Energy Independence of the Collins Asymmetry in pp Collisions at STAR

Yixin Zhang for STAR Collaboration

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Study of the origin of transverse single-spin asymmetries has triggered the development of the twist-3 formalism and the transverse-momentum-dependent parton distribution functions (TMDs). Measurement of the azimuthal distribution of identified hadrons within a jet in transversely polarized hadronic interactions provides an opportunity to study the TMD physics in the final state, *i.e.*, the Collins effect, which involves the convolution of the quark transversity with the Collins fragmentation functions. Significant discrepancies have been observed between experimental measurements of the Collins effect and theoretical predictions. Further precise measurements of the Collins effect can provide new insights into the three-dimensional structure of the proton.

STAR experiment at RHIC has reported precision measurements of Collins asymmetries from jet + $\pi^{\pm}$ production in transversely polarized pp collisions at a center-of-mass energy of $\sqrt{s}$ = 200 GeV. The STAR experiment reports high precision measurements of the Collins asymmetries for $\pi^{\pm}$ within jets from transversely polarized pp collisions at $\sqrt{s}$ = 510 GeV. With energy-scaled jet $x_T = 2p_T/\sqrt{s}$, a remarkable consistency is observed for Collins asymmetries of $\pi^{\pm}$ between 200 GeV and 510 GeV. This indicates that the Collins asymmetries are nearly energy independent, with at most a very weak scale dependence, in pp collisions. This energy independence is significantly contrast to predictions that TMD evolution of the Sivers function leads to a substantial suppression of TSSA for $W^{\pm}$ production. These results extend to high momentum scales (Q^2 up to 3400 GeV^2) and enable unique tests of evolution and universality in the transverse-momentum-dependent formalism, thus providing important constraints for the Collins fragmentation functions.