Hermite spline-based approach to calculations of charge transfer probabilities in heavy-ion collisions

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Low-energy heavy-ion collisions can be utilized as a unique tool for study of quantum electrodynamics effects in extremely strong electromagnetic fields [1]. Investigation of such effects requires the numerical methods for description of various processes in heavy-ion collisions.

In the present work we developed a new method for calculations of charge transfer probabilities in collisions of a one-electron ion with a bare nucleus. The approach is based on solving the time-dependent two-center Dirac equation using the finite basis set of cubic Hermite splines on a uniform grid. The Dirac equation is considered in the rotating reference frame that allows using a two-dimensional grid instead of a three-dimensional one.

The collision of $U^{91+}(1s)$ (as a target) with U^{92+} (as a projectile) was considered at the projectile energy E = 6 MeV/u. The charge transfer probabilities were calculated in a wide range of the impact parameter employing the developed method. The results are in a good agreement with the corresponding values of Ref. [2] where the calculations were performed by another method.

References:

[1] W. Greiner, B. Mueller, J. Rafelski, Quantum Electrodynamics of Strong Fields, Springer-Verlag, Berlin, (1985).

[2] I.I. Tupitsyn, Y.S. Kozhedub, V.M. Shabaev, G.B. Deyneka, S. Hagmann, C. Kozhuharov, G.Plunien, and Th. Stoehlker, Phys. Rev A 82, 042701 (2010).