Multiparton evolution: recombination

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based upon collaboration with

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- Motivation
- Recombination
- Diffraction

Introduction

Little doubt that we need multiple interactions in pp scattering at LHC

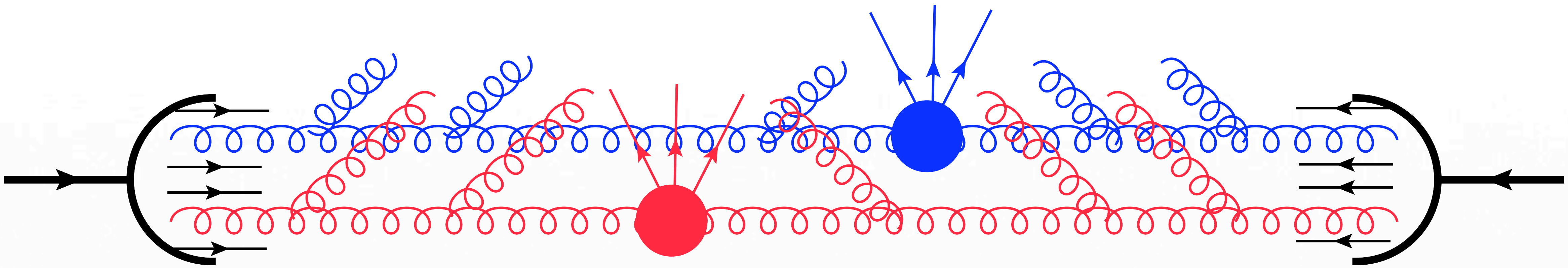
Theoretical background of multiple interactions: a (relatively) young field.

Questions:
- evolution equations : in x or in momentum scale ?
  (BFKL-type vs.higher twist B'F'KL)
- consistency requirements - AGK cutting rules
- detailed form of evolution equations
- in course of evolution, change the number of parton chains (triple vertex)

This talk: address particular aspects

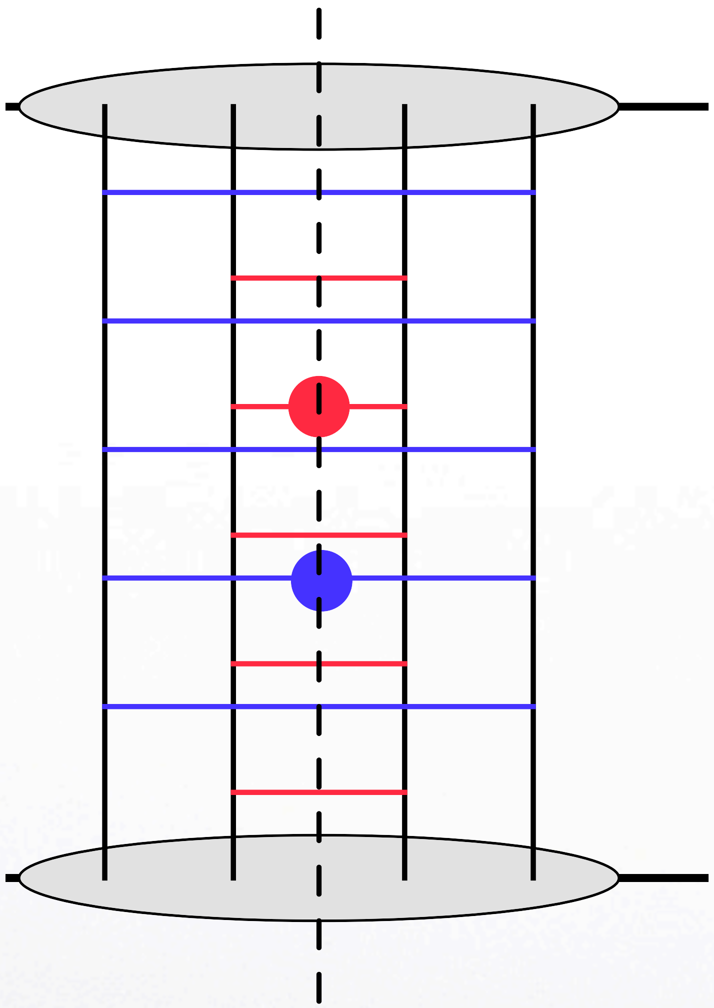
recombination (=correlation, swing,...), diffraction

Evolution of two chains = is double DGLAP good enough?

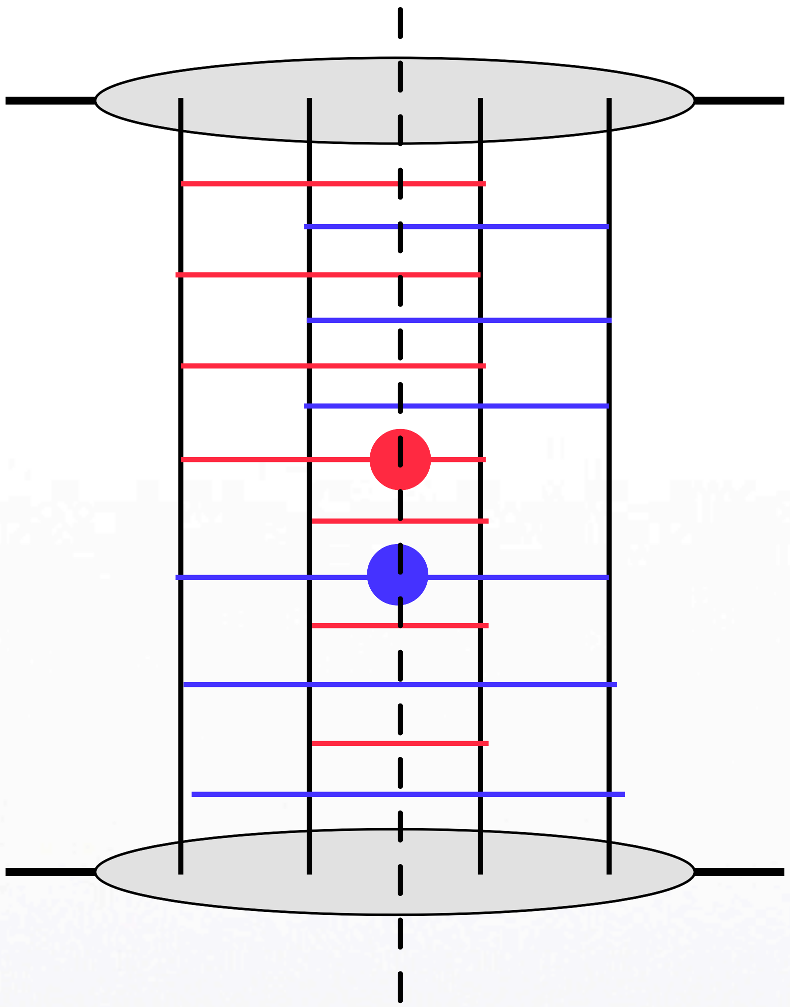


Motivation:

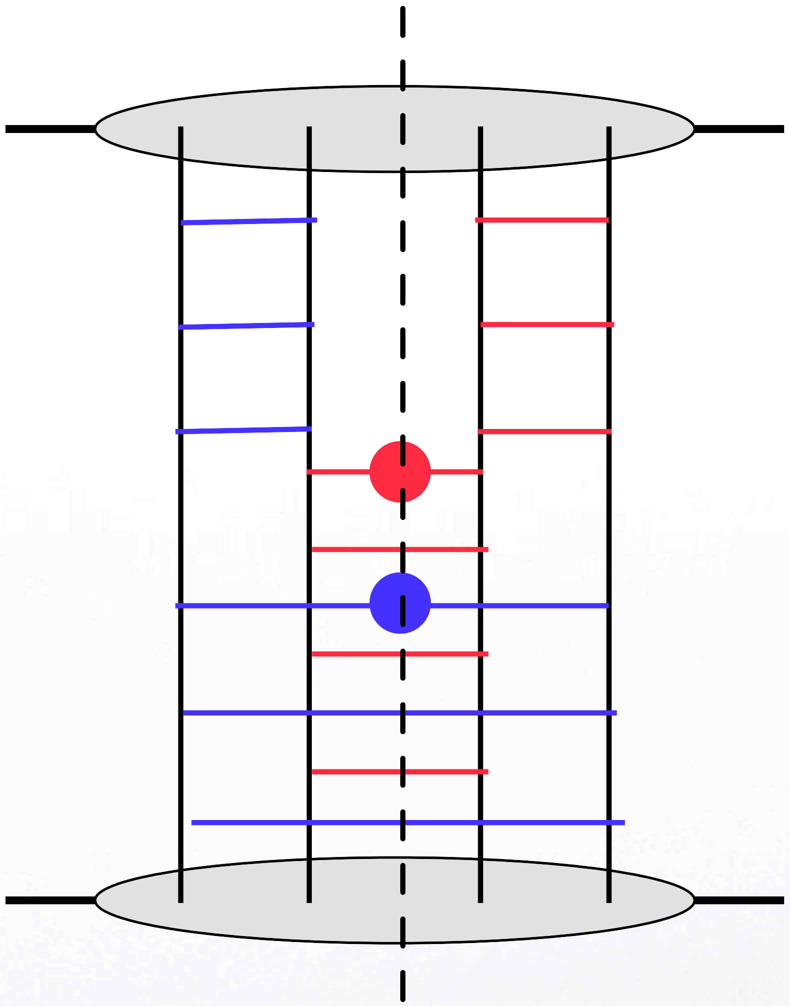
- corrections to double DGLAP
- diffraction
- saturation (ridge effect: Jamal's talk)



double DGLAP



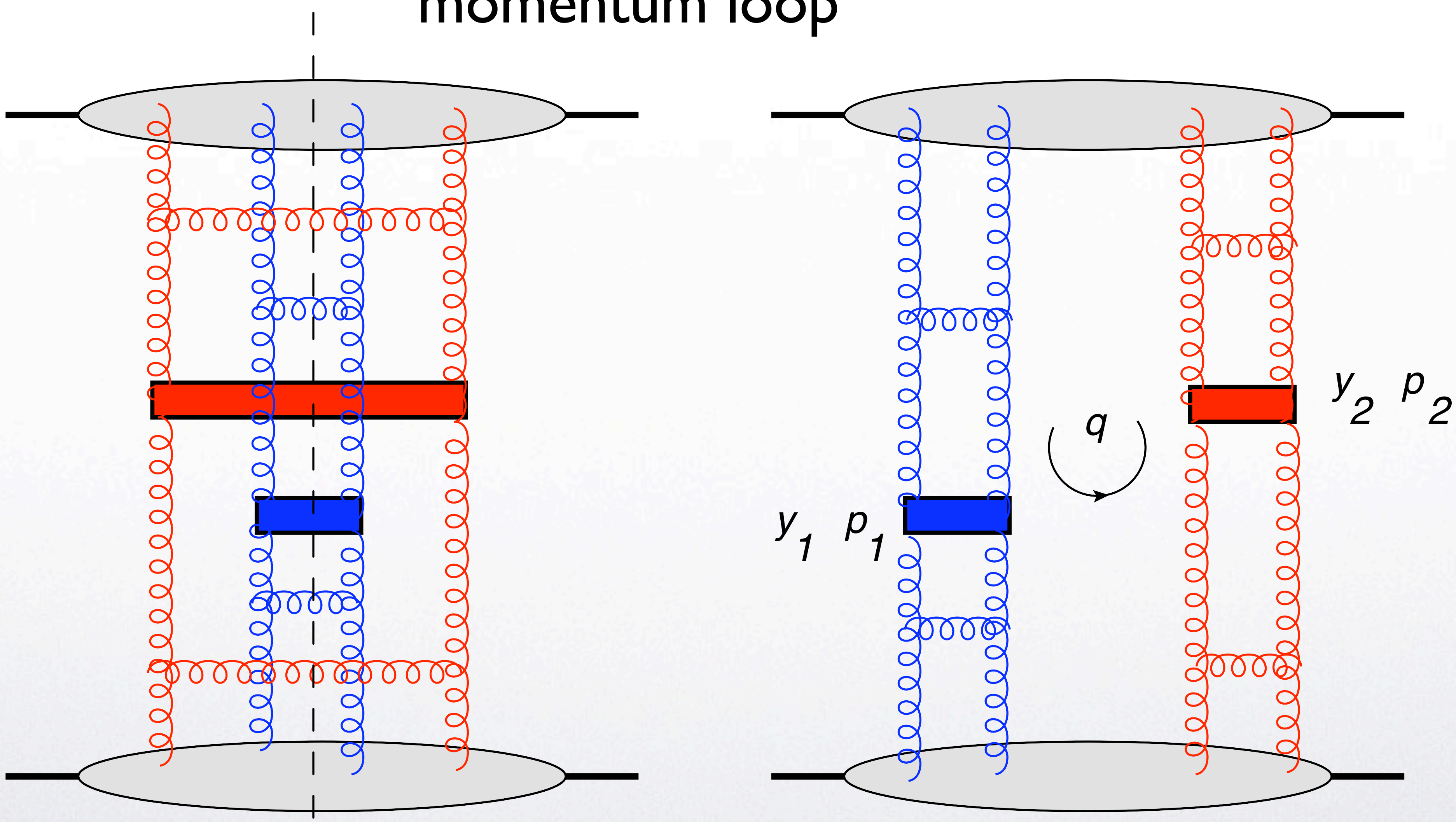
recombination 1



recombination 2
(diffraction)

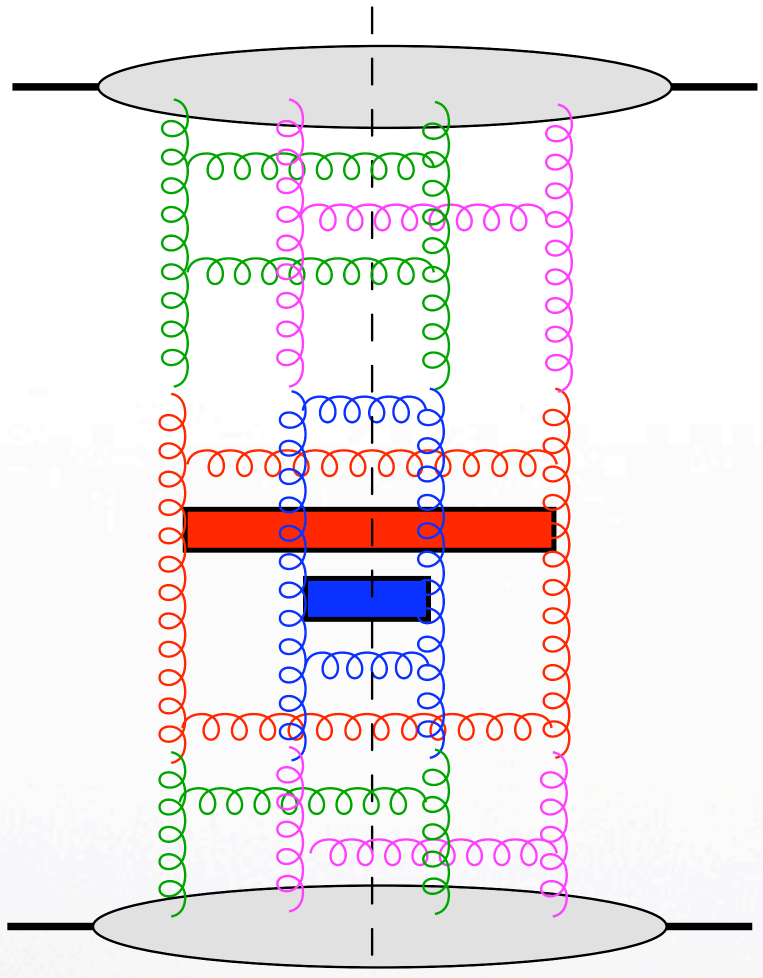
Recombination: a few details

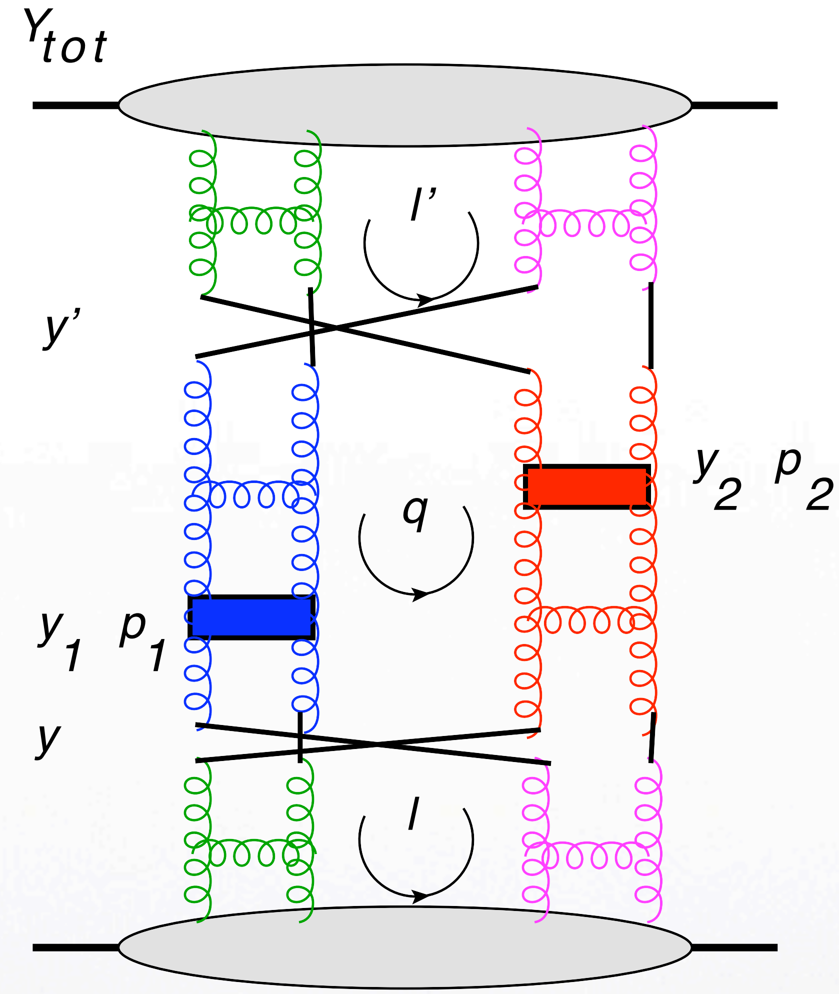
Production of two pairs of jets from two noninteracting chains: momentum loop



Dominant: small q^2, of order of initial scale Q_0^2, forward evolution

Include two recombinations:





Most important: the q integral $\int \frac{dq^2}{q^4}$

q serves as upper cutoff of the ladders close to the proton.

At small x: large anomalous dimension compensates the divergence near q=0.

$$\frac{d\sigma}{dY_1 dY_2 d_1^2 d_2^2} \sim \frac{1}{\tilde{R}^4}\frac{1}{(p_1^2)^2}\frac{1}{(p_2^2)^2}\int\frac{d\mu'}{2\pi i}\int\frac{d\mu}{2\pi i}\int\frac{d\mu_1'}{2\pi i}\int\frac{d\mu_1}{2\pi i}\int\frac{d\mu_2'}{2\pi i}\int\frac{d\mu_2}{2\pi i}\cdot$$

$$\cdot\int dY'\int dY\cdot\int\frac{d^2q}{q^4}$$

(BFKL-like)

$$\left[\left(\frac{q^2}{Q_0^2}\right)^{\mu'} e^{(Y_{tot}-Y')\chi(\mu')}\right]^2\cdot$$

(DGLAP-like)

$$\left[\left(\frac{p_1^2}{q^2}\right)^{\mu_1'} e^{(Y'-Y_1)\chi(\mu_1')}\right]\left[\left(\frac{p_2^2}{q^2}\right)^{\mu_2'} e^{(Y'-Y_2)\chi(\mu_2')}\right]$$

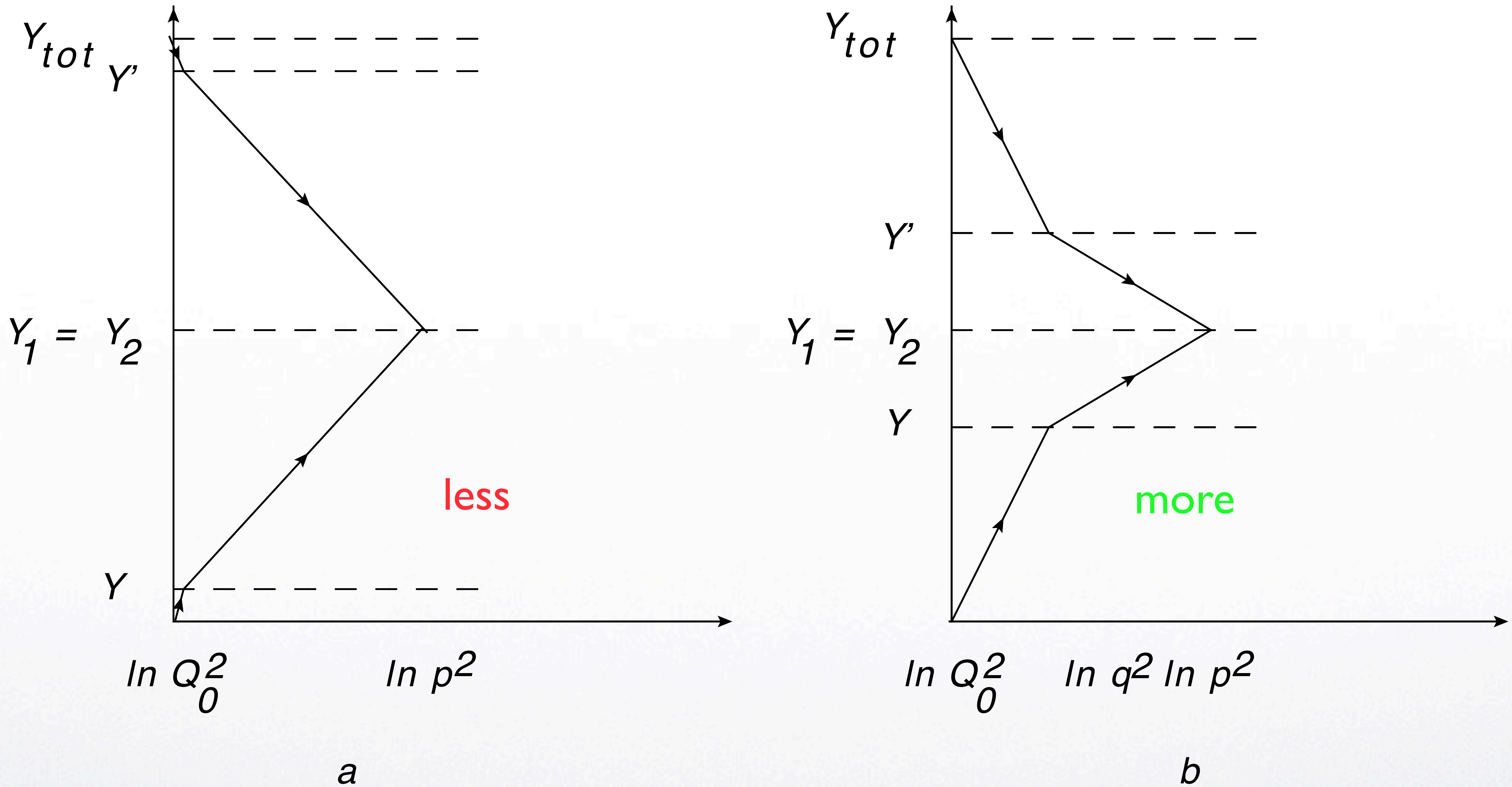
(DGLAP-like)

$$\left[\left(\frac{p_1^2}{q^2}\right)^{\mu_1} e^{(Y_1-Y)\chi(\mu_1)}\right]\left[\left(\frac{p_2^2}{q^2}\right)^{\mu_2} e^{(Y_2-Y)\chi(\mu_2)}\right]$$

(BFKL-like)

$$\cdot\left[\left(\frac{q^2}{Q_0^2}\right)^{\mu} e^{Y\chi(\mu)}\right]^2$$

Paths of evolution:



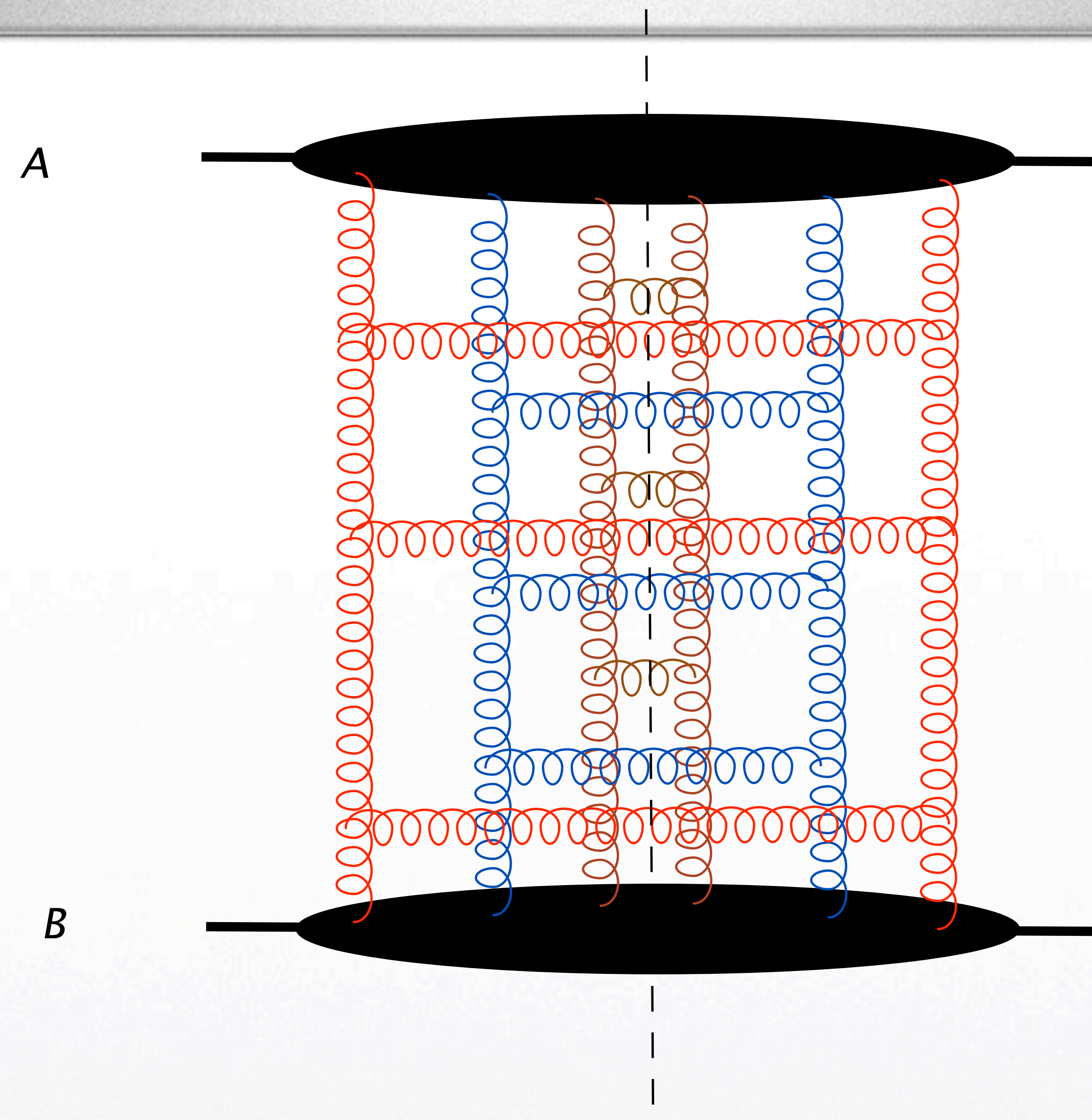
recombination is favored if

- small x evolution near them proton
- momentum evolution near the hard jet

Color suppression per recombination

$$\frac{1}{N_c^2 - 1}$$

More chains (in UE):



Color suppression: at first site ~ 10% per recombination

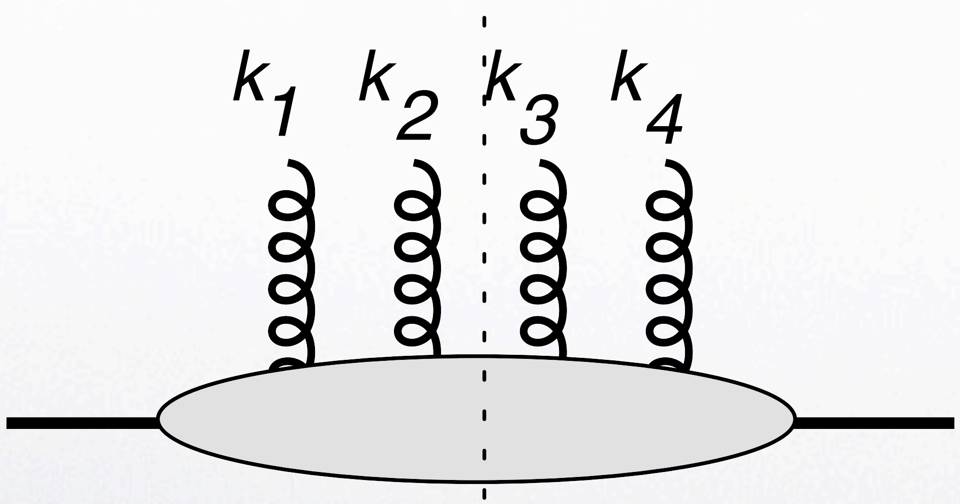
Closer look: less suppression: combinatorics (>1 for n=5 chains, 2 recombinations)

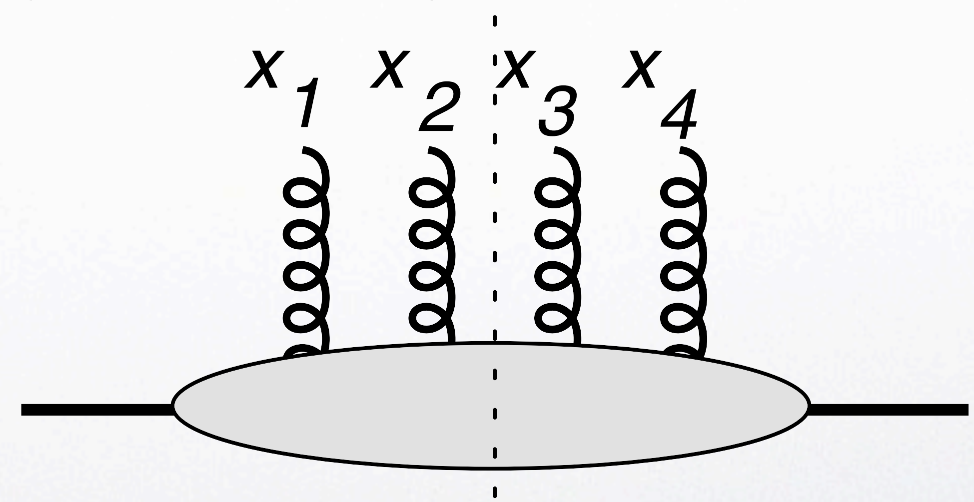
Evolution equations: two options

- evolution in rapidity (BKP)
- evolution in momentum scale (B'F'KL)

$$\partial_y \varphi_4(k_1, ...k_4; y) = \left(\sum_{ij} H_{ij} \otimes \varphi_4 \right) (k_1, ...k_4; y)$$

$$\partial_{lnQ^2} \psi_4(x_1, ...x_4; y) = \left(\sum_{ij} P_{ij} \otimes \psi_4 \right) (x_1, ...x_4; y)$$



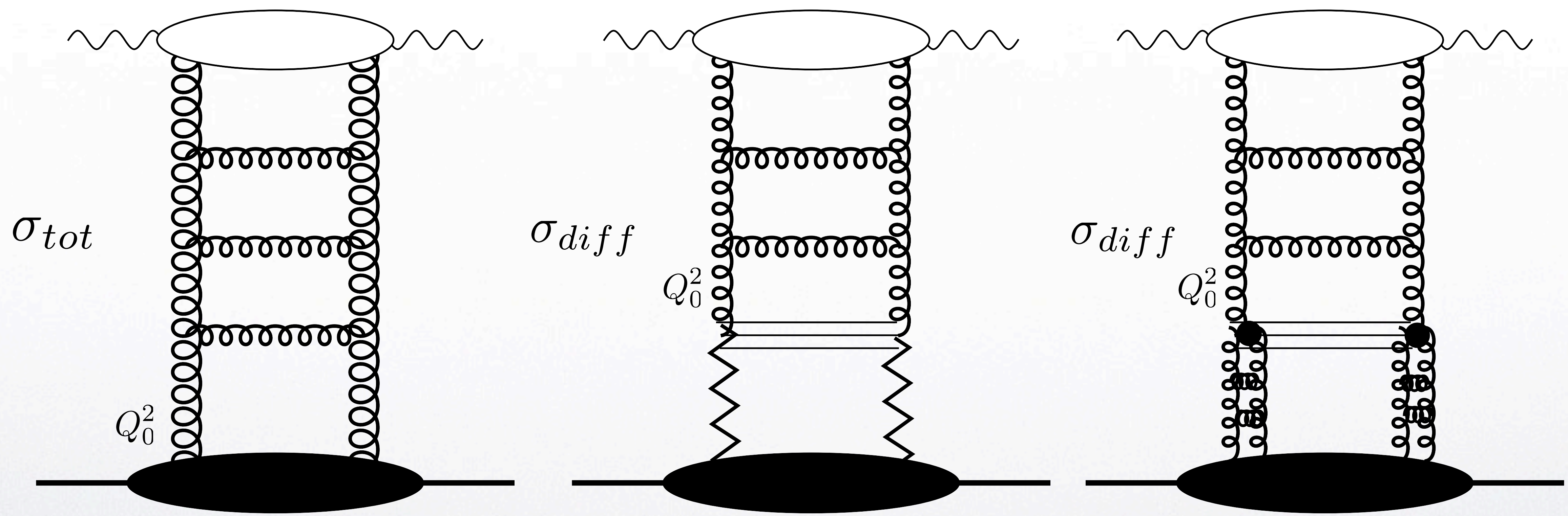


At each step of evolution: sum over all pairwise interactions

Diffraction

Rapidity gaps (on the partonic level) require color singlet states.

The HERA picture:



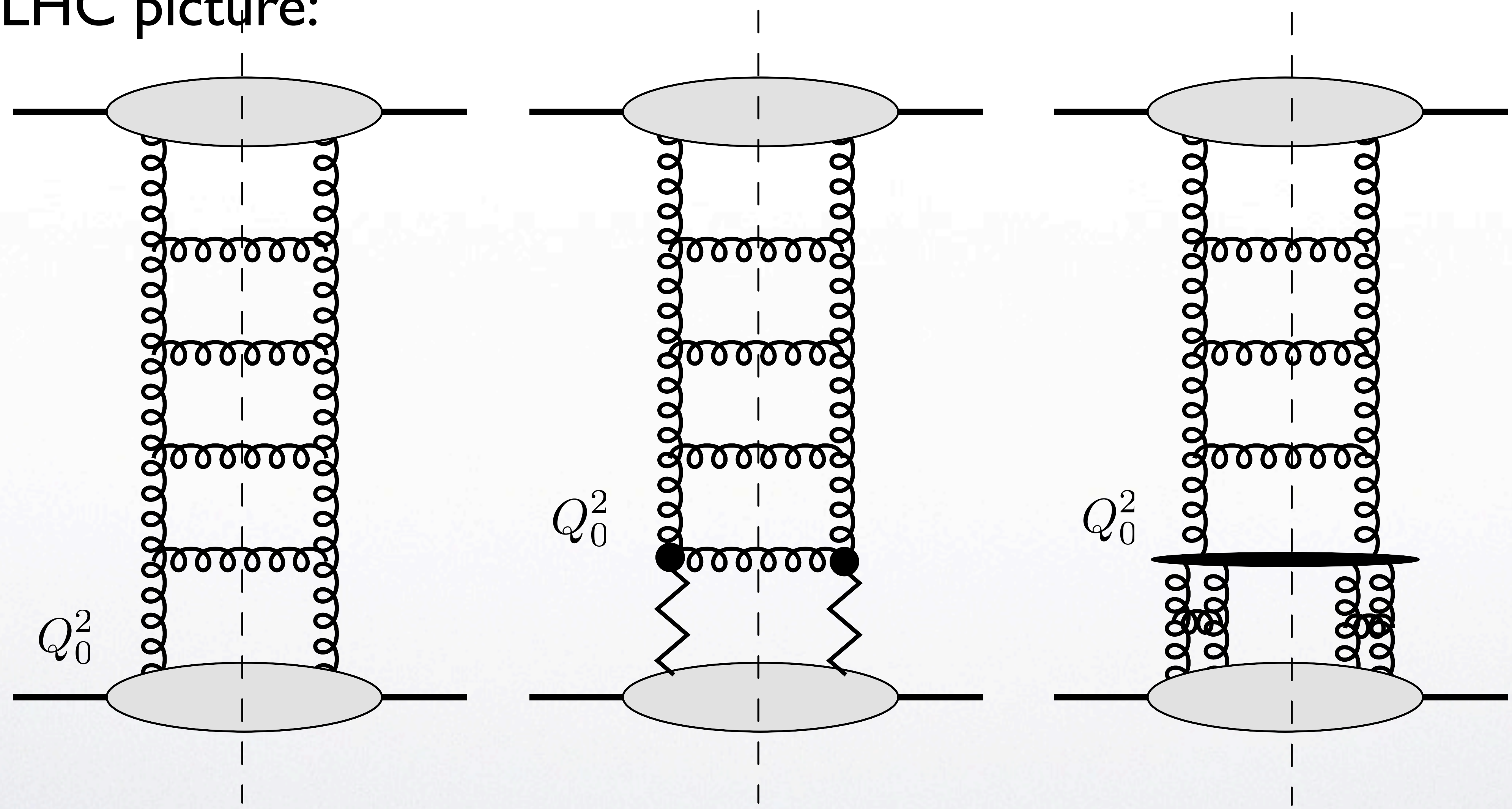
parton density, DGLP/BFKL

diffractive parton density, soft Pomeron

diffractive parton density, hard Pomeron

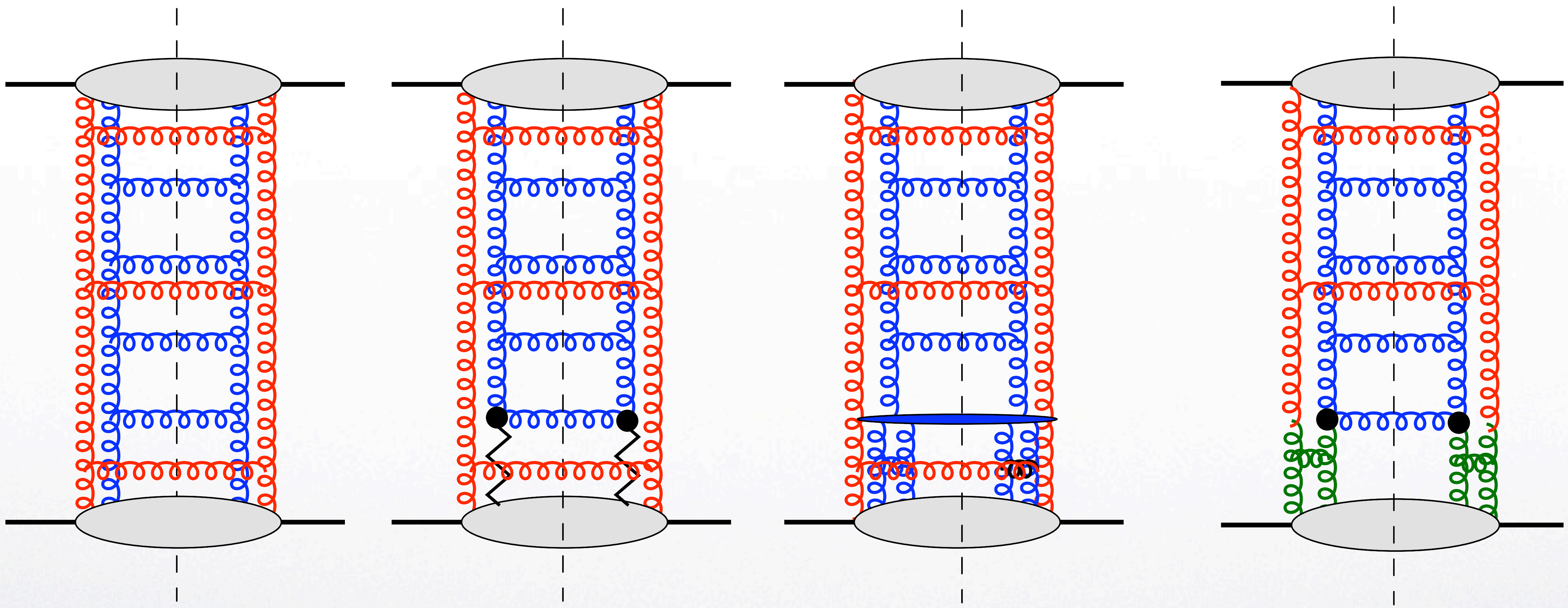
Counting problem: how much diffraction is inside the initial condition of DGLAP?
parton density does not contain hard diffraction. Best: unify the two description.

The LHC picture:



Again the same counting problem. In addition: need the survival probability

Survival probability:



Second (and third..) chain fills the gap.

Simplest possibility:
recombination

Conclusions:

Theory of multiple interactions needs more work:

- evolution equations
- recombination
- problems with diffraction

Main next task: numerical work

Hope: some of this maybe useful for Monte Carlo