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Large Rapidity Gap Events in DIS

- Dipole picture
- Phenomenology
  - → β - spectrum
  - → x_P - distribution
  - → Q^2 - dependence
  - → Azimuthal distribution
- Conclusions

- the conventional variables are used:

$$\beta = \frac{Q^2}{M^2+Q^2} \qquad (t=0)$$

$$x_{I\!P} = \frac{M^2+Q^2}{W^2+Q^2}$$

- closely related work:

[Bartels,
Levin,
Mueller,
Nikolaev, Zakharov
Diehl,
⋮
]

Dipole Picture

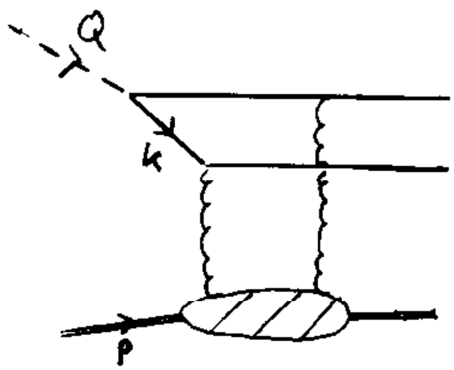
1) Quark-Antiquark Dipole :

γ : Photon helicity
h : Quark helicity

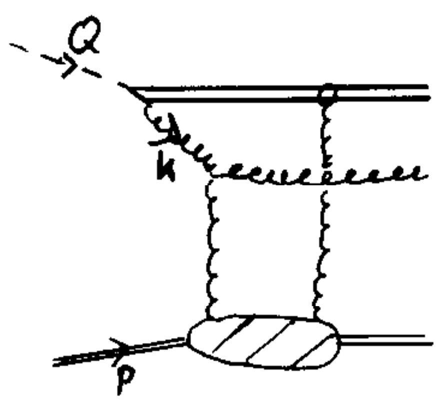
wave function:

vector

$$\Psi_h^\gamma(\alpha, k_t) = \begin{cases} \dfrac{\sqrt{2}\,(\alpha-1)\,k_t}{|k_t|^2+\alpha(1-\alpha)Q^2} & (+,+) \\[2ex] \dfrac{\sqrt{2}\,\alpha\,k_t}{|k_t|^2+\alpha(1-\alpha)Q^2} & (+,-) \\[2ex] \dfrac{\sqrt{2}\,\alpha\,k_t^*}{|k_t|^2+\alpha(1-\alpha)Q^2} & (-,+) \\[2ex] \dfrac{\sqrt{2}\,(\alpha-1)\,k_t^*}{|k_t|^2+\alpha(1-\alpha)Q^2} & (-,-) \\[2ex] 2\,\dfrac{\alpha(1-\alpha)\,Q}{|k_t|^2+\alpha(1-\alpha)Q^2} & (0,\pm) \end{cases} \qquad (\gamma, h)$$



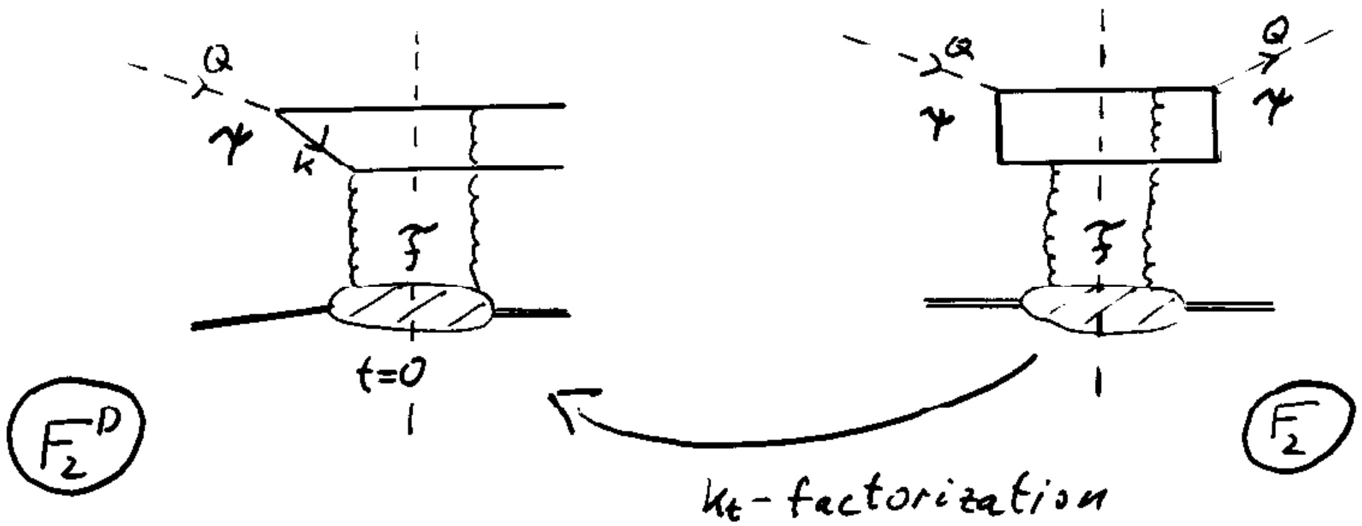
2) Effective Gluon-Gluon Dipole :



$$\Psi^{mn}(\alpha, k_t) = \frac{1}{\sqrt{\alpha(1-\alpha)Q^2}}\,\frac{k_t^2\,\delta^{mn} - 2\,k_t^m k_t^n}{k_t^2+\alpha(1-\alpha)Q^2}$$

tensor (transverse) ; $m,n = 1,2$

Phenomenology



- the wave function Ψ has to be folded with the unintegrated structure function $\mathcal{F}$.
  → this can be done in momentum space or impact parameter space.

$$\mathcal{F}(x_B, l_t^2, Q_0^2) = \frac{G(x_B, Q^2/Q_0^2)}{l_t^2 + Q_0^2}$$

$$G(x_B, Q^2/Q_0^2) = 0.877 \left(\frac{x_0}{x_B}\right)^{1-\alpha_{I\!P}(Q^2)} \left[\ln\left(\frac{Q^2}{Q_0^2}\right) + 1\right]^{-0.596} \quad [\exp(3t)]$$

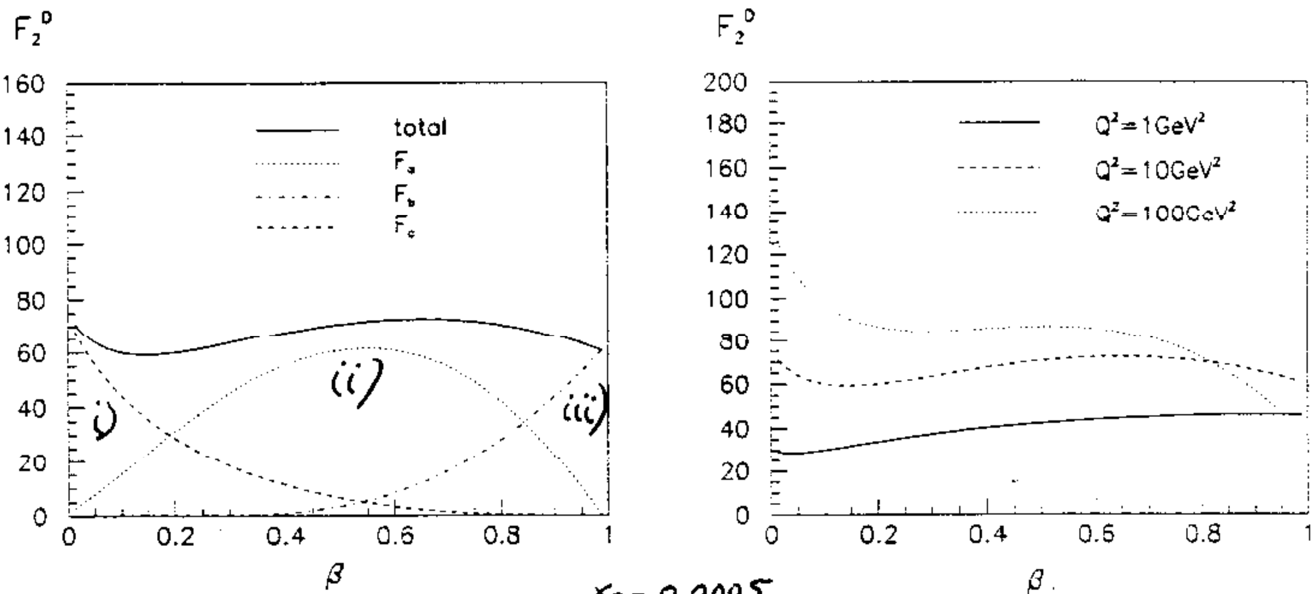
LPS-data

$$\alpha_{I\!P}(Q^2) = 0.085 + \begin{cases} 0.133 \ln[\ln(Q^2/Q_0^2) + 1] & \text{if} \quad Q^2 > Q_0^2 \\ 0 & \text{if} \quad Q^2 \leq Q_0^2 \end{cases}$$

$Q_0 = 1$ GeV

- the parameters are determined by a fit to F_2
  → the scale Q^2 has to be replaced by $k^2 \doteq \frac{k_t^2}{1-\beta}$

β-spectrum



$x_{\mathbb{P}} = 0.0005$

- the β-spectrum is rather flat around $Q^2 \approx 10$ GeV^2.

  $\rightarrow$ it consists of three major contributions:

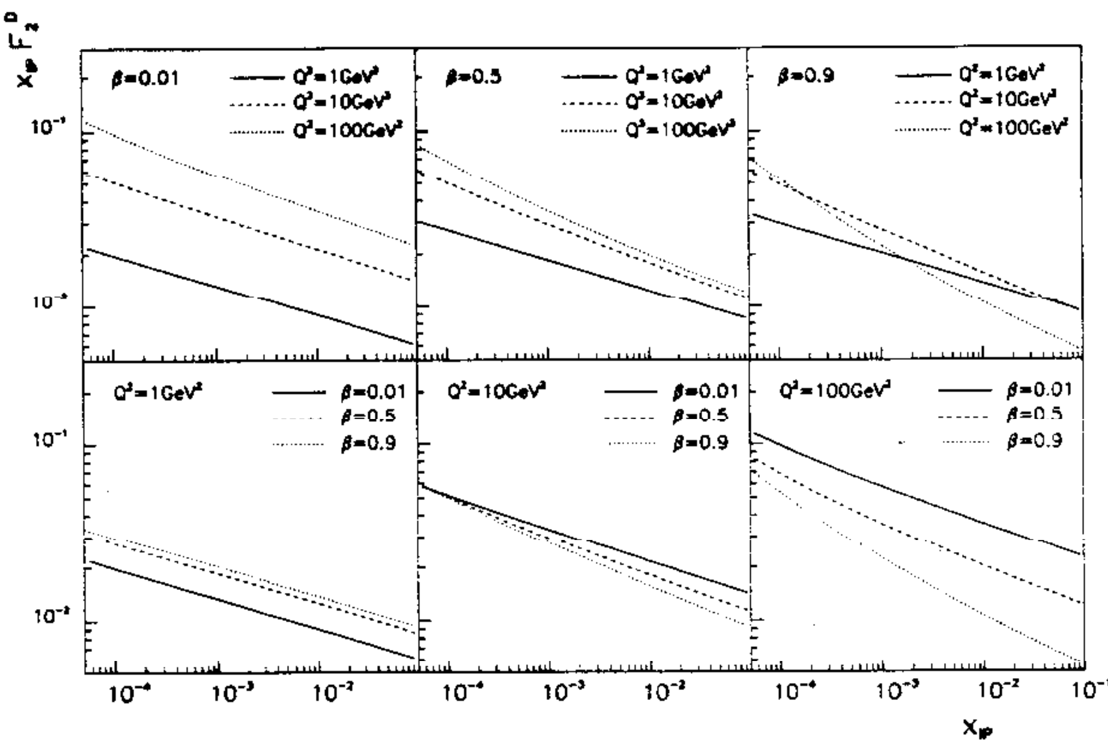
  i) small β : $q\bar{q}g$ (F_c)

  ii) medium β: $q\bar{q}$ (transverse) (F_a)

  iii) large β : $q\bar{q}$ (longitudinal) (F_b)
  $\hookrightarrow$ higher twist

- with increasing Q^2 the β-distribution starts tilting towards large β
  (the low β-regime increases and the large β-regime decreases $\rightarrow$ higher twist)

$x_{I\!P}$ - distribution

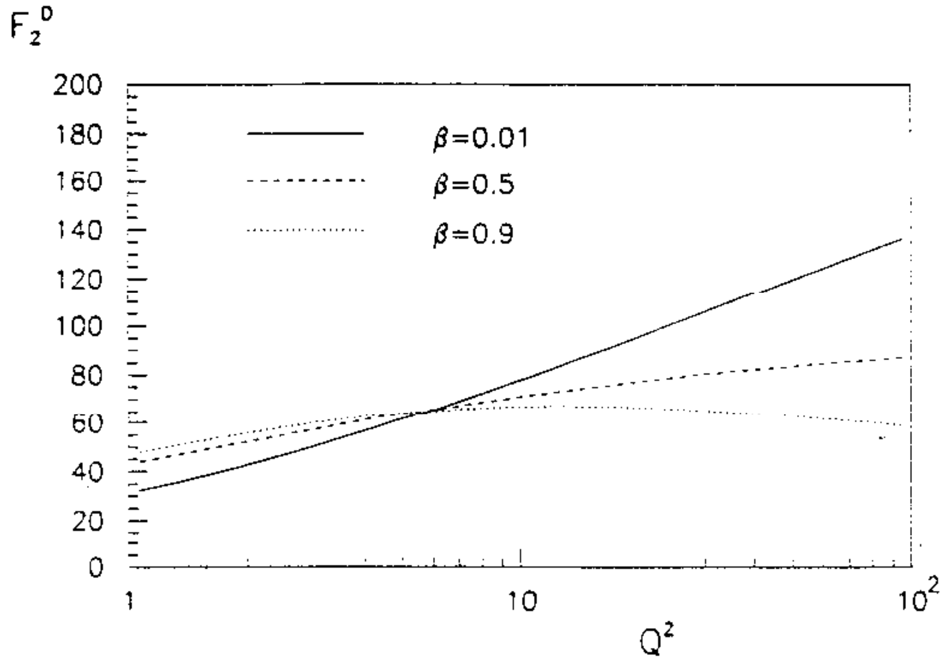


- increase of $\alpha_{I\!P}$ with increasing β and Q^2

  $\longrightarrow$ breaking of Regge-factorization

- at low β and Q^2 the Pomeron is purely soft ($\alpha_{I\!P} \simeq 1.085$)

Q^2- dependence



— all curves are rising at low Q^2 and diverge beyond $Q^2 = 10\ GeV^2$:

small β : keeps rising

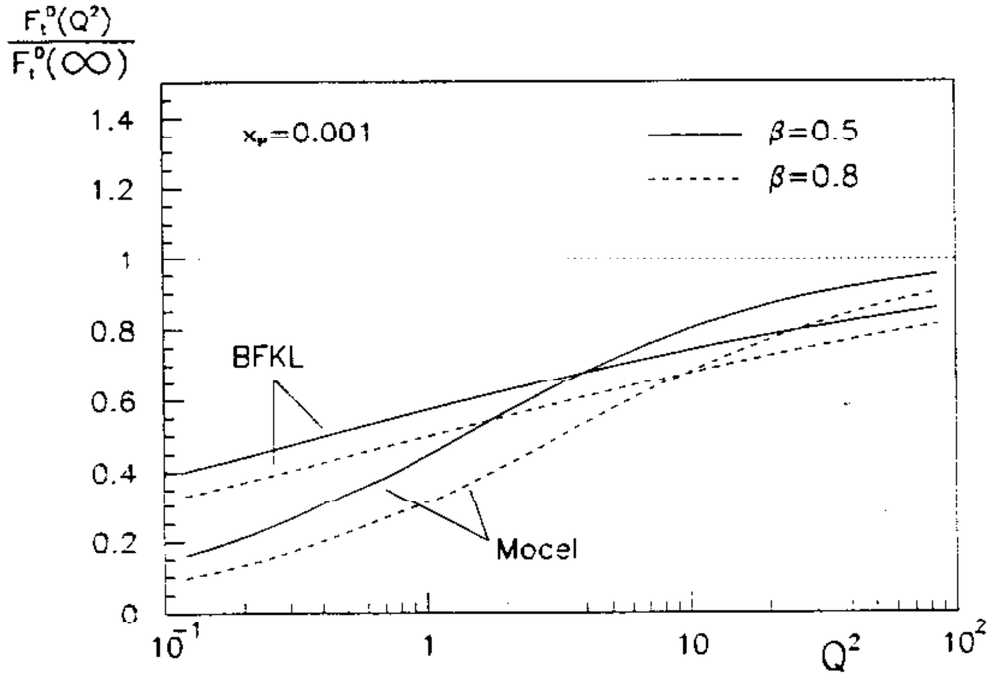
medium β : flattens out

large β : turns down

↓

higher twist

$q\bar{q}$ - final state with transverse polarized photons



— the asymptotic regime (leading twist) is approached rather slowly.

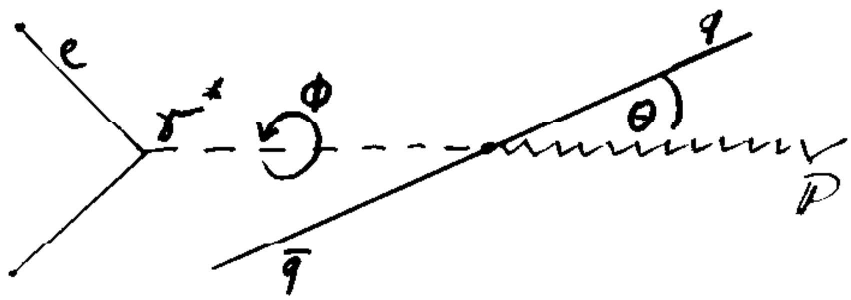
Even at $Q^2 = 10\ GeV^2$ F_t^D is 30% below its asymptotic value.

→ preasymptotic regime

→ higher twist corrections

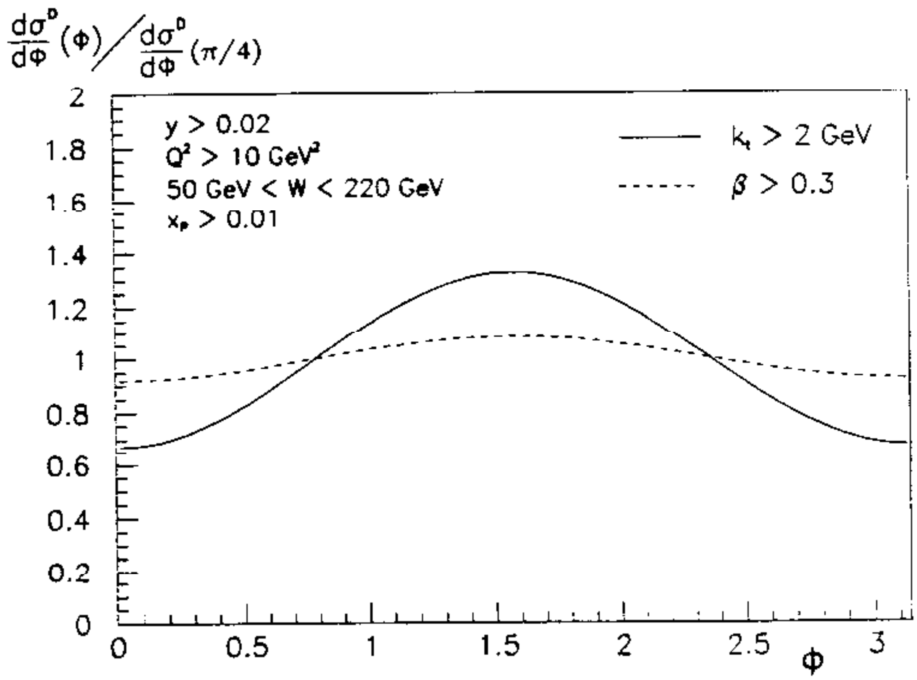
(Bartels)

Azimuthal - distribution



ϕ = azimuthal angle

θ = polar angle



——— : with a cut on k_t a strong oscillation is seen (peak at $\frac{\pi}{2}$)

- - - - : a slight oscillation can also be seen in the inclusive case ($\beta > 0.3$)

Conclusions

- rather flat total β-spectrum
- breaking of Regge-factorization
  - → increasing $\alpha_{\mathbb{P}}$ with increasing β and Q^2

* positiv slope in Q^2

→ preasymptotic regime (higher twist effects)

- azimuthal distribution with peak at $\frac{\pi}{2}$