WG5: THEORY

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- What did we discuss?

A1: Something that either cannot be measured or/and cannot be understood.

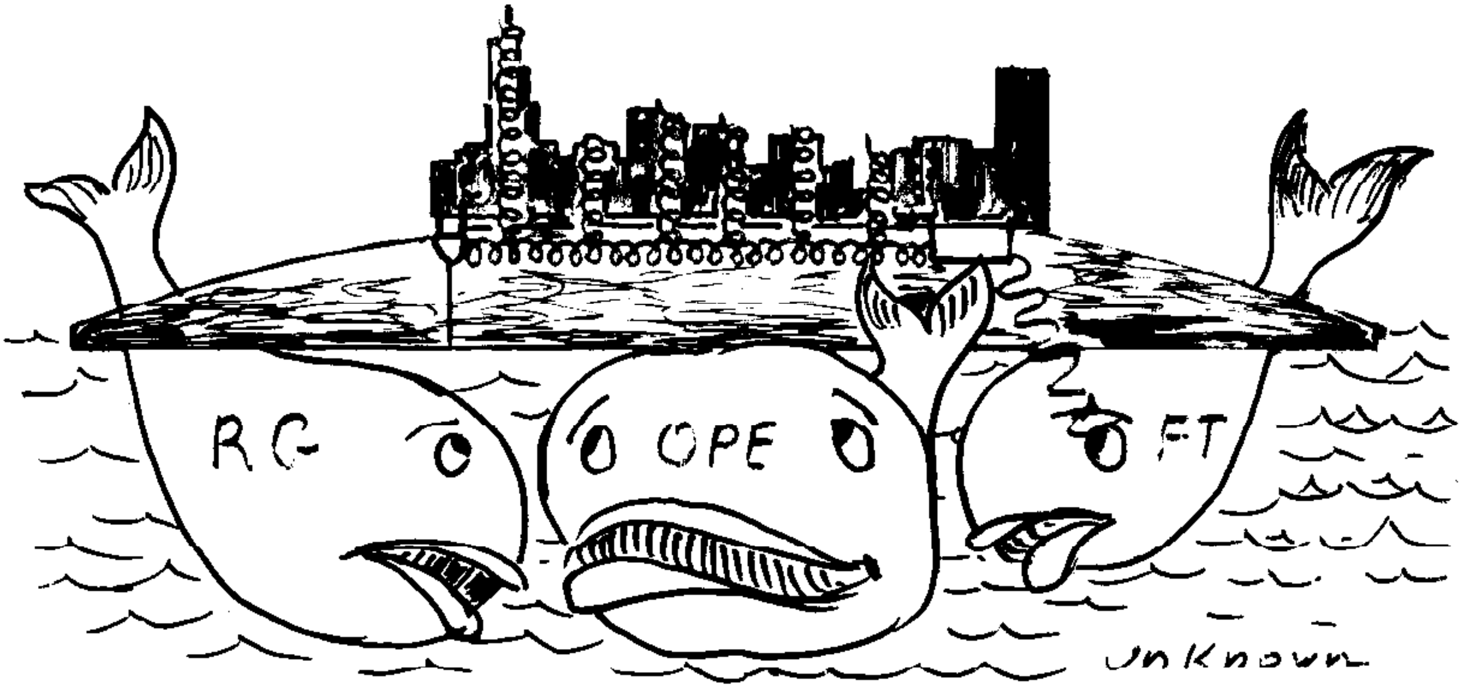
A2: How to calculate $\underbrace{\text{more}}_{\text{in wider kinematic region}}$ and $\underbrace{\text{better}}_{\text{with better theoretical accuracy}}$.

$$V = \pi R^2 L$$

R = transverse radius
L - longitudinal size
π = Constant

$\pi = 3.14$

Conclusions:
Our experimental result $\pi = 3.14\,190\%$ coincides with theoretical estimates $\pi = \frac{22}{7}$, given by Prof. Archimedus 20 centuries ago for cylinder. It allows us to develop a cylindric model for Greenland whale which will significally simplify a future theory.



- RG → evolution equations:
  DGLAP, BFKL, CCFM:

DGLAP: Dokshitzer, Gribov, Lipatov, Altarelli and Parisi

BFKL: Balitsky, Fadin, Kuraev, Lipatov

CCFM: Ciafaloni, Catani, Fiorani, Marchesini

- OPE → Wilson Operator Product Expansion

- FT → Factorization theorems
  → Collins, Soper, Sterman

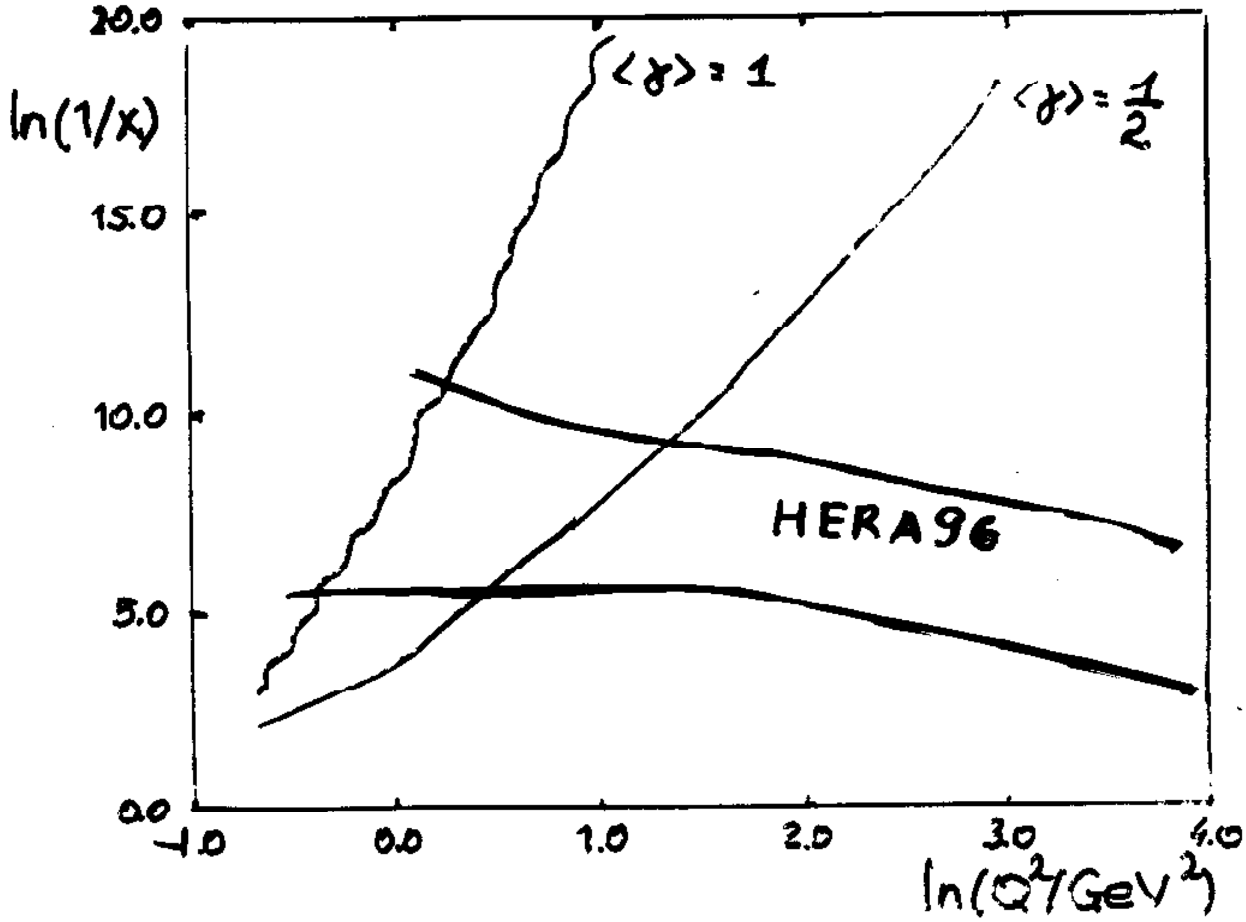
Unfortunately, in DIS our theory is still mostly

(P) QCD
↳ perturbative
practical

Fortunately, we have started to discuss nonperturbative contributions at large Q^2:

- renormalons: G. Marchesini
  G. Sterman
  A. Sotiropoulos
  M. Beneke
  R. Akhoury
  A. Schafer
- instantons : F. Schrempp
- semiclassical field approach: W. Buchmüller, A. Kovner, H. Weigert. J. Balitsky
- Lattice calculations: G. Schierholz

- The BFKL equation and Beyond.



- $x G(x, Q^2) \to C \; \dfrac{1}{x^{\langle\omega\rangle}} \left(\dfrac{Q^2}{Q_0^2} \right)^{\langle\gamma\rangle}$

- The BFKL ev. eq.:

$$\gamma \leq \frac{1}{2} \left(\pm \, O(\alpha_s) \right)$$

$$\omega \gtrsim \omega_L = \frac{4 N_c}{\pi} \alpha_s \ln 2$$

$$\pm \, O(\alpha_s^2)$$

Q1: What are next order corrections to the BFKL eq.?

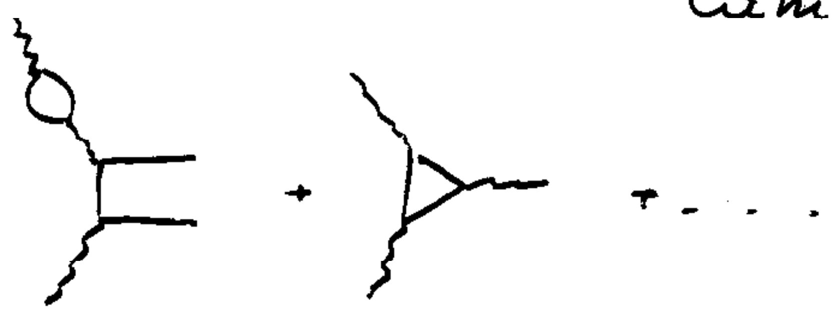
A1: We know the next order corrections, but we have not understood them.

Fadin, Lipatov + ...

- On the way to understanding:

(1) Quark contributions to α_s^2 kernel.

Camici, Ciafaloni (



Supports hypothesis that

$$\alpha_s K(k_1 k_2) \rightarrow \frac{\alpha_s(k_2)\,\alpha_s((k_1-k_2)^2)}{\alpha(k_1)} K(k_1 ...$$

M. Braun (95

E. Levin (95

$$K^{Born}_{RRGG}(q_1,q_2) = \frac{\bar g_\mu^4 \mu^{-2\epsilon}}{\pi^{1+\epsilon}\,\Gamma(1-\epsilon)} \frac{4}{\vec k^2}\Big\{ 2\left(\frac{\vec k^2}{\mu^2}\right)^{\epsilon}\Big(\frac{1}{\epsilon^2} - \frac{11}{6\epsilon}\Big(1-$$

$$-\epsilon^2\frac{\pi^2}{6}\Big) - \frac{2\pi^2}{3} + \frac{67}{18} - \epsilon\Big(\frac{404}{54} - 9\zeta(3)\Big)\Big) - \frac{\vec k^2(\vec q_1^{\,2}+\vec q_2^{\,2})}{8\vec q_1^{\,4}\vec q_2^{\,4}}\,\cdot$$

$$\cdot\big(2\vec q_1^{\,2}\vec q_2^{\,2} - 3(\vec q_1\vec q_2)^2\big) - \Big(\frac{11}{3}\frac{\vec k^2}{\vec q_1^{\,2}-\vec q_2^{\,2}} + \frac{\vec k^2(\vec q_1^{\,2}-\vec q_2^{\,2})}{16\vec q_1^{\,4}\vec q_2^{\,4}}\big(2\vec q_1^{\,2}\vec q_2^{\,2} - 3(\vec q_1\vec q_2)^2\big)\Big)\ln\Big(\frac{\vec q_1^{\,2}}{\vec q_2^{\,2}}\Big)$$

$$-\frac{2}{3}\frac{\vec k^2}{(\vec q_1^{\,2}-\vec q_2^{\,2})^3}\Big[\Big(1-\frac{2(\vec q_1\vec q_2)^2}{\vec q_1^{\,2}\vec q_2^{\,2}}\Big)\Big(\vec q_1^{\,4}-\vec q_2^{\,4}-2\vec q_1^{\,2}\vec q_2^{\,2}\ln\Big(\frac{\vec q_1^{\,2}}{\vec q_2^{\,2}}\Big)\Big) + (\vec q_1\vec q_2)\Big(2(\vec q_1^{\,2}-\vec q_2^{\,2})$$

$$-(\vec q_1^{\,2}+\vec q_2^{\,2})\ln\Big(\frac{\vec q_1^{\,2}}{\vec q_2^{\,2}}\Big)\Big)\Big] - \vec k^2\Big[4 + \frac{(\vec q_1^{\,2}-\vec q_2^{\,2})^2}{4\vec q_1^{\,2}\vec q_2^{\,2}} + \frac{1}{16}\Big(2 - \frac{3\vec q_1^{\,2}}{\vec q_2^{\,2}} - \frac{3\vec q_2^{\,2}}{\vec q_1^{\,2}}\Big)\Big(2 -$$

$$-\frac{(\vec q_1\vec q_2)^2}{\vec q_1^{\,2}\vec q_2^{\,2}}\Big)\Big]\int_0^\infty \frac{dx}{(\vec q_1^{\,2}+x^2\vec q_2^{\,2})}\ln\Big|\frac{1+x}{1-x}\Big| + \frac{2(\vec q_1^{\,2}-\vec q_2^{\,2})}{(\vec q_1+\vec q_2)^2}\Big[\ln\Big(\frac{\vec q_1^{\,2}}{\vec q_2^{\,2}}\Big)\times$$

$$\times\ln\Big(\frac{\vec q_1^{\,2}\vec q_2^{\,2}}{(\vec q_1^{\,2}+\vec q_2^{\,2})^2}\Big) + L\Big(1-\frac{\vec k^2}{\vec q_2^{\,2}}\Big) - L\Big(1-\frac{\vec k^2}{\vec q_1^{\,2}}\Big) + L\Big(-\frac{\vec q_1^{\,2}}{\vec q_2^{\,2}}\Big) - L\Big(-\frac{\vec q_2^{\,2}}{\vec q_1^{\,2}}\Big)\Big] +$$

$$+2\vec k^2\Big[\int_0^1 \frac{dt}{(\vec q_2^{\,2}t^2 - 2(\vec q_1\vec q_2)t + \vec q_1^{\,2})}\Big(\frac{(\vec q_2\vec k)}{\vec k^2} - \frac{\vec q_2^{\,2}(\vec q_1^{\,2}-\vec q_2^{\,2})}{\vec k^2(\vec q_1+\vec q_2)^2}(1+t)\Big)\times$$

$$\times\ln\Big(\frac{\vec q_2^{\,2}\,t(1-t)}{\vec q_1^{\,2}(1-t)+\vec k^2 t}\Big) + (\vec q_1 \leftrightarrow -\vec q_2)\Big]\Big\};$$

$$L(x) = \int_0^1 \frac{dt}{t}\ln(1-t); \qquad \vec k = \vec q_1 - \vec q_2;$$

$$\frac{\partial}{\partial \ln \frac{1}{x}} \mathcal{F}(x, \vec{q}^{\,2}) = \int d^{D-2}k\, \mathcal{K}(\vec{q}, \vec{k})\, \mathcal{F}(x, \vec{k}^{\,2});$$

$$D = 4 + 2\epsilon;$$

$$\mathcal{K}(\vec{q}, \vec{k}) = 2\omega(t)\,\delta(\vec{q} - \vec{k}) + \mathcal{K}^{one-loop}_{RRG}(\vec{q}, \vec{k}) + \mathcal{K}^{Born}_{RRGG}(\vec{q}, \vec{k}) + \mathcal{K}^{Born}_{RRQ\bar{Q}}(\vec{q}, \vec{k});$$

$$t = -\vec{q}^{\,2};$$

$$\omega(t) = -\bar{g}_\mu^2 \left(\frac{2}{\epsilon} + 2\ln\left(\frac{\vec{q}^{\,2}}{\mu^2}\right)\right) - \bar{g}_\mu^4 \left[\left(\frac{11}{3} - \frac{2}{3}\frac{n_f}{N_c}\right)\left(\frac{1}{\epsilon^2} - \ln^2\left(\frac{\vec{q}^{\,2}}{\mu^2}\right)\right) + \left(\frac{67}{9} - \frac{\pi^2}{3} - \frac{10}{9}\frac{n_f}{N_c}\right)\left(\frac{1}{\epsilon} + 2\ln\left(\frac{\vec{q}^{\,2}}{\mu^2}\right)\right) - \frac{404}{27} + 2\zeta(3) + \frac{56 n_f}{27 N_c}\right.$$

$$\bar{g}_\mu^{\,2} = g_\mu^2 \frac{N_c \Gamma(1-\epsilon)}{(4\pi)^{2+\epsilon}};$$

$$\mathcal{K}^{one-loop}_{RRG}(\vec{q}_1, \vec{q}_2) = \frac{\bar{g}_\mu^2 \mu^{-2\epsilon}}{\pi^{1+\epsilon}\Gamma(1-\epsilon)} \frac{4}{\vec{k}^2} \left\{1 + \bar{g}_\mu^2 \left[-2\left(\frac{\vec{k}^2}{\mu^2}\right)^{\epsilon}\left(\frac{1}{\epsilon^2} - \frac{\pi^2}{2} + 2\epsilon\zeta(3)\right) + \frac{11}{3\epsilon}\left(1 - \epsilon^2\frac{\pi^2}{6}\right) - \frac{2n_f}{3N_c\epsilon} + \frac{3\vec{k}^2}{(\vec{q}_1^{\,2} - \vec{q}_2^{\,2})} \ln\left(\frac{\vec{q}_1^{\,2}}{\vec{q}_2^{\,2}}\right) - 2\ln\left(\frac{\vec{q}_1^{\,2}}{\vec{q}_2^{\,2}}\right)\ln\ldots\right.\right.$$

$$- \ln^2\left(\frac{\vec{q}_1^{\,2}}{\vec{q}_2^{\,2}}\right) + \left(1 - \frac{n_f}{N_c}\right)\left(\frac{\vec{k}^2}{(\vec{q}_1^{\,2} - \vec{q}_2^{\,2})}\left(1 - \frac{\vec{k}^2(\vec{q}_1^{\,2} + \vec{q}_2^{\,2} + 4\vec{q}_1\vec{q}_2)}{3(\vec{q}_1^{\,2} - \vec{q}_2^{\,2})^2}\right)\ln\left(\frac{\vec{q}_1^{\,2}}{\vec{q}_2^{\,2}}\right) - \right.$$

$$\left.\left.\left. - \frac{\vec{k}^2}{6\vec{q}_1^{\,2}\vec{q}_2^{\,2}}(\vec{q}_1^{\,2} + \vec{q}_2^{\,2} + 2\vec{q}_1\vec{q}_2) + \frac{\vec{k}^4(\vec{q}_1^{\,2} + \vec{q}_2^{\,2})}{6\vec{q}_1^{\,2}\vec{q}_2^{\,2}(\vec{q}_1^{\,2} - \vec{q}_2^{\,2})^2}(\vec{q}_1^{\,2} + \vec{q}_2^{\,2} + 4\vec{q}_1\vec{q}_2)\right)\right]\right\},$$

(2) t-channel Unitarity +
reggeon (gluon) interaction

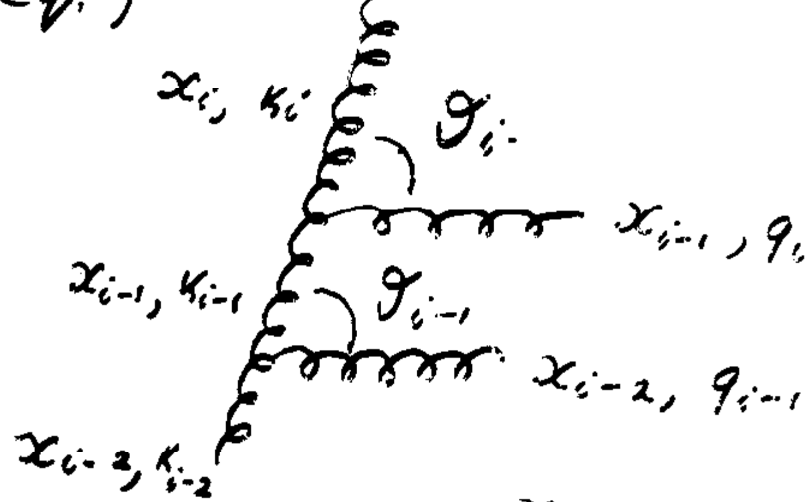
$\downarrow$

Conformally Symmetric Contribution
for α_s^2 kernel

$$\alpha_s^2 K^{(2)} \to \frac{1}{24} \ln^4 \frac{\rho_{11'}\rho_{22'}}{\rho_{12'}\rho_{12'}}$$

$\rho_{ik} = \vec{r}_{i} - \vec{r}_{k}$ A. White

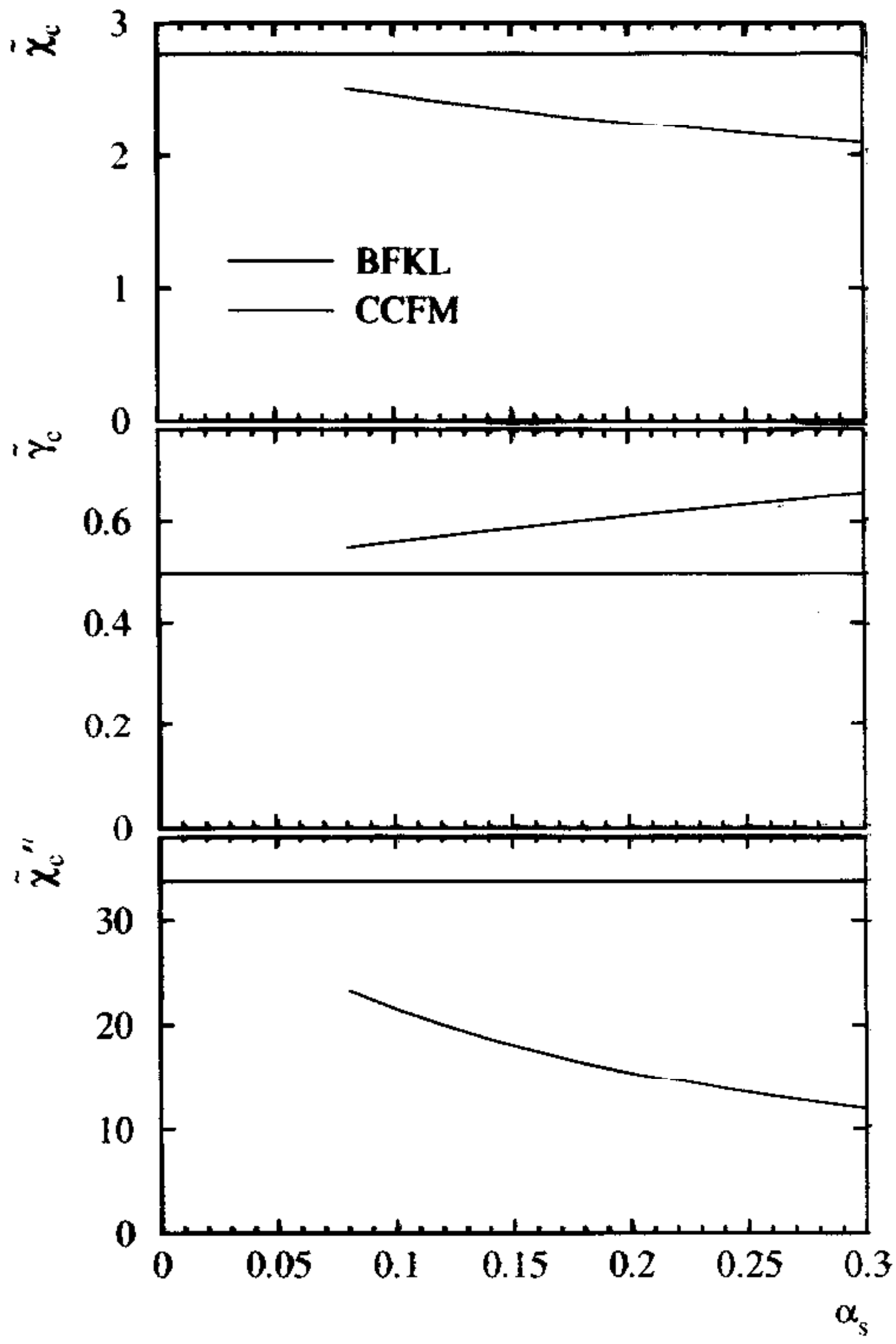
(3) Angular ordering G. Salam
(CCFM ev. eq.)



$x_i \ll x_{i-1} \ll$

$$\boxed{\vartheta_i > \vartheta_{i-1}} \longrightarrow q_i > \frac{x_i}{x_{i-1}} q_{i-1}$$

Study properties of the minimum of $\tilde{\chi}$, at $\tilde{\gamma}_c$



Q2: What is limitation on using the OPE at $x \to 0$ from the BFKL dynamics?

A2: The OPE can be safely used for

$$Q^2 \gtrsim Q_0^2(x_0)$$

$$x_0 < x < 1$$

where

$$\ln \frac{Q_0^2(x_0)}{\Lambda^2} \gtrsim \left[\frac{7 N_c \zeta(3)}{\pi b} \ln \frac{x_0}{x} \right]^{1/3}.$$

A. Mueller: hep-ph/961?

! This breakdown of the OPE is not due to higher twist terms, but rather to an inability to properly separate HARD and SOFT scales at $x \to 0$.

Q3: What corrections of the order of $\left(\frac{1}{Q}\right)^n$ we can expect in the BFKL kinematic region?

$$xG(x,Q^2) = xG^{BFKL}(x,Q^2) + \frac{m}{Q}\,xG^{(2)}(x,Q^2)$$

from IR renormalons.

E. L. (95)

A. Sotiropoulos (9

from different scenario for running α_S in the BFKL eq.

However

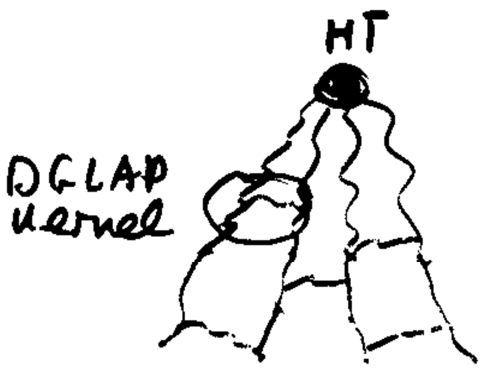
$$F_2(x,Q^2) = F_2^{BFKL}(x,Q^2) + \boxed{\frac{m^2}{Q^2}F_2^{(2)}(x,Q^2)}$$

the same power as in OPE.

● Q^2 and x dependence of high twist contribution

$$F_2(x,Q^2) = \underbrace{F_2^{LT}(x,Q^2)}_{\text{DGLAP ev. eq.}} + \frac{m^2}{Q^2} F_2^{HT}(x,Q^2)$$

Bukhvostov Lipatov ... (8



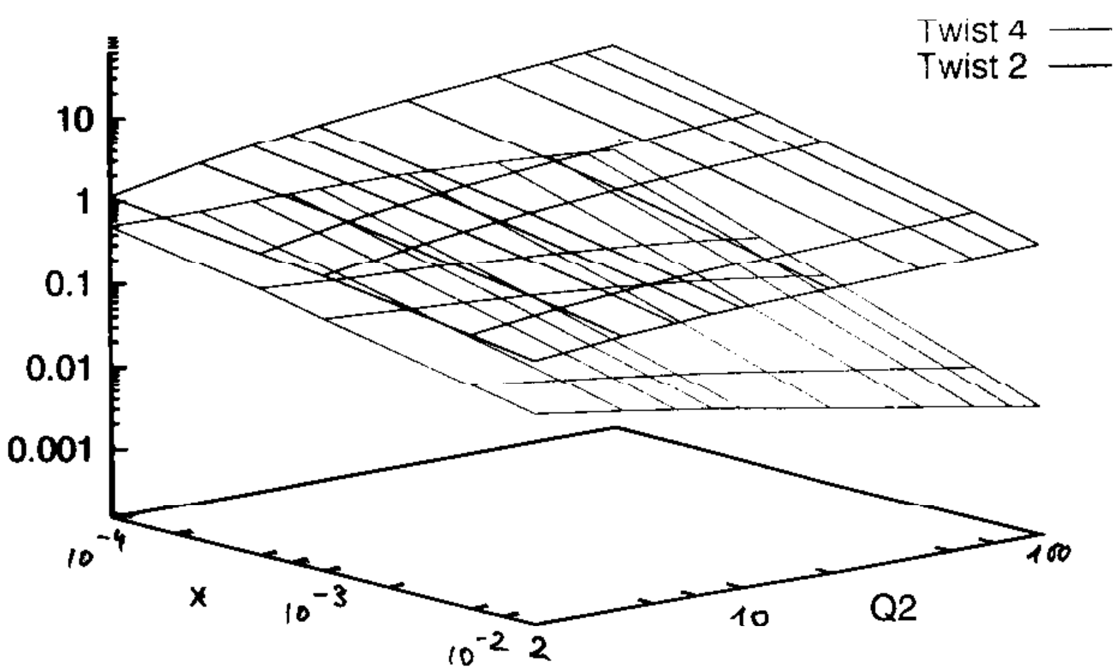
$\boxed{x \to 0}$

Solution has been found. J. Bartels, (9
J. Bartels, M. Wusthoff
E.L. Ryskin, Shuvaev

$$\gamma^{HT}(\omega) \approx 4\, \gamma^{LT}(\omega)$$

J. Bartels et.

Twist 4 vs. Twist 2 with 10% choice (increasing initial distr.)



- Back to Shadowing corrections

- $\mathcal{K} = xG(x,Q^2)\,\frac{\sigma(GG)}{\pi R^2} = \frac{3\pi\alpha_s}{Q^2R^2}\, xG(x,Q^2)$

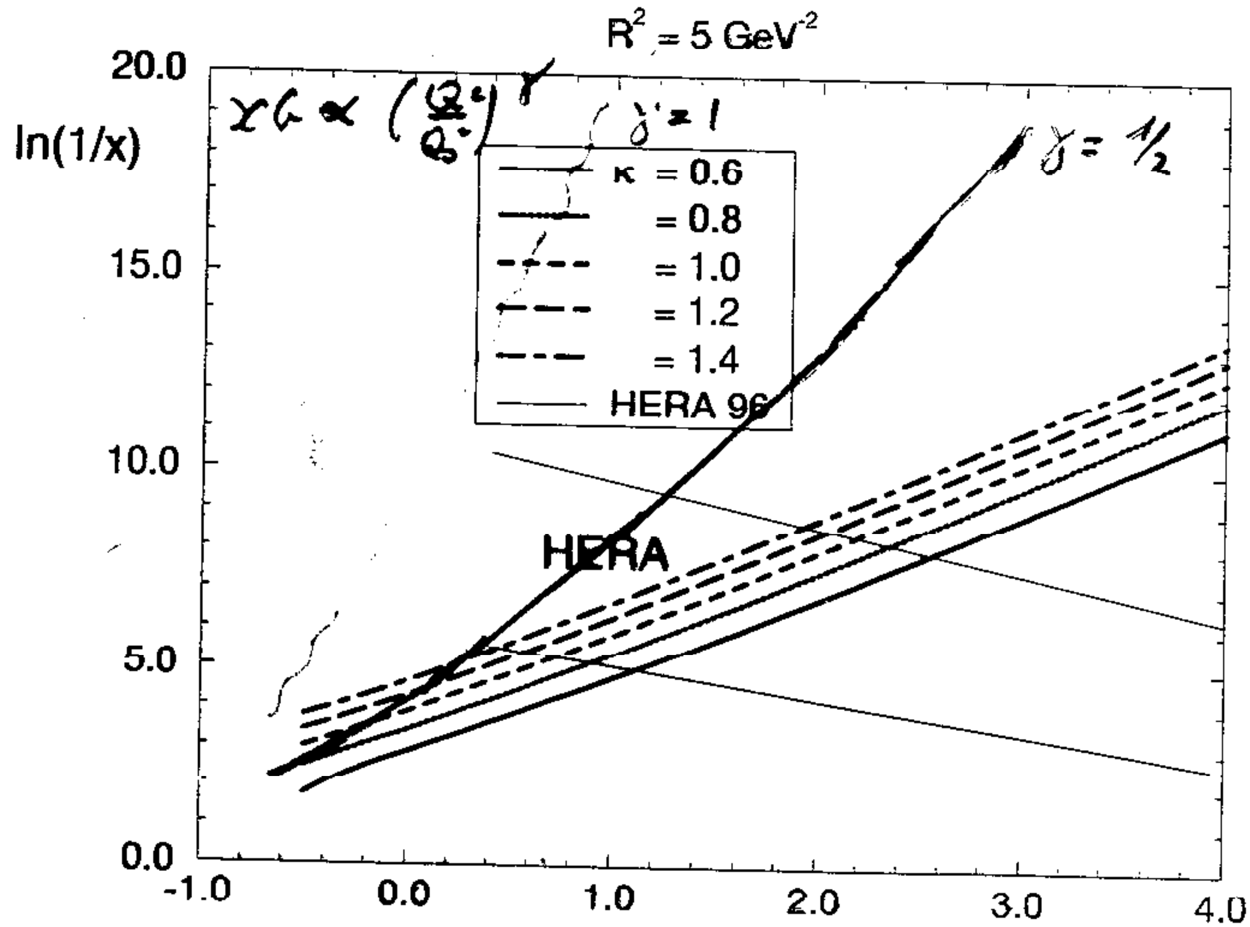
[Gribov, Levin, Ryskin (8 Mueller, Qiu (86)]

$\mathcal{K}$ = probability of gluon-gluon interaction inside of the parton cascade

$\mathcal{K}$ = strength of the SC.

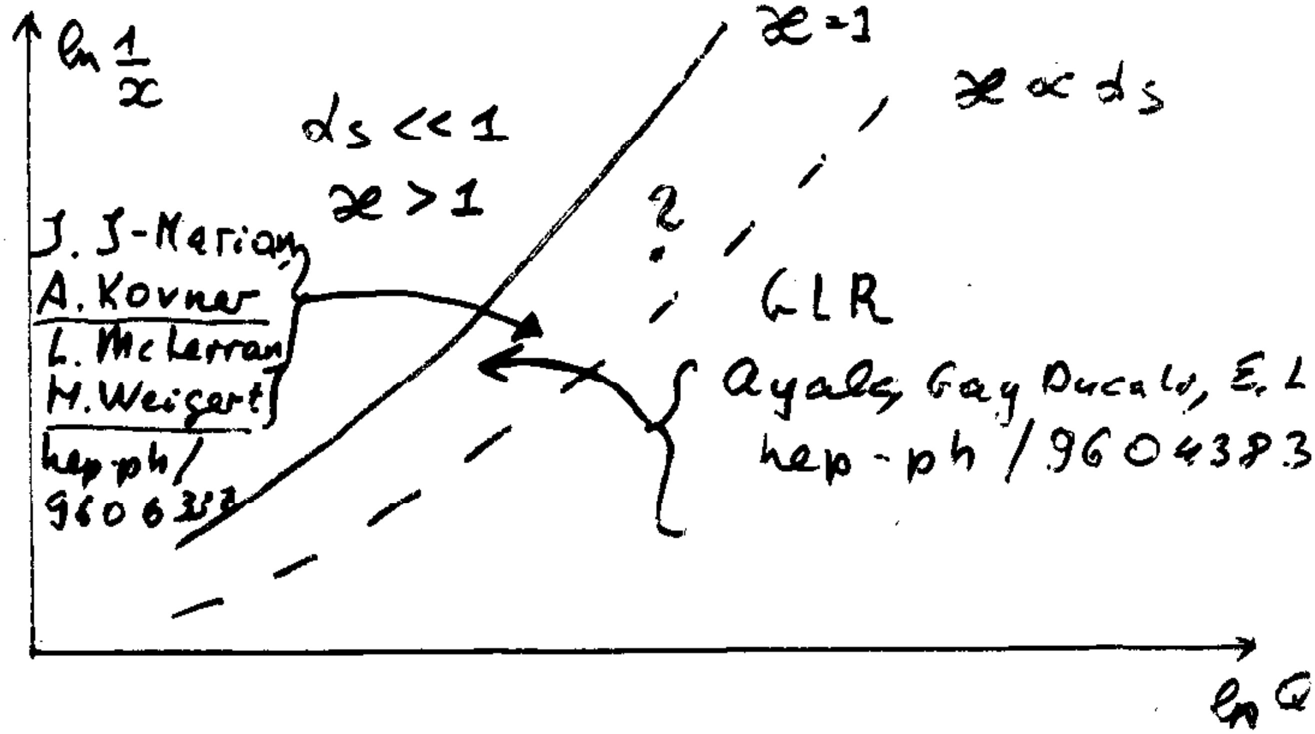
- $R^2 \simeq 5\ GeV^{-2}$ from HERA data.

Contour for κ = cte for Nucleon



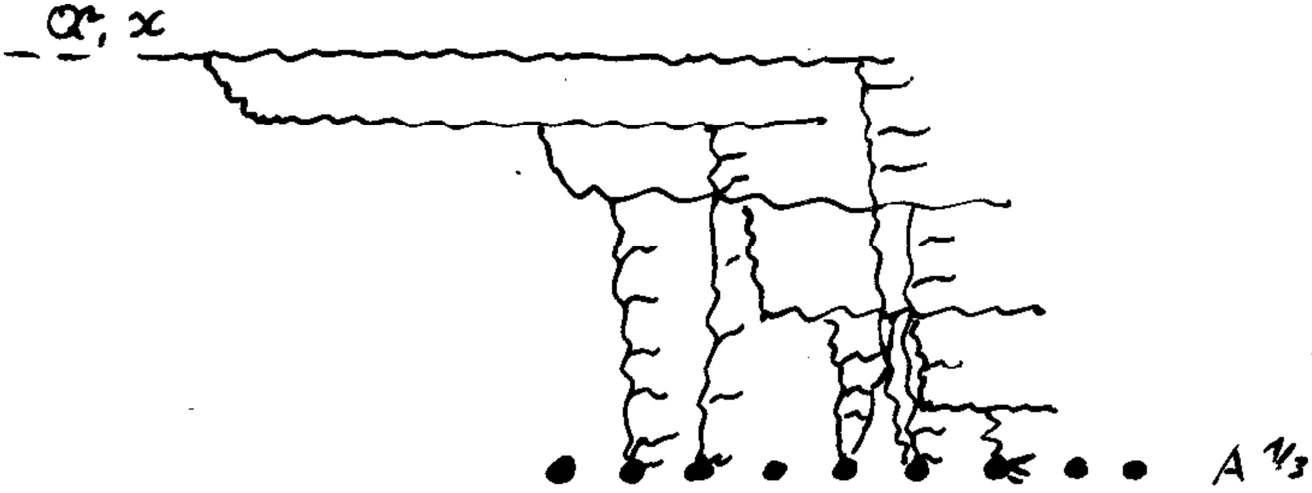
Q1: Why SC has not been seen at HERA while $\varkappa \geq 1$.

Q2: What comes first: SC or BFKL



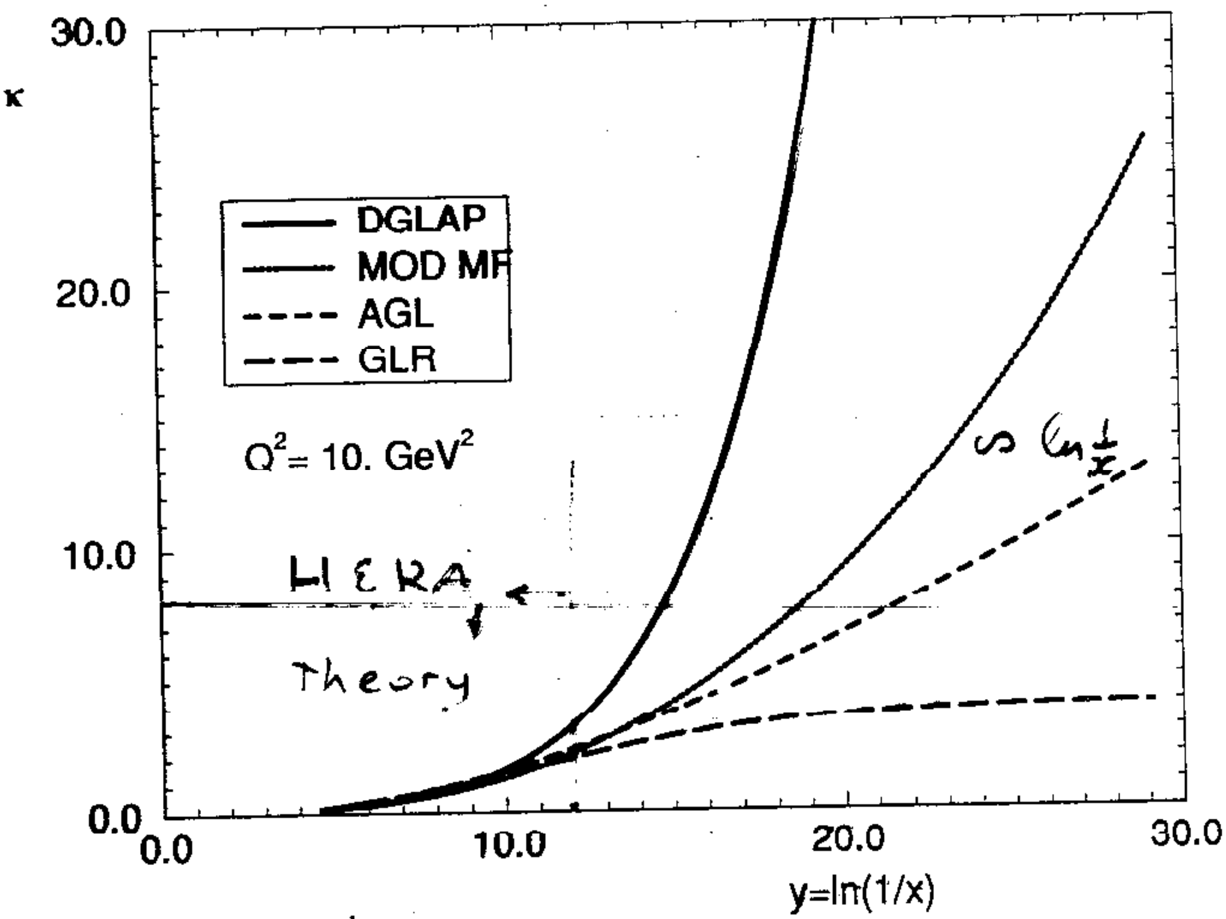
A1: } No answers, we need better
A2: } theory

• From pQCD to high parton density QCD

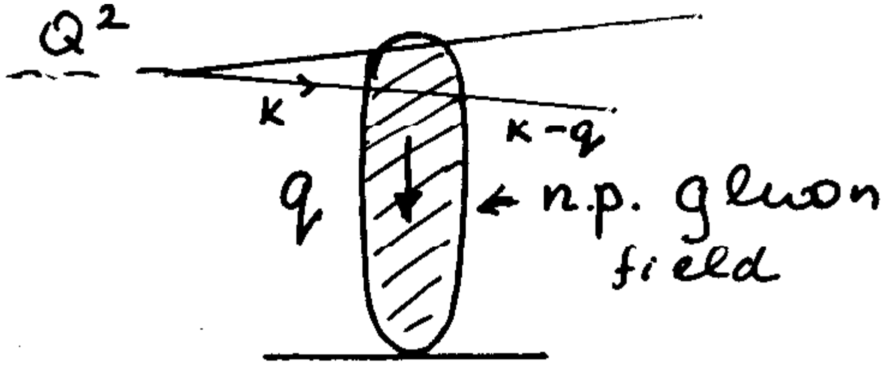


Each parton interacts with nucleus in Glauber - Mueller approach → Mueller (90) !!

κ values



- Semiclassical gluon field approach
[from hd QCD to p QCD]

- 

$$q_\perp \sim \Lambda_{QCD} \ll k$$

$$\omega_q = q_- \sim \Lambda_{QCD} \ll k_+$$

$$q_- = \frac{q_\perp^2}{q_+}$$

Bjorken, Kogut ('72
Buchmüller, ('95)
Hebecker
McDermott

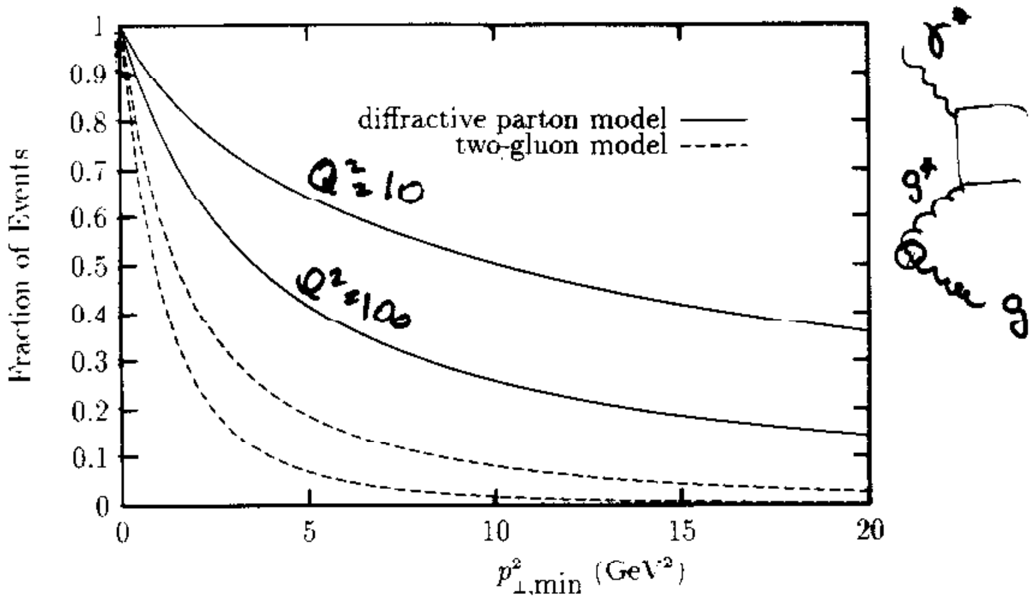
- We can say a lot on DIS
- and DDinDIS, using only general form of QCD Lagrangian.

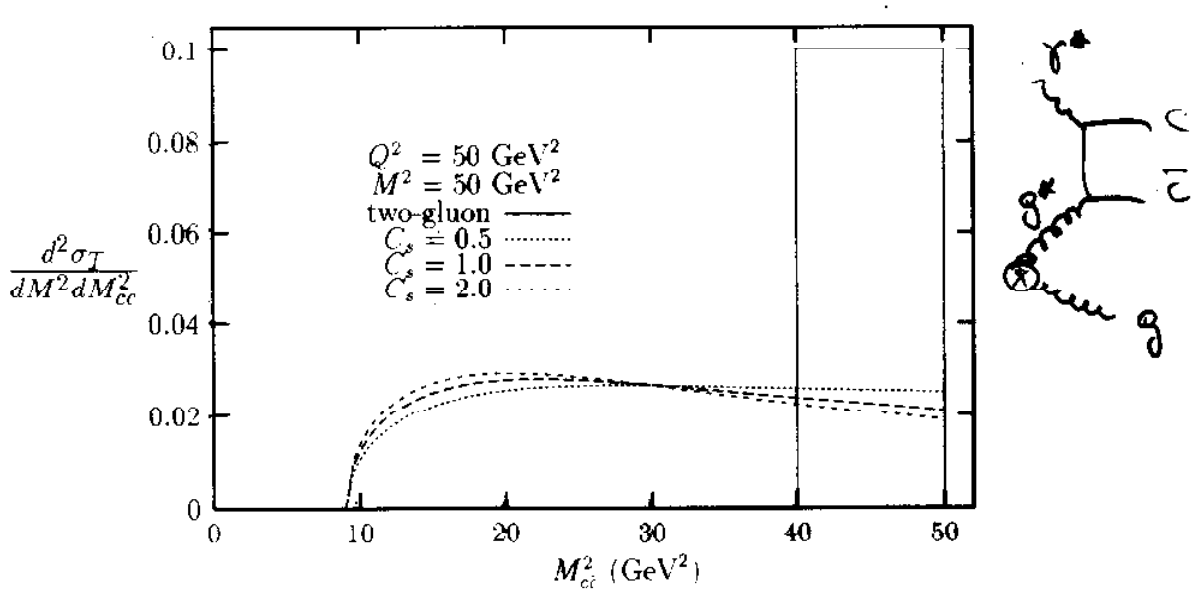
For example, for Diffractive charm:

$$\sigma_L^{DD} \sim \frac{1}{Q^2} \quad \sigma_T^{DD} \sim \frac{1}{Q^2}\left(\ln\frac{Q}{m_c} - 1/4\right)$$

$$\left(\sigma_L^{DD} \sim \frac{\Lambda^2}{Q^4}\left(\ln\frac{Q}{m_c} - \frac{3}{4}\right);\ \sigma_T^{DD} \sim \frac{\Lambda^2}{Q^2 m_c^2} \right)$$

WB, Hebecker, McDermott

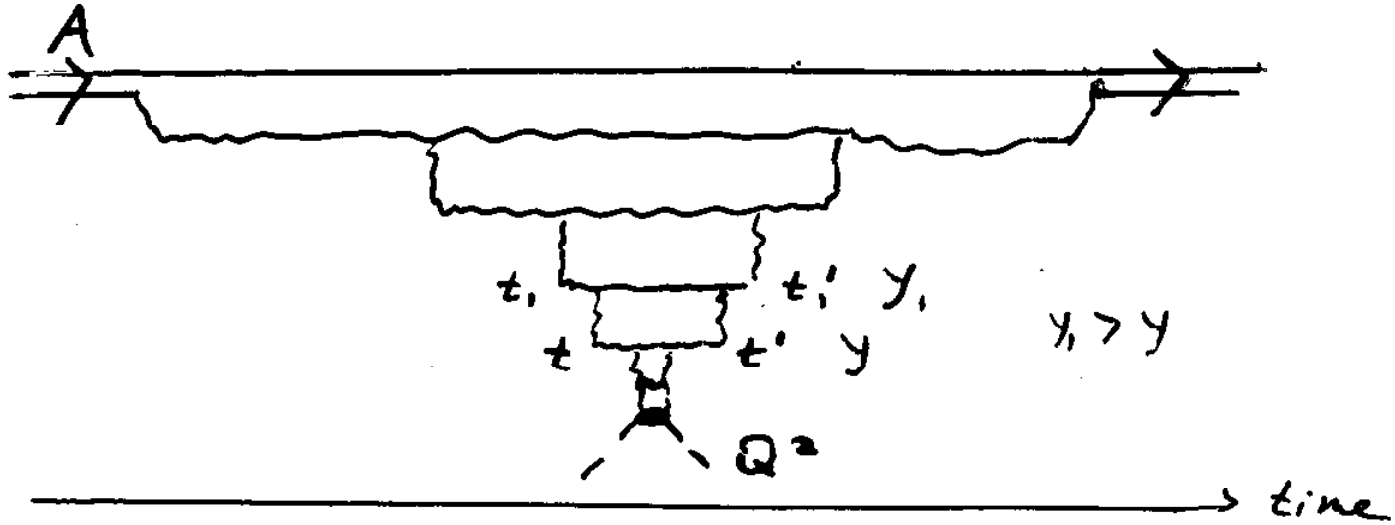




McLerran, Venugopalan (94)

• $\underbrace{\text{hd QCD:}}_{\text{effective action}}$

J. Jalilian-Marian, A. Kovner, Larry McLerran, H. Weigert
Y. Kovchegov (97)
Y. Kovchegov, D. H. Rischke (97



$$t_1 - t_1' \gg t - t'$$

$$\underbrace{\rho^a(t_1)}_{} \gg 1$$

is color charge density per unit transverse area and per unit rapidity

$$\frac{d\rho^a}{dy} \propto \alpha_s \rho^a \ll \rho^a$$

$$\langle O \rangle = \frac{\int D\rho \, DA^\mu_a \, O(A) \, e^{iS(\rho, A)}}{\int D\rho \, DA^\mu_a \, e^{iS(\rho, A)}}$$

$$S = i \int d^2x_t \, F(\rho(x_t))$$

$$- \frac{1}{4} \int d^4x \, G^2 +$$

$$+ \frac{i}{N_c} \int d^2x_t \, dx^- \, A_\mu J_\mu(\rho)$$

$$G_a^{\mu\nu} = \partial^\mu A_a^\nu - \partial^\nu A_a^\mu + g f_{abc} A_b^\mu A_c^\nu$$

$$F(\rho) = i \frac{\rho^2}{\mu^2}$$ ← free energy of partons at time t

$$\chi(y) = \int_y^\infty dy' \, \mu^2(y)$$

↓ charge per unit of rapidity

Assumption: $\chi(y)$

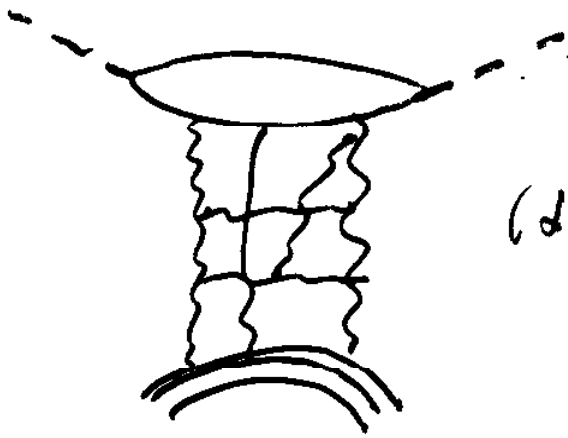
Result: non linear evolution equation for $xG(x, Q^2)$.

which

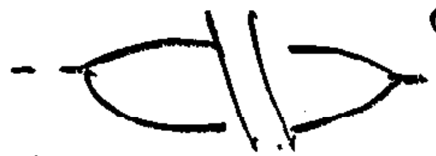
1. gives the DGLAP ev. eq. for $\rho \to 0$ and $Q^2 \gg \Lambda^2$
2. gives the BFKL equation for weak gluon field

(A. Kovner)

I • Formal derivation of the BFKL eq
Balitsky



$\left(\alpha_s \ln \frac{s}{m^2}\right)^n \longrightarrow$

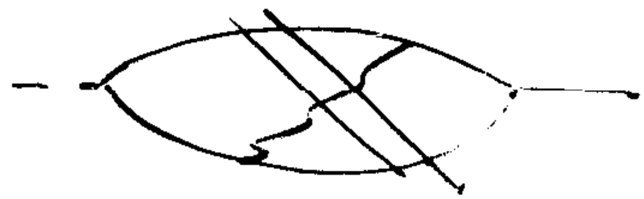


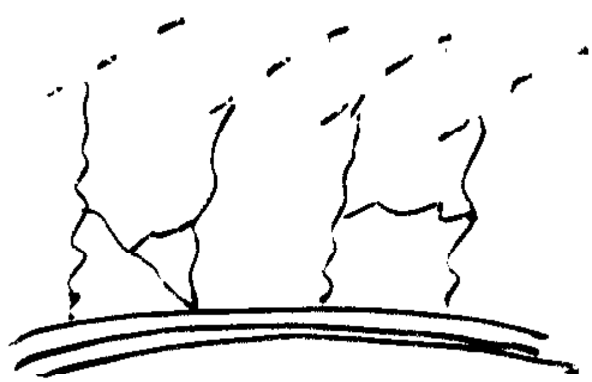
$\omega_+ = \frac{p_\perp^2}{s} \sim 1$

$\rightarrow$

$\frac{m^2}{s} < \omega_- < 1$

$+$

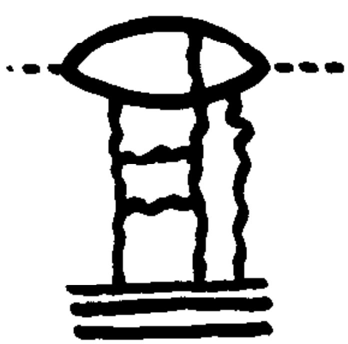
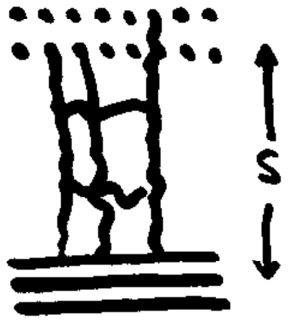




$\left(\alpha_s \ln \frac{s}{m^2}\right)^n$ in the matrix elements of Wilson line operators

OPE for high-energy scattering

$\omega_0 = 4\frac{\alpha_s}{\pi}\ln 2$

 $\Rightarrow$  $\Rightarrow \left(\frac{s}{s_0}\right)^{\omega_0} \cdot$ 

BFKL logs

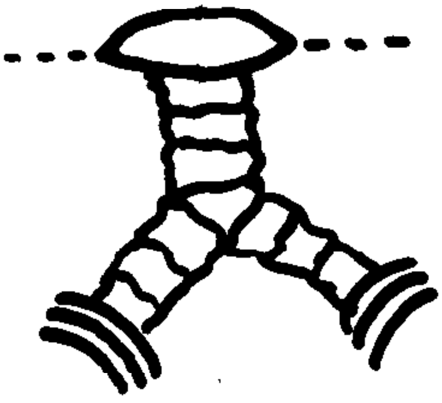
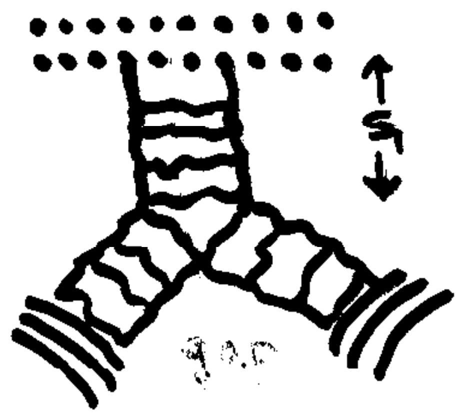
$s_0 \gg m^2$

$\alpha_s \ln \frac{s_0}{m^2} \ll 1$

input for BFKL evolution

$\cdots\cdots\cdots$ $P\exp i\int_{-\infty}^{\infty} A_\mu dy_\mu$ — Wilson line along $p^\xi = p_1 + \xi p_2$ $\quad s = \frac{m^2}{\xi}$

OPE for diffecitve scattering

 $\Rightarrow$ 

$\cdots\cdots$ - Wilson line to the left of the cut

$\cdots\cdots$ - to the right

$\Rightarrow \left(\frac{s}{s_1}\right)^{\omega_0} \cdot$  $\cdot$  $\cdot$ three-pomeron vertex =

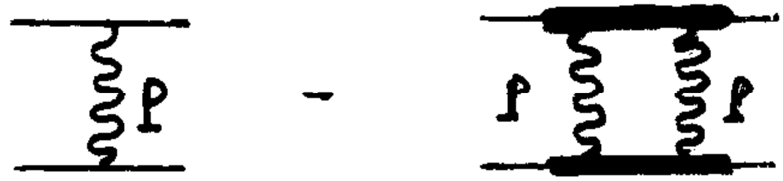
$= \left(\frac{s}{s_1}\right)^{\omega_0} \cdot \left(\frac{s_1}{s_0}\right)^{2\omega_0} \cdot$ three-pomeron vertex $\cdot$ $\left| \right.$  $\left. \right|^2$

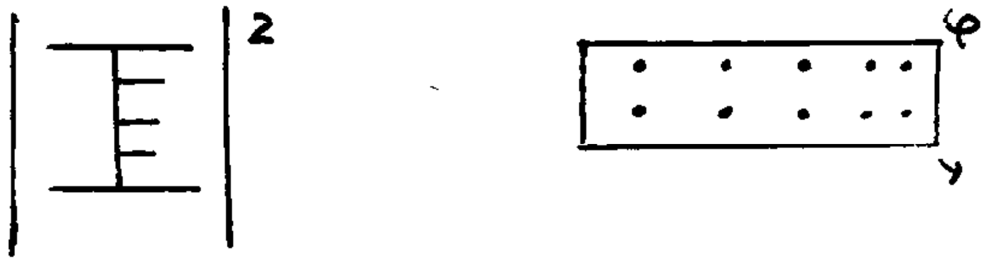
input at s_0

AGK cutting rules and F.T.

→ Abramovski, Gribov, Kancheli Sov. J. Nucl. Phys 18 (73) 308

(1) → in QCD Bartels, Ryskin (96)

$\boxed{\sigma_{tot}}$ =  =

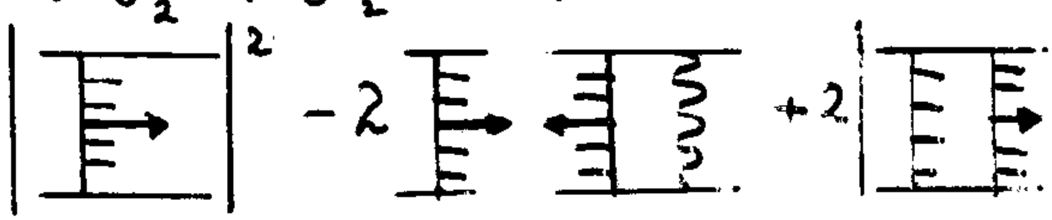
$= \underline{\sigma_1^{(1)}}$ 

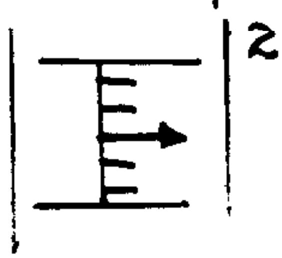
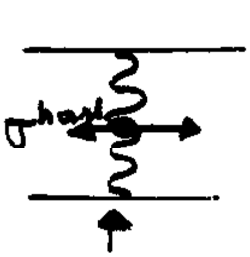
$\underline{\sigma_2^{(0)}}$ 

$\underline{\sigma_2^{(1)}}$ 

$\underline{\sigma_2^{(2)}}$ 

$$\sigma_2^{(0)} : \sigma_2^{(1)} : \sigma_2^{(2)} = 1 : -4 : 2$$

$\boxed{\sigma_{incl}}$ = 

=  = σ^{hard} 

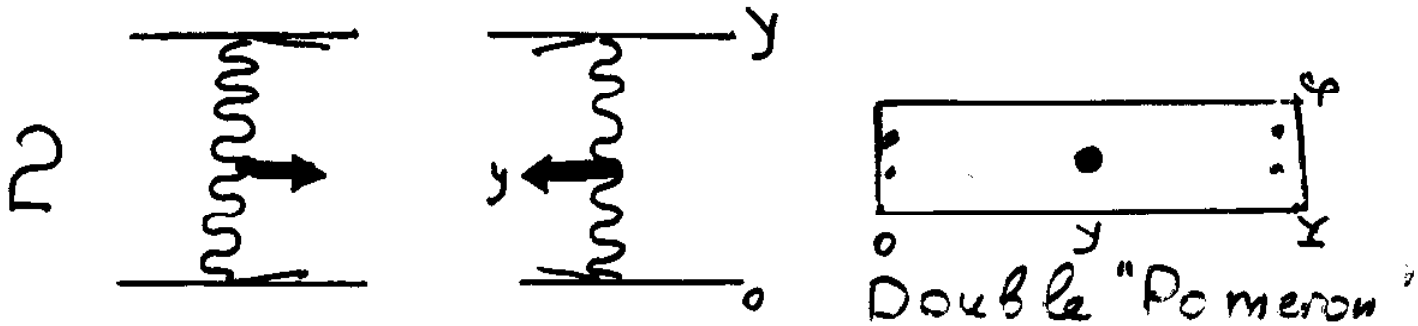
$x_1\, G(x_1, \mu^2)$

$x_2\, G(x_2, \mu^2)$

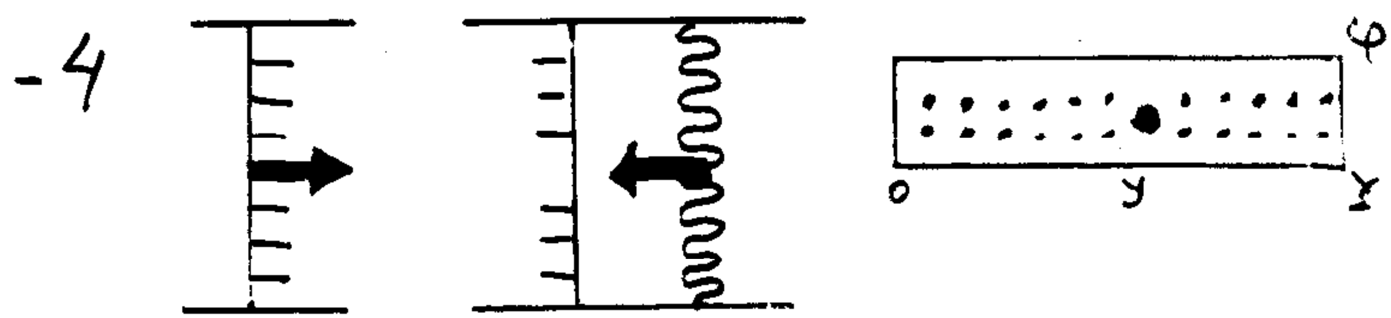
F.T.

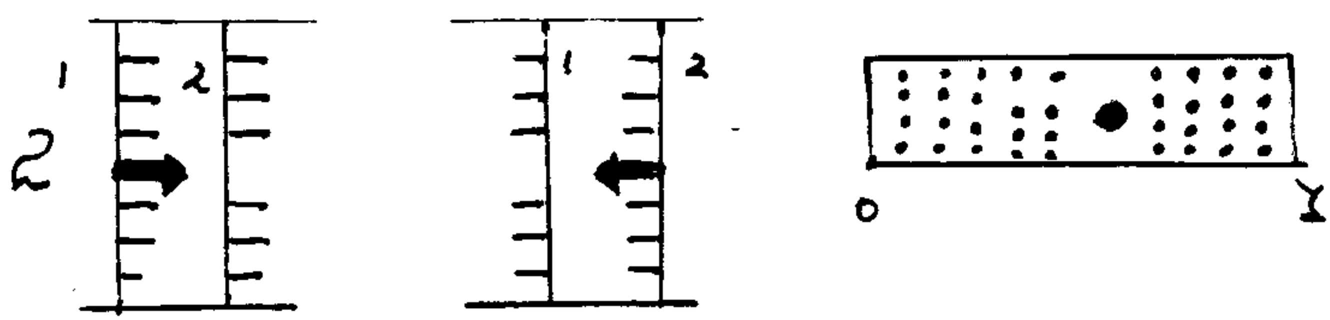
(2) Violation of the [illegible] in hard inclusive production at high energy.

A. Gotsman, E. Levin, U. Ma[illegible]
(19[illegible]

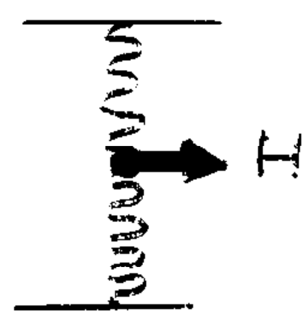


Double "Pomeron" Higgs productio[n]



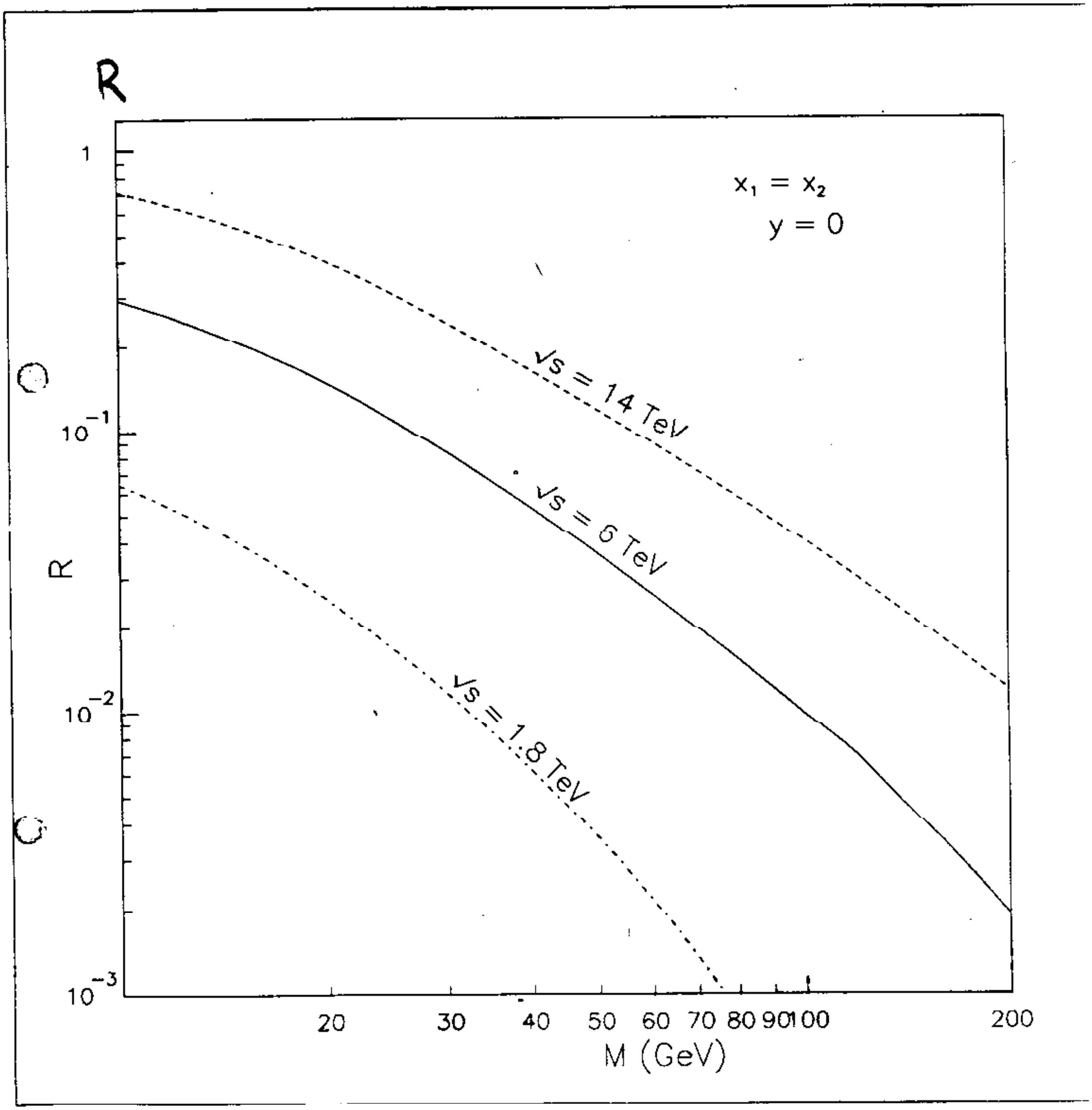


$$\sum = 2\left(\mathrm{Re}\, A_P^H\right)^2$$

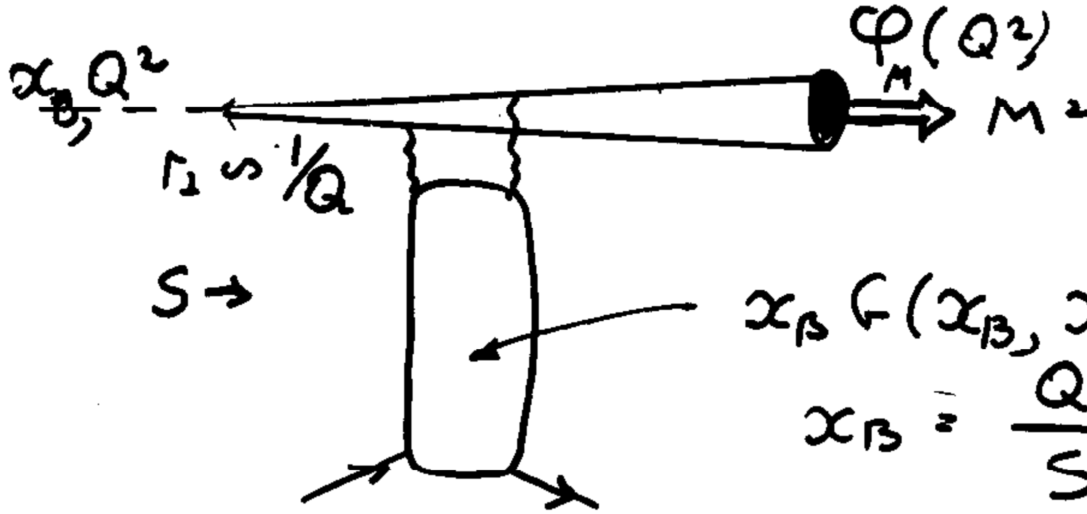
$A_P^H =$ 

- Good luck to find a mistake before DIS98!

A. Bialas
P. Landshof
Phys Lett.


R
1
10^{-1}
10^{-2}
10^{-3}
R
$x_1 = x_2$
$y = 0$
$\sqrt{s}$ = 14 TeV
$\sqrt{s}$ = 6 TeV
$\sqrt{s}$ = 1.8 TeV
20
30
40
50
60
70
80
90
100
200
M (GeV)

● F.T. for exclusive processes



$x_B\, G(x_B, x_M, Q^2)$

$$x_B = \frac{Q^2}{S}$$

$$x_M = \frac{M^2}{S}$$

$S \rightarrow \infty$

$$x\; G(x, Q^2)$$

$$x = x_B + x_M = \frac{Q^2 + M^2}{S}$$

M. Ryskin
S. Brodsky et all

Off diagonal str. function: J. Collins, (96
L. Frankfurt
M. Strikman

$\underline{G(x_B, x_M, Q^2)}$

$\gamma^* p \rightarrow Z + p$

Gribov, Levin, Ryskin (83)
Radyushkin (96
Freund (96)

$$P_q^q(z,x_M) = 2C_2\left\{\frac{z\,(z-x_M)}{(1-z)(1-x_M)} - \delta(1-z)\cdot\right.$$

$$\cdot\left[\int_{x_M}^{1}\frac{dt\,[t\,(1-x_M)+t-x_M]}{(1-t)(1-x_M)} + \int_0^{x_M}\frac{t\,dt}{1-t} + \frac{1}{2}\right.$$

$$P_G^G(z,x_M) = N_c\cdot\left\{\frac{z(1-z)}{1-x_M}\cdot\left[1+\frac{1-x_M}{z(z+x_M)}+\frac{1-x_M}{(1-z)}\right.\right.$$

$$-\delta(1-z)\left[\int_0^1\frac{dt\,(1+t)}{1-t}+\int_{x_M}^{1}\frac{dt\,(1+t-2x_M)}{(1-t)(1-x_M)}+\right.$$

$$-\frac{2}{3}n_F\,\delta(1-z)$$

$$P_q^G(z,x_M) = 2C_2\,\frac{1-z^2+1-x_M}{(z+x_M)(1-x_M)}$$

$$P_G^q(z,x_M) = \frac{z\,(z-x_M)+(1-z)^2}{1-x_M}$$

- Real nonperturbative stuff:
- Lattice experiment.

G. Schierholz

- Instantons.

F. Schrempp

$\boxed{\text{N. Kochelev}}$

① Instanton Liquid Model for proton (Shuryak ...)

② $F_2^{Inst} \sim Q^2 \langle \rho^2 \rangle$

4. Conclusions

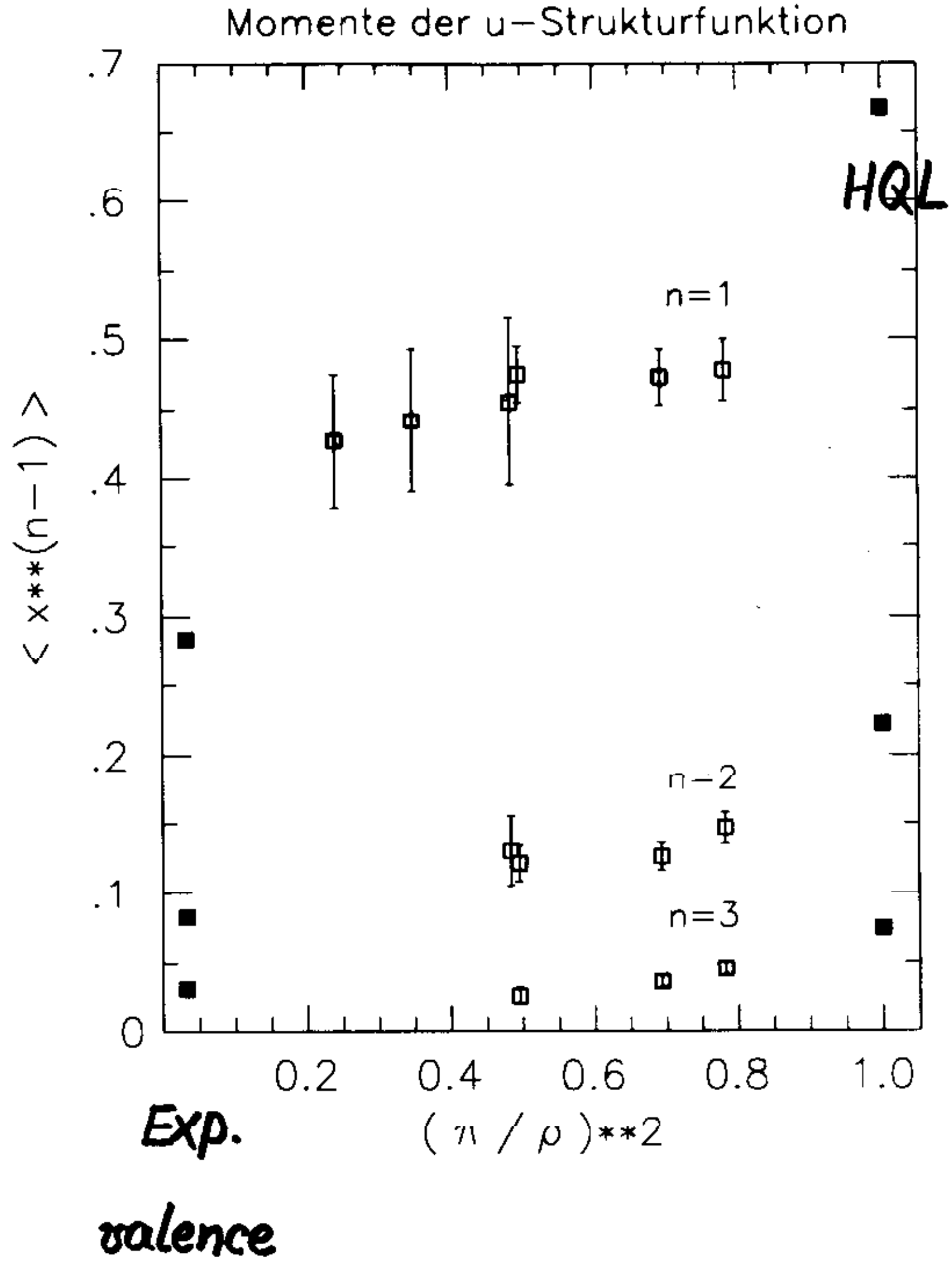
- Distinguished rôle of $e^{\pm}P$ scattering involving hard momentum scale Q.

- **Experimentally:**
  HERA offers unique window in DIS (and hard photoproduction?) to detect I-induced events through their characteristic multi-particle final-state signature.

- **Theoretically:**
  - Absence of IR divergencies associated with integration over I-size ρ.
  - Chirality-violating Amplitudes well-defined and calculable for small $\alpha_s(Q)$ and fixed scattering angles.
  - Inclusive framework to systematically calculate properties of I-induced multi-parton final state;

    accounts for exponentiation of produced gluons including final-state tree-graph corrections:

    * Optical theorem and Mueller-optical theorems, to express various I-induced inclusive cross sections as discontinuities of elastic n $\rightarrow$ n forward amplitudes $T^{(I)}_{n\rightarrow n}$
    * Uniform evaluation by means of $I\bar{I}$ valley method and saddle-point integration over collective coordinates.
    * Stable results, consistent with stringent energy-momentum sum rules.



Momente der u-Strukturfunktion
.7
.6
.5
.4
.3
.2
.1
0
0.2
0.4
0.6
0.8
1.0
< x**(n-1) >
(π / ρ)**2
n=1
n=2
n=3
HQL
Exp.
valence

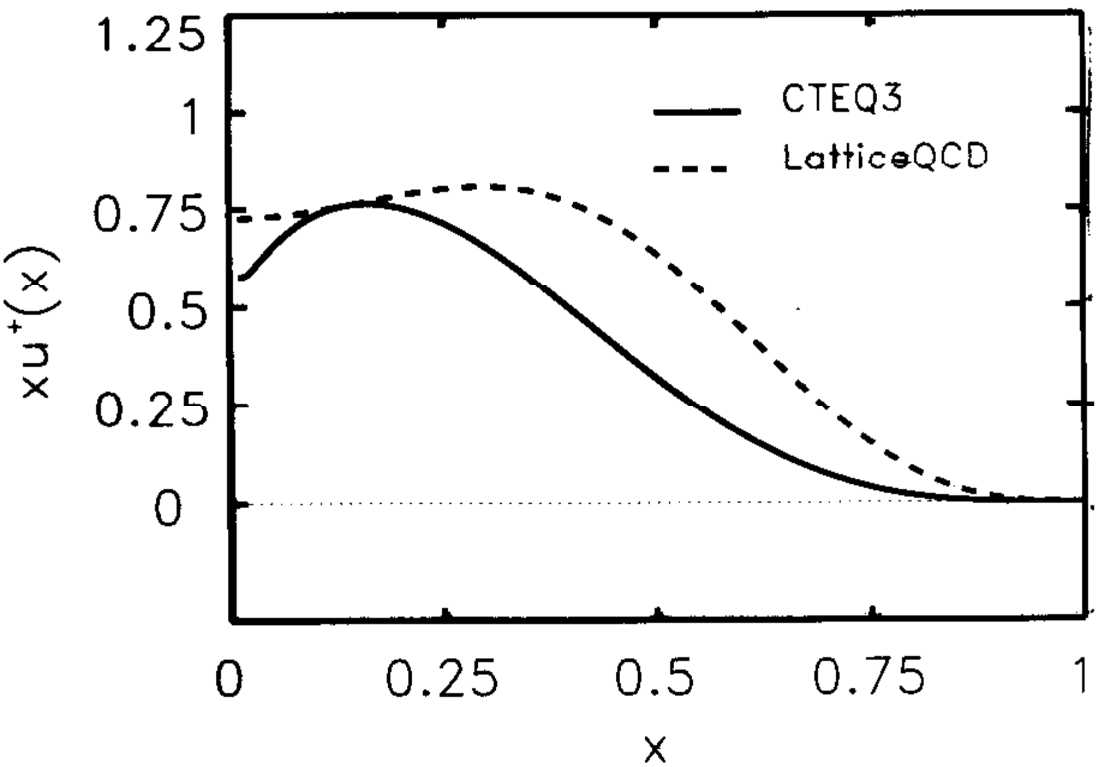


Fig. 3 Reconstruction of the u-quark distribution function using the lattice results for the first two moments [7] and the experimental normalization at small x. The solid line is the CTEQ parametrization [12] at $\mu^2 = 2.5$ GeV^2.

Weigl, Monkiewicz

Higher twist ?

- Summary:
- Next order corrections to the BFKL eq.
- Violation of the factorization theorem.
- Effective action for high parton density QCD.
- Beginning of the systematic study on Q^2 and x dependence of HT str. function.
- Exciting progress in nonperturbative approaches:
  - semiclassical gluon fields
  - shadowing corrections
  - lattice calculations
  - instantons in DIS
- Evolution equation for nondiagonal (exclusive) str. functio

Not bad, isn't it?