# Transversity and Inclusive Two-Pion Production

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Dihadron Fragmentation Functions (DiFF) describe the probability that a quark hadronizes into two hadrons plus anything else, i.e. the process $q \to h_1\, h_2\, X$. They can appear lepton-lepton, lepton-hadron and hadron-hadron collisions producing final-state hadrons. DiFF can be used as analyzers of the spin of the fragmenting quark. At present, the most important application of polarized DiFF is the measurement of the quark transversity distribution $h_1$ in the nucleon, which represents the probabilistic distribution of transversely polarized partons inside transversely polarized hadrons.

Transversity is a missing cornerstone to complete the knowledge of the leading-order (spin) structure of the nucleon. Its peculiar behavior under evolution represents a basic test of QCD in the nonperturbative domain. The most popular strategy to extract $h_1$ is to consider Deep Inelastic Scattering (DIS) of electrons on transversely polarized targets, and look for azimuthally asymmetric distributions of inclusively produced single pions when flipping the spin of the target (the socalled Collins effect). But the cross section must explicitly depend on the transverse momentum of the pion.

Inclusive production of two pions offers an alternative and easier framework, where the chiral-odd partner of $h_1$ is represented by the DiFF $H_1^{\triangleleft}$, which relates the transverse spin of the quark to the azimuthal orientation of the $(\pi\pi)$ plane. In fact, the leading-twist spin asymmetry is

$$A_{UT}^{\sin(\phi_R+\phi_S)} \equiv \frac{1}{\sin(\phi_R+\phi_S)}\,\frac{d\sigma^{\uparrow}-d\sigma^{\downarrow}}{d\sigma^{\uparrow}+d\sigma^{\downarrow}} \propto \frac{\sum_q e_q^2\,(h_1^q(x)/x)\;H_1^{\triangleleft q}(z,M_h^2)}{\sum_q e_q^2\,(f_1^q(x)/x)\;D_1^q(z,M_h^2)}\;, \tag{1}$$

where $M_h$ is the invariant mass of the two pions carrying a total $z$ momentum fraction, and $\phi_R$ and $\phi_S$ are the azimuthal orientations with respect to the scattering plane of the $(\pi\pi)$ plane and target spin, respectively.

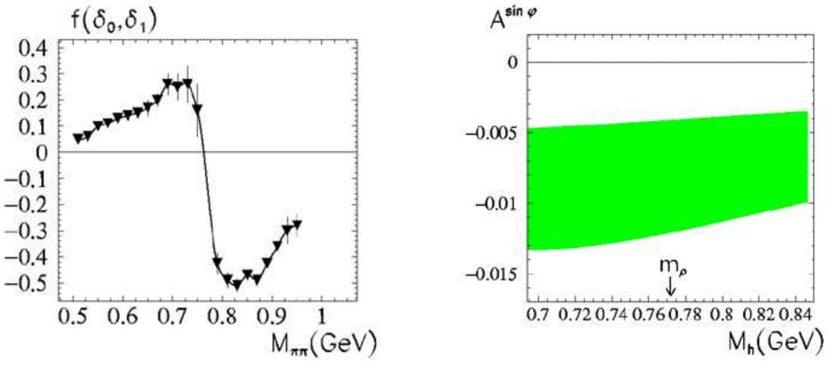


Figure 1: Left panel: expected trend of $A_{UT}$, for two-pion invariant mass $M_h$ around the $\rho$ mass, from $(\pi\pi)$ elastic phase shifts [see Jaffe *et al.*, Phys. Rev. Lett. **80** (1998) 1166]. Right panel: expected $A_{UT}$ from model calculation of $H_1^{\triangleleft}$ [see Radici *et al.*, Phys. Rev. D**65** (2002) 074031].

A measurement of the unknown $H_1^{\triangleleft}$ is planned by the BELLE collaboration. At the same time, in the literature very different predictions for $A_{UT}$ are available (see Fig. 1). Here, I will outline a new model for the fragmentation process and will discuss its performance with respect to the new upcoming HERMES data for the inclusive two-pion production in DIS on trasversely polarized protons. I will also discuss the option of polarized proton-(anti)proton collisions, that can be realized at BNL, GSI, and possibly JPARC. By combining the two cross sections for the $pp^{\uparrow} \to (\pi\pi)X$ and $pp \to (\pi\pi)(\pi\pi)X$ processes, all the unknowns can be determined self consistently.