Transverse spin and transverse momentum of partons: a twist analysis

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We point out the role of intrinsic transverse momentum of partons in the study of azimuthal asymmetries in deep-inelastic 1-particle inclusive leptoproduction. The leading asymmetries often appear in combination with spin asymmetries. This study leads not only to transverse momentum dependence in the argument of the parton distribution and fragmentation functions, but also to functions beyond the ones known from inclusive deep-inelastic scattering.

An interesting class of fragmentation functions are the T-odd fragmentation functions showing up in single-spin asymmetries. The most well-known is the Collins fragmentation function describing the decay of a transversely polarized quark into pions.

Including the transverse momentum dependent functions one has a full classification of the spin structure of the quarks in the nucleon. All functions can be interpreted as entries in the full density matrix for the nucleon. This enables derivation of various bounds[1]

We use Lorentz invariance and the QCD equations of motion to study the evolution of functions that appear at leading (zeroth) order in a $1/Q$ expansion in azimuthal asymmetries[2] This includes the evolution equation of the Collins fragmentation function. The moments of these functions are matrix elements of known twist-two and twist-three operators. We give the evolution in the large N_c limit, restricted to the non-singlet case for the chiral-even functions.

[1] A. Bacchetta, M. Boglione, A. Henneman and P.J. Mulders, Phys. Rev. Lett. 85 (2000) 712.
[2] A. Henneman, D. Boer and P.J. Mulders, hep-ph/0104217.