Exploring the Spin Structure of the Nucleon at STAR

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Abstract

Understanding the internal spin structure of the nucleon remains a challenge in strong interaction physics. The unique capability of RHIC to provide both longitudinally and transversely polarized hadronic collisions at various energies opened new avenues in studying the internal structure of the proton with unprecedented depth and precision. Significant progress has been made in the last few years through various measurements at STAR.

The longitudinal spin measurements have contributed significantly to our understanding of the quark and gluon helicity distributions inside the proton. The longitudinal double-spin asymmetry, A_{LL}, from STAR inclusive jet and dijet measurements, provides the first evidence of a positive gluon polarization with partonic momentum fraction $x > 0.05$. The reconstruction of $W^{\pm}/Z$ in longitudinally polarized proton-proton collisions indicates that there is a flavor separation of the light sea quark helicity distributions. In transversely polarized proton collisions, $W^{\pm}/Z$-bosons provide the first constraint on the sea-quark Sivers function and contributes to the tests of the predicted sign change. The tilt of the dijet opening angle provides a direct access to the first Mellin momentum of the Sivers function and avoids the spin-correlated fragmentation contributions. The 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 (TMD) Collins fragmentation function and the latter to the dihadron interference fragmentation function. These measurements shed lights on Sivers function, quark transversity and spin-dependent fragmentation functions in both collinear and TMD formalism. When combined with data from the future EIC, they will establish the validity and limits of factorization and universality, thus enabling a deeper understanding of fundamental QCD.

In this talk, an overview of recent results on both the longitudinal and transverse spin structure of the proton from STAR will be presented.