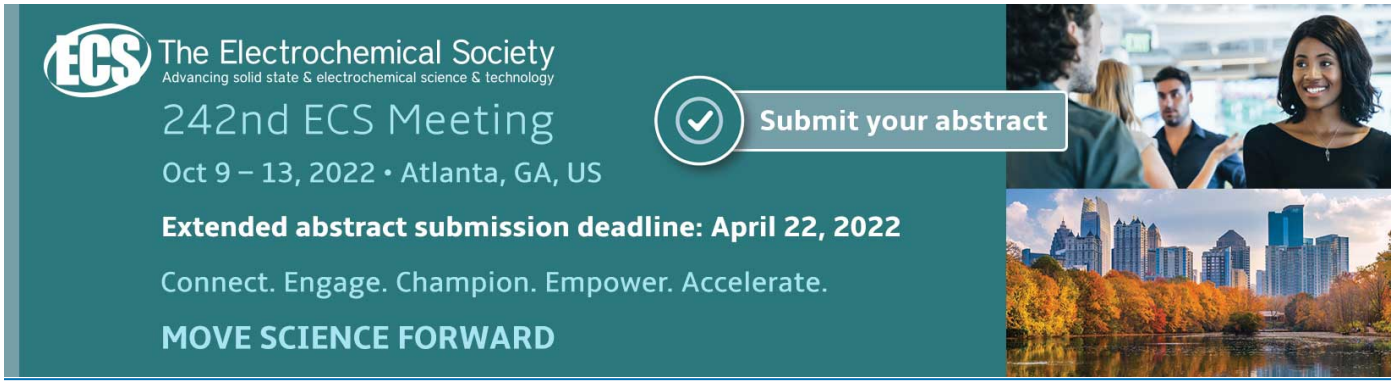
Double photoionization of He isoelectronic sequence



Double photoionization of He isoelectronic sequence

J Koncevičiūtė[1] * **and V Jonauskas**[1] †

[1]Institute of Theoretical Physics and Astronomy, Vilnius University, Saulteko av. 3, LT-10257 Vilnius, Lithuania

Synopsis Double photoionization of He-like ions is investigated using a few-step approach, that treats direct double photoionization as a sequence of two- (photoionization-ionization) and three-step (photoionization-excitation-ionization) processes.

The emergence and advancement of attosecond science provide the fastest time resolutions, corresponding to the timescale for electron motion in atoms [1], thus enabling oservation of a rapid response of electron in atoms to light waves, and electronic correlations.

To interpret the results of such experiments theoretical methods capable to describe the dynamics of a few-electrons systems are needed. Direct double photoionization is of greatest interest among these processes. This process cannot occur without electron correlations therefore it is thought that it cannot be treated perturbatively.

The aim of this work is to apply a few-step approach [2] to study double photoionization of the ground states of He-like ions with Z up to 10. This method treats direct double photoionization as a sequence of two- (photoionization-ionization) and three-step (photoionization-excitation-ionization) processes, thus simplifying the solution of the complex three-body Coulomb problem. This method requires relatively low computational resources and it has already been proved successful in the study of direct double ionization process for light ions. Therefore it is of great practical importance.

Flexible atomic code, which implements the Dirac-Fock-Slater approach, has been applied to calculate energy levels, radiative transition probabilities, as well as electron-impact excitation and single ionization cross sections. Electron-impact excitation and single ionization processes were investigated using the distorted-wave approximation. Coulomb (CG) and Babushkin (BG) gauges were used for the radiative transition calculations.

For He it is shown that the better agreement with experimental results is achieved when Coulomb gauge is used for the radiative transition calculations. Though positions of the peaks of obtained theoretical crossections correspond to that of experimental results, both gauges give significantly lower results at the peak. Similar tendency has been observed for other studied He-like ions.

In order to achieve better agreement with experimental results, theoretical cross sections were scaled to experimental ones. Scaling factors were obtained by a least squares method. It has been shown that scaling factors for CG and BG converge with increasing ionisation stages of investigated He-like ions.

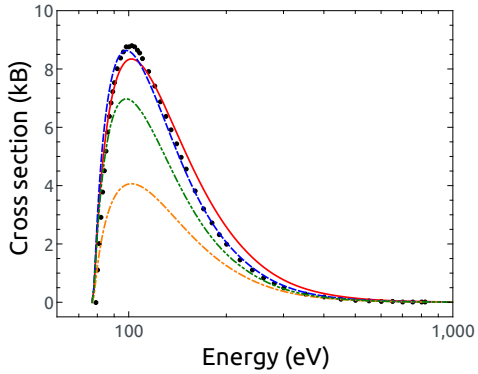


Figure 1. Double photoionization cross section of He. Solid line (red): scaled BG; long-dashed line (blue): scaled CG; pointed-dashed line (orange): BG; double-pointed-dashed line (green): CG; black points: experiment [3]

References

[1] Kim K T *et al* 2014 *Nat. Photon.* **8** 187
[2] Jonauskas V *et al* 2014 *Phys. Rev. A* **89** 052714
[3] Samson J A R *et al* 1998 *Phys. Rev. A* **57** 1906

*E-mail: jurgita.konceviciute@tfai.vu.lt
†E-mail: valdas.jonauskas@tfai.vu.lt