PROCEEDINGS OF SCIENCE

Measurement of the charm fragmentation into D* mesons at HERA

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The charm fragmentation function has been measured with the H1 and ZEUS detectors at HERA in the deep inelastic scattering and photoproduction regimes. The measured function has been compared to different fragmentation models implemented in leading-logarithm Monte Carlo simulations and next-to-leading-order calculations.

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1. Introduction

In charm production the non-perturbative transition of a charm quark to a hadron, which can not be calculated with the framework of pQCD, is usually described by the phenomenological models [1]. The two widely used phenomenological models are the Peterson [2] and Kartvelishvili [3] functions. Since these non-perturbative models are not calculated from the first principle, experimentally study is necessary to determine the parameters of the fragmentation functions.

Experimentally, the charm fragmentation function has been studied for many years in e^+e^- annihilation [4]. The ep collision at HERA also offers a unique place to study the fragmentation function of charm to D^* mesons. In this article we present the recent results obtained by the ZEUS and H1 collaborations [5].

2. Charm fragmentation functions at ZEUS

The data collected during the 1996−2000 running period corresponding to an integrated luminosity of 120 pb^{-1} were used in ZEUS analysis. The measurement was performed in the kinematic range $Q^2 < 1$ GeV^2 and $130 < W_{\gamma p} < 280$ GeV. The requirements on D^* and jets are $p_T^{D^*} > 2$ GeV and $|\eta^{D^*}| < 1.5$, $E_T^{jet} > 9$ GeV and $|\eta^{jet}| < 2.4$. The high jet E_T was chosen to minimize the bias from the D^*.

The fragmentation function is measured versus $z_{jet} = (E + p_{\|})^{D^*}/2E^{jet}$, where E is the energy of the D^* meson reconstructed from the decay chain $D^* \to D^0\pi_s \to (K\pi)\pi_s)$ and $p_{\|}$ is the longitudinal momentum relative to the axis of associated jet of energy E^{jet}. After taking into account the acceptance correction using Monte Carlo (MC) simulation (PYTHIA [6]), the relative cross sections as a function of z_{jet} were used to extract the fragmentation parameter of Peterson function. The MC distribution was fit to the data via a χ^2-minimization procedure to determine the best value of ε. The data is well described by the best value, $\varepsilon = 0.062 \pm 0.007^{+0.008}_{-0.004}$, of the fit, which is compatible with corresponding e^+e^- results [6].

Similarly, the parameters of the Peterson and Kartvelishvili functions were extracted in the next-to-leading order (NLO) framework [7], respectively. As the final state particles in the NLO QCD calculation are partons, to enable a fair comparison with the data, the predictions were corrected for effects of hadronization. The fit to the data gives the best value of $\varepsilon = 0.079^{+0.013}_{-0.009}$ and $\alpha = 2.67^{+0.25}_{-0.31}$. The data compared with the predictions of the Peterson and Kartvelishvili functions as implemented in FMNR is shown in Fig. 1.

3. Charm fragmentation functions at H1

The analysis of charm fragmentation in the DIS regime was performed with data, corresponding to an integrated luminosity of 47 pb^{-1}, taken by H1 detector in the years of 1999 and 2000. The virtuality of the exchanged photon and the inelasticity were required to be $2 < Q^2 < 100$ GeV^2 and $0.05 < y < 0.7$, respectively. The D^* candidates were required to have $2 < p_T^{D^*} < 15$ GeV, $|\eta^{D^*}| < 1.5$. The jet associated with a D^* was required to satisfy $E_T^{jet} > 3$ GeV.

In addition to the jet method, the hemisphere method was also used to investigate the charm fragmentation function and the fragmentation observable, z_{hem}, was defined as $z_{hem} = (E + p_{\|})^{D^*}/(E +$

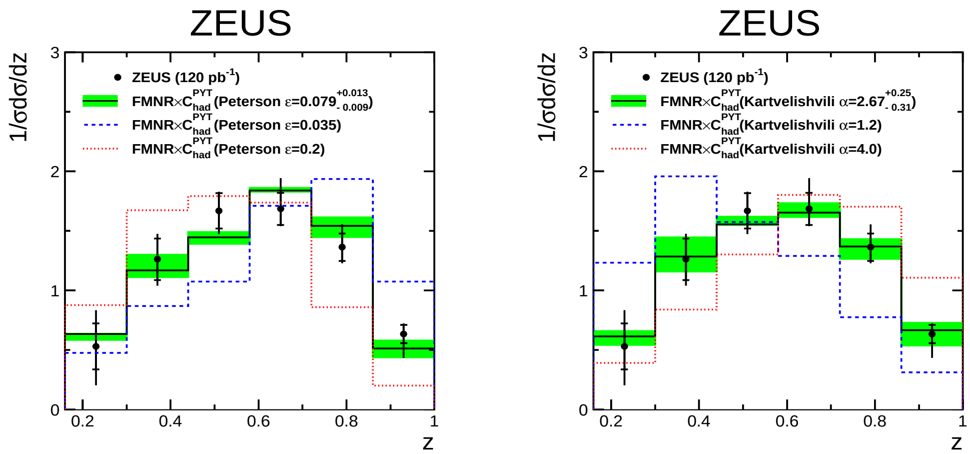

Figure 1: Charm fragmentation function for the ZEUS data compared to the predictions of the Peterson and Kartvelishvili functions as implemented in FMNR.

$p)^{D^* hem}$, where $p_{\|}$ is the longitudinal momentum of the D^* meson with respect to the direction of the three-momentum of the hemisphere and $(E+p)^{D^* hem}$ is the sum of the energy and the momentum of all particles of the D^* meson hemisphere.

The data was corrected using RAPGAP [8] in which the parameter setting tuned by the ALEPH collaboration[9] together with the Peterson fragmentation function is used for the fragmentation of partons in PYTHIA. The normalized cross sections as a function of the z_{hem} and z_{jet} were used to extract the parameters of Peterson and Kartvelishvili functions. The corresponding results are summarized in Table. 1. Within the framework of RAPGAP, the fragmentation parameters extracted using the z_{hem} and z_{jet} are in good agreement with each other. The fits to NLO calculation as implemented in HVQDIS [10] with the Kartvelishvili function (the fit for the data as a function of z_{jet} and z_{hem} is shown in Fig. 2. See Ref. [5] for more figures) , also give consistent results, while the Peterson parameterization is disfavored due to the poor description of data.

Furthermore, the no-D^* jet sample, containing events not fulfilling the jet energy requirement $E_T^{jet} > 3$ GeV, was used to investigate the threshold region. The fragmentation parameters extracted for the Peterson and Kartvelishvili functions are significantly different from those fitted to the D^* jet sample. Using this sample, the result obtained with the hemisphere method for the Kartvelishvili parameterization shows that the NLO calculation is also not able to describe the no-D^* jet data with the set of parameters obtained with the D^* jet sample.

Table 1: Fragmentation function parameters extracted for RAPGAP and HVQDIS.

Model	α Kartvelishvili		ε Peterson	
RAPGAP	$\alpha_{hem} = 4.4^{+0.6}_{-0.5}$	$\alpha_{jet} = 4.3^{+0.5}_{-0.4}$	$\varepsilon_{hem} = 0.030^{+0.007}_{-0.006}$	$\varepsilon_{jet} = 0.035^{+0.007}_{-0.006}$
HVQDIS	$\alpha_{hem} = 3.3^{+0.4}_{-0.4}$	$\alpha_{jet} = 3.8^{+0.3}_{-0.3}$	$\varepsilon_{hem} = 0.068^{+0.015}_{-0.013}$	$\varepsilon_{jet} = 0.034^{+0.004}_{-0.004}$

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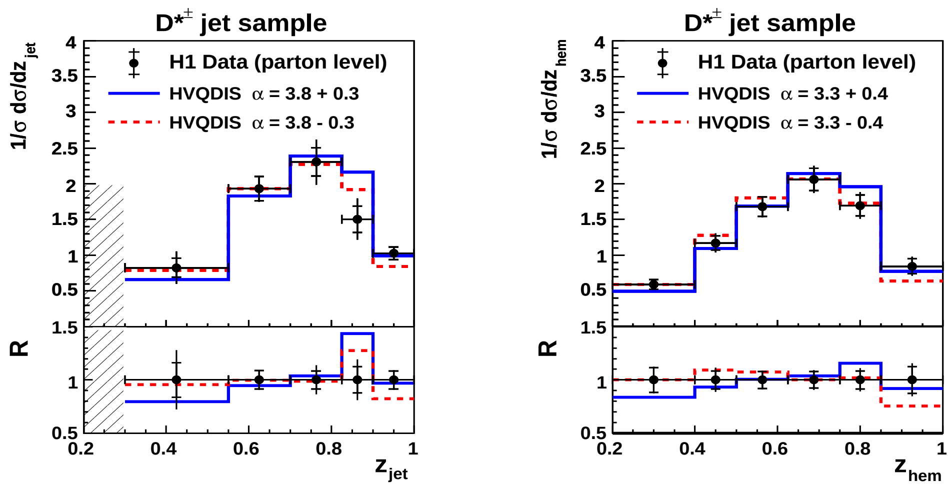

Figure 2: Charm fragmentation function for the H1 data compared to the predictions of the Kartvelishvili function as implemented in HVQDIS.

4. Conclusion

The fragmentation function for D^* was measured in photoproduction and DIS. Both the Peterson and Kartvelishvili functions provide a reasonable description of data. Different experimental methods yield compatible results within the same kinematic region. At high p_T the results are compatible to those from e^+e^- experiments. In the threshold region, a different parameterization will be needed.

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