JETS IN DIFFRACTIVE PHOTOPRODUCTION

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REPRESENTING THE H1 COLLABORATION

An analysis of events of the type $\gamma p \to XY$ is presented, where the systems X and Y are separated by a large rapidity gap, Y has mass less than 1.6 GeV and X contains a dijet system. Cross sections differential in jet transverse momentum and fractions of the photon and the pomeron momenta carried by the partons entering the hard scattering are measured and compared with POMPYT Monte–Carlo predictions using parton densities for the diffractive exchange as extracted from diffractive DIS measurements.

1 Introduction and Event selection

Observation of hard scattering in diffractive processes in $p\bar{p}$ (UA8, Tevatron) and in γp collisions at HERA [1] gave support to the hypothesis that the pomeron has a partonic structure [2]. In analysis of diffractive DIS at HERA the diffractive structure function $F_2^D(x_{I\!P/p}, \beta, Q^2)$ has been measured and parton distributions were extracted [3]. In this report we test the universality of diffractive parton densities using the class of large rapidity gap photoproduction events that contain a high transverse momentum dijet system.

The results are based on data obtained in 1994, from the collisions of 27.5 GeV positrons with 820 GeV protons, with an integrated luminosity of 2.2 pb^{-1}. Quasi-real photoproduction events are selected by requiring the scattered positron to be detected in the electron tagger situated 33 m downstream from the interaction point. For these events the photon virtuality and energy are limited to the ranges of $Q^2 \lesssim 10^{-2}$ GeV^2 and $0.25 < y < 0.7$. Diffractive processes are identified by an absence of hadronic activity in the pseudorapidity region $3.2 < \eta < 7.5$, near to the outgoing proton direction. The upper limit of the pseudorapidity gap restricts the measurement to the region $M_Y < 1.6$ GeV and $|t| < 1.0$ GeV^2. In order to reduce non–diffractive background we apply cut on $x_{I\!P/p} = M_X^2/W_{\gamma p}^2 < 0.05$. Approximately 400 events are selected which contain two jets in the pseudorapidity range $-1 < \eta^{jet} < 2$ with transverse momentum $p_T^{jet} > 5$ GeV.

2 Monte-Carlo

For comparison with the data we use the Monte Carlo generator program POMPYT 2.6 [4], based on the factorization of the ep jet cross section into a flux of photons emitted from the positron and a flux of objects with partonic structure emitted from the proton, followed by partonic hard interactions.

The flux distribution of the exchange from the proton is parametrized as a superposition of the pomeron and meson components, following the analyses of inclusive diffractive data in DIS [3]. The partonic content of pomeron is obtained from a QCD analysis of the same data. Three sets of light quark and gluon distributions are implemented. For the first set of parton distributions (Fit 1) only quarks contribute to $I\!P$ structure at the starting point for DGLAP evolution $Q_0^2 = 3$ GeV^2. Another two fits include gluons at the starting scale. These fits differ in their parametrizations of the parton distributions such that gluon distribution at low scale is either relatively flat in the fraction of pomeron momentum carried by the parton entering the hard scattering– $z_{I\!P}$ (Fit 2) or is peaked in the region of high $z_{I\!P}$ (Fit 3).

Parton densities in the photon are generated using the GRV-LO parametrization. Both resolved and direct photon contributions are included.

Uncertainties in the Monte–Carlo predictions due to the choice of scale at which the parton distributions are taken within the range $\mu = \hat{p}_T/2$ to $2\hat{p}_T$ are found to be at the level of 20%. Changing the choice of photon parton density parametrization leads to uncertainties of 10%.

3 Results and Discussion

Fig.1 shows the photoproduction cross section differential in jet momentum p_T^{jet} transverse to γp interaction axis. The data points include statistical and non–correlated systematic errors. There are in addition 22.5% overall systematic errors. The models in which the diffractive parton distributions are dominated by hard gluons reproduce the overall dijet rates to within the combined statistical and systematical uncertainties. In contrast, the model in which the pomeron consist of quarks at the starting scale underestimates the cross section by a factor $\sim 4-6$. Contributions from the sub-leading exchange are below 10%.

Fig.2a,2b show the differential cross sections as a function of the reconstructed fractional momentum of partons from the photon and pomeron x_γ^{jet} and $z_{I\!P}^{jet}$, which are defined as
$x_\gamma^{jet} = \sum_{jets}(E-P_Z)/\sum_{all}(E-P_Z)$, $z_{I\!P}^{jet} = \sum_{jets}(E+P_Z)/\sum_{all}(E+P_Z)$

Cross sections are compared with POMPYT predictions using gluon dominated pomeron parton densities. In the x_γ^{jet} distribution the contribution

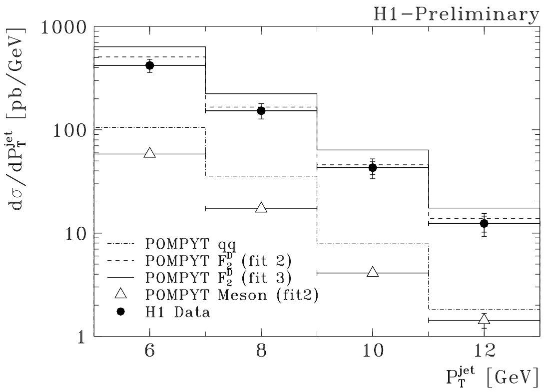

Figure 1: The dijet cross section differential in jet transverse momentum.

from direct photon processes is also shown, which is significant at high x_γ^{jet}. Both Monte-Carlo models follow the shape of the data distribution. However, with the exception of the highest x_γ^{jet} interval, there is an excess in the absolute predictions. In particular POMPYT with a "peaked gluon" shows large deviations from the measured distribution.

Several authors predict that the factorization that holds in inclusive hard scattering will break down in diffractive hard scattering [5]. The problem is that soft interactions between spectator partons in the spatially extended photon and the proton can destroy the rapidity gap. This effect is not expected to be present in direct photon interactions. Since no full calculations of spectator interactions in diffractive photoproduction exist, we compare the data to the POMPYT models after applying constant weighting factors, so called "survival probablities", $< S >= 0.65$ for the "flat" and $< S >= 0.4$ for the "peaked gluon" to all events generated with $x_\gamma < 0.8$. The introduction of this factor improves the distributions at low x_γ^{jet} and at all $z_{I\!P}^{jet}$ (Fig.2c,2d).

4 Conclusions

We measured the dijet cross sections $d\sigma/dp_T^{jet}$, $d\sigma/dx_\gamma^{jet}$ and $d\sigma/dz_{I\!P}^{jet}$ in diffractive photoproduction. The rates are consistent with a model in which diffractive parton densities are dominated by hard gluons at low scales and evolve according to DGLAP equations to a scale set by $\hat{p}_T$ of the outgoing partons.

If factorization of the hard scattering process holds also in resolved γp diffractive interactions, then parton distributions with a "flat" $I\!P$ gluon structure describe the data better than those where the gluon distribution is "peaked" at large $z_{I\!P}$.

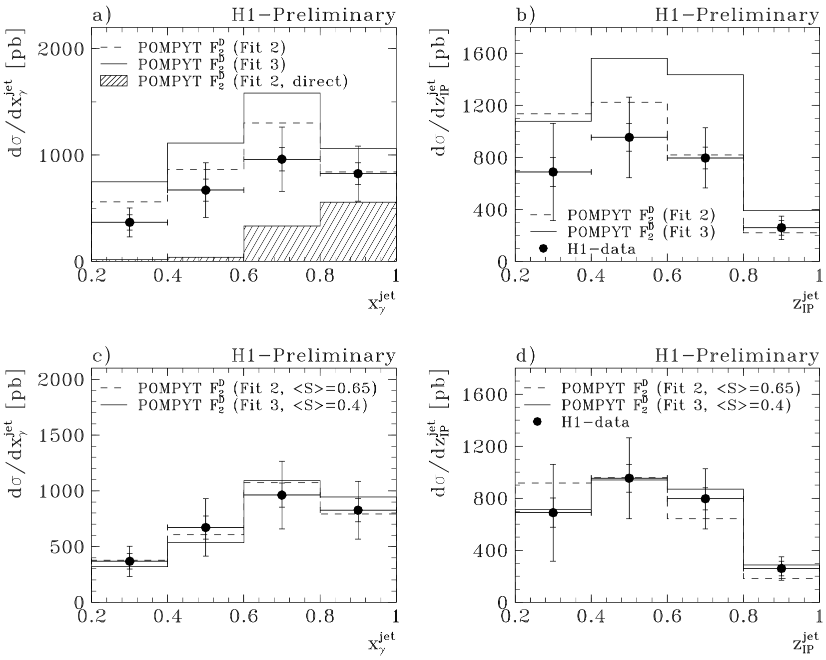

Figure 2: The dijet cross section differential in x_γ^{jet} and $z_{I\!P}^{jet}$, compared to POMPYT predictions with and without the introduction of rapidity gap destruction effects.

When testing a break down of factorization using a probability of the order of $40-70\%$ for the rapidity gap to be destroyed by additional soft interactions, then the jet rates are well described using the parton distributions as extracted from diffractive DIS with a "flat" or "peaked" gluon density at large $z_{I\!P}$.

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