

Dihadron Fragmentation Functions in the NJL-Jet Model†

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[QUARK FRAGMENTATION FUNCTIONS]

In order to describe the scattering of high energy electrons on nuclear targets in terms of quark degrees of freedom, the Nambu-Jona-Lasinio (NJL) model is often used as an effective theory of QCD. For example, this model was successfully applied in Ref.[1)] to describe quark distribution and fragmentation functions observed in semi-inclusive deep inelastic scattering (SIDIS) processes. Here we extend the model to the description of dihadron fragmentation functions (DiFFs), which are expected to play an important role for extracting the transversity parton distribution functions from SIDIS processes with two final detected hadrons[2)].

The unpolarized DiFFs ($D_q^{h_1 h_2}(z, M_h^2)$) for the process $q \to h_1 h_2$ depend on the sum of the light-cone momentum fractions $z = z_1 + z_2$ and the invariant mass squared $M_h^2 = (P_1 + P_2)^2$ of the produced hadron pair. In order to calculate these functions, we use the quark jet picture, with the elementary fragmentation functions for $q \to h$ calculated in the NJL-jet model[3)]. The multihadron emissions from a high energy virtual quark (flavor $q = u, d, s$) are described by using Monte-Carlo techniques, averaging over a sufficiently large number of events (10^{10} in the results shown below) and restricting the total number of primary emitted hadrons for each fragmentation chain to a predefined number (equal to eight in the results below). In this study we include the pseudoscalar π, K and vector (ρ, ω, K^* and ϕ) mesons. The strong 2-body and 3-body decays of the primary vector mesons to secondary π and K are also included in the simulations, and are very important to describe the invariant mass spectra of the final π and K pairs.

Fig.1 shows the DiFF for $u \to \pi^+\pi^-$, integrated over z in the region 0.2 to 0.8, for the cases of primary mesons only (dashed line) and the full final states including the decay products of the primary vector mesons (solid line). The ρ^0 peak around $M_h^2 \simeq (0.78\,\text{GeV})^2$, and the enhancement in the region below 0.4 GeV^2 coming from $\omega \to \pi^+\pi^-\pi^0$ with shifted invariant mass due to the unobserved π^0, are clearly seen in the figure. Fig.2 shows the results obtained by performing the Q^2 evolution in leading order (LO), where we assign a typical NJL-jet scale of 0.2 GeV^2 to the model results shown by the solid lines in Figs. 1 and 2. The vector meson decays have an important influence on the shape of the DiFFs even at very high values of Q^2.

The future development of our model will allow us to extract also the so called interference DiFFs by considering the fragmentation of a transversely polarized quark, which also play an important role to extract the transversity distribution functions from measured SIDIS two-hadron asymmetries.

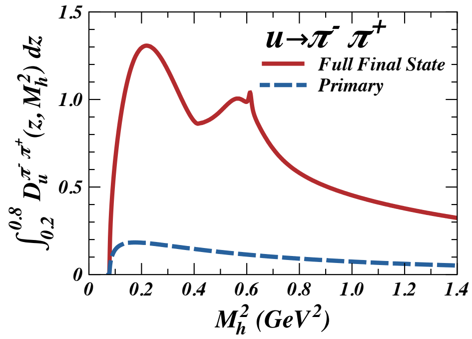

Fig. 1. Fragmentation function for $u \to \pi^+\pi^-$ calculated in the NJL-jet model, including only primary (dashed line) and full (solid line) final states.

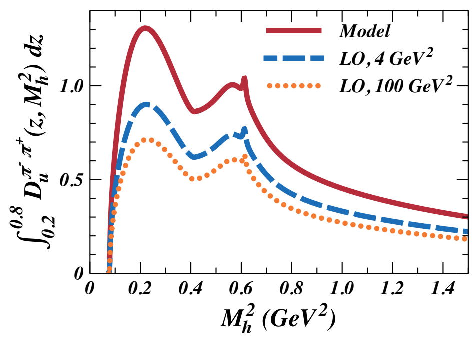

Fig. 2. The solid line is the same as in Fig.1, and the other lines show the results obtained by the Q^2 evolution in leading order (LO) to higher energy scales.

This work was supported by the Australian Research Council (Grants No. FL0992247 and No.CE110001004), the University of Adelaide, and the Japanese Ministry of Education, Culture, Sports, Science and Technology (Kakenhi Grant No. 20168769).

References

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† Condensed from an article by H.H. Matevosyan et al, Phys. Rev. **D 88**, 094022 (2013).

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