Fermilab FERMILAB-Conf-00/141-E CDF June 2000

DOUBLE POMERON EXCHANGE AT THE TEVATRON: RESULTS FROM CDF

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Results on dijet production with a double pomeron exchange event topology are presented. The events are selected with the requirement of a leading antiproton and a rapidity gap on the opposite side. By comparing the ratio of dijet production in double pomeron exchange to single diffraction with the corresponding ratio of single diffractive to non-diffractive dijet production factorization is tested.

Using data with a track in the Roman Pot Spectrometer (RPS) from a leading antiproton the CDF Collaboration measured the diffractive structure function from dijet production in single diffraction (SD) [1,2] and compared it to that measured by the H1 Collaboration at HERA. Differences observed in the magnitude as well as in the shape of the two diffractive structure functions indicate a breakdown of factorization. Two possible reasons for the factorization breaking may be the difference of process type, dijet production in $p\bar{p}$ collisions versus deep inelastic ep scattering, or the difference in center of mass system (cms) energies, $\sqrt{s} = 1800\text{GeV}$ at the Tevatron versus $\sqrt{s} \approx 300\text{GeV}$ at HERA. In this paper we present a factorization test in which only Tevatron data are used. This test is based on a comparison between the diffractive structure function measured in SD and that measured in double pomeron exchange (DPE) [3].

In Refs. 1,2, the ratio $R^{SD}_{ND}(x_{\bar{p}}, \xi_{\bar{p}})$ of dijet production rates of SD events, selected with a track in the RPS, to non-diffractive events (ND), collected with a minimum bias trigger, was measured as a function of $x_{\bar{p}}$, the x-Bjorken of the interacting parton in the antiproton, and of $\xi_{\bar{p}}$, the fractional momentum loss of the antiproton. The $x_{\bar{p}}$ was evaluated from the E_T^i and η_i of the jets:

$$x_{\bar{p}} = \frac{1}{\sqrt{s}} \sum_i E_T^i e^{-\eta_i} \quad (i = 1, 2, \text{ and } 3 \text{ if } \quad E_T^3 > 5\text{GeV}) \tag{1}$$

Using DPE events, characterized by a diffractive interaction at both the antiproton and the proton vertices, factorization can be tested by comparing $R^{SD}_{ND}(x_{\bar{p}}, \xi_{\bar{p}})$ with the ratio $R^{DPE}_{SD}(x_p, \xi_p)$ of DPE to SD events as a function of x_p-Bjorken and ξ_p. Factorization implies that

$$R^{SD}_{ND}(x_{\bar{p}}, \xi_{\bar{p}})/R^{DPE}_{SD}(x_p, \xi_p) = 1 \text{ for fixed } x \text{ and } \xi. \quad (2)$$

From the SD dijet sample, events with a DPE topology are selected by requiring a rapidity gap on the outgoing proton side (opposite the RPS). The rapidity gap is defined as no hit in the Beam-Beam Counters ($3.2 < \eta < 5.9$), and no towers in the forward calorimeter ($2.4 < |\eta| < 4.2$) with energy above noise. The correlated multiplicity distribution in these two detector components in Fig. 1 (a) shows the DPE signal in the (0,0) bin. The background contribution is determined by fitting the distribution along the diagonal with $N_{FCAL_p} = N_{BBC_p}$, Fig. 1 (b). The rise of the $\xi_{\bar{p}}$ distribution (measured with the RPS) with increasing $\xi_{\bar{p}}$ for DPE relative to SD dijet events, Fig. 1 (c), is attributed to the lower pomeron-pomeron relative to pomeron-proton cms energies and the steep x-dependence of the diffractive $\bar{p}$ structure. Fig. 1 (d) presents the distribution of the values of ξ_p, measured by using Eq. 1 for all "particles" (tracks and towers) in an event and changing the sign of η. For the factorization test, events in the region $0.01 < \xi_p < 0.03$ were selected.

Figure 2 shows the ratios R^{DPE}_{SD} as function of x_p and R^{SD}_{ND} as function of $x_{\bar{p}}$ normalized per unit ξ. The factorization test has to be performed at the same x and also at the same ξ. The insert of Fig. 2 displays the weighted average of the ratios R over the region of x within the kinematic boundaries indicated by the dashed vertical lines in the main figure as a function of ξ ($\xi_{\bar{p}}$ for SD and ξ_p for DPE). The SD data are presented in 6 bins in $\xi_{\bar{p}}$. Extrapolating the flat distribution of the ratio $R^{SD}_{ND}(\xi)$ to $\xi = 0.02$, where $R^{DPE}_{SD} = 0.8 \pm 0.26$, we obtain 0.15 ± 0.02, which results in $D \equiv R^{SD}_{ND}/R^{DPE}_{SD} = 0.19 \pm 0.07$. The discrepancy of D from unity represents a breakdown of factorization. The magnitude of D is similar to that found in comparisons between measured W and dijet production rates at the Tevatron with expectations from diffractive DIS at HERA [4,5].

Several other interesting results obtained from the DPE data have been reported [3]. In comparison with SD events, the DPE events have a slightly steeper E^*_T distribution, where E^*_T is the averaged transverse energy E_T of the two leading jets. The two leading jets are more back to back, hinting to less radiation in DPE than in SD. In DPE, the mass of the dijet system accounts for up to 65% of the mass of the central system, $M_X = (s\xi_p\xi_{\bar{p}})^{\frac{1}{2}}$, as compared with up to 25% in SD. These trends are also seen in comparing SD with ND dijet events. The absolute DPE cross section for dijets with $E_T > 7$ [10] GeV in the kinematic range of $0.035 < \xi_{\bar{p}} < 0.95$, $0.01 < \xi_{\bar{p}} < 0.03$, $|t_{\bar{p}}| < 1\text{GeV}^2$ (the 4-momentum transfer squared at the antiproton vertex) and $-4.2 < \eta_{jets} < 2.4$ is found to be $\sigma^{DPE} = 43.6 \pm 4.4(stat) \pm 21.6(syst)$ $[3.4 \pm 1.0(stat) \pm$

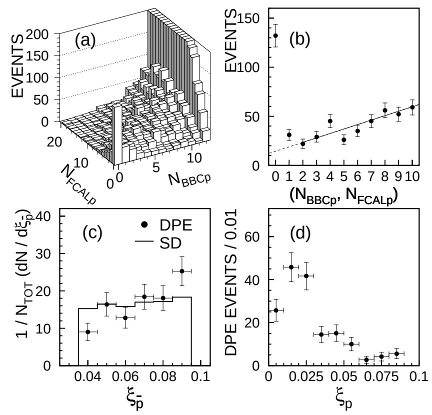

Figure 1: (a) BBC hits versus forward calorimeter towers above threshold, (b) multiplicity along the diagonal, (c) $\xi_{\bar{p}}$ for DPE and SD events and (d) ξ_p in DPE dijet events.

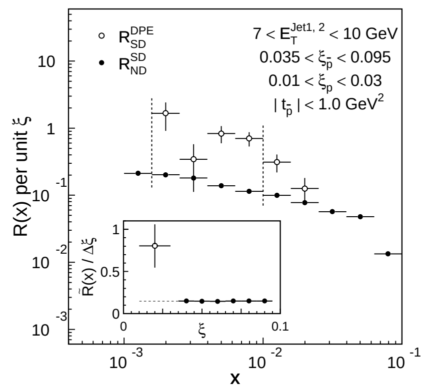

Figure 2: Ratios of DPE to SD (SD to ND) dijet event rates per unit ξ_p ($\xi_{\bar{p}}$) as function of x_p ($x_{\bar{p}}$). Inset: the weighted average of the above ratios in the region of x within the vertical dashed lines.

2.0(*syst*)]nb. From the dijet mass fraction distribution (fraction of dijet mass to total pomeron-pomeron cms energy) a 95% C.L. upper limit for events in which the dijet mass accounts for the entire pomeron-pomeron cms energy was set at 3.7nb. This limit is smaller than the prediction of Ref. 6 by a factor of $\sim 10^3$, but compatible with the prediction of Ref. 7.

Acknowledgments

The support from the Max Kade Foundation and the Ministry of Education, Science and Research of the Federal State Nordrhein-Westfalen of Germany is gratefully acknowledged.

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