How well do we know the transverse polarization quark densities or A reassessment of a reassessment of the Collins mechanism for single spin asymmetries.

Elliot Leader
High Energy Physics, Imperial College, London
e-mail: e.leader@ic.ac.uk

Of the three fundamental quark densities, the number density q(x), the longitudinal polarization density $\Delta q(x)$ and the transverse polarization density $\Delta_T q(x)$, (sometimes called the transversity), almost nothing is known about the latter, because, unfortunately, it does not contribute to lepton-hadron deep inelastic scattering. We only know it must respect the Soffer bound $|\Delta_T q(x)| \leq \frac{1}{2}| q(x) + \Delta q(x) |$.

At present the only way to study $\Delta_T q(x)$ is via the Collins mechanism explanation of the very large spin asymmetries (up to 40%) found in reactions of the type $p^{\Uparrow}N \to hX$ involving a transversely polarized proton colliding with an unpolarized target. For a wide variety of targets and detected hadrons h the asymmetries seem to be independent of energy and grow with both x_F and p_T, and for almost three decades there has been no serious theoretical understanding of them.

In the Collins mechanism a transversely polarized quark of momentum **p**, spin vector **s,** in the final state, fragments into a hadron h with momentum $z\mathbf{p} + \mathbf{k}_T$. The fragmentation can then depend upon the scalar $\Delta^N D(z, k_T)\mathbf{s}.(\mathbf{p}\times\mathbf{k}_T)$. This gives rise to a spin asymmetry, since **s** is linked via QCD to the polarization of the polarized quark in the initial state, and that, in turn, depends on $\Delta_T q(x)$. In short the asymmetry is controlled by products of the type $\Delta_T q(x)\Delta^N D(z,k_T)$.

Although neither $\Delta_T q(x)$ nor $\Delta^N D(z,k_T)$ are known, the separate x_F and z dependence in the data, coupled with some reasonable simplifying assumptions, means that both types of function can be accessed by fitting the data.

Several papers [1,2] have studied π production, but none is reliable. In our most recent study with M.Boglione [2] we were forced to make approximations to reduce a 4-dimensional integral to a 2-dimennsional one, in order to be able to do a best-fit analysis in a reasonable amount of time. We now believe these approximations severely distort the results and the $\Delta_T q(x)$ we found cannot be trusted.

A more comprehensive study, in collaboration with M.Anselmino, M.Boglione, U, d'Alesio and F.Murgia is in progress, and will, we believe, yield the first ever reliable information about the transverse polarization densities $\Delta_T q(x)$.

[1] M.Anselmino, M.Boglione and F.Murgia, Phys.Lett. **B362** (1995) 164; Phys.Rev. **D60** (1999) 054027. M.Anselmino and F.Murgia, Phys.Lett. **B442** (1998) 470.
[2] M.Boglione and E.Leader, Phys.Rev. **D61** (2000) 114001.