Double ionization of He by ion impact: correlation factors

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Synopsis The Continuum Distorted Wave-Eikonal Initial State approximation for H^+, He^{2+} and Li^{3+} ions impacting on He targets is used to study double ionization processes from the intermediate to high projectile energy range. Transition probabilities and absolute cross sections for double ionization channel are calculated taking into account the final state electron-electron correlation in the framework of the Gamov factor and the repulsive Coulomb wave formalisms. Results are compared with previous calculations and recent experimental data.

Collisions of bare ion projectiles impacting on He atoms are the simplest systems for investigation of single and multiple electron transitions. The study of these collisional systems is crucial to fully understand the mechanisms underlying these basic reactions. Moreover, they are of interest in several fields such as heavy-ion therapy [1], thermonuclear fusion [2], hot plasmas [3].

In this work, double ionization process of He targets impacted by H^+, He^{2+} and Li^{3+} projectiles are analyzed theoretically in detail at intermediate and high collision energies. Absolute cross sections for these processes are obtained by computation of transition probabilities as a function of the impact parameter in the framework of the Continuum Distorted Wave-Eikonal Initial State theory (CDW-EIS) [4]. Roothaan–Hartree–Fock (RHF) wavefunctions [5] were used to represent the atomic states of He. In order to take into account the electron-electron correlation in the final state we employ the Coulomb density of states (Gamov factor) and the repulsive Coulomb wave formalisms [6].

The results are compared with other theoretical calculations and available experimental data. Since double ionization is a reaction that contributes to the frequently measured net cross sections, it is very important to consider, in the final channel, the electron correlation in multiple processes to shed light on each pure electron process.

The developed method for calculation of double ionization allows to study both more complex atomic and molecular targets, which can be used to investigate molecular fragmentation mechanisms.

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