Relativistic evaluation of inner-shell vacancy-production probabilities in low-energy ion-atom collisions

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The previously developed relativistic technique for evaluation of charge-transfer and electron-excitation processes in low-energy ion-atom collisions [1,2] based on active-electron approximation is extended for describing many-electron processes. The method employs the independent particle model, where the effective many-particle Hamiltonian is approximated by a sum of single-particle Hamiltonians reducing the electronic many-particle problem to a set of single-particle equations for all electrons in the collision system. The many-electron wave function is constructed from Slater determinants with single-electron wave functions. Time-dependent single-particle equations are solved using the coupled-channel approach with atomic-like Dirac-Fock-Sturm orbitals, localized at the ions (atoms). Interaction with other electrons is effectively described by the screening density-functional theory potential. Many-particle probabilities are calculated in terms of single-particle amplitudes employing the formalism of inclusive probabilities [3,4]. The developed method is applied to evaluations of the probabilities of many-particle processes. In particular, the K-vacancy-production probability in the Ne–F⁺⁺(1s²2s) collision at the projectile energies 230 keV/u and 530 keV/u is investigated in details and compared with experimental data and calculations based on the one-active-electron approximation [1]. The K-vacancy production probability is also calculated for the Xe–Xe⁵¹⁺(1s²2s) collision. The role of the relativistic effects is analyzed.

References:


