Transverse target spin asymmetry in exclusive ρ^0 production

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Abstract

In this work we present the measurement of the transverse target spin asymmetry in the exclusive ρ^0 production using the COMPASS spectrometer at CERN. This will constitute an essential step to get information about Generalized Parton Distributions.

The GPDs framework

The study of the Generalized Parton Distributions (GPD) [1] is of major interest for the understanding of the structure of the nucleon in terms of quarks and gluons. It can give new information on the correlation between longitudinal momentum and transverse position of partons. Moreover, it can provide access to the orbital angular momentum of partons in the nucleon through the Ji sum rule[2]. It has been shown that the GPD H and particulary the GPD E can be constrained by the transverse target spin asymmetry for vector meson production on the proton. This observable has been measured for exclusive ρ^0 production using the 160 GeV muon beam and the ^{6}LiD polarized target of the COMPASS experiment at CERN.

The studied reaction is $\mu N \rightarrow \mu' \rho^0 N'$ where N is a quasi-free nucleon in the polarized deuteron. The reaction can be described in terms of virtual photoproduction $\gamma^* N \rightarrow \rho^0 N'$. The conditions of applicability of the GPD formalism are the following : the virtual photon has to be longitudinal, Q^2 large and the momentum transfer squared between initial and final proton, t, small.

The exclusive ρ^0 production and transverse target spin asymmetry

In this reaction, the muon beam scatters off the quasi-free nucleon through the exchange of a virtual photon and produces a ρ^0 which decays into two pions. At COMPASS the outgoing muon and both pions are detected, but the recoil proton is not. To insure the exclusivity of the reaction, we apply a cut on the missing energy $|\frac{M_X^2 - M_p^2}{2M_p}| < 2.5$ GeV. To select the ρ^0 production, we apply a cut on the invariant mass of the two-pion system : $|M_{\pi^+\pi^-} - M_{\rho^0}| < 0.3$ GeV. We also select events with $Q^2 > 1$ (GeV/c)^2.

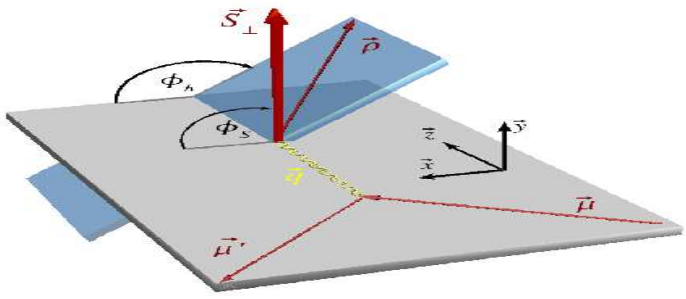

Figure 1: Definition of ϕ and ϕ_S for the exclusive ρ^0 production

Counting rates are expressed as a function of the angle $(\phi - \phi_S)$ between the spin of the target and the production plane (Fig 1). The transverse target spin asymmetry is then defined by $A^{sin(\phi-\phi_S)} = \frac{\sigma(\phi-\phi_S)-\sigma(\phi-\phi_S+\pi)}{\sigma(\phi-\phi_S)+\sigma(\phi-\phi_S+\pi)}$ and represents the asymmetry of the cross section between the $(\phi-\phi_S)$ direction and the opposite one $(\phi - \phi_S + \pi)$.

With the two cells of the COMPASS target and the two polarization configurations, we have four sets of data for each bin of $(\phi - \phi_S)$. To cancel systematic effects, we extract the asymmetry from a double ratio [4] of counting rates: $r = \frac{N^+_{up}(\phi-\phi_S).N^+_{down}(\phi-\phi_S)}{N^-_{up}(\phi-\phi_S).N^-_{down}(\phi-\phi_S)} = 1 + 4 \cdot A sin(\phi - \phi_S)$ where *up* (or *down*) refers to the target cell and + (or −) refers to the target polarisation. Then we extract the asymmetry A by fitting the ratio r.

Results and future work

Our results on the deuteron target are found to be compatible with zero (Fig 2). Further analysis will allow to disentangle the contribution of the incoherent production on a quasi-free nucleon from the coherent production on the nuclei in the ^{6}LiD target.

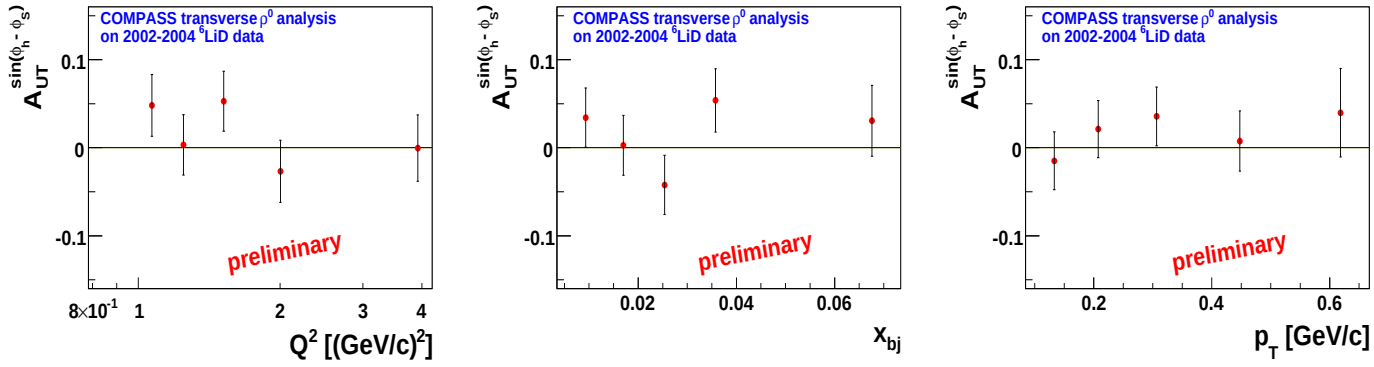

Figure 2: Transverse target spin asymmetries as a function of Q^2 (left), x_{bj} (middle) and p_T (right)

A rejection of the low values of the transverse momentum of the vector meson, p_T, with respect to the virtual photon direction will select the incoherent production. Studies regarding systematic errors and statistical precision of our measurement are underway.

Moreover, only the longitudinal virtual photon contribution has to be considered for a prediction on GPD. A method to extract the asymmetry for longitudinal photons was proposed by Diehl and Sapeta [3]: the contributions of longitudinal and transverse ρ^0 can be estimated from the angular distribution of pions in the ρ^0 decay. By assuming the s-channel helicity conservation, we can determine the contribution from longitudinal photons.

References

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