§ 2.4.2　小さなx領域 の構造関数（p.19）

small x ↔ large rapidity ↔ Regge kinematics　$1 << s/|t|$

→ $|t| < 1$ GeV　nonperturbative

→ $|t| > 1$ GeV　perturbatice

[1] small x behaviour of F_2, F_L

$$F_{2,L}(x, Q^2) \sim x^{-\lambda(Q^2)} = e^{-\lambda(Q)\ln(x)}$$

BFKL equation

$$[\alpha_s \ln(x)]^n \ \ (\mathrm{LO}),\ \ \alpha_s[\alpha_s \ln(x)]^n \ \ (\mathrm{NLO})$$

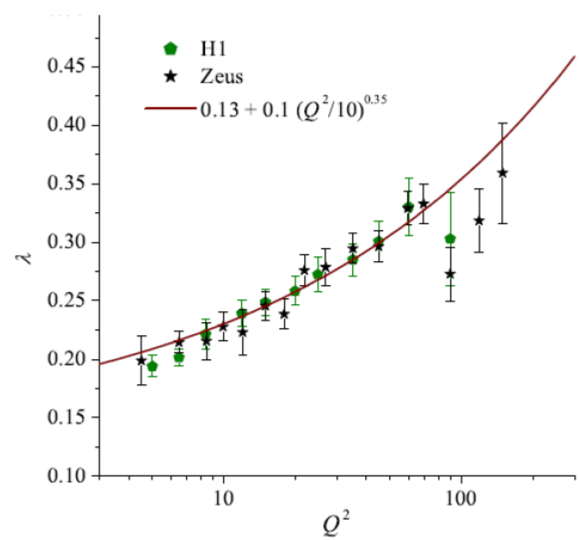
↓　　　　　↓

$x^{-\frac{12\alpha_s}{\pi}\ln 2}$　　　　$x^{-1.1-1.3}$

unitarity　violation

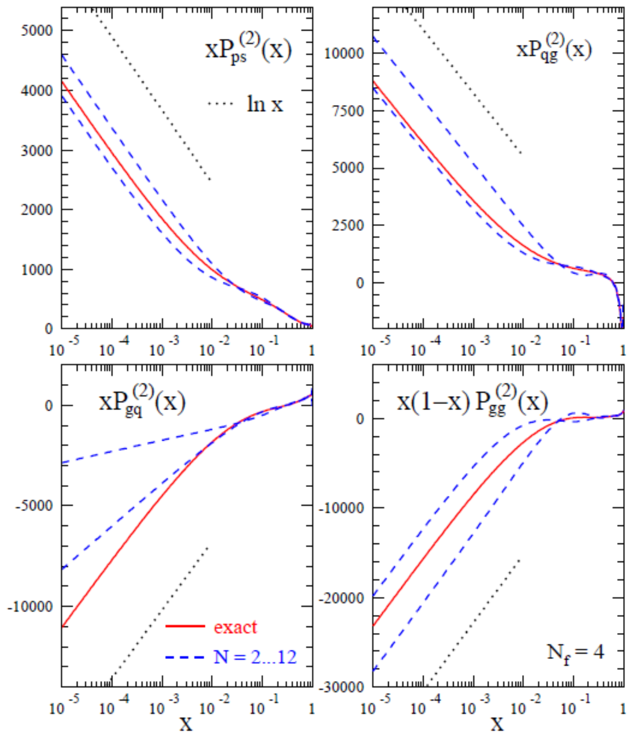
→ "improved BFKL resummation

Altarelli, Ball,Forte ; Kowalski, Lipartov,Ross,Watts;
Avsar, Stasto, et al. , etc.



Kowalski et al (2010)

実際にはHERAの領域では対数項はdominantではない。



Singlet : exact vs. leading $\frac{\ln(x)}{x}$

赤線　　　黒点線

Moch,Vermerseren, Vogt (‘04)

[2] Gluon Saturation

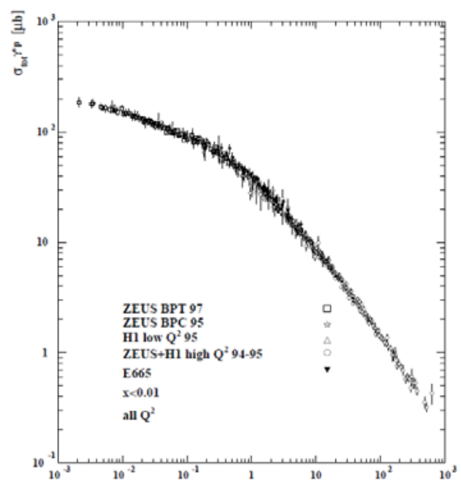
- Steep rise of F_2 gets milder at

$$Q^2 = Q_s^2(x)$$

"Saturation Scale"

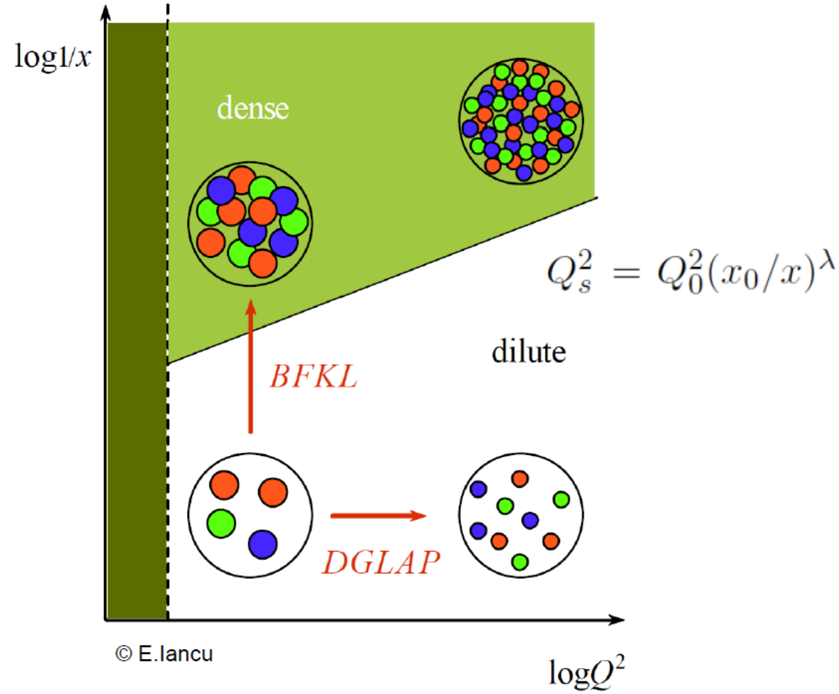
- Geometrical Scaling

$$\sigma^{\gamma^* p}(x, Q^2)$$



$$\tau = \ln(Q^2/Q_s^2)$$

Saturation



Dynamics

- Color Dipole Model (GBW)
- Color Glass Condensate (CGC)
- DGLAP eq. (saddle-point approx.)

— F_2,F_L, F^Dを統一的に記述できるか？

— 精度を上げてスケーリングの破れを見る。

- nonlin. eff. would limit precision of PDF extractions at HERA

study by Bartels, Golec-Biernat, Peters using GBW dipole model
at $Q^2 = 5\,\mathrm{GeV}^2$ and $x_B = 2.5 \times 10^{-4}$ found

$$\frac{F_2^{\text{full}}}{F_2^{\text{twist 2}}} \approx 0.94 \qquad \frac{F_L^{\text{full}}}{F_L^{\text{twist 2}}} \approx 0.66$$

Diehl’s talk at DIS08

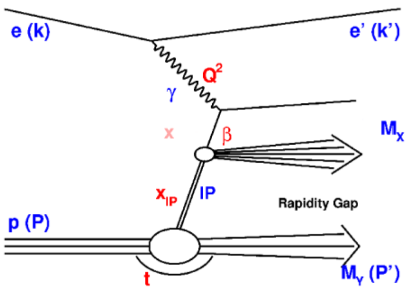
F_Lの方がsaturationが見やすい（らしい）。

[3] Diffraction

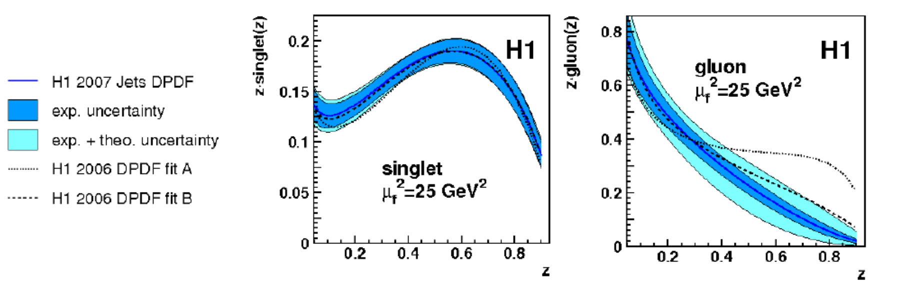
$$F_{2,L}^{D}(x_{\mathbf{P}},t,\beta,\beta^2) = f_{2,L}(x_{\mathbf{P}},t)F_{\mathbf{P}}(\beta,Q^2) + n_{\mathbf{R}}f_{2,L}(x_{\mathbf{R}},t)F_{\mathbf{R}}(\beta,Q^2)$$

pomeron Reggeon

Extracting DPDFs



- Fit β and Q^2 dependence at fixed x_{IP}
- Parametrise at starting scale Q_0^2 and evolve using NLO DGLAP
- PVF allows to combine DPDFs with pomeron flux Ansatz
- Diffractive Jets constrain gluon part of DPDFs



8

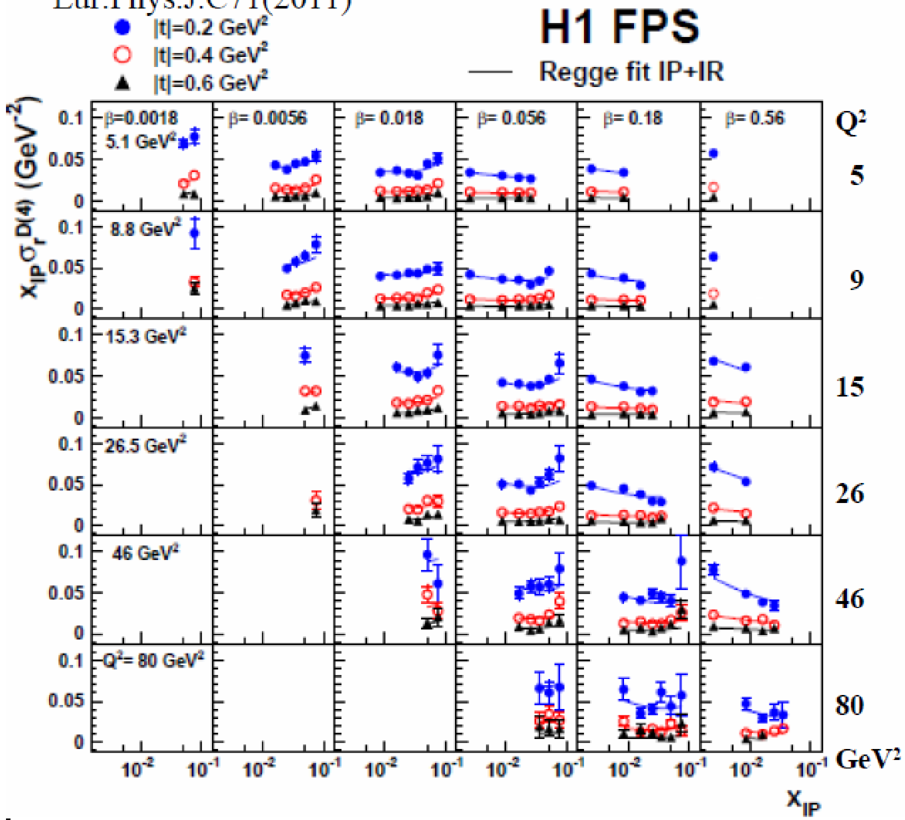
New H1 Results from Proton tagged Data

Regge fit: Assumption: Regge/vertex factorization

$$F_2^{D(4)} = f_{I\!P}(x_{I\!P},t)F_{I\!P}(\beta,Q^2) + n_{I\!R} \cdot f_{I\!R}(x_{I\!P},t)F_{I\!R}(\beta,Q^2)$$

Pomeron contribution — Reggeon contribution

Eur.Phys.J.C71(2011)



$$f_{I\!P}(x_{I\!P},t) = A_{I\!P} \cdot \frac{e^{B_{I\!P}t}}{x_{I\!P}^{2\alpha_{I\!P}(t)-1}}$$

$$\alpha_{I\!P}(t) = \alpha_{I\!P}(0) + \alpha'_{I\!P}t$$

$$f_{I\!R}(x_{I\!P},t) = A_{I\!R} \cdot \frac{e^{B_{I\!R}t}}{x_{I\!P}^{2\alpha_{I\!R}(t)-1}}$$

$$\alpha_{I\!R}(t) = \alpha_{I\!R}(0) + \alpha'_{I\!R}t$$

$F_{I\!R}(\beta,Q^2)$ from the parametrization of the pion trajectory

input from other measurements

Input: $\alpha_{I\!R}(0) = 0.50$

$\alpha'_{I\!R} = 0.3\, GeV^{-2}$

$B_{I\!R} = 1.6\, GeV^{-2}$

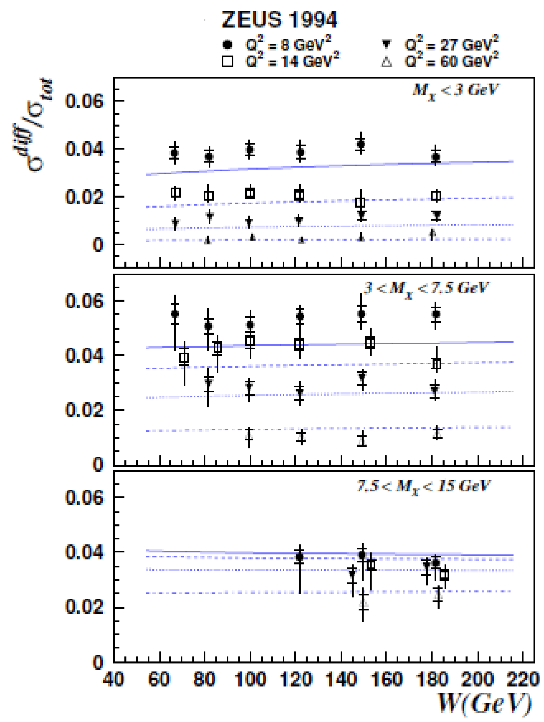
Fit Results

Parameter	Value
$\alpha_{I\!P}(0)$	1.10 ± 0.02 (exp.) $\pm$ 0.03 (model)
$\alpha'_{I\!P}$	0.04 ± 0.02 (exp.) $^{+0.08}_{-0.06}$ (model) GeV^{-2}
$B_{I\!P}$	5.73 ± 0.25 (exp.) $^{+0.80}_{-0.90}$ (model) GeV^{-2}
$n_{I\!R}$	$[0.87 \pm 0.10$ (exp.) $^{+0.60}_{-0.40}$ (model)$] \cdot 10^{-3}$

Diffractive とInclusiveの関連

Diehl's talk at DIS08

- provides natural explanation why F_2^D / F_2 flat in x (at given Q^2 and β)



K. Golec-Biernat, M. Wüsthoff, '99 $\longrightarrow$
plot calls for an update

[4] Small-x での偏極構造関数

High-energy evolution (double logs)

$$[\alpha_s \ln^2(x)]^n \ \ (\mathrm{LO}), \ \ \alpha_s[\alpha_s \ln^2(x)]^n \ \ (\mathrm{NLO})$$

[5] Soft, Semi-hard Physics ?

[6] Jets, etc.