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Constraining Lambda potential in dense nuclear matter from the Lambda directed flow

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We investigate the possibility of constraining the Lambda (Λ) potential in dense nuclear matter from the Λ directed flow (v_1).

The hyperon puzzle in neutron stars, extensively discussed in recent decades, refers to the problem that most of the equations of state (EOS) with hyperons are not sufficiently stiff to support the observed massive neutron stars. The presence or absence of hyperons in neutron stars is one of the important elements determining the stiffness of EOS with hyperons. The Λ potential at high densities is a key ingredient in discussing the presence of Lambda hyperons, but it is not well constrained by the available experimental data.

In this talk, we investigated the possibility that Λ v_1 can constrain the Λ potential at high densities [1]. We use the Lorentz vector version of the relativistic quantum molecular dynamics (RQMDv) model [2] implemented in the JAM2 transport code. By using RQMDv, the rapidity dependence of the proton v_1 at $\sqrt{s_{NN}} = 2-20$ GeV is reproduced by a single parameter set [2]. We compare Λ v_1 calculated by using Skyrme-type Λ potentials that are consistent with Λ hypernuclear data [3]. We show that the Λ v_1 is not sensitive to the density dependence of the Λ potential but is sensitive to the momentum dependence. Also, we found that the Σ hyperon and the hyperon resonances are largely produced, and thus, their potentials would largely affect Λ v_1.

[1] Y. Nara, A. Jinno, K. Murase, and A. Ohnishi, Phys.Rev. C 106, 044902 (2022).
[2] Y. Nara and A. Ohnishi, Phys. Rev. C 105, 014911 (2022).
[3] A. Jinno, K. Murase, Y. Nara and A. Ohnishi, Phys. Rev. C108, 065803 (2023).

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