An overview of nucleon spin and 3D structure at STAR

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Abstract

Spin, a fundamental and subtle concept in nuclear physics, is deeply rooted in the symmetries and structure of space-time. The primary goal of the Spin Physics Program at the STAR experiment is to use spin as a probe to unravel the internal structure and the QCD dynamics of nucleons with unprecedented precision. This is made possible by the unique capability of RHIC to provide both longitudinally and transversely polarized hadronic collisions at various energies.

Longitudinally polarized data from STAR have, for the first time, provided evidence for a positive gluon polarization at partonic momentum fraction $x>0.05$, with ongoing efforts aimed at further constraining gluon helicity. Measurements of the reconstructed W bosons in longitudinally polarized collisions probe asymmetric anti-quark helicity distributions in the proton sea. Transversely polarized data open new territory in studying the 3D structure of the proton. The W/Z bosons serve as probes for the sea-quark Sivers function and contribute to tests of the predicted sign-change phenomena. The tilt of the dijet opening angle provides direct access to the first Mellin momentum of the Sivers function. Novel measurements of the azimuthal distributions of identified hadrons in jets and spin-dependent dihadron correlations directly probe the collinear quark transversity in the proton, with the former coupled to the transverse momentum dependent Collins fragmentation function and the latter to the dihadron interference fragmentation function.

This presentation will provide an overview of recent results on nucleon spin and the 3D structure of the proton from the STAR experiment.