From small spots in nucleons to weak gluon shadowing in nuclei

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gluon shadowing needs an overlap of gluonic clouds of nucleons

both

in the longitudinal direction (small x) and in the transverse plane (size of the gluonic clouds)

Experimental evidences for small gluonic spots in the nucleon - the well known puzzle of the small diffractive cross section -
the large mass diffraction

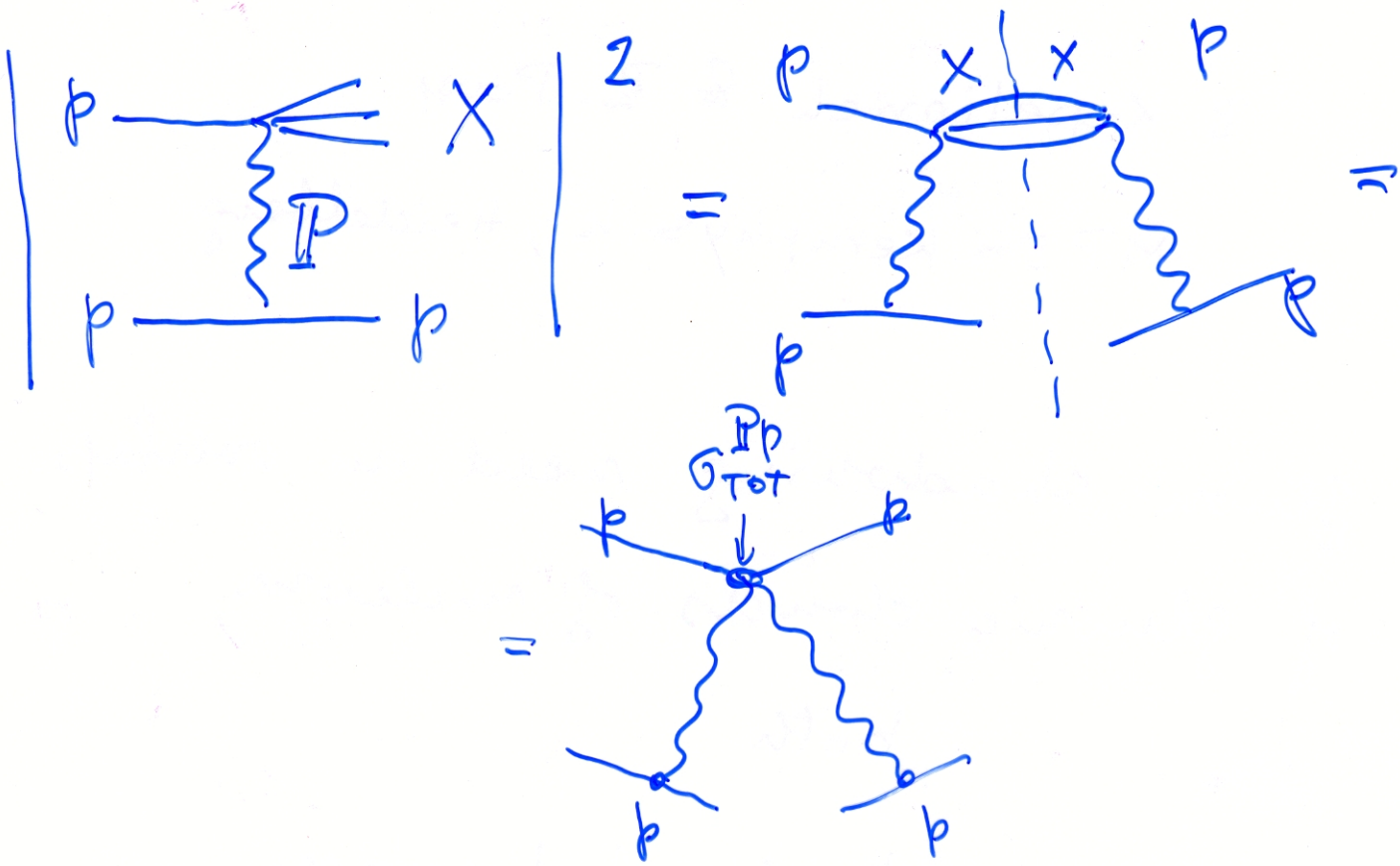
$g \sim \frac{1}{M^2}$

From this cross section one deduces

$$\sigma_{tot}^{Pp} \simeq 2\,mb$$

This is small as compared to any hadronic cross section even $J/\psi + p$!

Extraction of the $\sigma_{tot}^{\mathbb{P}p}$ from the diffractive cross section



Model

$\frac{r_0^2}{R_h^2} \approx 0.1$

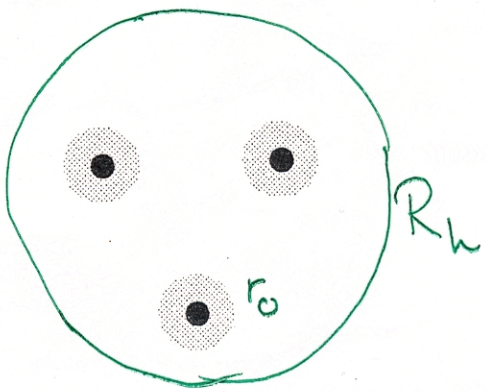


Figure 1: *A skeleton of three valence quarks in the proton, surrounded by gluon clouds of much smaller size than the mean quark separation.*

Ref. Kopeliovich, Potashnikova, Hp, Predazzi

PRL 85 (00) 507

$$\sigma_{pp} = \sigma_0 + N_q \frac{9}{4} C r_0^2 \frac{4\alpha_s}{3\pi} \ln \frac{s}{s_0} \qquad \sigma_n = 1$$

$N_q = 3 \quad C \approx 2.3$ Dipol approximation

$$\sigma_n = 3 \frac{9}{4} C r_0^2 \frac{1}{n!} \left[\frac{4\alpha_s}{3\pi} \ln \frac{s}{s_0} \right]^n$$

$$\sigma_{pp} = \sigma_0 + \sum_n \sigma_n = \sigma_0 + 3 \frac{9}{4} C r_0^2 \left(\frac{s}{s_0} \right)^{\Delta}$$

$$\Delta = \frac{4\alpha_s}{3\pi} \approx 0.17 \pm 0.01$$

$$\langle \alpha_s(k_\perp) \rangle \approx 0.4$$

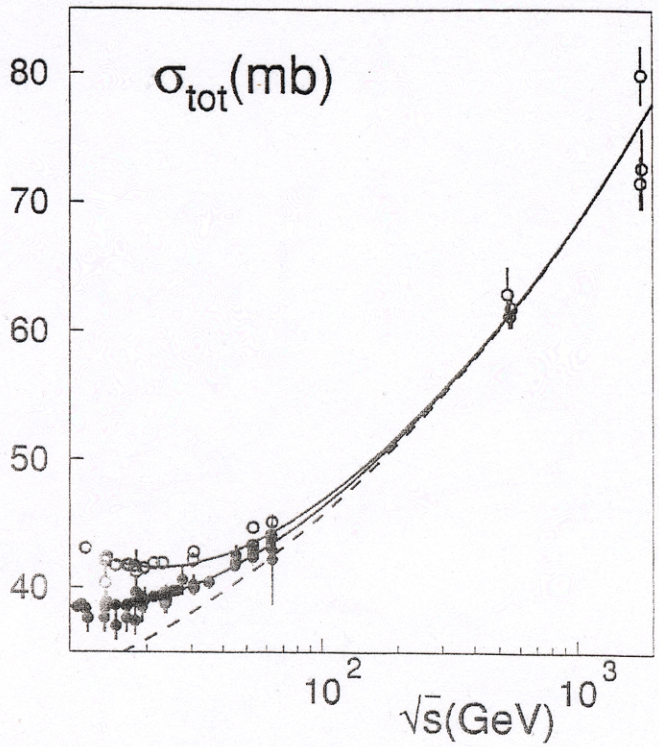


FIG. 4. Data for total pp (solid circles) and $\bar{p}p$) (open circles) cross sections [43] at $\sqrt{s} > 10$ GeV. The dashed curve shows the predicted energy dependence for the net Pomeron contribution whose normalization is fixed by the $\sqrt{s} = 546$ GeV data [42]. The solid curves (bottom for pp and upper for $\bar{p}p$) represent the results corrected for the Reggeon contribution which is fitted to the data.

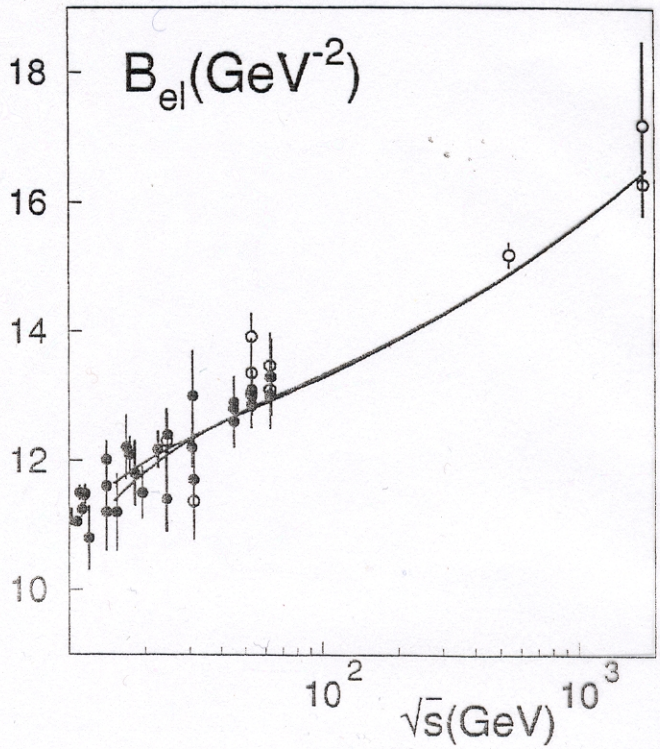


FIG. 5. Data for the elastic slope [44] and our predictions. The upper and bottom curves and, correspondingly, the open and solid circles belong to $\bar{p}p$ and pp, respectively.

$\sigma_{pp} = 2\int \mathrm{Im}\, f_p(bs)\, d^2b$

Unitarized

$\sigma_{pp} \to 2\int [1 - e^{-\mathrm{Im} f_p(bs)}]\, d^2b$

$B_{el} = B_0 + 2\alpha' \ln s$

$\alpha' = \frac{\alpha_s r_0^2}{3\pi} \approx 0.1\ \mathrm{GeV}^{-2}$

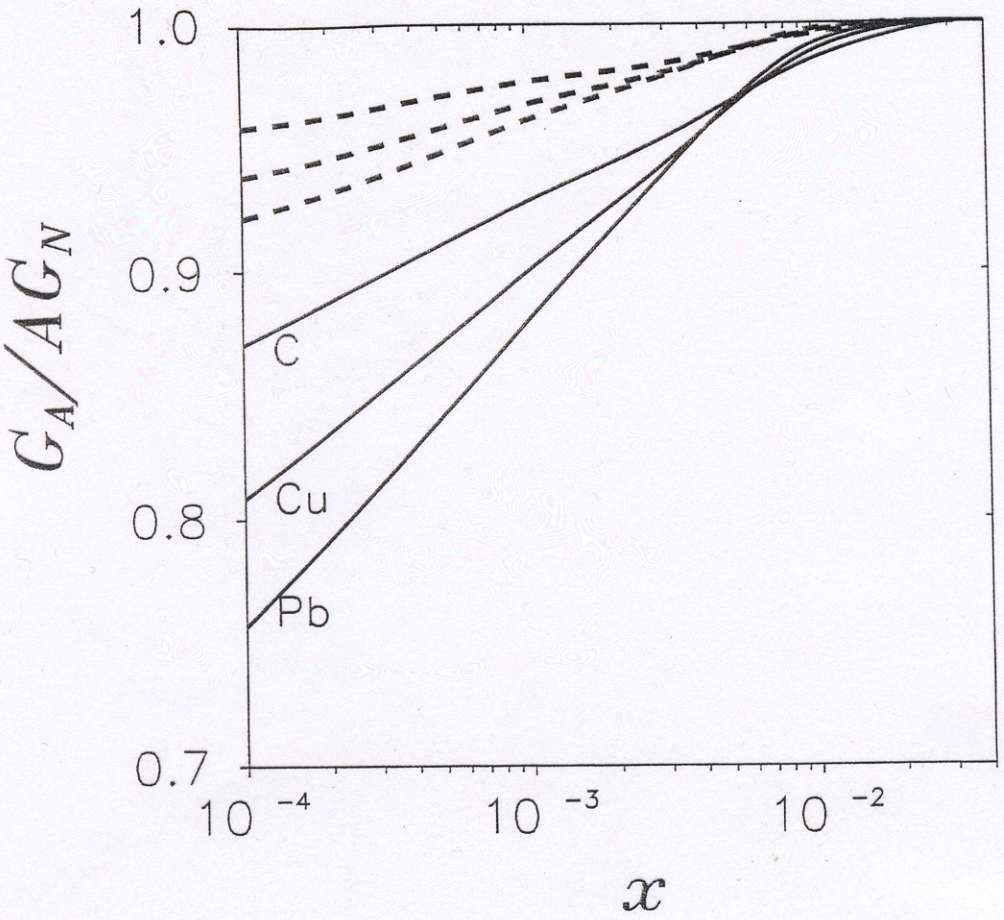
The bare Δ and α' observed in the elastic photoproduction of J/ψ

Zeus Collaboration Eur. Phys. J. C 24 (02) 345

Similar results:

① correlation length on the lattice
≈ 0.2 – 0.3 fm
D'Elia, Di Giacomo + Meggiolaro
Phys. Lett. B 408 (97) 315

② Shuryak & Zahed
hep-ph/0307103 2003



— $Q^2 = 4\ \text{GeV}^2$

--- $Q^2 = 40\ \text{GeV}^2$

Kopeliovich, Schäfer, Tarasov

P.R. D62 (00) 054022

Most of the models predict stronger shadowing

But the new NLO analysis agrees with the upper prediction.

de Florian and Sassot, hep-ph 0311227