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RAPIDITY GAPS IN HARD PROCESSES AT DØ

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Latest results on jet production with rapidity gaps at the Fermilab Tevatron Collider are presented. Jet production via color-singlet exchange at high momenta transfer is observed as a class of events with low particle multiplicity (or rapidity gaps) between the two highest transverse energy jets. The particle multiplicity in various regions, and the dependencies on jet pseudorapidity separation and jet transverse energy are studied for these events. Results from two classes of dijet events with one or two forward rapidity gaps are also presented. The topology of these events is consistent with expectations for hard single diffraction and hard double pomeron exchange processes, respectively.

1 Rapidity Gaps Between Jets

Two jets separated by a rapidity gap, defined as a region of rapidity (or pseudorapidity η) containing no final-state particles, has been proposed as a signature for jet production via the exchange of a color-singlet (colorless) object [1,2]. Recent experiments provide evidence for a strongly-interacting color-singlet [3,4,5,6]. We present new results on color-singlet exchange from the 1994-95 collider run.

Comparing particle multiplicities is a convenient method for distinguishing color-singlet exchange from the color-octet background. Particle multiplicity between the two leading transverse energy (E_T) jets is approximated by counting electromagnetic (EM) calorimeter towers (0.1 x 0.1 in $\eta - \phi$) with $E_T > 200$ MeV (n_{cal}) and central tracks (n_{trk}). We present a new measurement of color-singlet exhchange as a function of the E_T of the two leading jets. The fractional excess above a parametrization of the background mulitplicity is observed to be roughly constant and on the order of 1% of the inclusive dijet sample over a significant range of E_T, consistent with a strongly-interacting color-singlet exchange process. Future studies will include an η dependence measurement.

Color exchange fluctuations can also produce rapidity gaps. Therefore, the presence of a rapidity gap is not sufficient to tag an event as color-singlet exchange. It is interesting to study the characteristics of a rapidity gap sample (with $\mathrm{n_{cal}} = \mathrm{n_{trk}} = 0$ between the jets) as compared to a background sample (with $\mathrm{n_{cal}} = 3$ and $\mathrm{n_{trk}} > 2$ between the jets). We can also include a 'quiet' sample (with $\mathrm{n_{cal}} = 0$ and $\mathrm{n_{trk}} > 0$, or $\mathrm{n_{cal}} = 1$ and $\mathrm{n_{trk}} = 0$) to study our efficiency for tagging color-singlet events. For this comparison, n_{cal} is

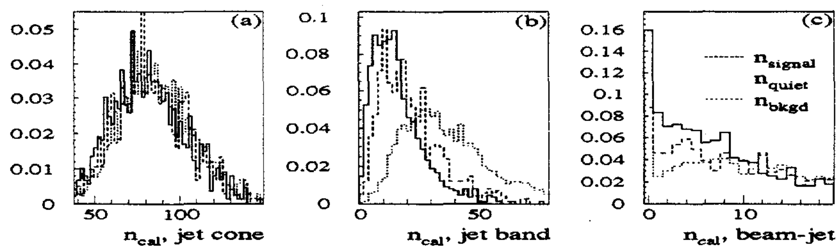

Figure 1: Multiplicity (n_{cal}) a) in cone of leading jets, b) in band of jets excluding the jets, c) in beam-jet region

the number of EM calorimeter towers with energy (E) $>$ 200 MeV . Using an energy threshold provides greater sensitivity for tagging forward particles. The rapidity gap sample is estimated to be about 90% color-singlet exchange, while the background sample is estimated to be about 90% color exchange. The multiplicity (n_{cal}) in different $\eta - \phi$ regions is compared for the rapidity gap sample, the background sample, and the quiet sample. Figures 1(a)-(c) show the multiplicity in: a) the cone ($R = \sqrt{\Delta\eta^2 + \Delta\phi^2} = 0.7$) of the two leading jets, b) the η band ($\eta_{jet} \pm 0.7$) of the jets, excluding the jet cone, and c) the beam-jet region ($|\eta| > |\eta_{jet}| + 0.7$).

These distributions show that the multiplicity in an event is correlated across $\eta - \phi$. Rapidity gap events tend to have lower multiplicities than non-gap events in most event regions. These correlations are presumably due to differences between color and color-singlet exchange processes. In the future, the internal jet structure and more detailed multiplicity correlations will be studied.

2 Forward Rapidity Gaps

Hard diffraction has recently been defined as events which contain a hard scattering opposite a large rapidity gap. Jet production in diffractive events has been observed by both UA8 [7] and HERA[8]. CDF has set an upper limit of 0.75% of dijet events due to hard single diffraction [8]. Observations and measurements of hard diffraction give new insight into the pomeron.

The DØ collaboration implemented several triggers to search for hard single diffraction and hard double pomeron exchange in the 1994-96 running period. The triggers utilized the Level Ø detectors, which are arrays of scintillating tiles surrounding the beam pipe on either side of the central calorimeter, and are used for tagging inelastic scattering. An inclusive trigger ignored Level Ø. A single veto trigger vetoed events with hits in one array. A double veto trigger vetoed events with hits in both arrays. Figure 2 shows a two dimensional multiplicity distribution for the inclusive trigger for EM calorimeter towers with $E > 200$ MeV $(n_{cal(EM)})$ and hadronic calorimeter towers with $E > 600$ MeV $(n_{cal(HAD)})$ in the region $2 < |\eta| < 4$ for the minimum multiplicity hemisphere of the detector. The spike at zero multiplicity shows there is an excess of events with a forward rapidity gap in both the electromagnetic and hadronic calorimeters. Other studies show that these rapidity gap events are also quiet in other detectors such as the forward tracking and forward muon system. The fractional excess observed in the forward region is $0.67 \pm 0.05\%$, where the error includes only statistical uncertainties and a systematic uncertainty based on the choice of range for the fit.

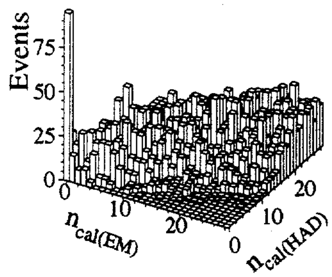

Figure 2: Multiplicity Distribution in Inclusive Sample

The fraction of single gap events in the inclusive sample can be measured, and then combined with the measured fraction of double gap events in the single veto sample to give a fraction of double gap events in the inclusive sample. The double gap events are present at a rate of $O(10^{-6})$ of the inclusive sample. Further study is required to associate this rate with hard double pomeron exchange.

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