Single transverse spin asymmetry (A_N) via charged pion production in polarized p + Au collisions at $\sqrt{s}$ = 200 GeV

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A proton is basically composed of many sea quarks and gluons in addition to the three valence quarks. According to the early EMC (European Muon Collaboration) data in the 80s, the contribution of the quarks and antiquarks to the entire proton's spin value (1/2) is less than 30%. As a result, the rest should come from the gluon spin and the orbital motions of quarks, antiquarks and gluons. The detailed spin structure of the proton can be revealed by investigating the longitudinal and transverse components. In particular, the transverse spin structure of the proton can provide some insight into the angular momentum component of the partons in the proton.

Transverse single spin asymmetries (**A_N**) are relevant to the transverse spin structure of the proton. Initially, **A_N** of hadrons produced in the transversely polarized pp collision was expected to be small, but experiments instead measured large asymmetries of up to **A_N** ≈ 40%. To better describe the large **A_N** measurements, the theoretical framework has been extended to include transverse momentum dependent (TMD) distributions and multiparton dynamics (higher twist effects).[1] At least two TMD effects have been proposed to explain the observed nonzero asymmetries. The first of these, known as the Sivers effect, correlates the proton spin with the partonic transverse momentum **k_T**.[1, 2] The second TMD effect, known as the Collins effect, describes the coupling of a transverse quark polarization (transversity) and a transverse spin dependent fragmentation from a struck quark into a hadron.[1, 3]

On the other hand, a pA collision gives a parton distribution and transverse momentum distribution in the nucleus by comparing the nucleon PDF. The generally accepted cold nuclear matter (CNM) effects are "Nuclear shadowing," "Gluon saturation," "Radiative energy loss," and the "Cronin effect." Nuclear shadowing means modification of the parton distribution functions within a nucleus. Gluon saturation signifies saturation of the gluon distribution function. Radiative energy loss means modification of the momentum fraction of partons due to multiple soft scattering. Finally, the Cronin effect implies broadening of the transverse momentum distribution due to multiple scattering of incident partons. Until recently, the transverse spin structure and CNM had been studied separately. The RHIC Run15 experiment was the first high-energy polarized proton and nuclear collision in the world. This unique collision experiment allows us to explore the spin degree of freedom in CNM effects.

A_N of neutral pions and inclusive charged hadrons have previously been measured with the PHENIX midrapidity spectrometer. These asymmetries have been found to be consistent with zero.[4] These precise results are all consistent with zero over the observed **p_T** range,[1] as shown in Fig. 1. In addition to a pp collision, **A_N** of neutral pions in a pA collision has already been analyzed. The analysis of **A_N** of charged pions using central arm detectors in the midrapidity region in a polarized pA collision is in progress. Wide **A** (nucleon number) coverage of **A_N** measurements from a polarized pp to pA collision will allow us to study the **A** dependence of **A_N** and the CNM effects in the system of transverse polarized protons colliding with nuclei.

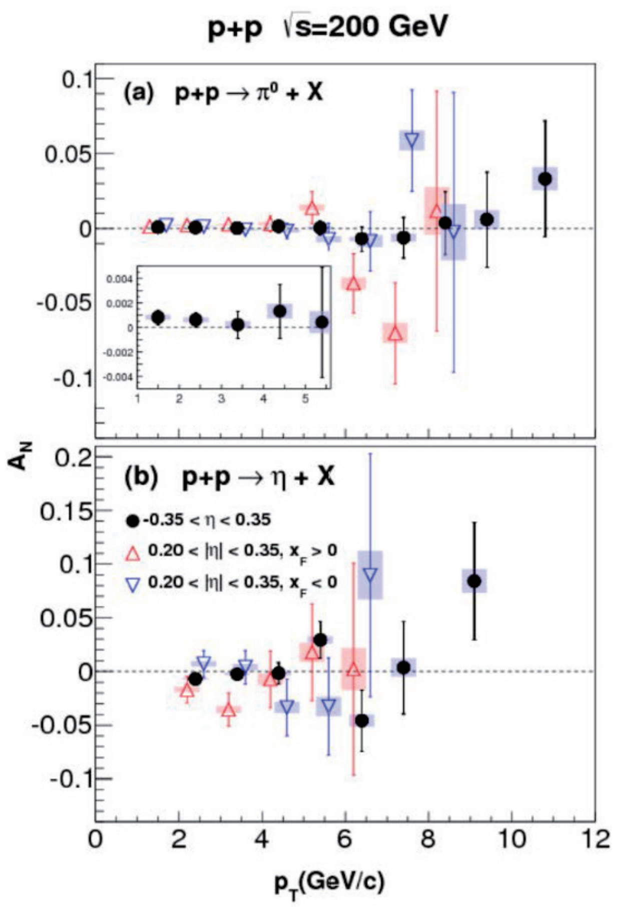

Fig. 1. **A_N** measured at midrapidity ($|\eta|$ < 0.35) as a function of **p_T** for (a) π_0 and (b) η mesons.[1]

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References

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