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Verifying repulsive Λ potential at high densities using heavy-ion collision and hypernuclear data

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The hyperon puzzle, namely the problem that hyperonic matter equations of state cannot support the observed massive neutron stars, has been attracting much attention. One of the proposed scenarios is that the Λ particles do not appear even at high densities due to the repulsive Λ potential at high densities generated by the ΛNN three-body force between the Λ particles and medium nucleons. From the chiral effective field theory, a Λ potential that satisfies this scenario has been obtained (Gerstung et al. (2020)). However, the density dependence of this potential has not been verified using experimental data.

In this talk, we will report that the above Λ potential reproduces the experimental data of heavy-ion collisions and Λ hypernuclei. We have found that the repulsive Λ potential explains both data on the Λ directed flow of heavy-ion collisions at $\sqrt{s_{NN}} = 3.0 - 20$ GeV within a relativistic quantum molecular dynamics implemented in JAM (Nara et al. (2022)), and the Λ binding energy of hypernuclei by the spherical Skyrme-Hartree-Fock method (Jinno et al. in prep.) within the uncertainties of the model. We conclude that the repulsive Λ potential from the ΛNN three-body force can be a solution for the hyperon puzzle.

We also discuss the possibility that the Λ-potential parameter region allowed by the data of the Λ binding energy extends to a more repulsive region than empirical ones (Lanskoy, Yamamoto (1997); Gurelia et al. (2012)). If the time allows, we also examine the empirical Λ potential using heavy-ion data.

Theory / experiment

Theory

Group or collaboration name

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