Convoluted quasi-Sturmian basis in Coulomb three-body problems

S. A. Zaytsev, G. Gasaneo, L. U. Ancarani,
M. S. Aleshin, J. A. Del Punta, M. J. Ambrosio

A formalism equivalent to the First Born Approximation has been recently proposed to treat the double ionization of helium by high-energy electron impact. The four-body problem is reduced to a three-body one where the dynamics of the two ejected electrons of coordinates is described by the driven equation. We solve this driven equation by an expansion into a basis set of two-particle functions which are calculated by using recently introduced so called quasi-Sturmian (QS) functions. QS functions satisfy a two-body non-homogeneous Schrödinger equation with a Coulomb potential and an outgoing-wave boundary condition. Specifically, the two-particle basis functions are obtained, by analogy with the Green's function of two non-interacting hydrogenic atomic systems, as a convolution integral of two one-particle QS functions. We also propose the integration path which is useful for numerical calculations of this integral representation. Note that by construction, these basis functions look asymptotically (as $\rho \to \infty$) like a six-dimensional outgoing spherical wave. On the other hand, the basis functions asymptotic behavior in the so called three-body region Ω_0 where all three particles are well separated is not correct since they miss out the phase factor, corresponding to the Coulomb e-e interaction. Nevertheless, we expand the solution in terms of these two-particle basis functions and explore the expansion convergence properties. It is very surprising, in view of the fact that the equation is non-compact on the basis set, that the convergence is achieved in our calculations. The results are in agreement in shape, but not in magnitude, with the experimental data.