Strong color fields from fits to parton distributions

Sener Ozonder
University of Minnesota

1 Motivation

• Color Glass Condensate can calculate the gluon distribution function of each nucleus as well as the initial energy density deposited in the color flux tubes.

• We explore the phenomenological parameters of a realistic version of the Color Glass Condensate model where
a) colliding nuclei have finite longitudinal thickness,
b) color neutrality is imposed on the nucleon scale.

We fix the intrinsic parameters of the model from the data of gluon distribution functions. The goal of this work is to reach a phenomenological model of Color Glass Condensate that can later be used to calculate the initial energy density in heavy-ion collisions.

2 Model

• Fluctuations in color density ρ are random (white noise) except that the fields are correlated at scales smaller than the nucleon size *a*.

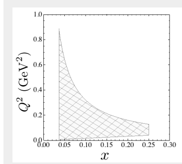
$$\langle \rho(0)\rho(x_{\|};x_{\perp})\rangle = \delta(x) - \frac{3}{4\pi a^2}\frac{\exp^{-\frac{\sqrt{3}}{a}\sqrt{x_{\|}^2+x_{\perp}^2}}}{\sqrt{x_{\|}^2+x_{\perp}^2}}$$

$$\widetilde{\langle \rho\rho\rangle} = 1 - \frac{1}{1+\frac{a^2}{3}(q_{\|}^2+q_{\perp}^2)} \stackrel{q\to 0}{=} 0$$

This modified propagator is infrared safe and gauge invariant. No gauge non-invariant gluon mass needs to be introduced in the gluon propagator as in $\tilde{G}(q_{\perp}) = \frac{1}{q_{\perp}^2 + m_{\mathrm{gluon}}^2}$.

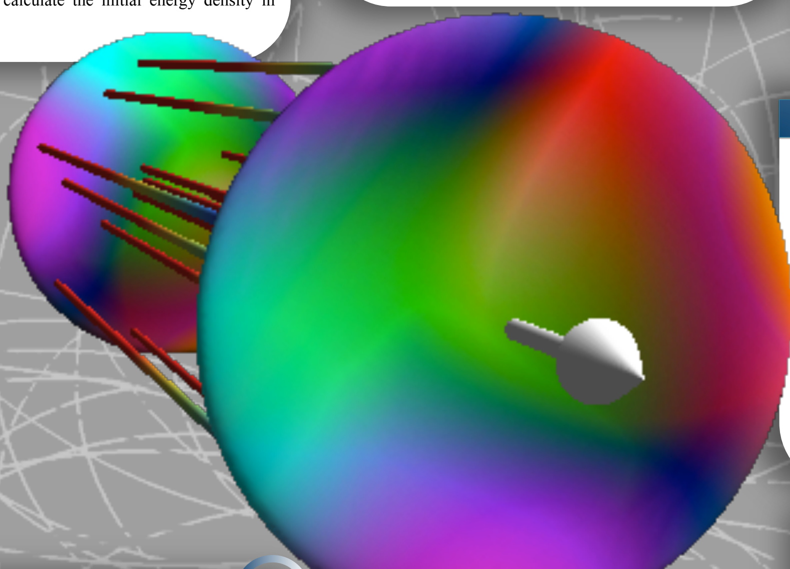
•A nucleus has a finite thickness, so gluon distribution $xG(x,Q^2)$ becomes dependent on the longitudinal coordinate $x_{\|}$ and hence on x (Feynman x) as in the data.

3 Model



Validity region of the model for gold ions

• The model can calculate the gluon distribution function only at very low Q^2. We need to evolve our result separately to higher momentum values that comparison with the data would be possible.



4 Procedure

$xG(x,Q^2)$ from the model at Q^2=0.55 GeV² → DGALP evolution (QCDNUM code) → $xG(x,Q^2)$ evolved to Q^2=5, 25, 100 and 1000 GeV²

compare

$xG(x,Q^2)$ GJR2009 data parametrization at Q^2=5, 25, 100 and 1000 GeV²

• The model has been evolved from Q^2=0.55 GeV² to higher momentum values and compared with the data of gluon distribution functions as parametrized by GJR2009.

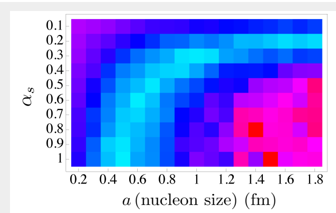
• This procedure has been repeated for different values of the parameters of the model:

$$0.1 < \alpha_s < 1$$

$$0.2 \text{ fm} < a \,(\text{nucleon size}) < 1.8 \text{ fm}$$

5 Best fit

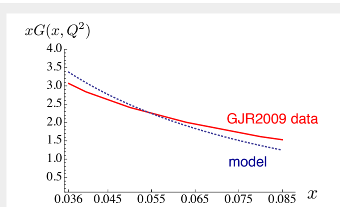
• We calculated the goodness of fit χ^2 for different model parameters α_s and a (nucleon size) at energies Q^2=5, 25, 100 and 1000 GeV².



$\chi^2 = \sum (xG_{\mathrm{model}} - xG_{\mathrm{data}})^2$ for the model evolved to Q^2=100 GeV². Best fits occur in light blue regions.

• We find best fits for α_s=0.3, 0.4 and 0.5 at a=1, 0.9 and 0.7 fm, respectively, for the absolute normalization of the model at 1.54.

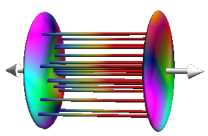
6 Result



Comparison between the model and data parametrization at Q^2=100 GeV², a=1 fm and α_s=0.3.

7 Future

• We achieved a realistic Color Glass Condensate model of which parameters are fixed from gluon distribution data. This model can be extended to include impact parameter dependence.
• Next, we will apply this model to heavy ion collisions to calculate the initial energy density.



References

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Contact

ozonder@umn.edu

University of Minnesota