Hyperon single-particle potentials from QCD on lattice

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We will report result of our theoretical study on hyperon single-particle potentials in nuclear medium based on QCD.

Hyperon single-particle potentials determine chemical potential of hyperons in the medium, and hence have a crucial impact for hyperon onset in neutron stars. Therefore, the potentials interest physicist for these decades, and are currently one of the most hot subjects in physics.

Experimental studies on Λ-hypernuclei have provided lots of information and revealed that Λ single-particle potential $U_\Lambda \simeq -30$ MeV at the normal nuclear density. In order to reveal single-particle potential of other hyperons, many experimental efforts are devoted and still on-going at many facilities. For example, the first Ξ-hypernucleus was found recently at KEK in Japan.

In spite of these experimental efforts, knowledge about single-particle potential of Σ and Ξ hyperons are badly limited. Consequently, it is very interesting to predict U_Σ and U_Ξ theoretically. There are theoretical studies on these potentials already in the literature, but most of them based on phenomenological or QCD-inspired model of hyperon-nucleon forces. While, we start from QCD, the fundamental theory of strong interaction.

First, we carry out lattice QCD numerical simulations and extract hyperon-nucleon interactions by means of the recently-developed HAL QCD method. Then, we apply the resulting interactions to established method for baryonic matter, for example, the Brueckner-Hartree-Fock theory. At present, we are executing the numerical simulations with dynamical quarks at almost the physical point. Therefore, we will be able to report some preliminary QCD predictions for the hyperon single-particle potentials in the physical world.