Physics in Collision - Zeuthen, Germany, June 26-28, 2003

MEASUREMENT OF TRANSVERSITY AT HERMES

Armine Rostomyan
Yerevan Physics Institute, DESY Hamburg
On behalf of the HERMES collaboration

ABSTRACT

We present HERMES results on single spin asymmetries in electroproduction of charged and neutral pions. Data were obtained with longitudinally polarized targets and an unpolarized positron beam as well as with unpolarized targets and a polarized beam. In addition, we discuss the status of the measurement with a transversely polarized target. These measurements allow to access various unknown chiral-odd and/or time-odd structure functions for the first time.

Deep inelastic scattering experiments have been a key method to probe the structure of matter since decades. At leading twist, the quark structure of hadrons is described by three distribution functions: the momentum distribution $q(x)$; helicity distribution $\Delta q(x)$; and transversity distribution $\delta q(x)$. $q(x)$ is measured by unpolarized lepton-nucleon scattering while $\Delta q(x)$ by longitudinal double polarized scattering. $\delta q(x)$ is still unmeasured because its chiral-odd structure implies that it is not directly observable in inclusive lepton-nucleon scattering experiments. However, it can be probed in semi-inclusive pion production where it enters in combination with another chiral-odd and T-odd fragmentation function (like the Collins function).

A single-spin asymmetry is predicted to appear in the dependence of the cross section on the azimuthal angle ϕ that is defined as the angle between the spin axis of the transversely polarized target and the plane defined by the virtual photon momentum and the momentum of the outgoing pion. The observed asymmetries can be interpreted through the Sivers [1] or the Collins [2] mechanism. With a longitudinally polarized target chiral-odd spin distribution functions closely related to transversity can possibly be accessed.

HERMES is one of the experiments that collected data from both longitudinally and transversely polarized targets. Single spin asymmetries on a longitudinally polarized target and with a longitudinally polarized beam were presented on the poster. About 1 million DIS events have been already collected with a transversely polarized hydrogen target. The effect of both the Sivers and Collins mechanisms is presently under investigation and the results are not ready to be reported.

The analyzing powers for beam (target) longitudinal polarization are evaluated as

$$A_{LU(UL)}^{sin\phi} = \frac{\frac{L^{\uparrow}}{L_P^{\uparrow}} \sum_{i=1}^{N^{\uparrow}} sin\phi_i^{\uparrow} - \frac{L^{\downarrow}}{L_P^{\downarrow}} \sum_{i=1}^{N^{\downarrow}} sin\phi_i^{\downarrow}}{\frac{1}{2}(N^{\uparrow} + N^{\downarrow})} \tag{1}$$

where $\uparrow$ / $\downarrow$ denotes positive/negative helicity of the beam (target). $N^{\uparrow/\downarrow}$ is the number of selected events involving a detected pion for each beam (target) spin state corresponding to dead-time corrected luminosities $L^{\uparrow/\downarrow}$ and $L_P^{\uparrow/\downarrow}$, the latter being averaged with the magnitude of the beam (target) polarization.

In Figure 1, the analyzing powers $A_{UL}^{sin\phi}$ (single spin asymmetry with unpolarized beam (U) and longitudinally polarized target (L)) on polarized deuteron and proton targets are shown as a function of x, $P_{\perp}$ and z [4, 5, 6]. Here x is the Bjorken scaling variable describing the fraction of the nucleon's momentum carried by the struck quark, $P_{\perp}$ is the transverse momentum of the observed pion, z is the pion fractional energy. A_{UL} for π^+ production on the deuteron is found greater then zero, but smaller than that obtained on the proton. In the context of models based on transversity, the different size of the asymmetries for π^+ production on the proton and deuteron can be attributed to the dominant role of the u-quark contribution in the observed asymmetry. The analyzing powers for π^0 production are found positive for both deuteron and proton and of similar size. For π^- production, only the deuteron data suggest an asymmetry different from zero. The result for K^+ production on the deuteron is compatible with that of π^+ production which may indicate the dominant contribution from u-quarks fragmenting into kaons. The results for the two targets show a similar behavior in their kinematic dependences on x, $P_{\perp}$ and z. The observed increase of A_{UL} with increasing x suggests that the single-spin asymmetries are associated with valence quark contributions.

The preliminary measurement of the beam-spin asymmetry $A_{LU}^{sin\phi}$ in semi-inclusive pion electroproduction has been presented as well. At leading twist,$A_{LU}^{sin\phi}$ contains only the term proportional to $H_1^{\perp}$.

The appearance of this single-spin asymmetries can be interpreted as an effect of chiral-odd spin distribution functions coupled with a time-reversal-odd fragmentation function. This fragmentation function offers a means to measure transversity in the future using data from transversely polarized target.

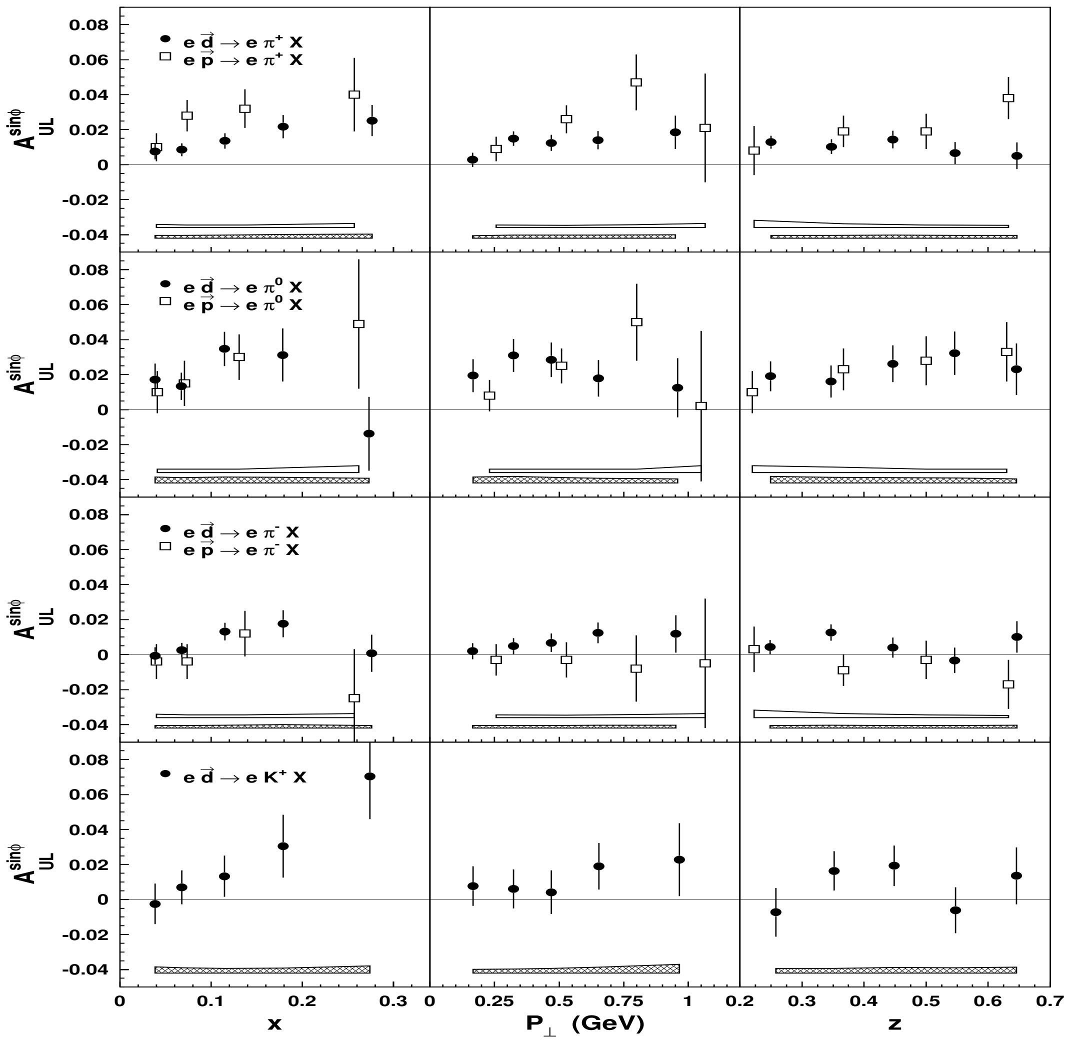

Figure 1: *Single spin asymmetries on longitudinally polarized H and D targets.*

References

1. P.J.Mulders and R.D.Tangerman, Nucl.Phys. **B461**, 197 (1996).
2. J.Collins, Nucl.Phys. **B396**, 161 (1993).
3. L.P.Gamberg, G.R.Goldstein and K.A.Oganessyan, [hep-ph/0301018].
4. HERMES Collaboration, A.Airapetian et al, Phys. Rev. Lett. **84** (2000) 4047.
5. HERMES Collaboration, A.Airapetian et al, Phys. Rev. **D64** (2001) 097101.
6. HERMES Collaboration, A. Airapetian et al, Phys. Lett. **B562** (2003) 182.