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Nonrelativistic energy spectra of three-particle systems calculated in the adiabatic approach by using finite difference method

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Precise spectroscopy of light atomic and molecular systems gives us new insides in the fundamental laws and physical constants of nature [1]. In particular, exotic atoms like antihydrogen and antiprotonic helium could also allow comparison between matter and antimatter characteristics and test of CPT symmetry [2]. From theoretical point of view, development of very accurate techniques like adiabatic and variational methods give us the tools to compute different atomic quantities with high precision [3].

Here, we present accurate calculations of nonrelativistic energy levels of three-particle systems, like for example $\bar{p}He^+$, in adiabatic approximation. In our approach, the electronic wavefunctions are computed by using two-dimensional finite difference method (FDM) and the radial wavefunctions are obtained by solving a system of eigenvalue problems [4] by iterative application of one-dimensional FDM. We analyze the results of using the method with Cartesian and logarithmic stencils and different number of node points. We show that the level of precision allows our results to be used in computations of leading relativistic corrections to transition spectra of these systems and accurately determining the effects of interactions with external fields. A comparison with other computations of light atomic systems' energy spectra has been made and the advantages and disadvantages have been assessed.

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