

# WHAT TO TELL THE LAB. DIRECTOR ON LOW $x$ PHYSICS

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**“The power of prophecy was  
only given to fools”**

*Jewish saying*

# QCD at high energy

## Before HERA

- DOF at short distances:  
quarks and gluons;
- DGLAP evolution equations;
- Dirty large cross section physics:

HE phenomenology with forbidden  
word - Pomeron;

## Now

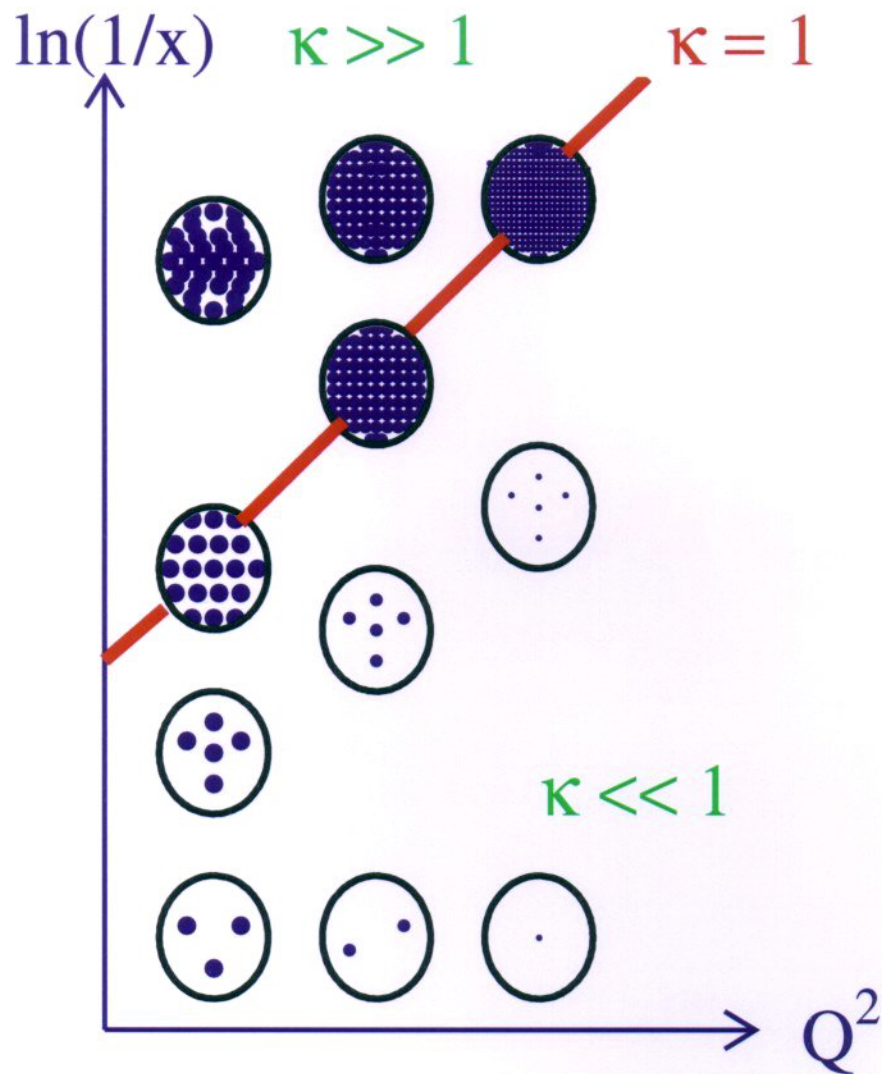
DOF at short distances:  
Colour dipoles;  
DGLAP evolution equations  
gluon saturation;  
matching between “soft”  
and “hard” interactions;  
Revival of Pomeron;  
Understanding that Pomero  
is not enough;

# Soft Pomeron today

1. M. Genovese, N.N. Nikolaev and B.G. Zakharov, “*Diffractive DIS from generalized BFKL Pomeron: prediction for HERA*”. **J.Exp. Theor.Phys.** 81 (1995) 625;
2. A.B. Kaidalov and Yu.A. Simonov, “*Glueball masses and Pomeron trajectories in nonperturbative QCD approach*”, **Phys.Lett.B477(2000)** 163;
3. R. C. Brower, S. D. Mathur and Chung-I Tan , “*From black hole to Pomeron:tensor glueball and Pomeron intercept at strong coupling*”, hep-ph/0003153;
4. R.A. Janik and R. Peschanski, “*Minimal surfaces and reggeization in the AdS/CFT correspondance*”, **Nucl.Phys.B586 (2000)** 163;
5. R.A. Janik, “*String fluctuations, AdS/CFT and the soft Pomeron intercept*”, hep-th/0010069;
6. B.Z. Kopeliovich,I.K. Potashnikova, B. Povh and E. Predazzi, “*Nonperturbative gluon radiation energy dependence of elastic scattering*”, **Phys.Rev.Lett.85 (2000)** 507;
7. D.Kharzeev and E. Levin , “*Scale anomaly and soft Pomeron in QCD*”. **Nucl.Phys.B578(2000)** 351;
8. D.Kharzeev, Yu. Kovchegov and E. Levin, “*QCD instantons and the soft Pomeron*”, hep-ph/0007182 .
9. K. Tuchin, “*The Pomeron intercept in  $\lambda\phi^3$  - theory in 4 minkowski + 1 compact dimensions*”, hep-ph/0007311.



# Gluon Saturation

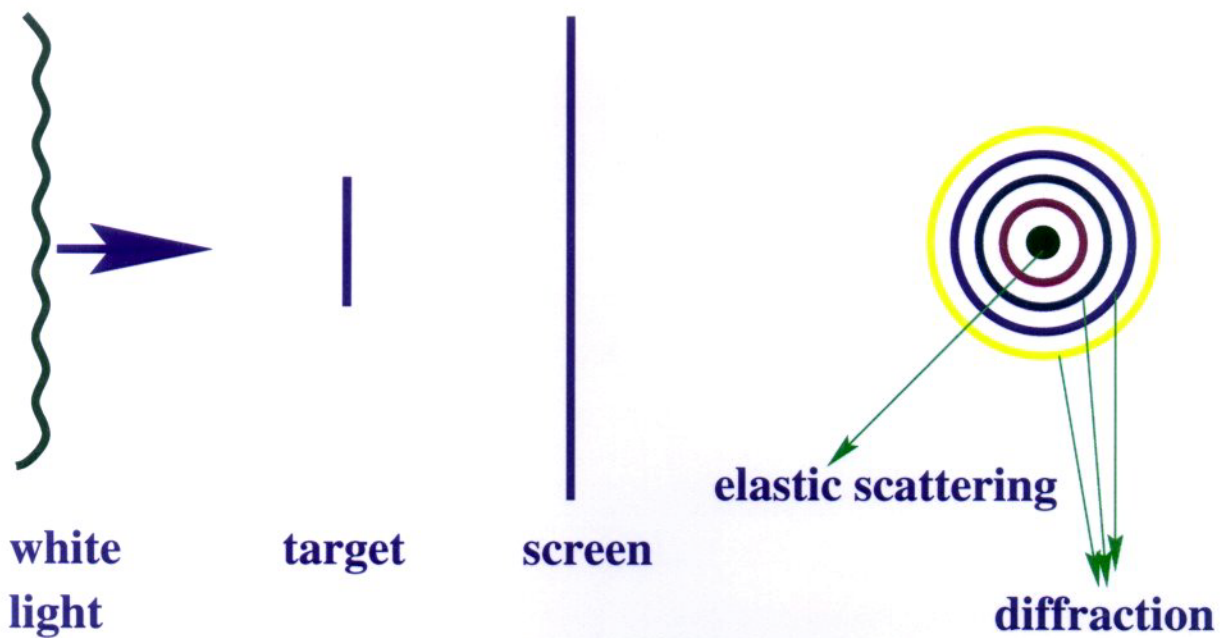




There are no HERA data  
that contradict the saturation  
hypothesis

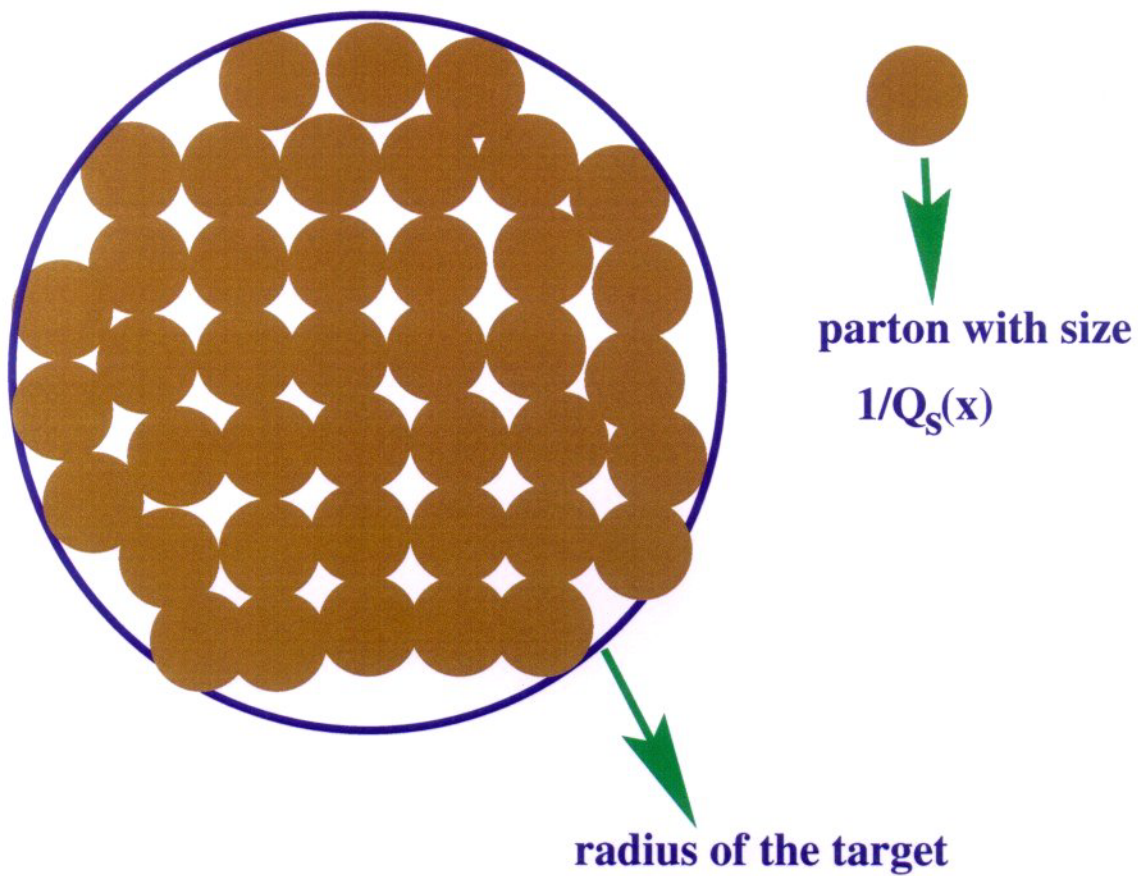
Thanks to Golec-Biernat and Wüsthoff who  
developed a simple model to show this

HERA can claim a discovery of a  
new QCD regime on more grounds  
than CERN with advocated Quark-  
Gluon Plasma discovery



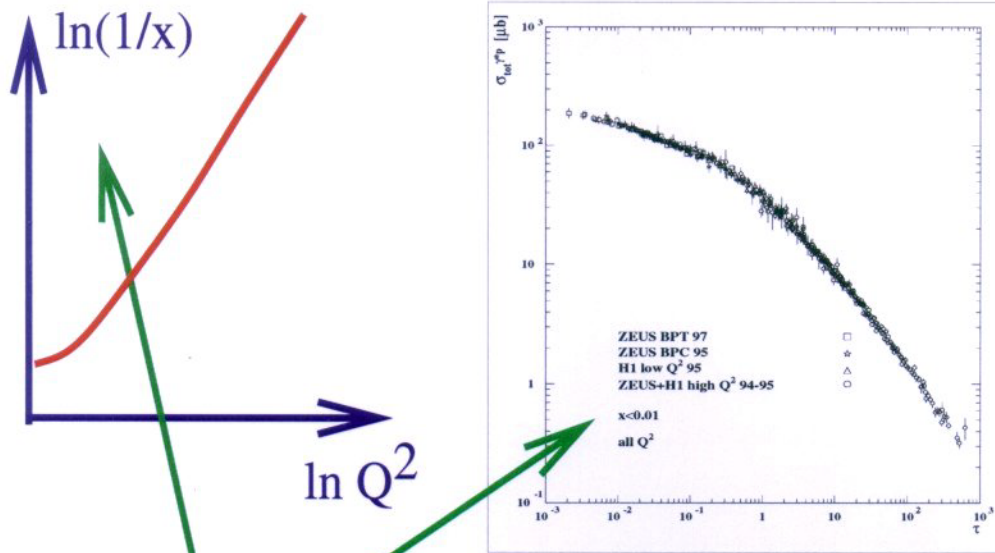
- $\sigma_{in} \Rightarrow$  heat in the target;
- $\sigma_{elastic} \Rightarrow$  white spot in the centre;
- Diffraction  $\Rightarrow$  colour maxima;

**Saturation= the only scale  $Q_s(x)$**





# A new scaling



● Stasto, Golec-Biernat & Kwiecinski

$$\sigma(\gamma^*p) = F(\tau = Q^2 / Q_s^2(x))$$

● Bartles & E.L. (1992) ; McLerran & Venugopalan (94)  
E.L. & Tuchin (1999) ; McLerran & Kovchegov (98);

## New scaling:

- follows directly from hdQCD theory;
- in a good agreement with HERA data;
- a deviation from this scaling gives a possibility to measure  $Q_s^2(x)$ ;

**HERA**  $\Rightarrow Q_s(x) = 1 \div 2 \text{ GeV};$

**THERA**  $\Rightarrow Q_s(x) = 2 \div 3 \text{ GeV};$

**THERA**  $\Rightarrow x = 10^{-6};$

**THERA**  $\Rightarrow$  at  $x = 10^{-4}$  wider region  
in  $Q^2$  than HERA;

**THERA has a good chance:**

- to check a new scaling;
- to find the value of  $Q_s(x)$ ;



# Diffraction = the only scale $Q_s(x)$ .

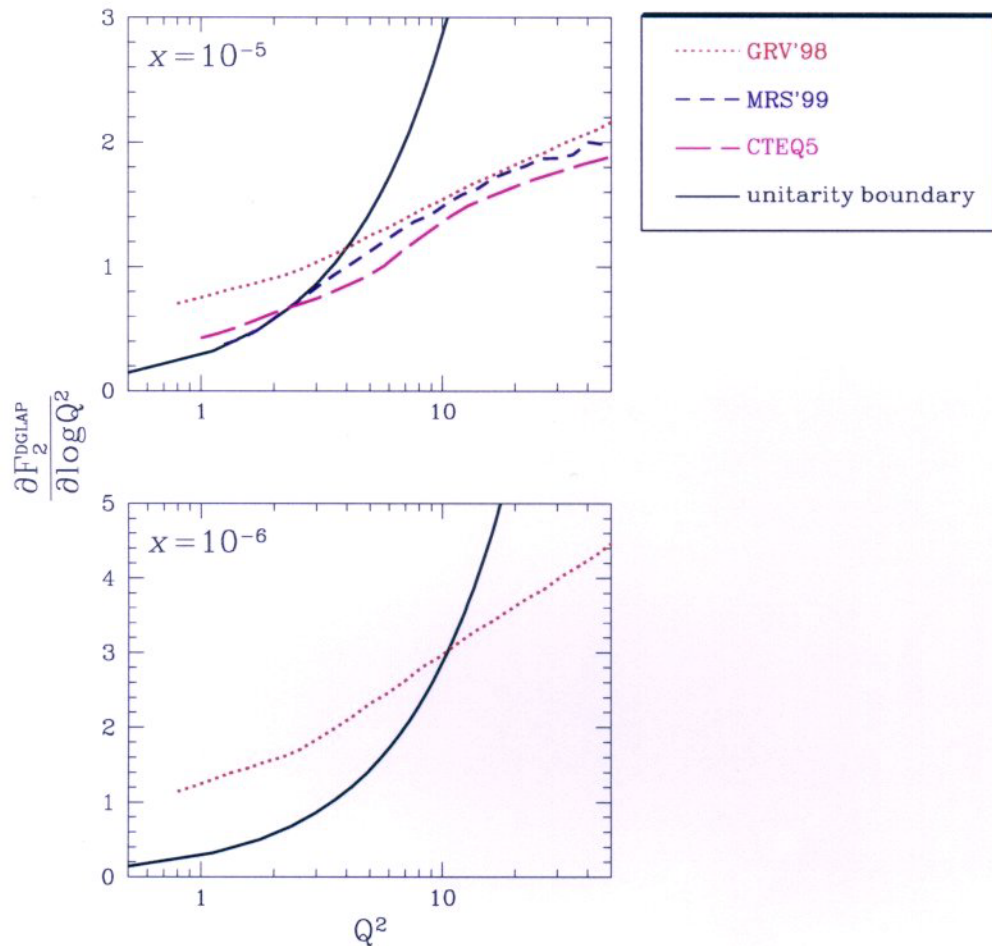
## Message:

- Diffraction stems from short distances  $\propto 1/Q_s(x)$ ;
- $t$ -dependence should show at seqt of minima at  $t \approx Q_s(x)$ ;



# Unitarity.

## At THERA:



**“Expertise comes from making all possible mistake”**

*Niels Bohr*

**Tomorrow we have a chance to make the last one.**