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SOME REGULARITIES WITHIN THE STARK WIDTHS AND SHIFTS OF RESONANCE LINES OF SINGLY CHARGED IONS FROM HE TO CA

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The aim of this paper is to present noticed regularities of Stark broadening and shift parameters of resonance spectral lines of singly ionized atoms from helium to calcium.

The existence of certain regularities of Stark broadening and shift parameters of neutral spectral lines of homologous groups of elements was the basis for an assumption that similar regularities may be also found for ion spectral lines. A recently published paper by Puric et al./1/ has proved that Stark widths of alkali-like atom and ion resonances linearly depend on the atomic charge number Z. However, in a paper given by J.Puric and V.Glavonjić /2/ a periodicity of the dependence of Stark widths of resonance spectral lines of neutral and singly ionized atoms from He to Ca on atomic charge number Z has been noticed and discussed. As it was stated there, there is a lack both in theoretical and experimental data for a complete set of resonances for all ions from He to Ca. In order to complete as much as possible the set of the reliable theoretical data a new method for estimation of Stark widths and shifts of corresponding resonance lines, not given by Griem /3/, has been elaborated. The basis for this method were the expressions for Stark widths (w) and shifts (d) of ion lines given in the paper by S. Brechot and H.Van Regemorter /4/. Namely, they have found that w and d values linearly depend on $|X|^{2/5}$ and $|X|^{2/5}$ signX respectively. Actually, using available theoretical data given by Griem /3/ as well as experimental ones obtained by Puric and Konjević /6/ and Fleurier et al. /7/, it is possible to obtain graphs similar to those in Fig. 1 a and b. From these graphs the mentioned linear dependence of w and d is obvious (within 20%) for ns-n'p and np-n's transitions. Calculating $|X|^{2/5}$ for corresponding resonance lines and using Fig. 1.a and b one can get w and d values of the lines.

In order to check the above described estimation for theoretical calculation Griem's semiempirical formula for Stark widths with Gaunt factor $g=0.2$ was used in case of resonance spectral lines of all singly ionized atoms from He to Ca. The
estimated values from the trends similar to those given by Griem were consistently higher (up to 3 times) in comparison with those obtained from the semilempirical formula with \( g = 0.2 \). In order to avoid these discrepancies the Gaunt factor has to be corrected for the corresponding ion as it is given in Fig. 2. Namely, instead of taking \( g = 0.2 \) or even \( g = 0.9 - \frac{1.1}{z} \) as Kobzev /5/ has suggested one has to take approximately \( g = 0.9 \left( 1 - \frac{1}{z^*} \right) \) where \( z^* = 2 \) for singly charged ions, for all temperatures from 5000 K to 40 000 K in order to get data following the appropriate linear trend given in Fig. 1. a and b.

Finally Fig. 3. a and b show the dependences of \( w \) and \( d \) of the ionization potential \( I \) on the atomic charge number \( Z \). It is evident that \( w \) and \( d \) depend periodically on \( Z \) in a similar manner as the ionization potential does.

One can expect, generally, that the calculations now in progress will show that the established linear dependence of \( w \) and \( d \) on \( |X|^{5/2} \) and \( |X|^{5/2} \text{sign}_X \) respectively, and the corresponding periodical dependence on the atomic charge number \( Z \) are universal also for other heavier elements.

References
2. J. Purić and V. Glavonjić, SPIG, contributions, 273, Dubrovnik (1978)