ABOUT the DEPENDENCE of electron BINDING ENERGIES ON NUCLEAR CHARGE AND IONISATION STATE IN FREE IONS

Shpatakovskaya G.V.

Keldysh Institute of Applied Mathematics, Russian Academy of Sciences, Moscow, Russia,   
[shpagalya@yandex.ru](mailto:shpagalya@yandex.ru)

The analysis of the experimental and theoretical electron binding energies in all the elements of the periodic table from neon to uranium has been carried out in the paper [1]. The semi classical pattern in the Thomas-Fermi (TF) model for the analysis has been developed in the papers [2, 3]. As a result some ordering of electron levels in the closed shells of neutral atoms has been established. The ordering enables to construct the two independent on the atomic number *Z* functions , which one can use to estimate electron binding energies in an atom:

 (1)

In the report the approach [2, 3] is applied to analyze a dependence on the atomic number of electron binding energies in the free positive ions. The TF model and Bohr-Zommerfeld condition are used to determine the electron levels in the ion. The ion TF function  depends on the ionization state . Here  is the ion charge.

As a result the equation (1) is true for the ions too, the functions  depending on the parameter. The analysis of the s-state levels for demonstrates both an atomic number *Z*- and ionization state scaling in the ion closed shells. The last one appears in presence of the common part in the curves  for the different values .

To verify the similar regularities in the results of more expanded quantum-mechanical models the binding energies  in some free ions of the elements from neon to barium calculated by the model MCDF [4] are analyzed. It is shown that the obtained pairs of values  and  have the functional dependence in the ion closed shells. It means some similarity under discussion displays. The scaling property is offered to use for the energy eigenvalue estimations as initial values in more exact computations.

This work was supported in part by the Russian Foundation for Basic Research (project no. 17-01-00207).

References

1. Karpov V.Ya. and Shpatakovskaya G.V. About atomic number scaling of electron binding energies of the closed shells in elements of periodic table. JETP, 2017, **151**, issue 2 (in print).
2. Karpov V.Ya. and Shpatakovskaya G.V. Semiclassical calculation of electron spectra in atoms through two universal functions. Book of abstracts. XLIII International Zvenigorod Conference on Plasma Physics and Controlled Fusion. February 8-12, 2016. P. 196
3. G.V.Shpatakovskaya and V.Ya.Karpov, Atomic number scaling in the free atoms. Journal of Physics: Conference Series, ELBRUS-2016 (in print)
4. [http://www.dreebit.com/tl\_files/dreebit\_metro/images/dreebit/downloads/tutorial\_electron binding\_energies2.pdf](http://www.dreebit.com/tl_files/dreebit_metro/images/dreebit/downloads/tutorial_electron%20%20binding_energies2.pdf)