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Correlation in double ionization of He by ultrashort pulses[1]

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Double ionization of helium has long been of considerable interest in atomic physics since it provides insight into the role of electronic correlation in the full three-body Coulomb break-up process, which is of fundamental importance for the understanding of the dynamics in more complex atoms. The recent availability of attosecond XUV pulses allows to directly probe and possibly control the temporal structure of the ionization process. We have implemented an ab initio simulation of the interaction of ultrashort laser pulses with a helium atom. The wave function is represented in a time-dependent close-coupling (TDCC) scheme and time integration is performed utilizing the Arnoldi-Lanczos method. The spatial discretization employs an FEDVR basis, which lends itself to effective parallelization. We will present results on two-photon double ionization of He by ultrashort pulses over a wide range of photon energies. At low energies only non-sequential double ionization is possible (where both electrons share the energy of the photons, and consequently have to be ionized within a short period). For photon energies above 54.4 eV (the ionization potential of the He^+ ground state), sequential double ionization is allowed. This process proceeds in two steps – single ionization of He followed by ionization of the remaining He^+ ion. By using attosecond XUV pulses, these two separated stages of the sequential process are confined to within a short time interval of each other. We show that the angular distributions of the emitted electrons reveal the signature of a non-sequential process under the condition that sufficiently short pulses are used, while for longer pulses the sequential process completely dominates. The correlation time for double ionization can thus be directly observed using attosecond XUV pulses. This work was performed in collaboration with S. Nagele, R. Pazourek, E. Persson, B. I. Schneider, L. A. Collins, and J. Burgdörfer.

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