Exploring the Transverse Spin Structure of the Nucleon at STAR

The STAR Collaboration

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Abstract

Efforts toward understanding the transverse spin structure of the nucleon fueled rapid and rich development of twist-3 and transverse-momentum-dependent (TMD) physics in the last two decades. The unique capability of RHIC to provide transversely polarized p+p and p+Au collisions opened new avenues in studying the 3D tomography of the proton with unprecedented depth and precision. Significant progresses have been made in the last few years through various transverse spin measurements at STAR.

In this talk, we will present recent results from STAR's transverse spin program. The reconstruction of $W^{\pm}/Z$ in transversely polarized proton collisions provides the first constraint on the sea-quark Sivers function and contributes to the tests of the predicted sign change. The transverse single spin asymmetry for inclusive jets is sensitive to the initial-state twist-3 quark-gluon correlators, which are related to the Sivers function through the Efremov-Teryaev-Qiu-Sterman function. 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 TMD Collins fragmentation function and the latter to the dihadron interference fragmentation function. These measurements shed new lights on Sivers function, quark transversity and spin-dependent fragmentation functions in both collinear and TMD formalism. When combined with data from future EIC, they will establish the validity and limits of factorization and universality, thus enabling a deeper understanding of fundamental QCD.