Diffraction: Suggestions from HERA for Tevatron-RunII

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1. The BFKL Pomeron

HERA results on forward jets are published in Nucl.Phys.B 538 (1999) 3 (H1) and Eur.Phys.J.C 6 (1999) 239 (ZEUS).

H1 compares experimental data with fixed-order matrixelement calculations (LO DISENT) and LO-BFKL analytic predictions. Data are well above the fixed-order matrixelement calculations, but below the analytic predictions. For large x, data, fixed-order matrixelement calculation, and BFKL curve tend tio coincide. Since hadronization has not been included in the analytic calculations, it has been suggested to compare π_0 or charged pion final states instead of jets. Data on Angular decorrelations are reproduced also by non-BFKL Monte Carlo (e.g. Ariadne 4.08); they do not seem to provide such a clear BFKL footprint.

ZEUS first compares analytic calculations (LO BFKL) with fixed-order matrixelement (NLO MEPJET) and several Monte Carlos (all on the partonic level). In particular, Ariadne 4.08 lies between MEPJJET and analytic BFKL calculations. Jet Data are then compared with the Monte Carlos: Ariadne 4.08 comes closest to the data.

These results are quite consistent with those obtained by H1 and can be summariized as follows: Data are above the fixed-order matrixelement predictions, but below the LO BFKL curve. At small rapidity separation between the forward jet and the quark pair, the three curves (data, fixed-order matrixelement predictions, BFKL curve) converge. A (very cautious) interpretation: data show that, with increasing rapidity separation, there is "something more" than the processes contained in the fixed order QCD calculations, most likely the radiation of a few extra gluons, which leads to a growth in $1/x_B$. BFKL (plus corrections?) could be the right theoretical tool for calculating the production of these gluons.

On the theoretical side, we need to include hadronization; furthermore we have to understand how to incorporate the NLO corrections to BFKL. It is not enough to lower the power of $1/x_B$: we also need NLO corrections to the quark-antiquark pair at the photon vertex and the NLO corrections at the jet-production vertex.

As a suggestion for the analysis of TEVATRON data (in addition to what has been done already or is presently being done): in order to support (or to disprove) the HERA conclusion from above, one might try to compare data in an analogous way with fixed order matrixelement calculations and with the analytic BFKL curve.

In detail: at fixed machine energy vary the rapity gap the two jets, i.e. vary the longitudinal momentum fractions of the partons coming from the proton and the antiproton. This introduces a dependence upon the x-shape of the parton distributions. Parton densities are now better known than 10 years ago when the Mueller-Navelet Jets where first suggested. Using CTEQ, MRS or gluon densities form HERA, one might therefore try to produce a prediction for a 'fixed-oder matrixelement calculation' (=two jet final state, with no parton being produced between them), as well as a LO BFKL prediction (for gluon production between the two jets). Since both predictions will decrease with increasing rapidity separation, it may be useful to consider the ratios: BFKL/(fixed order calculation) and data/(fixed order calculation).

The HERA message leads to the expectation that, for small rapidity separation beteen the jets, the data should be close to the fixed order calculations (and the BFKL curve, improved by the arguments of DelDuca and Schmidt). With increasing rapidity, the ratio: data/(fixed order calculation) should start to rise, but (most likely) stays below the curve BFKL/(fixed order calculation). The theoretical curves have a built-in uncertainty, due to the parton densities used for the calculation, which should be marked in the plots.

If the results of such an analysis are encouraging, theorists have to work on the NLO corrections, analogous to the forward jet corrections described above.

2. Large Momentum Transfer

3. Diffractive Structure Function