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STRUCTURE OF HYPERNUCLEUS $^{7}_{\Lambda}$Li WITHIN THE THREE-CLUSTER MODEL

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Structure and nuclear reactions in hypernuclear systems are highly relevant at present. The increased amount of new experimental data over the past decades supports such interest in these objects. The interaction of the Λ particles with nucleons is responsible for forming light and weakly bound hypernuclei. Among them is the $^{7}_{\Lambda}$Li hypernucleus. One of the interesting features of $^{7}_{\Lambda}$Li is that it has reached the spectrum of bound states (four bound states) among other light hypernuclei. Recall that the ordinary ^{7}Li nucleus has only two bound states. Besides, in an experiment [1] the bulk properties of this nucleus have been studied and it was found that a significant decrease of the size of the $^{7}_{\Lambda}$Li hypernucleus occurred when the Λ hyperon was added to a weakly bound nucleus, such as ^{6}Li. As the Λ particle is not a subject to the Pauli principle, it can be located in the center of the nucleus, attracting the surrounding nucleons to itself. This, in turn, leads to the compression of the $^{7}_{\Lambda}$Li nucleus.
In our work, we study the bound and resonant states of the $^{7}_{\Lambda}$Li hypernucleus within the three-cluster model [2], which uses several three-cluster configurations and oscillator functions to expand wave functions of the inter-cluster interaction. To describe inter-cluster motion and to numerate channels of the three-cluster system, we use hyperspherical coordinates and a large set of hyperspherical harmonics. To achieve a more correct description of the nucleus under study, two three-cluster configurations of the $^{7}_{\Lambda}$Li nucleus were involved in the calculations: ^{4}He + d + Λ, ^{3}He + ^{3}H + Λ. These configurations allow a more accurate description of the structure of the $^{7}_{\Lambda}$Li hypernucleus and the dynamics of its cluster-cluster interaction, such as Λ+^{6}Li, d+$^{5}_{\Lambda}$He, ^{4}He+^{3}H. In our calculations, we use the Hasegawa-Nagata nucleon–nucleon potential [3] and the YNG nucleon–hyperon potential [4], which enables us to correctly reproduce the interaction of nucleons with nucleons and nucleons with the Λ hyperon.
We calculated energies and wave functions of bound states of $^{7}_{\Lambda}$Li, and determined those channels that give the maximal contribution to the wave function of these states. We also determined the mass root-mean-square radii of the bound states, which indicate that the hypernucleus $^{7}_{\Lambda}$Li is more compact than the ordinary nucleus. The calculated correlation functions provided information about the most probable relative positions of the interacting clusters. The weights of the functions of a fixed oscillator shell in the wave functions of the bound states of $^{7}_{\Lambda}$Li unambiguously demonstrate that the lambda hyperon can be located inside the nucleus ^{6}Li with significant probability. It is also demonstrated that our model reasonably well reproduces existing experimental data for the energies of bound states.
We also studied the phase shifts of so-called 3-to-3 scattering, which describe processes in a three-cluster continuum, and found several resonance states that decay into three fragments (clusters). These results can be considered a prediction of the existence of narrow resonance states and can be used for planning future experiments.

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