DIFFRACTIVE PRODUCTION OF DIJETS AND D* MESONS AT ZEUS

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The study of the hadronic final state in diffractive electron-proton collisions at HERA can provide informations about the dynamics of diffraction and the strong interaction in general. One of the main questions is whether the QCD factorisation theorem holds for diffraction. Two analyses related to this latter topic are presented: the diffractive production of dijets at large photon virtualities and the diffractive photoproduction of D^* mesons. In both cases the cross sections are compared to both LO and NLO predictions.

1. Introduction

It has been proven that the cross section for diffractive Deep Inelastic Scattering (dDIS) that the cross section can be written as the convolution of a process-dependent component related to the hard subprocess and a process-independent diffractive parton distribution function (dPDF). This statement is known as *QCD factorisation theorem*[1,?,2]. For the diffractive photoproduction case (dPhP), this theorem is not expected to hold because of secondary interactions between the proton and the hadron-like photon which destroy the rapidity gaps in the event and slow down the outgoing proton. The extraction of the dPDFs, the test of their universality and the confirmation of the factorisation breakdown for hadron-like events are important milestones in the understanding of diffraction. This program can be pursued with the study of specific final states like dijets or charmed mesons because of the presence of a hard scale. These processes are particularly interesting because they are sensitive to the gluon content of the diffractive exchange (which is known to be gluon rich [3]).

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2. Diffractive production of dijets in DIS

Events with diffractive production of dijets at large photon virtualities were searched for in a sample corresponding to a luminosity of 65.2 pb^{-1}. Events were selected with values of the photon virtuality in the range $5 < Q^2 < 100$ GeV^2 and $\gamma^* p$ center of mass energy in the range $100 < W < 250$ GeV. The jets were reconstructed in the $\gamma^* p$ c.m.s. with the $k_\perp$ algorithm. At least two jets with transverse energy $E_T^* > 4$ GeV were required (variables noted with an star are measured in the $\gamma^* p$ frame); furthermore the jet with the highest E_T^* had to have $E_T^* > 5$ GeV and all the jets had to be in the pseudorapidity range $-3.5 < \eta^* < 0.0$. Diffractive events were selected with the Large Rapidity Gap method (LRG): events with hadronic activity at $\eta > 2.8$ were rejected. A cut $x_{\mathbb{P}} < 0.03$ was also imposed. Here $x_{\mathbb{P}}$ indicates the fractional momentum loss of the proton. The measured differential cross sections are compared to two different LO MCs, Satrap[4] and Rapgap[5]. In both cases a satisfactory agreement was obtained, with Rapgap performing slightly better at high E_T^*. The same cross sections are then compared to several NLO predictions. These NLO calculations differ for the dPDFs used as input. Three different sets of dPDFs are considered: the "H1 2002 fit (prel.)"[6], the "ZEUS-LPS" fit [7] and the "GLP" fit [8]. These three dPDFs are very different, presumably reflecting differences in the data sets used for the parton densities extraction. The uncertainty on the calculation related to the scale choice is of the order of 20% while the contribution from the uncertainty on the dPDFs was not taken into account. Bearing this in mind, the comparison with the data points (shown in Fig.2 suggests that the calculation using the "GLP" fit significantly underestimates the measured cross sections while the other two NLO predictions provide a reasonable description of the data. In view of the large uncertainties, a firm conclusion on the validity of the factorisation theorem is however impossible.

3. Diffractive photoproduction of $D^*(2010)$ mesons

The data sample corresponded to an integrated luminosity of 78.6 pb^{-1}. $D^*(2010)$ mesons were identified via their decay chain $D^{*+} \to D^0 \pi_S^+ \to K^- \pi^+ \pi_S^+$ ($+c.c.$). In order to select a PhP sample, events with one scattered electron candidate were rejected. The kinematic region was restricted to the region $Q^2 < 1$ GeV and $130 < W < 300$ GeV. The D^* candidate had to be reconstructed in the range $|\eta(D^*)| < 1.6$ and had to have a minimum transverse momentum $p_T(D^*) > 1.9$ GeV. The diffractive selection was carried out with the LRG method selecting only events with hadronic activity at pseudorapidities not lower than $\eta_{MAX} = 3.0$. An additional cut $x_{\mathbb{P}} < 0.035$ was applied. The final number of D^* candidates was 454 ± 30. The measured differential cross sections were compared to the Rapgap[5] LO MC which gives a fair description of the data. A NLO calculation using the

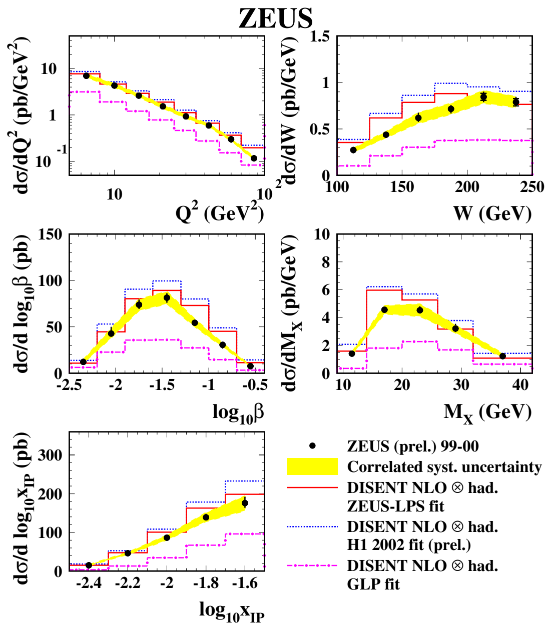

Figure 1. Comparison of the measured differential cross sections of dijets in dDIS as a function of Q^2, W, $Log_{10}\beta$, M_X and $Log_{10}x_{\mathbb{P}}$ (points) with the three different NLO calculations available (lines). The inner error bars of the points show the statistical errors and the outer ones the total experimental uncertainty from the sum in quadrature of the statistical and the systematic uncertainties. The uncertainties on the predictions are not displayed.

"H1 2002 fit (prel.)" [6] dPDFs was compared to the data (Fig.3). The data and the calculations agree, but the uncertainties af the calculation are so large that it is again impossible to draw a firm conclusion.

4. Conclusions

The cross sections for the diffractive production of dijets in DIS and the diffractive photoproduction of D^* mesons have been measured both for the first time at the ZEUS detector. Both are well described by LO MCs. In order to test QCD factorisation, these measurements were compared to NLO calculations which use dPDFs as input. The dDIS dijets data points are of such a good precision to be potentially very discriminating. The comparison was done with three different dPDFs: for two of them the agreement with the data is satisfactory and for one of them a significant underestimation is apparent. In any case the uncertainty on the calculations is so large that a quantitative conclusion on the validity of QCD factorisation for diffractive events is not yet possible. The situation for the D^* sample is similar.

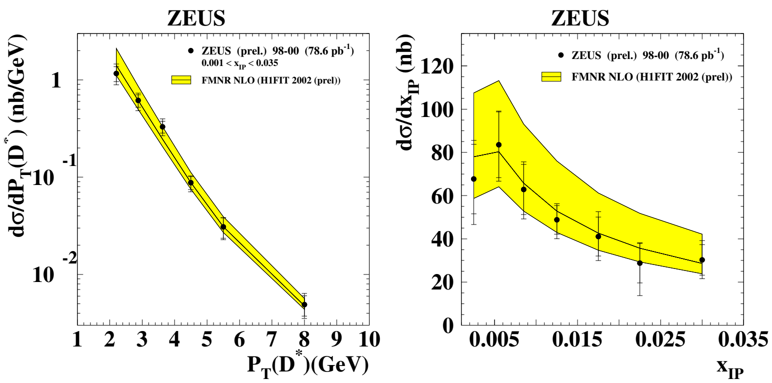

Figure 2. The differential cross sections for D^* in diffractive photoproduction as a function of $p_T(D^*)$ and $x_{\mathbb{P}}$ (points) compared to the NLO prediction obtained using the "H1 2002 fit (prel.)" dPDFs (lines). The inner error bars represent the statistical error and the outer error bars the statistical and systematic errors summed in quadrature. The band around the solid line indicates the uncertainty on the NLO calculation due to the renormalisation and factorisation scale choice.

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