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ON INTERACTION OF LAMBDA HYPERON WITH LIGHTEST NUCLEI IN TWO-CLUSTER MODEL

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The study of reaction dynamics in nuclear and hypernuclear systems is one of the most interesting and relatively new areas of modern nuclear physics and astrophysics. Numerous experimental and theoretical investigations in this area provide a deeper understanding of the properties of dense nuclear matter, as well as the structure of unusual objects in interstellar space, such as neutron stars. In this respect, the peculiarities of interaction between a hyperon and a nucleon are of significant particular importance. Recall that hyperons are baryons containing one or more strange quarks, and their interaction with nucleons has a significant impact on the internal structure of high-density matter, including neutron stars. Depending on the characteristics of the strength of this interaction, a neutron star may become a hyperon star, or a kaon condensate is more likely to form inside it. These facts stimulate the applications of different theoretical models to understand the structure of light hypernuclei and their interactions.
This research is devoted to the study of discrete and continuous energy spectra of the lightest hypernuclei — ${}^{2}_{\Lambda}$H, ${}^{3}_{\Lambda}$H, ${}^{4}_{\Lambda}$H, and ${}^{5}_{\Lambda}$He. These hypernuclei were considered as two-cluster configurations: Λ+p, Λ+d, Λ+^{3}H, and Λ +^{4}He, respectively. We also studied ordinary nuclei ^{2}H, ^{3}H, ^{4}H, and ^{5}He formed by interaction of neutrons with protons, deuterons, and nuclei ^{3}H and ^{4}He, respectively. This allows us to reveal and understand peculiarities of the hypernuclei. To describe such nuclei and hypernuclei, we employ the algebraic version of the resonating group method (RGM) [1]. This method is based on solving the Schrödinger many-particle equation in matrix form by using the basis of orthonormal oscillator functions.
In the present study, the Hasegawa-Nagata potential [2] and the YNG potential [3] were used to describe nucleon–nucleon and hyperon-nucleon interactions, respectively. The present model with such potentials allows us to correctly describe the energy of bound states of hypernuclei ${}^{3}_{\Lambda}$H, ${}^{4}_{\Lambda}$H, and ${}^{5}_{\Lambda}$He. Our analysis confirmed that there is no bound state in the ${}^{2}_{\Lambda}$H hypernucleus, since the weak interaction of the lambda hyperon with the proton and neutron. We determined the mass root-mean-square radius and average distance between the lambda hyperon and the s-shell nucleus. These quantities indicate that the hypernuclei of interest are weakly bound systems with a large distance between the lambda hyperon and the nucleus. It was found that ${}^{2}_{\Lambda}$H, ${}^{3}_{\Lambda}$H, ${}^{4}_{\Lambda}$H, and ${}^{2}_{\Lambda}$He, contrary to ordinary nuclei, have no resonance states in the two-cluster continuum.
The results obtained in this work will be used to study hypernuclei ${}^{6}_{\Lambda}$Li, ${}^{7}_{\Lambda}$Li, and ${}^{8}_{\Lambda}$Li within a three-cluster microscopic model.

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