

Midrapidity Spin Asymmetries at STAR

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This year, the STAR detector joined with other experiments at RHIC recording the first collisions of polarized protons. At $\sqrt{s} = 200$ GeV, these measurements represent a large leap in the energy of polarization studies with polarized proton beams. Both beams were polarized vertically with alternating spin directions, allowing for extraction of possible single- and two-spin transverse asymmetries for a number of processes. Data were collected in STAR with a minimum-bias trigger over the pseudorapidity range $|\eta| < 1.4$ and all azimuthal angles ϕ .

We have developed an analysis procedure taking advantage of the full azimuthal symmetry of the detector to permit simultaneous and independent extraction of 1- and 2-spin physics asymmetries and a number of possible instrumental asymmetries [1]. We have applied this procedure to the leading charged particles detected in the STAR TPC in more than 9 million minimum-bias events, analyzed in various kinematic bins in η , P_T , and charge sign.

For a given reaction process of choice, the yields ($N_{\pm\pm}$) may depend on polarizations of beams ($\pm P_1, \pm P_2$)

$$N_{\pm\pm}(\phi, \eta) = L_{\pm\pm} \cdot \sigma(\eta) \cdot \text{eff}(\phi, \eta) \cdot \left[1 \pm A_y(\eta) P_1 \cos(\phi) \mp A_y(-\eta) P_2 \cos(\phi) \right. \\ \left. \pm \frac{A_{yy} + A_{xx}}{2} (|\eta|) P_1 P_2 \pm \frac{A_{yy} - A_{xx}}{2} (|\eta|) P_1 P_2 \cos(2\phi) \right]$$

Note especially the ϕ -independent term $A_{yy} + A_{xx}$, which is normally omitted in PQCD predictions, but is allowed by symmetry principles and known to be sizable at lower energies in soft processes. It is similar in structure to A_{LL} (also ϕ -independent), which we will have to measure in future runs to extract information on gluon polarization in a polarized proton, and subject to similar instrumental asymmetries associated with relative luminosity monitoring. In the method presented, the four spin-sorted ϕ -distributions normalized to luminosities are transformed to three ϕ -dependent ratios, and decomposed on trigonometric series $a_0 + a_1 \cos(\phi) + a_2 \cos(2\phi)$. All together, there are three coefficients extracted per ϕ -ratio, so one can extract simultaneously the 4 physics raw asymmetries in the above equation, plus 5 terms sensitive to instrumental asymmetries.

In this talk some details about accounting for spin pattern for colliding bunches, recording relative luminosities, and measuring relative amplitudes of polarization of both RHIC beams will be given as well.

As the beam polarizations during the 2002 run were very small of 10%-20%, we were able only to place upper limits on physics asymmetries. However, several of the instrumental asymmetries studied have direct or indirect relevance to the demands of the ΔG measurement program, as well as to other high priority future spin measurement programs with STAR.

References

- H. O. Meyer, Phys. Rev. C56 (1997) 2074.
- H. O. Meyer et al., Phys. Rev. Lett. 81 (1998) 3096.