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Probing early-time longitudinal dynamics with the Λ hyperon's spin polarization in relativistic heavy-ion collisions

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We present a systematic study of the hyperon global polarization's sensitivity to the collision systems' initial longitudinal flow velocity, by extending our previous work [1] to event-by-event 3+1D hydrodynamic simulations. By explicitly imposing local energy-momentum conservation when mapping the initial collision geometry to macroscopic hydrodynamic fields, the evolution of systems' orbital angular momentum (OAM) and fluid vorticity are studied. We find that a simultaneous description of the Λ hyperons' global polarization and the slope of pion's directed flow can strongly constrain the size of longitudinal flow at the beginning of hydrodynamic evolution. We constrain the initial longitudinal flow size and the fraction of orbital angular momentum in the produced QGP fluid as a function of collision energy with the STAR measurements in the RHIC Beam Energy Scan program. We examine the effects of the new thermal shear gradients on the hyperon's polarization. The gradients of μ_B/T can change the ordering between Λ's and anti-Λ's polarization. Finally, we investigate a variety of collision systems, including isobar, Cu+Au, Au+Au, and U+U, at the top RHIC energies. It enables us to study the system-size dependence of novel correlations among hyperons polarization and charge hadrons' averaged transverse momentum and anisotropic flow coefficients. These correlations are one of the key observables to verify the OAM-vorticity-polarization paradigm in heavy-ion collisions.

[1] S. Ryu, V. Jupic and C. Shen, "Probing early-time longitudinal dynamics with the Λ hyperon's spin polarization in relativistic heavy-ion collisions", arXiv:2106.08125 [nucl-th]

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