Gluons in Nuclei

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(LBNL)

Dependence on X_0, Q_0, CTEQ

Shadowing

$$\frac{\times G^A}{A \times G^N}$$

x, Q, A, b_L

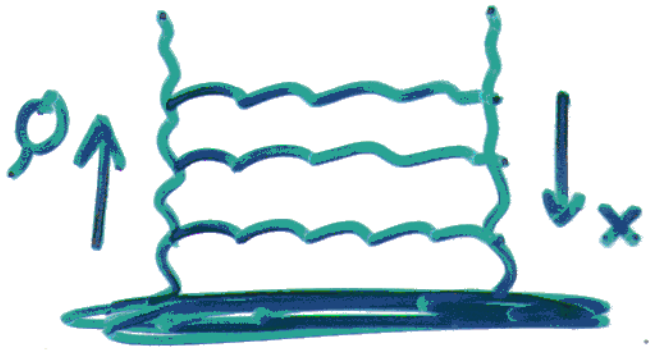
Cross Section

higher twist, F_2

Perturbative QCD

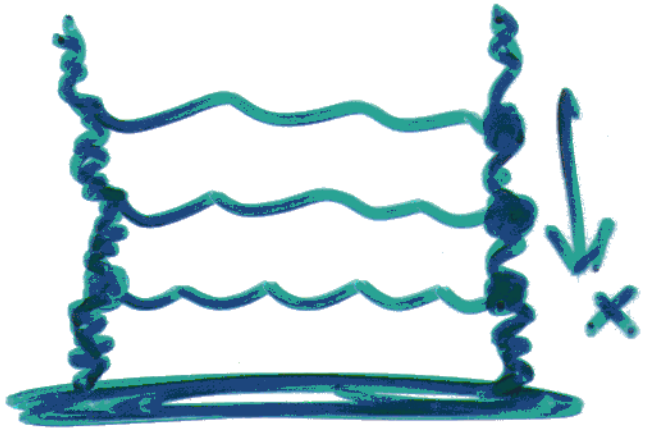
DGLAP (DLL) $\frac{\partial^2}{\partial y \partial \ln \mu^2} \times G \sim \times G$

gluon "ladder"



BFKL $\frac{\partial}{\partial y} f(x, k_1) \sim C(k_1, p_1) f(x, p_1)$

"pomeron"



Both

Sharp rise

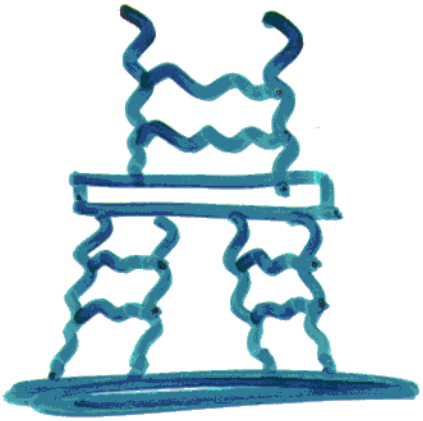
linear

Gluon Recombination

$$P \sim \frac{\alpha_s}{Q^2} \frac{xG}{\pi R^2} \sim 1$$

GLR/MQ

$$\frac{\partial^2}{\partial y \partial \ln Q^2} xG \sim xG\left[1 - \# \frac{xG}{Q^2 R^2}\right]$$



2 ladders $\longrightarrow$ 1 ladder

if $P \sim 1$ need

$n \longrightarrow 1$

Generalized MV action

$$S = -\frac{1}{4} G_{\mu\nu} G^{\mu\nu} + i \int d^2x_1 \, F(\rho) + \frac{i}{N_c} \int d^2x_1 dx^- \delta(x^-) \, \mathrm{tr} \, \rho(x_1) \, W(A^-)$$

RG

$$A_\mu = b_\mu + \delta A_\mu + a_\mu$$

b_μ → classical, δA_μ → hard, a_μ → soft

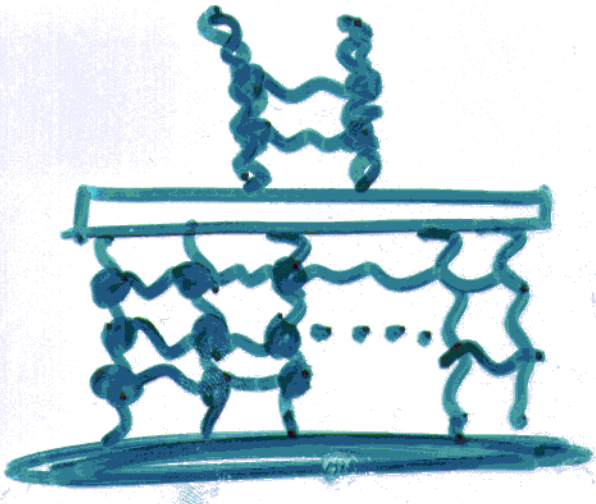
$$\frac{d}{dy} Z = \alpha_s \left\{ \frac{1}{2} \frac{\delta^2}{\delta\rho \delta\rho} Z\chi - \frac{\delta}{\delta\rho} Z\gamma \right\}$$

$Z \equiv e^{-F}$

n "pomerons" $\longrightarrow 1$

J. Jalilian-Marian, A. Kovner, H. Weigert

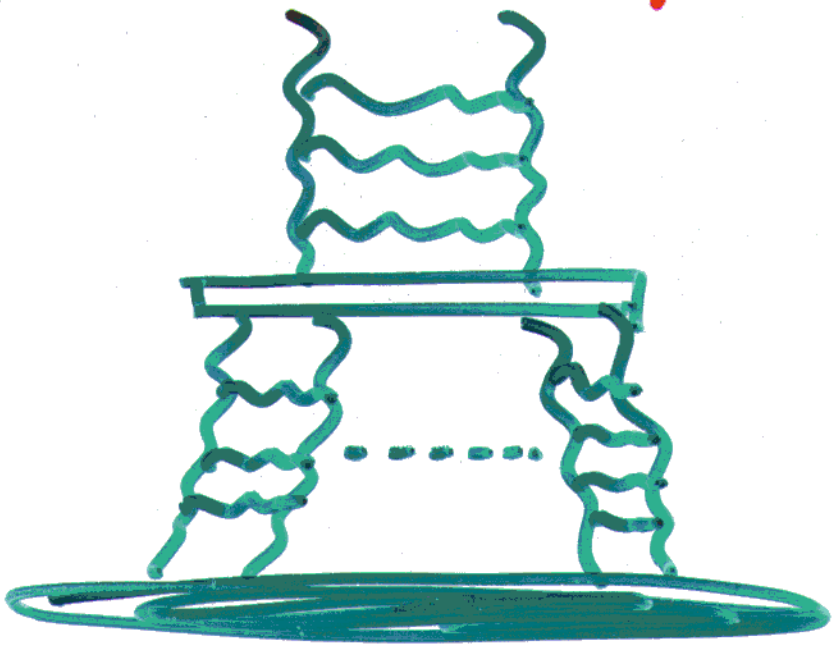
phys. rev. D59, 014015 (1999)



BLL

$$\frac{\partial}{\partial y\,\partial \ln Q^2} xG(x,Q,b_\perp) \sim \left[1 - \frac{1}{K} e^{1/K} E_1(1/K)\right]$$

$$K \sim \frac{xG(x,Q,b_\perp)}{Q^2}$$



J. Jalilian-Marian, A. Kovner, A. Leonidov and H. Weigert, hep-ph/9807462

Solution

with X.N. Wang (LBNL)

Characteristics PDE → ODE

Initial Conditions

$x_0 \sim .05 - .07$

$Q_0 \sim .7$ GeV ?

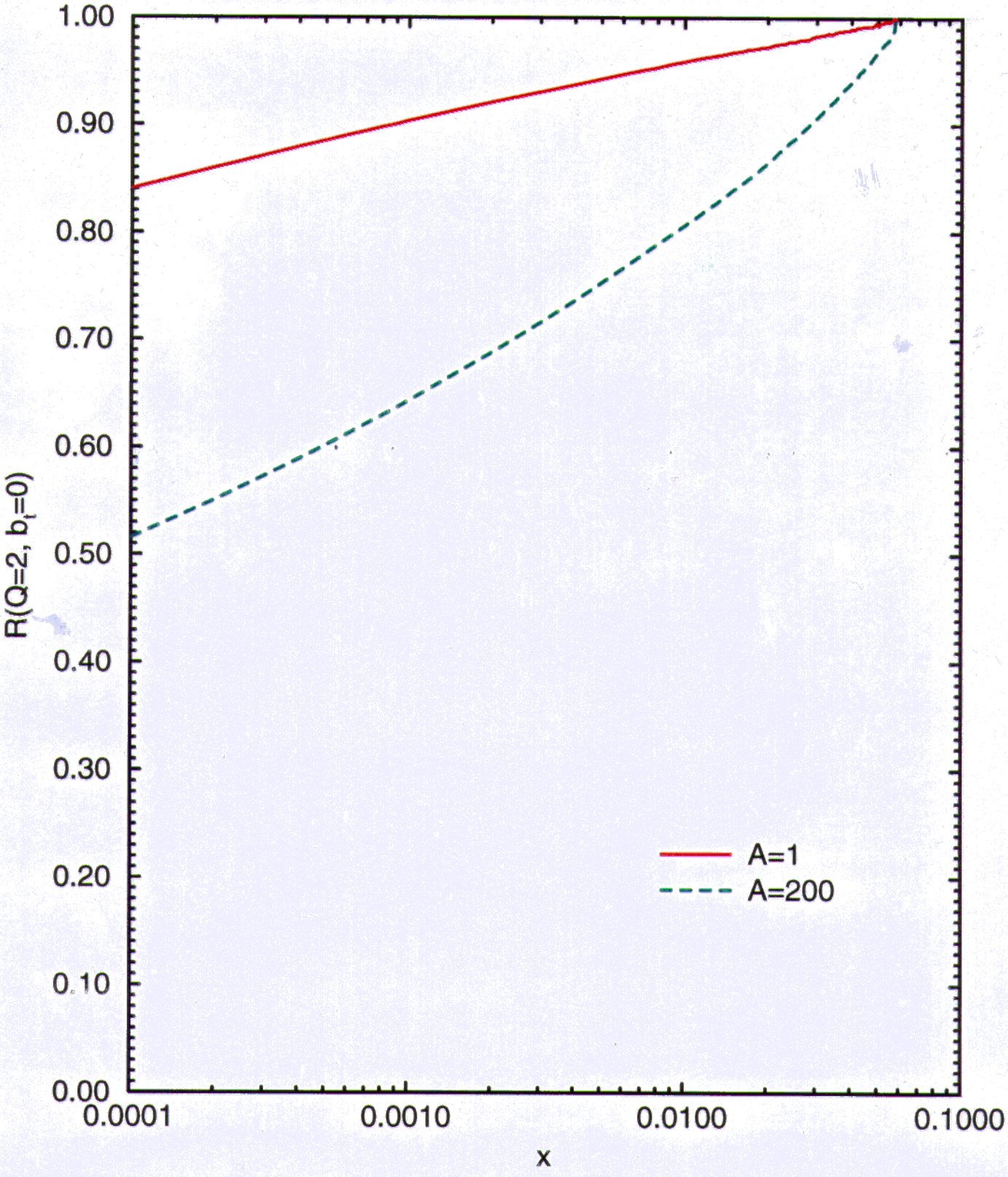
$xG|_{x_0,Q_0}$ CTEQ, MRS, GRV

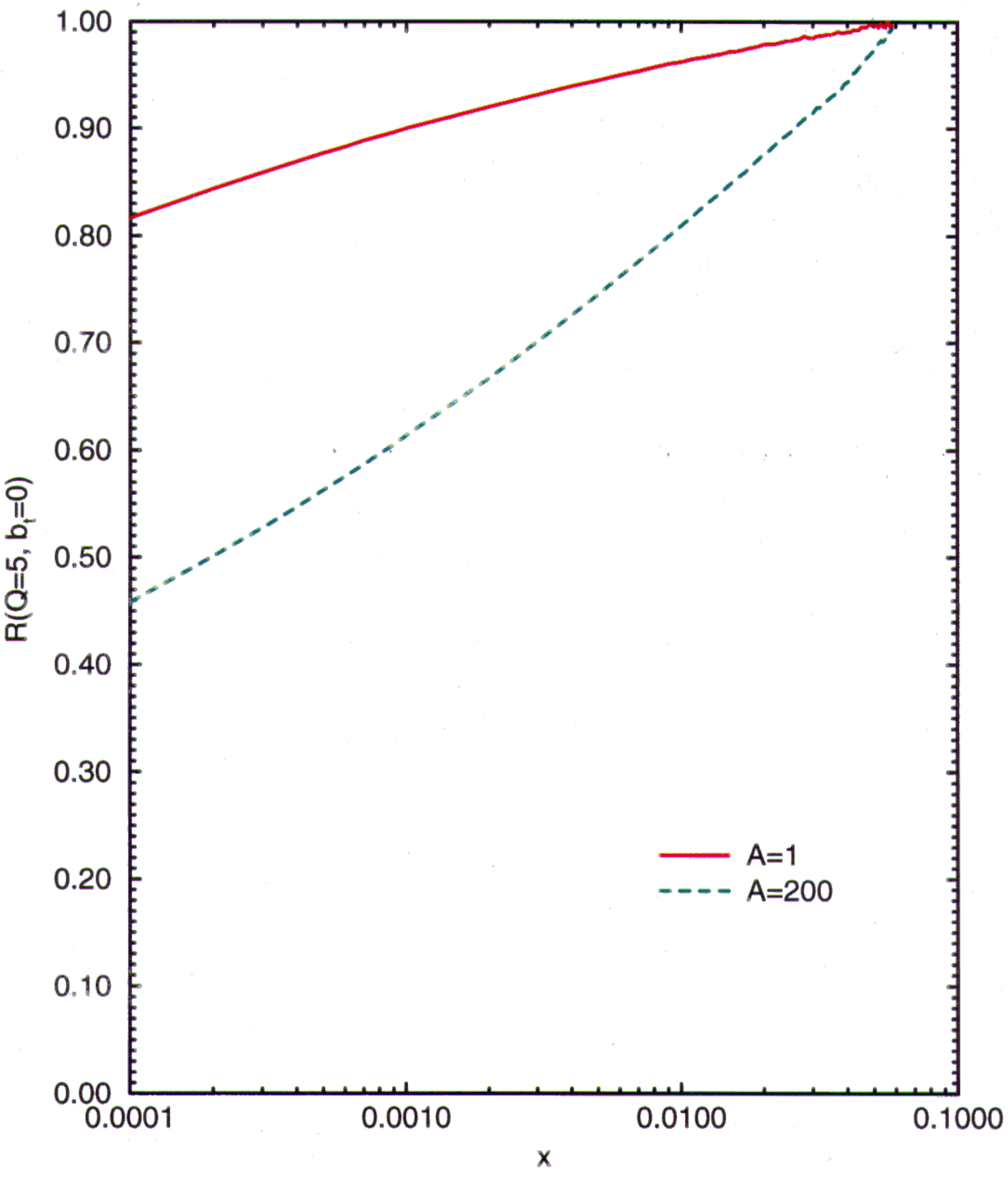
$$xG^A(x,Q,b_\perp)\Big|_{x_0,Q_0} = S^A(b_\perp)\, A\, xG^N(x,Q)\Big|_{x_0,Q_0}$$

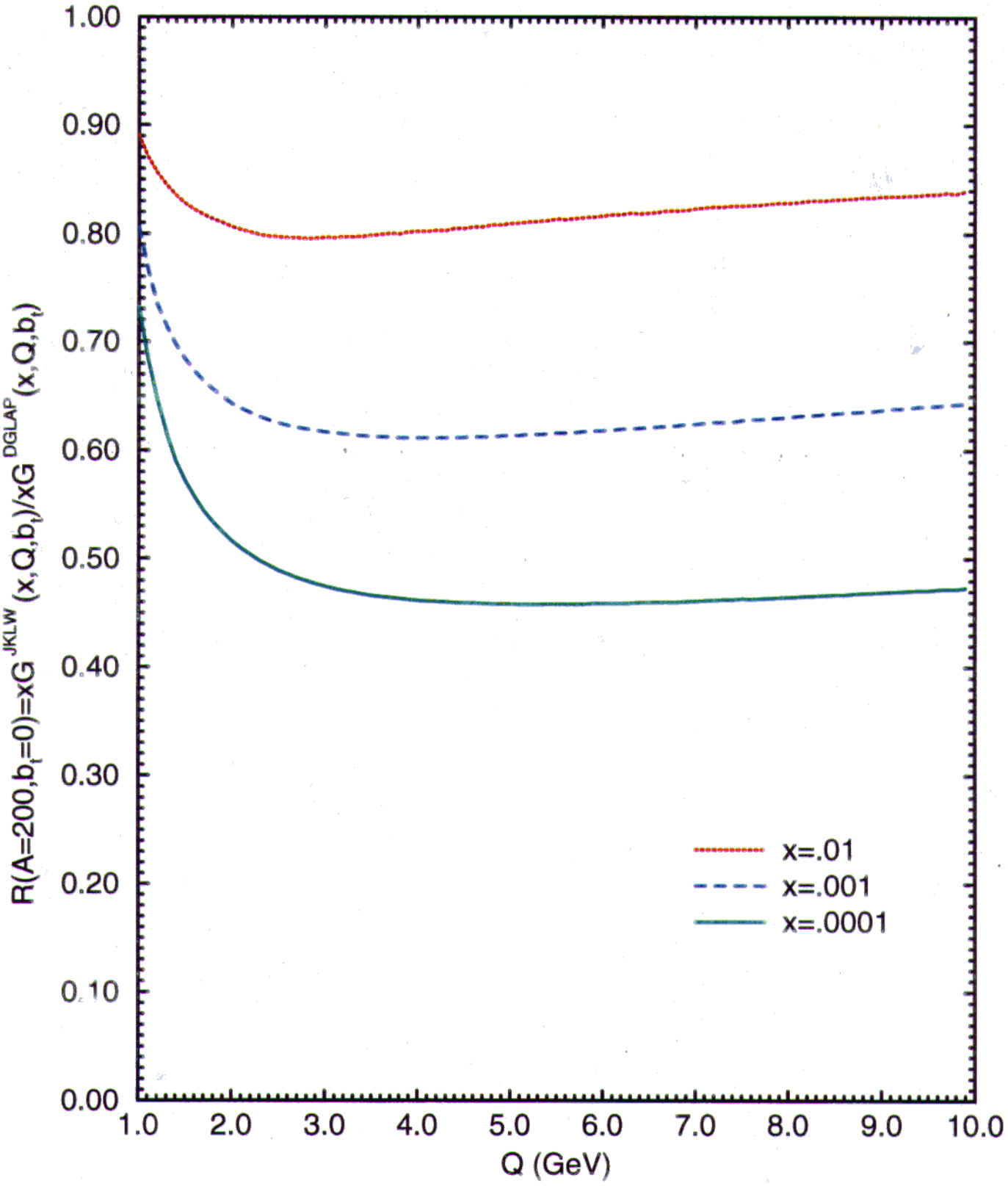
$$xG^N(x,Q,b_\perp)\Big|_{x_0,Q_0} = S^N(b_\perp)\, xG^N(x,Q)\Big|_{x_0,Q_0}$$

$$R \equiv \frac{xG(x,Q,b_\perp)}{xG^{DGLAP}(x,Q,b_\perp)}$$

All-order

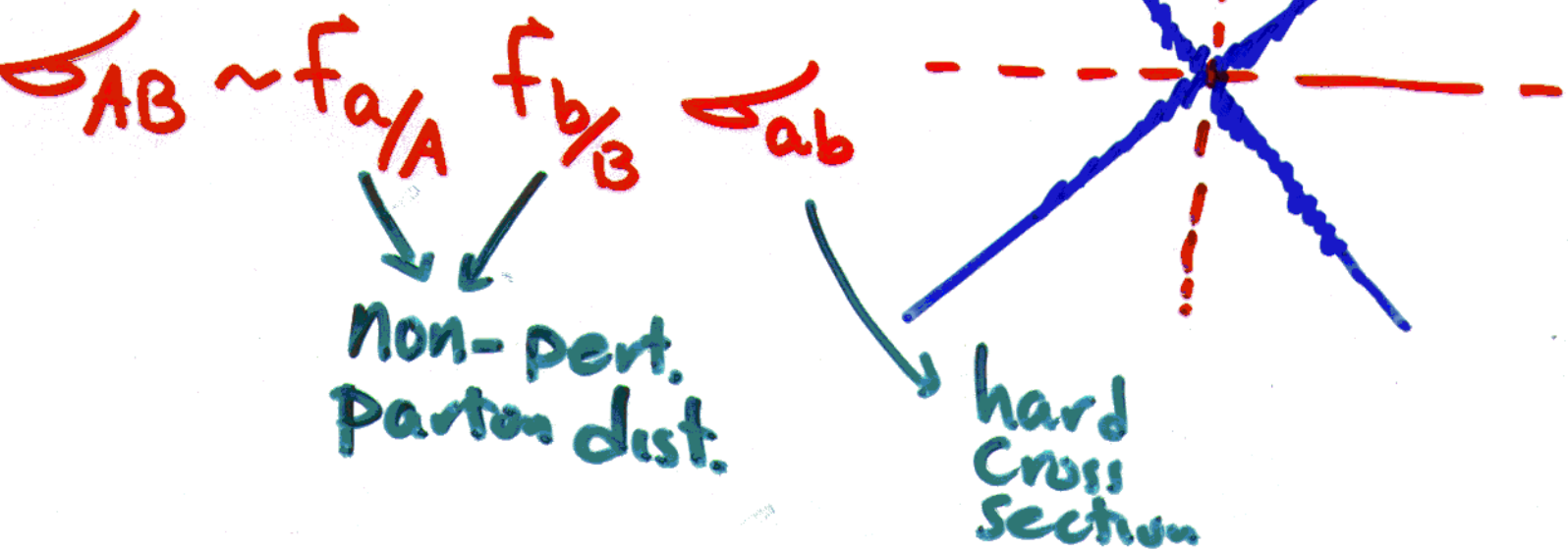

1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
R(Q=2, b_t=0)
0.0001
0.0010
0.0100
0.1000
x
A=1
A=200


1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
R(Q=5, b_t=0)
0.0001
0.0010
0.0100
0.1000
x
A=1
A=200

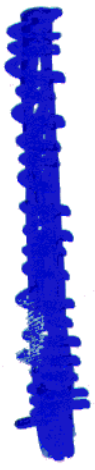

1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Q (GeV)
R(A=200,b_t=0)=xG^JKLW(x,Q,b_t)/xG^DGLAP(x,Q,b_t)
x=.01
x=.001
x=.0001

Ultra-relativistic heavy ion Collisons

RHIC, LHC



$f_{a/A}$ subject to PQCD evolution



IMF