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Single hadron double longitudinal spin asymmetries at $p_T 1$ GeV/c and $Q^2 1$ GeV^2 measured at COMPASS and prospects for EIC

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In order to understand why quark spins only contribute about a third to the nucleon spin, quite a few recent experiments have focussed on the measurement of the gluon polarization in the nucleon. To access the gluon polarization reactions where the gluons from polarized nucleon significantly contributes are necessary. For example, choosing such a kinematic where the Photon Gluon Fusion (PGF) hard process in semi-inclusive DIS or quark-gluon (gluon-gluon) hard scattering are enhanced in nucleon-nucleon interaction. This can be achieved by studying spin dependent asymmetries in production of hadrons at high transverse momentum p_T.

RHIC has recently measured such double spin asymmetries $A_{LL}(p_T)$ for pion production at high center of mass energies, and inclusion of its data to global fits based on NLO collinear pQCD calculations gives some constraints on the gluon polarization in the range $0.05 x_G 0.2$ [1].

The validity of the calculations of partonic cross sections at NLO has recently been extended to COMPASS at lower center of mass energies by adding leading-log gluon resummation in the unpolarized case [2]. The calculations reproduce now within scale uncertainty the cross section for single hadron production as a function of p_T measured recently at COMPASS [3]. Once extended to the polarized case, $A_{LL}(p_T)$ measurements at COMPASS can also be used to constrain the gluon polarization without large uncertainties about validity of the NLO pQCD framework at COMPASS energies.

We will present preliminary COMPASS results on double longitudinal spin asymmetries $A_{LL}(p_T)$ for single hadron production measured on the deuteron and the proton at $Q^2 1$ GeV^2, $p_T 1$ GeV/c and center of mass energy $\sqrt{s} = 18$ GeV. These asymmetries are computed separately for three bins in pseudorapidity to improve the sensitivity to the gluon polarization. All COMPASS data taken from 2002 to 2011 by scattering 160 GeV polarized muons on longitudinally polarized 6LiD and NH3 targets have been used, and the number of hadrons collected with $p_T 1$ GeV/c for this analysis amounts to about 60 million. The obtained asymmetries will be compared to theoretical predictions at NLO without gluon resummations.

These results will be supplemented by a prospect study on a similar analysis at EIC.

[1] E.C. Aschenauer et al., arXiv:1304.0079 [nucl-ex].

[2] D.P. Anderle, F. Ringer and W. Vogelsang, Phys. Rev. D87 (2013) 034014.

[3] C. Adolph et al., (COMPASS collaboration), Phys. Rev. D88 (2013) 091101.

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