Our ups and downs in QCD evolution

Eugene Levin

Tel Aviv University

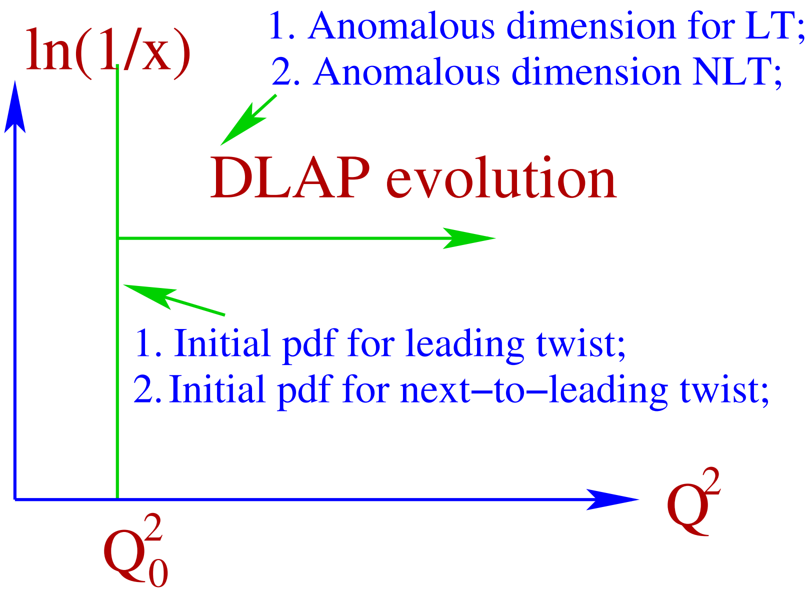
November 30, 2000

Questions to answer:

- What are our assumptions and prejudices in the DGLAP evolution?
- Why the non-linear evolution is better than the DGLAP one?
- Why we think that a regime of gluon saturation has been reached at HERA?

We $:=$ E. Gotsman, E. Levin and U. Maor, S. Bondarenko, M. Lublinsky, E. Naftali and K. Tuchin

GLAP evolution



- **Since pQCD is an asymptotic series , the GLAP has an intristic accuracy given**

$$R = \frac{\alpha_S^n \ \textbf{term}}{\sum_{k=1}^{n} \ \alpha_S^k \textbf{term}}$$

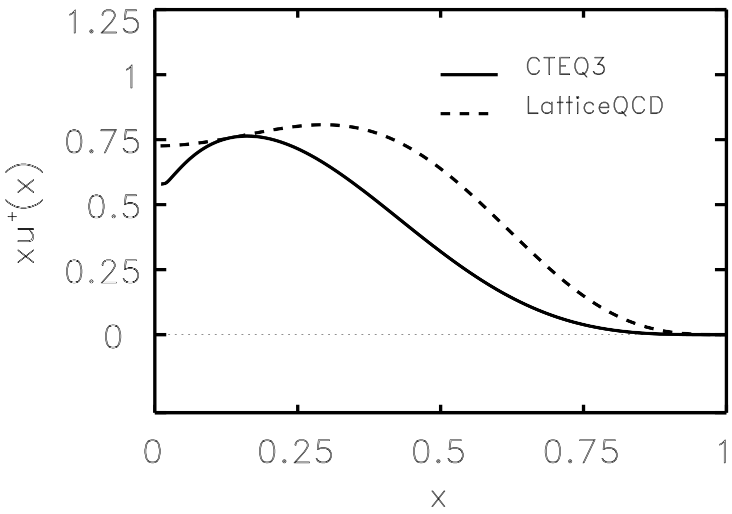
calculated with the same initial condition.

- **Our estimates**

$$R \ \geq \ 15 \div 20\%$$

- **We cannot find an initial parton distribution from experimental data, since we cannot extract the leading twist contribution;**

- It should be done in non-perturbative QCD but first lattice QCD result is rather discouraging;

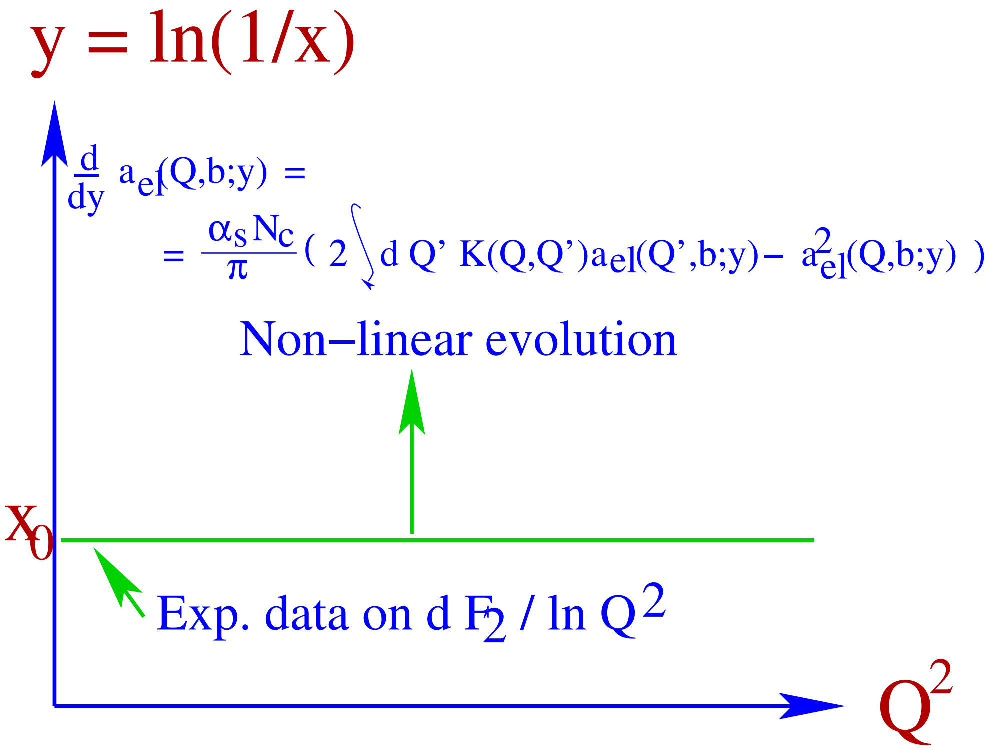


- Schierholz, DIS'97

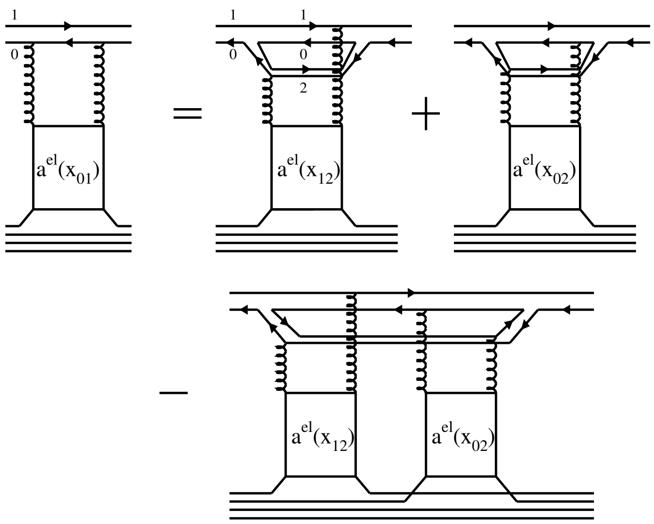
- We do not know the higher twist anomalous dimension and we cannot conclude that the higher twist contributions are small at $Q^2 > Q_0^2$ even if they are small at $Q^2 = Q_0^2$;

> The wide spread opinion, that the DGLAP evolution gives a well defined theoretical procedure, is **not correct**.

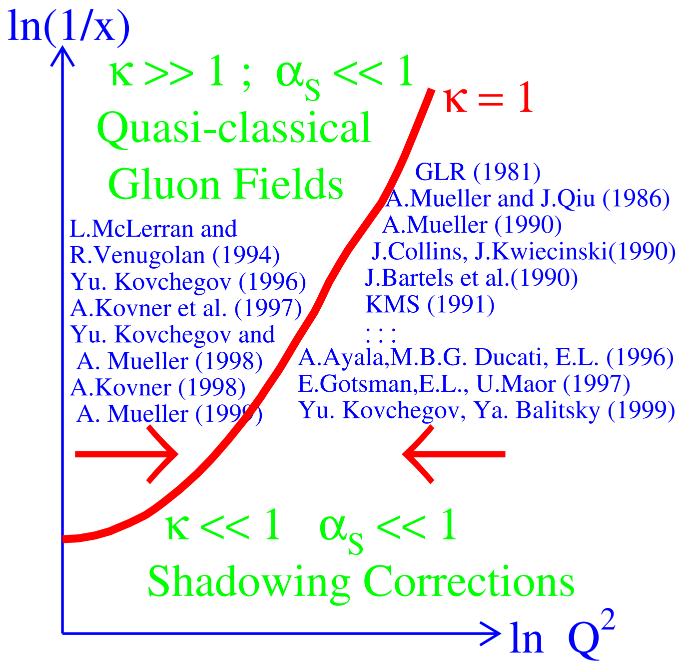
Non-linear evolution



The theory status of the non-linear evolution is not worse than the DGLAP one.



- **Thanks to :**



- **The initial parton (dipole) distribution is the experimental data on $dF_2/d\ln Q^2$;**

- **The non-linear evolution gives a natural account for the higher twist contributions;**

Has HERA reached a saturation ?

YES

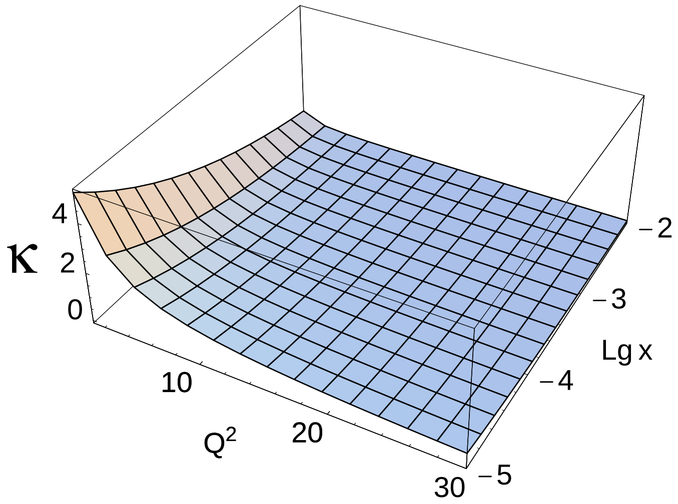
- **There are no experimental data that are in contradiction with asymptotic predictions of high parton (dipole) density QCD:**
  - $dF_2/d\ln Q^2 \propto Q^2$;
  - $\sigma^{diff}/\sigma_{tot} \propto Const(x_B)$;
  - **Shrinkage of diffraction peak for J/Ψ production:** $0 < \alpha'_{eff} < \alpha'_{soft\ Pomeron}$;

- **HERA data show a new scaling**

$$\sigma_{tot} = R^2 Q^2 F(Q^2/Q_s^2(x));$$

- **All data can be described in the simplest model of Golec-Biernat and Wusthoff;**

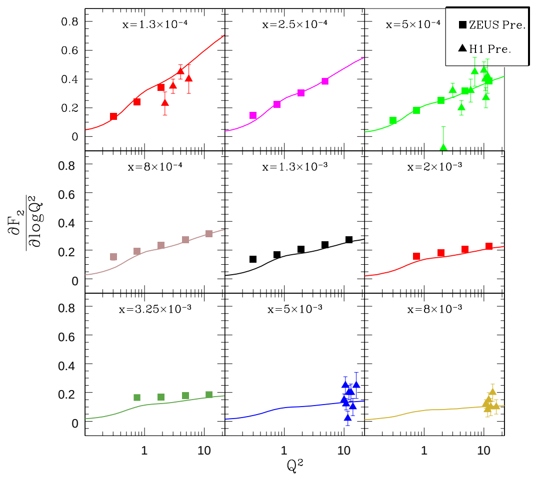
- **The simple estimate from the gluon density extracted from HERA data show a large packing factor;**



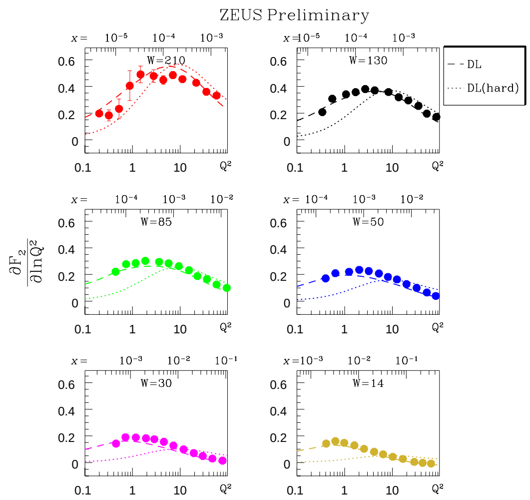
B U T

Alternative explanations:

F_2 - slope:



- **Saturation model**



- **Soft + Hard Pomeron**

“ Expertise comes from making all possible mistakes”

Niels Bohr