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Exploring the dense QCD matter with spin hall effect

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Spin Hall effect (SHE) is a generation of spin polarization for moving spin carriers in material under an external electric field. Recent theoretical analyses show that spin Hall current can be induced by the baryon chemical potential μ_B gradient[1], which plays role of the analogous electric field and becomes sizable at the beam scan energies of RHIC .

We study and predict this SHE signature for the hot and dense QCD matter created at RHIC-BES, using 3+1-d viscous hydrodynamics with AMPT initial condition. We propose to use the second Fourier coefficients of the local spin polarization of net Lambda hyperon as a sensitive probe to SHE. The resulting SHE observables show a qualitative difference in both the sign and beam energy dependence in calculations with and without SHE. Experimental observation of these distinct qualitative features would constitute strong evidence for SHE in the QCD matter under extreme density[2].

We also investigate the sensitivity of SHE signature to the initial Baryon stopping, QCD EoS at finite density and Baryon diffusive constant, and discuss the prospect of employing SHE to extract the properties of QCD matter at RHIC-BES energies[2].

Reference
[1] Y. Hidaka, S. Pu, and D.-L. Yang, Phys. Rev. D97, 016004 (2018), 1710.00278; Shuai Liu and Yi Yin, Phys. Rev. D 104 (2021) 5, 054043.
[2] B. Fu, L. -G. Pang, H. Song, Yi Yin in preparation

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