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Hyperonic interactions and charge symmetry breaking in neutron stars

Studying of the properties of baryonic interactions is one of the important problems of nuclear physics. Nowadays nucleon-nucleon interaction is studied much better than hyperonic interactions. There are some models of hyperonic interaction, based on experiments with hypernuclei, but substantial uncertainties still remain. Studying of neutron stars can be promising for understanding the properties of hyperonic interactions. Wide range of extreme conditions is realised inside neutron stars, such as high densities and pressure. Since the structure of neutron stars is similar to the one of the nucleus, the methods from nuclear physics are applicable for neutron stars description, but at high densities there may be additional sensitivity to certain properties of the baryonic interaction. In recent years there were many important discoveries in neutron stars physics: new neutron stars were observed, masses and radii were measured and the first gravitational signal from neutron stars merger was obtained by the LIGO-Virgo collaboration. Registration of gravitational waves provides us with the new measurable characteristic of neutron stars, called tidal deformability. In the present work we build a model of neutron star matter consisting of nucleons, leptons, and Λ-hyperons with the Skyrme baryonic force. Using this model we calculate masses, radii and tidal deformabilities of neutron stars. We study different properties of ΛN -interaction and their connection with characteristics of neutron stars. In particular we consider two alternative ways to describe nonlinear effects in ΛN -interaction: dependence on a nucleon density (~ $\rho\alpha$) and the three-body ΛNN force. This two ways are almost equivalent in hypernuclei, but can lead to different results in neutron stars. We also consider the charge symmetry breaking (CSB) effect in neutron stars and compare results with our calculations for neutron-rich hypernuclei. Since neutron stars are neutron-rich systems, CSB effect definitely should affect them. Although it is often considered to be insignificant in the ΛN -interaction, its study can lead to some interesting physical conclusions. Finally, we attempt to find the best combination of Skyrme parametrizations of nucleon-nucleon, nucleon-hyperon and hyperon-hyperon interactions, considering both maximum mass and tidal deformability restrictions.

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