Ab initio scattering calculation in three-body Coulomb systems: $e^+ - \mathrm{H}$, $e^- - \bar{\mathrm{H}}$ and $e^+ - \mathrm{He}^{+*}$

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We present the results of our detailed calculations of scattering characteristics in the systems $e^+ - \mathrm{H}$, $e^- - \bar{\mathrm{H}}$ and $e^+ - \mathrm{He}^+$ with zero total angular momentum. We calculate all possible cross-sections in the low-energy region which admits up to seven open channels including the rearrangement channel of the positronium formation. All resonances of the $\mathrm{e}^+ - \mathrm{H}$ ($e^- - \bar{\mathrm{H}}$) system obtained and approved previously by a number of authors [1, 2, 3] are clearly reproduced in the calculated cross sections, which demonstrates that our results are highly accurate and consistent. In the cross sections of the $\mathrm{e}^+ - \mathrm{He}^+$ system we see no sign of resonances reported in papers [4, 5]. Alternatively, the exterior complex scaling approach has been used for calculating resonant energies in the $\mathrm{e}^+ - \mathrm{H}$ and $\mathrm{e}^+ - \mathrm{He}^+$ systems.

The three-particle multichannel Coulomb scattering problem with rearrangement channels is treated by the potential splitting approach [6] incorporated into the framework of Faddeev-Merkuriev equations [FME] [7]. In contrast to [8] where the integral equations formalism has been used, we operate with the differential form of the FME. Coulomb potential splitting into the long-range tail part and the short-range core part is performed in two-body configuration space, reducing the number of FME splitting parameters [9] drastically. For this kind of splitting procedure we have developed a method of fine tuning the splitting radius in order to optimize the calculations for the given energy region. Using the FME allows us to produce results that are uniformly accurate for elastic scattering, excitations, relaxations and rearrangements.

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