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Dissertation Award in Nuclear Physics Talk: Global polarization of Lambda hyperons in Au+Au Collisions at RHIC

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Non-central heavy-ion collisions have large ($\sim 10^5\hbar$) angular momentum which may be transferred, in part, to the quark-gluon plasma (QGP) through shear forces that generate a vortical substructure in the hydrodynamic flow field. The vortical nature of the system can polarize emitted hadrons along the direction of system angular momentum. Λ and $\overline{\Lambda}$ hyperons, which reveal their polarization through decay topology, should be polarized similarly. These same collisions are also characterized by dynamic magnetic fields with magnitude as large as 10^{14} Tesla. A splitting between Λ and $\overline{\Lambda}$ polarization may signal a magnetic coupling and provide a quantitative estimate of the field strength at freeze out. Details of the magnetic field and its evolution are of particular interest to other novel phenomena in heavy-ion collision physics.

The STAR Collaboration made the first non-trivial observation of global hyperon polarization in non-central Au+Au collisions in the RHIC Beam Energy Scan. A magnetic splitting is hinted at, but the improved statistics and resolution achievable with future runs are required to make a definitive measurement of the magnetic field. Using a simple magneto-hydro equilibrium framework for interpreting the data allows for the direct extraction of the physical parameters relevant to this measurement, the vorticity and magnetic field. The extracted vorticity in this system is found to be considerably larger than any previously measured value, lending a new superlative to the QGP: “the most vortical fluid’.