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Constraining Transversity and Nucleon Transverse-polarization Structure Through Polarized Proton Collisions at STAR

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A complete picture of collinear nucleon spin structure, at leading twist, requires knowledge of three types of parton distribution functions (PDFs): the unpolarized PDFs; the helicity PDFs; and the transversity PDF, the net transverse polarization of quarks within a transversely polarized nucleon. Of the three, transversity is the most difficult to probe due to its chiral-odd nature. Current knowledge of nucleon transverse-polarization structure comes from measurements of transverse single-spin asymmetries (SSAs) from semi-inclusive deep inelastic scattering (SIDIS). These SIDIS measurements, combined with those of electron-positron collisions, have allowed the first extraction of transversity. The kinematic reach of these measurements leaves poor constraints at higher values of Bjorken-x. One avenue to enrich understanding over a different kinematic range is jet and di-hadron production from polarized-proton collisions. The STAR detector at RHIC has seen non-zero SSAs due to the effects of transversity coupled to the Collins and interference fragmentation functions (IFFs) for the first time in $p\uparrow + p \longrightarrow$ jet + π^$\pm$ + X and $p\uparrow + p \longrightarrow \pi^+\pi^-$ + X, respectively, at $|\eta| < 1$ from 2.2 pb^-1 at $\sqrt{s}$ = 200 GeV, collected in 2006. In 2011 and 2012, STAR integrated 25 pb^-1 and 20 pb^-1 of transversely polarized proton data at $\sqrt{s}$ = 500 GeV and $\sqrt{s}$ = 200 GeV, respectively. Higher precision measurements of Collins and IFF asymmetries at 200 GeV should allow for more precise constraints of transversity across the kinematic range of p+p collisions. Extending these measurements for the first time to 500 GeV allows one to examine the effects of transverse-polarization structure for a different mix of partonic subprocesses than those found at 200 GeV, for instance, with more favorable sensitivity to linearly polarized gluons. The comparison of all asymmetry moments at 200 GeV and 500 GeV may also yield insight into longstanding theoretical questions concerning evolution, universality, and factorization breaking in non-collinear formulations of pQCD. Results from the 2011 jet analysis at $\sqrt{s}$ = 500 GeV will be presented, including the first-ever measurements offering constraints on models involving gluon linear polarization. The progress of the 2011 IFF analysis at $\sqrt{s}$ = 500 GeV and the 2012 jet and IFF analyses at $\sqrt{s}$ = 200 GeV will also be presented.

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