

Evaluation of the probabilities of single and double photoionization of helium atom by trajectory method

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Synopsis Capabilities of new trajectory-based method are demonstrated in calculation of single- and double-photoionization probabilities in helium atom. The method is suitable for wide range of field strengths and reproduces effects, attributed to electron-electron correlations.

The study of photoionization as a fundamental process is especially relevant in connection with development of ultrafast strong field radiation sources. Because of complexity of the theoretical description of the processes in atoms under the exposure of strong pulses, the study and the development of appropriate theoretical methods is very important. In spite of the progress in theory many interesting features of these processes are difficult to reproduce by means of the existing theoretical methods. It concerns, for example, the effects of electron-electron correlations. Rather popular in this connection are trajectory-based methods.

In previous works we developed the trajectory method for evaluating transition probability in quantum system [1]. Here we demonstrate capabilities of the new variant of our method using Weyl symbols of initial and final states in calculating probabilities of single- and double-photoionization of helium atom.

The calculation of the Weyl symbols for the groups of states, for example for the entire ionization continuum, is rather difficult even for the hydrogen atom. For this reason some simple models of final distributions were used. In spite of simplicity these models have given rather good results.

For example, photoionization probability dependence on electric field strength is shown in figure 1, where line 1 – total ionization probability, 2 – single ionization probability, 3 – double ionization probability. The lines 4, 5, 6 – the same values from [2]. Field parameters are the same as in work [2]. Our results correlate well with calculation of [2] and with our calculations based on previous

variant of method [1]. Maximal discrepancy (about factor 2) we have for single-photoionization probability at very strong field, where saturation is observed.

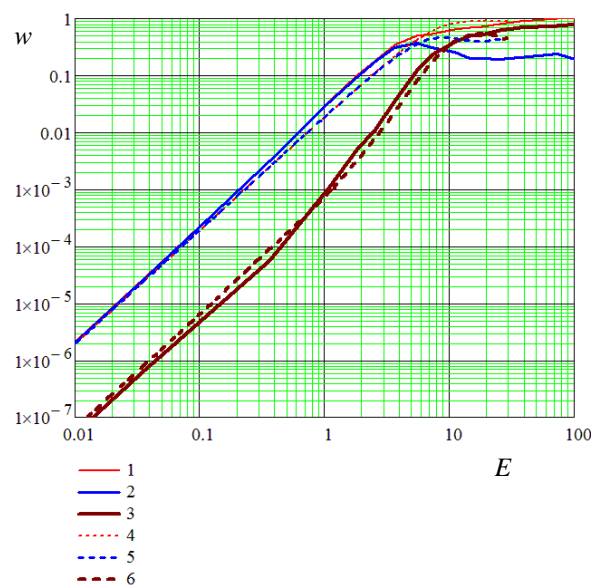


Figure 1. Photoionization probabilities dependence on electric field E (atomic units)

Gained results show that method works in wide range of the field strengths. It reproduces effects attributed to electron-electron correlations, such as stabilization of an atom in intense laser field [2].

References

- [1] Bichkov A.B., Smirnov V.V. 2013 *Laser Phys.* **23** 055302
- [2] Birkeland, *et al.* 2010 *Phys. Rev. Lett.* **104** 163002

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