets of theoretical results agree rather well (within estimated uncertainties of the experiment and theories) with experimental ones. However, the agreement with the modified semiempirical formula is better (with the average ratio $w_m/w_{DK} = 1.04$) than the semiclassical formula ($w_m/w_G = 0.79$). No systematic trend (increase or decrease of the ratio experiment/theory) along analogous transitions of the homologous sequence of doubly ionized inert gases can be detected.

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