Diatomic systems containing antihydrogen

V. Sharipov[a], L. N. Labzowsky[b], and G. Plunien[c]
[a] *Institute of Physics, St. Petersburg State University, 198904, Uljanovskaya 1, Petrodvorets, St. Petersburg, Russia*
[b] *Petersburg Nuclear Physics Institute, 188350, Gatchina, St. Petersburg, Russia*
[c] *Technische Universität Dresden, Mommsenstrasse 13, D-01062, Dresden, Germany*

Experimental success in production of antihydrogen ($\bar{\mathrm{H}}$) atoms [1], [2] has stimulated investigations of atom-$\bar{\mathrm{H}}$ systems. The $\bar{\mathrm{H}}$ atoms were produced in experiments in Rydberg (highly excited) states. Thus, it is important to develop a plausible description of excited states of atom-$\bar{\mathrm{H}}$ systems. This description for a several particle system is presented being applied to the hydrogen-antihydrogen [3], [4] and helium-antihydrogen quasimolecules [5].

Within the adiabatic approximation potential energy curves and the leptonic part of the wave functions corresponding to different values of leptonic orbital angular momentum projection onto the internuclear axis are calculated employing Ritz variational principle. Adiabatic corrections to the leptonic potentials are also obtained. Basis functions are constructed as products of explicitly correlated Gaussians and spherical harmonics which describe correctly the motion of leptons with arbitrary orbital angular momentum projection onto the molecular (internuclear) axis. The hadronic part of the wave function for each leptonic level of the hydrogen-antihydrogen and helium-antihydrogen systems is calculated by solving the Schrödinger equation with the obtained leptonic potentials. Corresponding solutions are generated utilizing precise B-spline representations. Employing leptonic and hadronic parts of the wave function and obtained potential curves a complex non-local optical potential in the form proposed in [6] is constructed. This potential describes non-adiabatic effects which can take place in atom-$\bar{\mathrm{H}}$ system, namely the ejection of the positronium atom. With calculated wave functions the electron-positron and proton-antiproton annihilation rates are computed for a number of quasimolecular states. The positronium ejection decay rates are also computed for the quasimolecular levels under consideration. The existence of metastable states with lifetime about few μsec is predicted in He-$\bar{\mathrm{H}}$ quasimolecule.

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