Diffractive Di-Jet Production in H1

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Abstract. Diffractive interactions with two high p_T jets are studied in photo- and electroproduction at HERA. Within the large errors, the absolute cross sections and the differential distributions are reasonably well described in both cases by models based on a factorisable pomeron flux and a meson component, the pomeron structure function being obtained from a QCD analysis of inclusive diffractive interactions in deep inelastic scattering.

INTRODUCTION AND EVENT SELECTION

In diffractive interactions at HERA, high p_T jet production has been observed both in photoproduction ($Q^2 \simeq 0$) [1] and in electroproduction with $Q^2 > 10$ GeV^2 [2]. This followed the observation of high p_T jets in diffractive $\bar{p}p$ interactions by the UA8 experiment [3], which first gave support to the hypothesis of a partonic content of the pomeron [4].

The hard scale provided by the jet p_T allows perturbative QCD calculations which in turn give insight into important open questions, in particular the universality of the partonic content of the pomeron.

The results presented here are based on data obtained in 1994, from the collision of 27.5 GeV positrons with 820 GeV protons, with an integrated luminosity of 2.2 pb^{-1} in photoproduction and 2 pb^{-1} in electroproduction. In both cases, events were tagged by the absence of activity in the forward detectors with $7.5 > \eta > 3.2$ and by the detection in the central tracker and the liquid argon calorimeter of a hadronic system X, of mass M_X. For photoproduction, the scattered positron was detected in the electron tagger situated 33 m downstream from the interaction point, with good acceptance for $Q^2 < 0.01$ GeV^2 and $0.25 < y < 0.7$; for electroproduction, it was detected in the backward electromagnetic calorimeter, with $7.5 < Q^2 < 80$ GeV^2 and $0.1 < y < 0.7$. In both cases, the condition $x_{\mathbb{P}} < 0.05$ is imposed, where $x_{\mathbb{P}} = (Q^2 + M_X^2)/(Q^2 + W^2)$. The analyses are performed in the rest frame of the system X, the transverse momenta being defined with respect to the photon direction.[1] Jets with a transverse momentum cut $p_T > 5$ GeV are selected using a cone algorithm with radius $R = 1$.

RESULTS

A total of 400 dijet events are selected in photoproduction, and 78 events in electroproduction. The Q^2, y and $x_{\mathbb{P}}$ cuts, supplemented in the photoproduction case by the condition $-1 < \eta_{jet} < 2$, ensure a good containment of the system X in the detector and a good reconstruction efficiency. In the following, all distributions are corrected for acceptance and smearing effects using Monte Carlo simulations, which indicate a good correlation between the simulated quantities and the reconstructed variables.

The Monte Carlo simulations use the programs POMPYT [5] for photoproduction and RAPGAP [6] for electroproduction. Both are based on the factorisation of the jet production cross section into a flux of objects with a partonic structure emitted from the proton, followed by a hard interaction with the photon at a scale chosen in photoproduction to be the transverse momentum $\hat{p}_t$ of the partons in the hard subprocess, and in electroproduction the photon virtuality. The flux distribution of the exchange is parameterised as a superposition of a pomeron and a meson component, following the analysis of inclusive diffractive data in deep inelastic scattering [7]. The parton content of the pomeron is obtained from a QCD analysis of the same data, and is characterised for Q^2 about 5 GeV^2 by a gluon momentum weighted distribution peaking above $x_{g/\mathbb{P}} = 0.9$; at the higher scale values of the present analyses, radiation tends to flatten this distribution. The meson is modelled following the pion structure function [8], and is thus rapidly decreasing with β (β is the momentum fraction of the exchanged object carried by the struck quark). The POMPYT simulation includes for the photon a resolved and a direct contribution; the latter corresponds to $x_\gamma \simeq 1$, where $x_\gamma = \Sigma(E-p_z)_{jj}/\Sigma(E-p_z)_h$, the sums extending in the numerator over hadrons forming the jets, and in the denominator over hadrons in the X system.[2]

The data are compared to the Monte Carlo predictions as a function of p_T^2, x_γ and ξ. The variable ξ, defined as $\xi = (Q^2 + M_{jj}^2)/(Q^2 + M_X^2)$ where M_{jj} is the invariant mass of the dijet system,[3] is related to the fraction of the pomeron (or meson) momentum carried by the parton participating in the hard interaction. In the case of a boson gluon fusion process, it corresponds to the momentum fraction carried by the initial gluon.

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1) The momentum transfer transverse to the proton beam axis, which is small and not measured, is neglected. In photoproduction, the reference axis is thus the proton beam direction.
2) The $+z$ direction is that of the outgoing proton, and thus of the pomeron, whereas the photon longitudinal momentum is along the $-z$ direction.
3) In photoproduction, ξ reduces to $\xi = \Sigma(E+p_z)_{jj}/\Sigma(E+p_z)_h$.

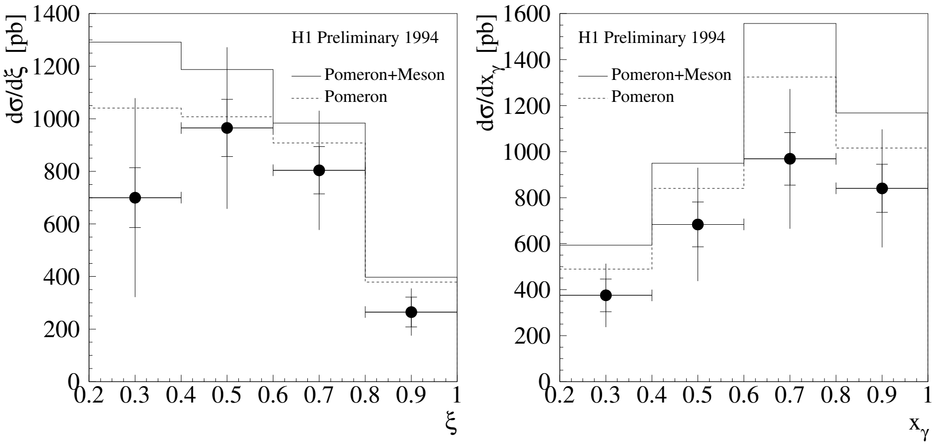

FIGURE 1. Di-jet cross section in photoproduction, as a function a) of ξ; b) of x_γ.

The photoproduction results are displayed in Fig.1, where the Monte Carlo predictions for the pomeron and the meson contributions are shown separately.[4] Within the large errors, which do not include the uncertainty on the scale choice, a reasonable agreement is observed with the POMPYT Monte Carlo predictions, both in normalisation and in shape. In contrast, the data are incompatible with a soft parton distribution in the pomeron, parameterised e.g. as $\beta \cdot G(\beta) = 6\ (1-\beta)^5$ [4] (not shown). The shape of the ξ distribution also disfavours the hypothesis of a "super hard", non QCD-evolved gluon distribution in the pomeron, as suggested in [3]. As the POMPYT predictions are based on an analysis of inclusive deep inelastic diffractive scattering, the factorisation hypothesis is supported by the present data, within the limits of the measurement precision and the uncertainty inherent in the choice of factorisation scale. Finally, the x_γ distribution indicates that both a resolved and a direct photon contribution are required to explain the data.

The electroproduction results in Fig.2 lead to conclusions similar to photoproduction, both the normalisation and the shape of the data being reasonably described by the RAPGAP Monte Carlo. The ξ distribution is compatible with a dominating photon gluon fusion contribution, with the gluon distribution in the pomeron obtained from inclusive diffractive interactions. Given the large uncertainties, mainly of statistical origin, the data can hardly distinguish between the choice of Q or of p_T as the scale for the hard interaction.

In conclusion, diffractive dijet production has been studied for $x_{\mathbb{P}} < 0.05$, both in photo- and in electroproduction. The data are reasonably well described by Monte Carlo simulations based on the analysis of inclusive diffractive interactions in deep inelastic scattering. This gives support, within

4) The pomeron contribution dominates over the meson even for $x_{\mathbb{P}} \simeq 0.05$, because of the difference in the parton distributions and the kinematical effects related to the jet requirement.

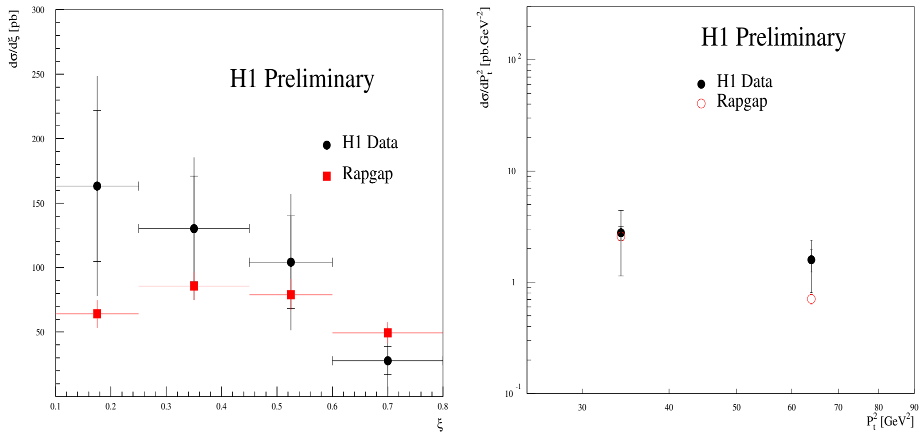

FIGURE 2. Di-jet cross section in electroproduction, as a function a) of ξ; b) of p_T^2.

the precision of the present measurement, to the hypotheses of a factorisable pomeron flux, accompanied by a meson component, and of a universal pomeron structure function.

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