The Diffractive Structure Function: $\xi$ dependence

Christina Mesropian
The Rockefeller University
The Diffractive Structure Function

Subject of interest:
Hard diffraction process:
production of high $p_T$ dijets

Study the diffractive structure function

$$F^D_{ij}(x, Q^2, \xi) = x \left[ g^D(x, Q^2, \xi) + \frac{4}{9} q^D(x, Q^2, \xi) \right]$$

Regge factorization:
$$F^D_{ij} = \int p^D(\xi) \times F^p(\beta, Q^2)$$

$\xi$ - fractional momentum loss of $\bar{p}$

$\beta = \frac{X}{\xi}$ fraction of the $P$ momentum
carried by the struck parton

Single Diffractive dissociation

December 02, 2003
Christina Mesropian
The Diffractive Structure Function

2 dijet samples:

SD: diffractive – leading $\bar{p}$
ND: non-diffractive

kinematic region

$|t| < 1 \text{GeV}^2$

$0.035 < \xi < 0.095$

$E_{T_{jet1,2}} > 7 \text{GeV}$

Measure ratio of SD to ND

$$R_{\text{SD}}^{\text{ND}} (x_p, \xi)$$

then

$$F_{jj}^{D} (x_p, Q^2, \xi) = R_{\text{SD}}^{\text{ND}} (x_p, \xi) \times F_{jj}^{ND} (x_p, Q^2)$$

known ND structure function
The Diffractive Structure Function

Power Law dependence

\[ F_{ij}^D = C \left( \frac{1}{\beta^n} \right) \left( \frac{1}{\xi^m} \right) \]

for \( \beta < 0.5 \)
\( n = 1.0 \pm 0.1 \)
\( m = 0.9 \pm 0.1 \)
The Diffractive Structure Function: Run I

\( \xi \) dependence

contributions from reggeon exchange in \( 0.035 < \xi < 0.095 \) range

if reggeon has different structure than pomeron

change in shape for \( R_{SD/ND} \) as a function of \( x \)

no \( \xi \) dependence
The Diffractive Structure Function: Run 2:

to study \( \xi \) dependence for low \( \xi \) (<0.035) values

rapidity gaps

events without hits in BSC on the \( p \) or \( \bar{p} \) side

East \( \text{dijets} \)

West
BSC gap requirement
Beam Shower Counters:

scintillation counters around the beam pipe

detect particles traveling in direction from interaction point along beam pipe

5.5 < |\eta| < 7.5 coverage

BSCs provide East and West gap triggers:
The Diffractive Structure Function: Run 2: Trigger

gap trigger rate decreases with increasing luminosity – additional interactions “kill” gap

<table>
<thead>
<tr>
<th>Trigger name</th>
<th>PS</th>
<th>Rate (Hz)</th>
<th>Cross Section</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1_GAP.WEST.JET5</td>
<td>1</td>
<td>101.2</td>
<td>12.8 µb</td>
</tr>
<tr>
<td><strong>Level 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2_PS500.L1_GAP.WEST._&amp;_JET5</td>
<td>500</td>
<td>0.20</td>
<td>27.6 nb</td>
</tr>
<tr>
<td>L2_JET15.&amp;_L1_GAP.WEST.T_PS50</td>
<td>50</td>
<td>0.25</td>
<td>34.3 nb</td>
</tr>
<tr>
<td>L2_JET40.&amp;_L1_GAP.WEST.T</td>
<td>1</td>
<td>1.63</td>
<td>223.0 nb</td>
</tr>
<tr>
<td><strong>Level 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIFF_GAPW.ST5</td>
<td>1</td>
<td>0.20</td>
<td>27.4 nb</td>
</tr>
<tr>
<td>DIFF_GAPW.JET20</td>
<td>1</td>
<td>0.11</td>
<td>15.3 nb</td>
</tr>
<tr>
<td>DIFF_GAPW.JET50</td>
<td>1</td>
<td>0.19</td>
<td>25.5 nb</td>
</tr>
</tbody>
</table>

MBR Monte Carlo simulation

Sum of ADC counts for BSC1-E counters

- **NON-GAP trigger**
- **GAP+J5 trigger**
The Diffractive Structure Function: Run 2

determination of $\xi$:

from the information of final state particles in the diffractive mass system $X$

$$\xi_{\bar{p}p} = \frac{1}{\sqrt{s}} \sum_i E_T^i e^{-\eta^i}$$

information from calorimeters:

forward calorimeters:

MiniPlugs: $3.5<|\eta|<5.1$

$$\Delta \eta_{gap} \approx \ln \xi$$

low $\xi$ values

$0.001 < \xi$

possibly…
The Diffractive Structure Function: Run 2

Tighter cut on BSCW gap for cross reference with RP+Jet data sample

ADC spectrum for BSC1-W1 station

Tighter cut on BSCW gap

December 02, 2003
Christina Mesropian
The Diffractive Structure Function: Run 2

Cleaner sub-sample

0-0 bin corresponds to BSCW+MPW gap sub-sample
The Diffractive Structure Function: Run 2

BSCW- Gap + Jet Sample

$0.001 < \xi$

Strategy for the analysis:

- calculate $\xi$ for each event
- separate clean diffractive sample:
  - calculate $x$ for dijet system
  - compare with ND Jet5 sample
  - cross checks with RP + Jet5 sample
- different $Q^2$ samples for the same trigger…
Summary

FACT:
New possibility to extend $\xi$ range down to 0.001 for $Q^2 \leq 100$ GeV$^2$

QUESTION:
Will the $\xi$ distribution at the Tevatron be the same as at HERA at very low $\xi$?

ANSWER:
New results from CDF Run 2 data coming soon!