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The effect of phenomenological $\Lambda\alpha$ potentials in ${}_{\Lambda\Lambda}^6\text{He}$ hypernuclei by using modern $\Lambda\Lambda$ potential derived from lattice QCD

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Abstract

Recently, the $\Lambda\Lambda$ potential at nearly physical quark masses has been calculated in the lattice QCD simulations by the HAL QCD Collaboration, which are the most consistent potential with the experimental data. In this study making use of this $\Lambda\Lambda$ interaction, the binding energy and the radius matter for the ground state of hypernucleus ${}_{\Lambda\Lambda}^6\text{He}$ is calculated via solving the coupled Faddeev equations. Here, for the $\Lambda\alpha$ interaction, three different and common types of interactions; the Isle-type potential, the single Gaussian potential and the Maeda-Schmidt potential are examined. Numerical analyzes for ${}_{\Lambda\Lambda}^6\text{He}$ using three $\Lambda\Lambda$ interaction models and three models of phenomenological $\Lambda\alpha$ interaction lead to the values of ground state energy between 7.197 and 8.408 MeV, and the value of the radius of matter in the range of 1.731 to 1.954 fm. Numerical results show that the minimum value of ground state binding energy, which is closest to the experimental value, occurs when one uses the HAL QCD $\Lambda\Lambda$ potential at lattice time $t/a=12$ and the MS phenomenological type $\Lambda\alpha$ potential. Also, the geometrical properties of ${}_{\Lambda\Lambda}^6\text{He}$ system are investigated.

Keywords: ${}_{\Lambda\Lambda}^6\text{He}$ hypernuclei, HAL QCD $\Lambda\Lambda$ potential, $\Lambda\alpha$ potential, three-body cluster systems

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