Computing Binary Scattering and Breakup in Three Body System

S.L. Yakovlev, P.A. Belov

Department of Computational Physics, Saint Petersburg State University, Saint Petersburg, Ulyanovskaya Str. 1, 198504, Russia

Two methods for solving the three body scattering problem for energies above the breakup threshold are presented. The configuration space three body Faddeev equation has been chosen for the basis of the computational algorithms. One of the methods is based on the traditional combination of the finite difference and spline approximations of the solution. The asymptotic boundary conditions are represented in the form of the hyper spherical adiabatic expansion. This expansion is constructed in such a way that the binary channel and breakup channel are orthogonal at any large but finite values of the hyper radius. This property allows using the asymptotic value of the Faddeev component as the boundary value for the Faddeev equation. Solving this boundary value problem at the sequence of extended hyper radii leads to the subsequent set of the binary amplitudes and breakup amplitudes. The convergence is guaranteed by the appropriate choice of mesh parameters and by the properly chosen number of basis functions in the hyper spherical adiabatic expansion.

The second method uses the exterior complex rotation method for solving the inhomogeneous Faddeev equation. If the incoming wave is subtracted from the Faddeev component the rest obeys the inhomogeneous equation and asymptotically behaves as the outgoing spherical waves. In this case the rotation of the hyper radius in the upper complex half plane leads to the exponential decrease of outgoing spherical waves. As the result, the scattering problem can be reformulated as the problem of solving the inhomogeneous Faddeev equation with homogeneous zero boundary conditions at large values of hyper radius. The binary and breakup amplitudes can then be computed from the appropriate integral representations.

Both methods are applied for solving the n-d scattering problem above the breakup threshold. For the s-wave scattering the binary and breakup amplitudes have been calculated for states with the total spin S=1/2, 3/2.

All the calculations have been done with the supercomputing facilities of the Computational Resources Center of SPbSU.