HERA results: what needs still to be done?

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- Structure Functions
- Diffraction
- Multiple interactions

Structure Functions

One of the main HERA results: structure functions in the low Q^2/low x region.
High statistics and precision of F_2 data, very precise QCD evolution.

General believe: leading twist DGLAP works down to low Q^2, higher twist is small (few percent level).

Two points of view:

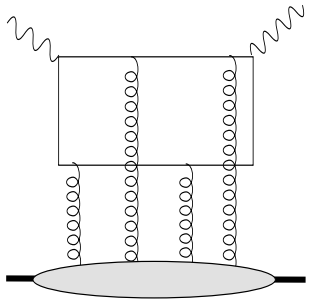
A: "At low Q^2 initial conditions for DGLAP
- belong to nonperturbative dynamics -
is useless to apply pQCD to this region"

B: "Transition should be smooth
- study onset of corrections -
most attractive: idea of saturation"

Questions:
is F_2 enough to establish the validity of DGLAP at low Q^2? Could low Q^2 data spoil the praecision of LHC predictions?

How good is evidence for saturation?
How to find further evidence?
Hope for NLO corrections?

Ad A:
We have no systematic theoretical investigation of the gluon twist-4 corrections at low x.
Leading log result at low x: partial cancellation of $\Delta F_L < 0$ and $\Delta F_t > 0$.



Explaination why $\Delta F_2 = \Delta F_L + \Delta F_t$ is small?
Urgent need for F_L at low Q^2.

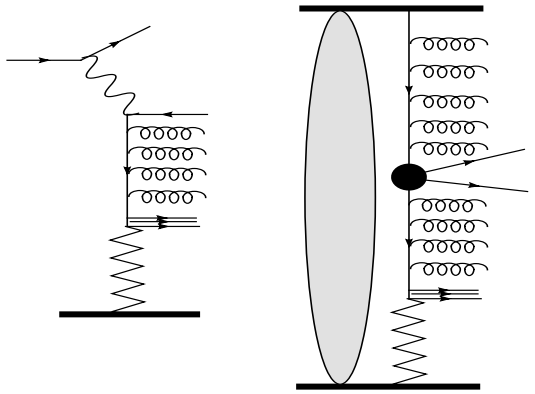
Ad B:
Test of saturation models for F_L data (at low Q^2).

Saturation can be tested at the LHC, analytic QCD calculations needed:

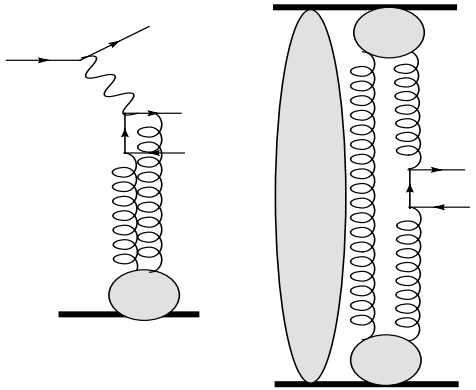
- for baryons: dipole picture not complete
- single jet inclusive cross section under investigation

Diffraction

Key issue at proton colliders: survival probability (not so important at HERA).
Current models based are upon clean separation of hard and soft dynamics:



diffractive structure function

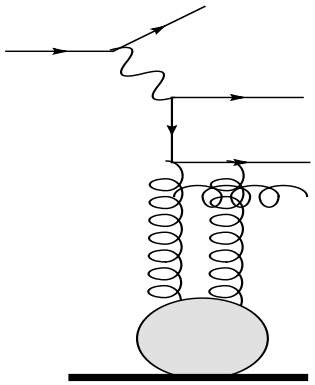


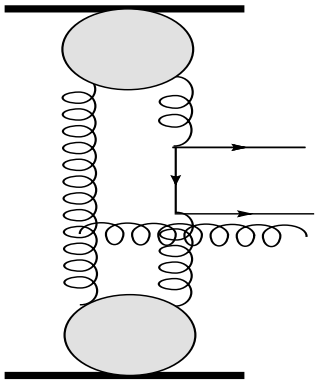
diffractive exclusive final state

Consequence: survival factor has weak dependence upon variation of hard scale.
Presumably not quite correct. But how to compute?

First step: compare HERA and Tevatron data (differentially in hard scale and in β/ξ) .

Another question in exclusive diffractive final state:





HERA: NLO for $q\bar{q}$
Vary the rapidity of the gluon.
Interest:
azimuthal dependence,
test of saturation model
...

LHC:

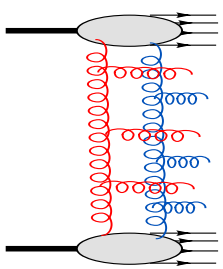
NLO for diffractive dijet, Higgs

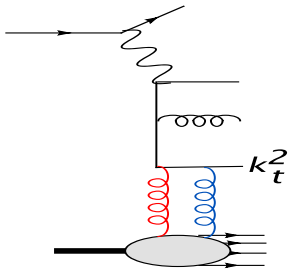
Do we understand exclusive states in diffraction?

Multiple Interactions

No doubt that events at LHC will be full of multiple interactions.
For which cross sections (multijet final states...), in which kinematic regions will corrections from multiparton chains be important?
Evidence at HERA (photoproduction) and at Tevatron (Field).
Monte Carlo programs for multiple interaction do not contain (hard) diffraction.

Do HERA data offer special insight? Could diffraction be a key?





Difficulty: scale k_t^2 should not be small. Therefore not all HERA diffraction data can be used. Strategy?