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Lensing Mechanism Meets Small-x Physics: Single Transverse Spin Asymmetry in Polarized Proton-Proton and Polarized Proton-Nucleus Collisions

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We calculate the single transverse spin asymmetry (STSA) in polarized proton-proton and polarized proton-nucleus collisions (A_N) generated by a partonic lensing mechanism. The polarized proton is considered in the quark-diquark model while its interaction with the unpolarized target is calculated using the small-x/saturation approach [1], which includes multiple rescatterings and small-x evolution. The phase required for the asymmetry is caused by a final-state gluon exchange between the quark and diquark, as is standard in the lensing mechanism of Brodsky, Hwang and Schmidt [2]. Our calculation combines the lensing mechanism with small-x physics in the saturation framework. The expression we obtain for the asymmetry A_N of the produced quarks has the following properties: (i) The asymmetry is generated by the dominant elastic scattering contribution and $1/N_c^2$ suppressed inelastic (color quadrupole) contribution (with N_c the number of colors); (ii) The asymmetry does not fall off with the produced quark's momentum p_T until the momentum reaches the saturation scale Q_s, and then only falls off as $1/p_T$ for larger momenta; (iii) The asymmetry decreases with increasing atomic number A of the target for p_T below or near Q_s, but is independent of A for p_T significantly above Q_s. We discuss how these properties may be qualitatively consistent with the data on A_N published by the PHENIX collaboration [3] and with the preliminary data on A_N reported by the STAR collaboration [4].
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Primary authors: SANTIAGO, Melvin (Ohio State University); KOVCHEGOV, Yuri (The Ohio State University)

Presenter: SANTIAGO, Melvin (Ohio State University)

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