Democratic and Nondemocratic Motion of Three Clusters with the Hyperspherical Harmonics

Yu.A. Lashko, **G.F. Filippov**, **V.S. Vasilevsky**

Bogolyubov Institute for Theoretical Physics, 03143 Kyiv, Ukraine

The Hyperspherical Harmonics method (HH) enjoys wide application in solving problems of nuclear, atomic and molecular physics in the framework of quantum mechanics. In particular, during the last decades this method have been intensively used to study bound and continuous spectrum states of three- and four-cluster systems.

This report is devoted to study ability of the hyperspherical harmonics to describe different scenarios of decay of the compound system, which is assumed to consist of three interacting clusters. More specifically, we are going to study how many hyperspherical harmonics is required to describe correctly decay of the compound system into the binary channels, provided that two clusters makes a bound state.

All the results presented here is obtained within a microscopic three-cluster model that takes into account the internal structure of the interacting clusters, correctly treats the Pauli principle and relays on a complete set of the oscillator functions to describe relative motion of clusters. Within the model we consider a number of nuclei with a prominent three-cluster structure and with two-cluster decay channels whose threshold energy is lower than the three-cluster threshold. Namely, we study the following nuclei: ^{7}Li$= \alpha + d + n = \alpha + t \bigoplus^6Li+n$, ^{8}Be$= \alpha + t + p = \alpha + \alpha \bigoplus^6Li+p$ and ^{10}Be$= \alpha + \alpha +^2 n =^8Be+^2 n \bigoplus^6He+\alpha$.

To avoid very disputable and complicated matter about proper boundary conditions, we used simple but efficient way of investigation of many-channel three-cluster systems. We constructed matrix elements of a microscopic hamiltonian between many-body oscillator functions, and then calculated eigenvalues and eigenfunctions of the hamiltonian matrix. The eigenvalues represent bound states (if the corresponding energy is below the lowest two-cluster threshold) and pseudo-bound states in two-body continuum (if energy of the states is above the two-cluster threshold, but below three-cluster threshold) or three-body continuum (when the energy exceeds the energy of three-cluster threshold).

We concentrated our attention on bound and pseudo-bound states in two-body continuum. It was demonstrated that very restricted number of the hyperspherical harmonics is required to describe bound states below two-body threshold or the states in two-body continuum. The eigenstates of three-cluster hamiltonian, which lie below three-cluster threshold, were shown to have a proper asymptotic form for bound states or the states decaying into two fragments.