Single transverse spin asymmetries of forward neutron production in $\sqrt{s_{NN}} = 200$ GeV polarized $p+A$ collisions at PHENIX

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The first high energy polarized proton-nuclei collisions at RHIC in 2015 give us opportunities to study unexplored reaction mechanisms of hadron production in the forward region. In PHENIX, single transverse spin asymmetries ($A_{NS}$) of forward ($6.8 < \eta < 8.8$) neutron production in $\sqrt{s_{NN}} = 200$ GeV $p+$Al, and $p+$Au collisions are measured, and an unexpected strong $A$-dependence in $A_{NS}$ is found.

The cross section and $A_{NS}$ from the $p+p$ data, which covers the non-perturbative region ($p_T < 0.2$ GeV/$c$), have been well described by a one pion exchange (OPE) model in Regge theory. In the OPE model, $A_{NS}$ arises mainly from the interference of the helicity flip amplitude via pion exchange and the helicity nonflip amplitude via $a_1$-Reggeon exchange. However, this model cannot describe the observed $A$ dependence.

Since our data covers small $-t$ range ($< 0.5$ (GeV/$c$)$^2$), electromagnetic interaction may not be ignorable for the large Z nucleus, and ultra peripheral collisions (UPC) and Coulomb nuclear interference (CNI) can also play important role in asymmetry. In order to study competing effects, a correlation study using beam beam counters (which detect charged particles at $3.1 < \eta < 3.9$) was done which can reduce or enhance their relative contributions. The resulting asymmetries demonstrated drastic dependence depending on hit requirements in the beam beam counters.

In this talk, the $A_{NS}$ results and current progress in the interpretation of the data will be presented.