Gluon saturation in nucleons and nuclei

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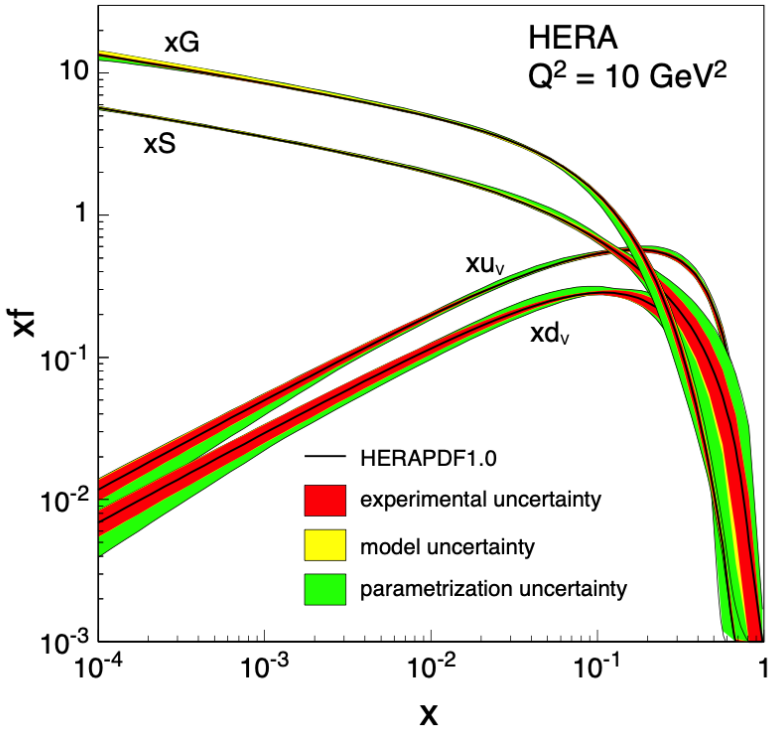
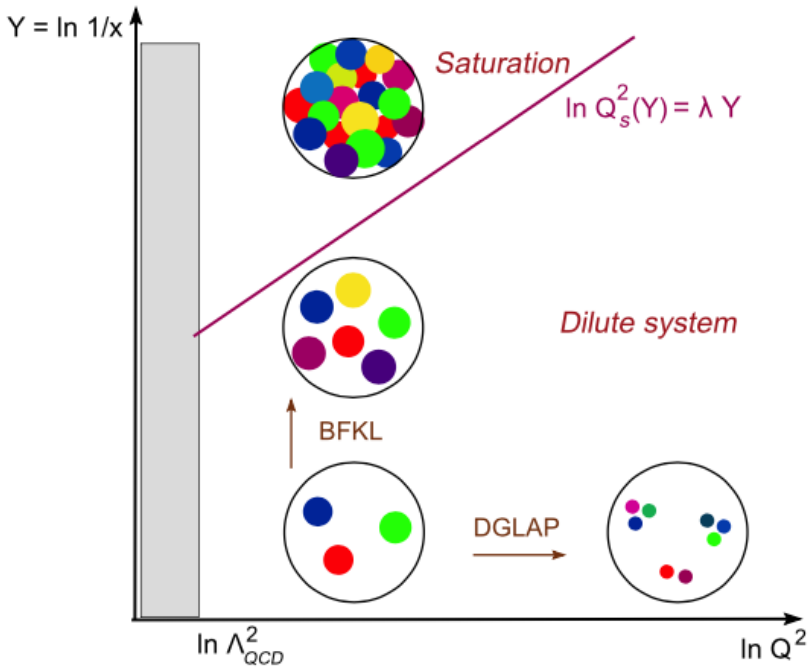
Gluon saturation

- ep DIS experiments at HERA revealed that the small x structure of nucleons is dominated by gluons and $q\bar{q}$ pairs (sea quarks).

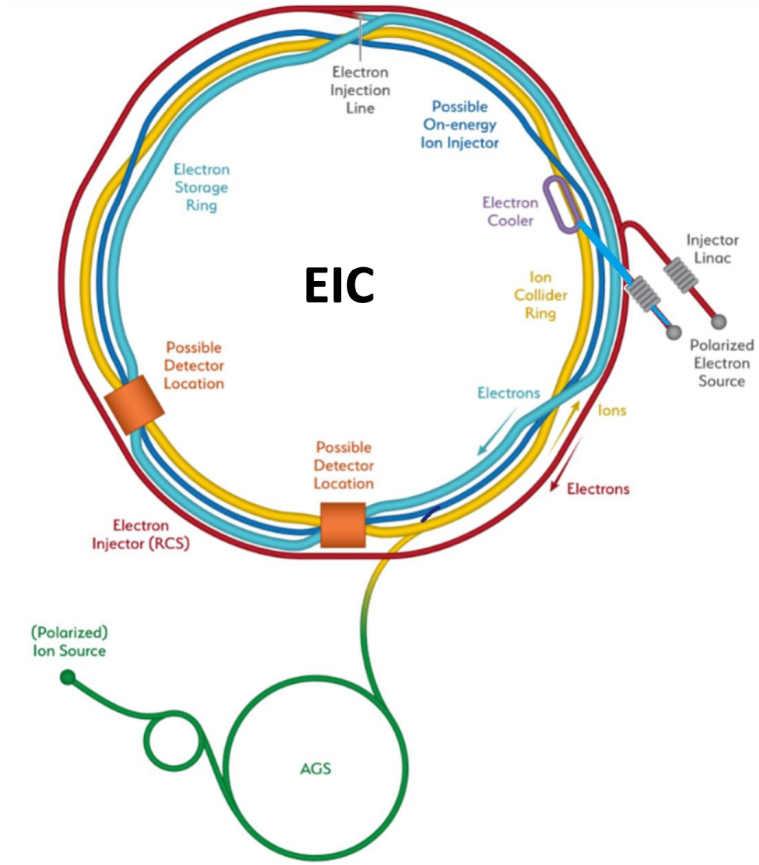




- Is the power-like growth of gluon and sea quark distributions saturated for $x = Q^2/s \to 0$?

Electron-ion collider (EIC)

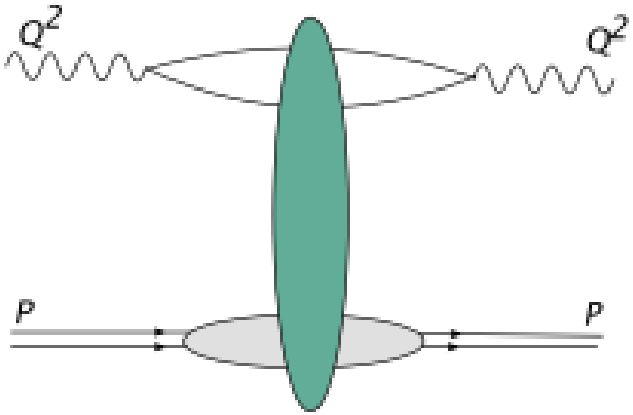
- The EIC at Brookhaven planned for 2030s will address this question



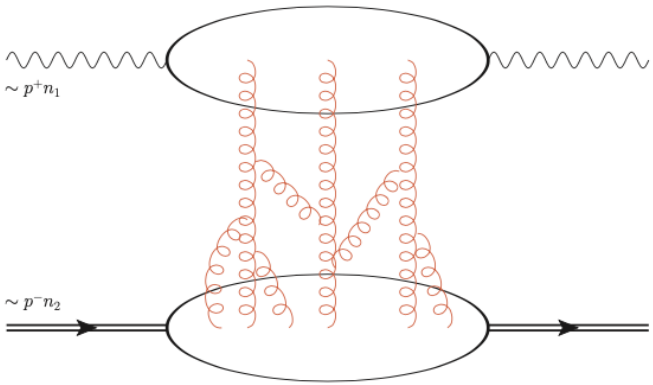
- Good theoretical tools to answer this question are indispensable

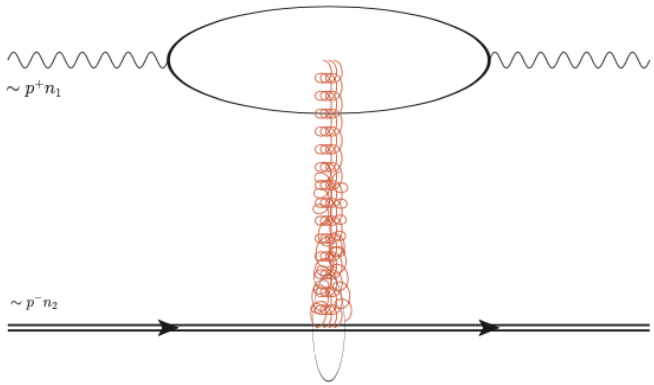
Picture of DIS at small x

- $q\bar{q}$ pair (a dipole) interacts with proton through gluon exchanges



- Semi-classical shock wave after Lorentz boost of p





Shock wave approach in eikonal limit

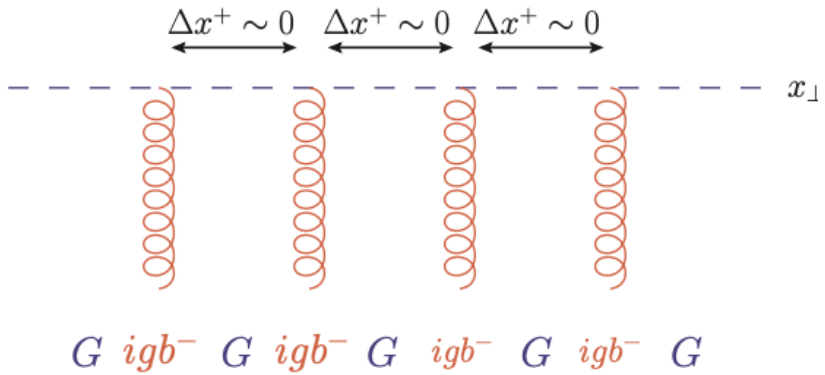
- Only one component of the color field, $b^-(x^+, \vec{x}_\perp)$, matters

$$b^+(x^+, x^-, \vec{x}) \longrightarrow \frac{1}{\Lambda} b^+(\Lambda x^+, \frac{x^-}{\Lambda}, \vec{x})$$

$$b^-(x^+, x^-, \vec{x}) \longrightarrow \Lambda b^-(\Lambda x^+, \frac{x^-}{\Lambda}, \vec{x})$$

$$b^k(x^+, x^-, \vec{x}) \quad \Lambda \sim \sqrt{\frac{s}{m_t^2}} \quad b^k(\Lambda x^+, \frac{x^-}{\Lambda}, \vec{x})$$

- Multiple interactions collapse to the light-cone time $x^+ \approx 0$



- Wilson line operators appear: $U = P \exp\{\int_{-\infty}^{\infty} dx^+ \, b^-(x^+, \vec{x}_\perp)\}$

Beyond the eikonal limit studies

- Examination of the impact of beyond the eikonal limit corrections on shock wave approach and physics predictions with it:
  - full dependence on color fields: $b^{\mu}(x^{+}, x^{-}, \vec{x}_{\perp})$
  - finite width $\Delta x^{+} \neq 0$ of interactions
- Interplay with α_s corrections - impact on B-JIMWLK equations
- Impact on calculations of physical processes in DIS at EIC:
  - exclusive diffractive dijet production
  - photon plus jet production
  - also forward Drell-Yan pair production at LHC

Partners

IFJ PAN

First name / Family name	Function (Researcher, Engineer etc)	Role in the pre-project	% of participation
Krzysztof Golec-Biernat	Researcher	Leader	30%
Sebastian Sapeta	Researcher	Participant	30%

IJCLab

First name / Family name	Function (Researcher, Engineer etc)	Role in the pre-project	% of participation
Samuel Wallon	Researcher	Leader	30%
Michael Fucilla	Post-doc	Participant	30%
Joseph Yarwick	PhD student	Participant	30%

Budget for 2024

IFJ PAN

Type of expenses	Amount
Personnel	
Equipment	
Consumables	
Travel & subsistence	3000 EURO
Total	3000 EURO

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Type of expenses	Amount
Personnel	
Equipment	
Consumables	
Travel & subsistence	3000 EURO
Total	3000 EURO