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Hydrodynamic study of Lambda spin polarization: from qualitative towards quantitative investigation

The "local Lambda polarization puzzle" in relativistic heavy-ion collisions has challenged conventional models based solely on thermal vorticity, which fail to reproduce the observed sign of local polarization. Recently, incorporating shear-induced polarization (SIP) successfully reproduces the sign and opens the path toward a quantitative description of spin polarization.

Using 3+1D MUSIC with AMPT initial conditions and the "strange memory scenario," we show that global and local Lambda polarization in 200 GeV Au+Au and 5.02 TeV Pb+Pb collisions are well described. The same framework also predicts system-size–independent signals in 200 GeV Ru/Zr isobar collisions, consistent with STAR results. At RHIC Beam Energy Scan energies, we further identify a baryonic spin Hall effect: baryon chemical potential gradients induce Lambda/anti-Lambda local polarization splitting. Simulations with AMPT, SMASH, and 3D Glauber initial conditions predict growing signals at lower energies, in agreement with recent BES-II measurements.

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