

LDRD Proposal: Exploring signatures of saturation and universality in e+A collisions @ eRHIC

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Q_s from dipole model fits to e+p, e+A data

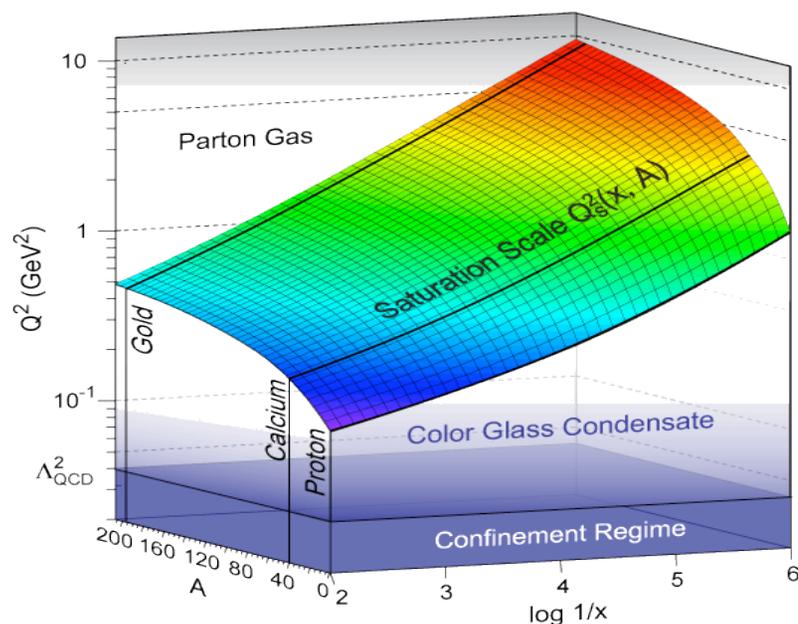


Fig. by T. Ullrich

Kowalski,Lappi,RV, PRL 100, 022303 (2008)
Kowalski,Lappi,Marquet,RV, PRC 78, 045201 (2008)

$$k_T < Q_S: \text{occ. \#} \sim 1/\alpha_S$$

$$k_T > Q_S: \text{occ. \#} \ll 1$$

$$\alpha_S(Q_S^2) \ll 1$$

- What are the signatures of saturation in DIS off nuclei?
- What signatures are most sensitive to saturation?
- Can we anticipate precocious onset of saturation?
- Can one reliably and uniquely extract the A , b and s dependence of Q_s ?

Dipole models heuristic: only qualitative answers

Improvement: Q_s from mean field BK equation

Fixed coupling LO BFKL: $Q_s^2 = Q_0^2 e^{c \bar{\alpha}_s Y}$

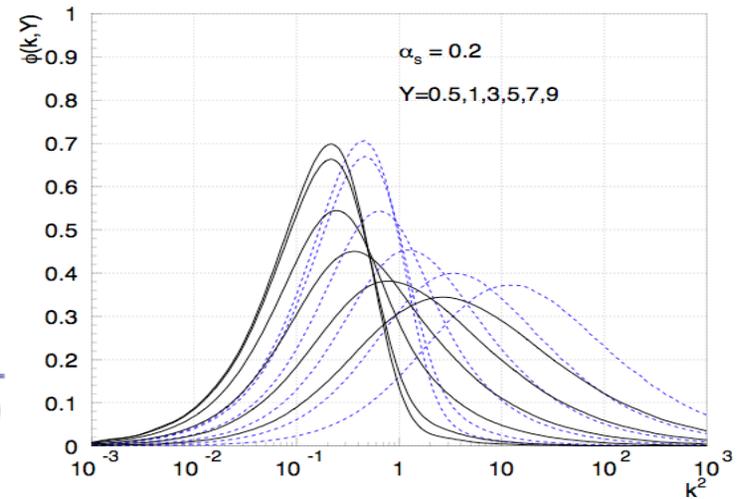
LO BFKL+ running coupling: $Q_s^2 = \Lambda_{\text{QCD}}^2 e^{\sqrt{2b_0 c(Y+Y_0)}}$

Re-summed NLO BFKL + CGC:

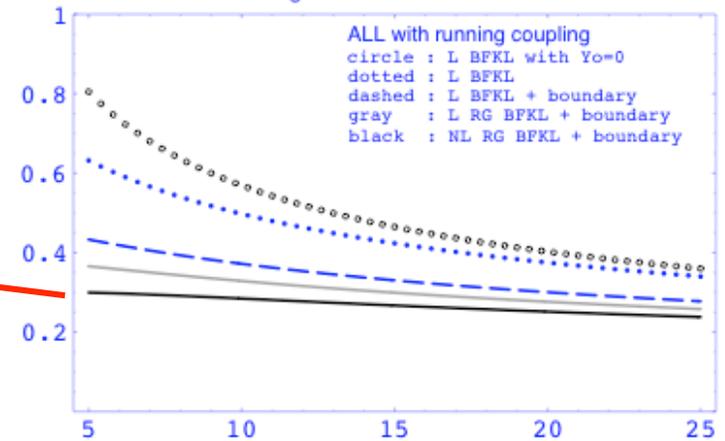
Triantafyllopoulos

$$\lambda \equiv \frac{d \ln Q_s^2}{dY}$$

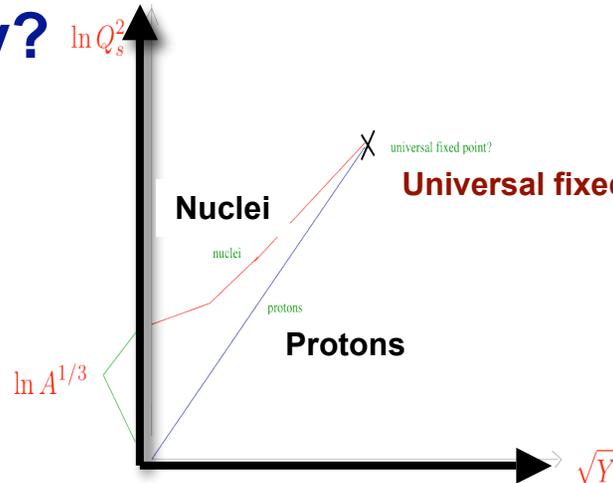
Very close to HERA result!



The Logarithmic Derivative of Q_s^2



Universality? $\ln Q_s^2$



All nuclei lose memory of initial condition: RG fixed point of QCD ?

State-of-the-art: JIMWLK RG eqns. for energy, A and b evolution of multi-parton correlators

Goal: Solve RG eqns. by functional Boltzmann-Langevin techniques on the Lattice. Numerically challenging. One attempt thus far

Anticipated results:

- Classify DIS final states by sensitivity to two and higher point quark and gluon correlations
- Develop numerical functional Langevin methods for solving JIMWLK eqns. at fixed and running coupling. (Investigate improved algorithms.)
- Compare results to NLL BK results
- Investigate geometrical scaling, universality of different final states based on quantitative results for light and heavy nuclei. Compare to other frameworks (DGLAP based)
- Application of numerical solns. to $p+A$ and $A+A$ collisions. Global analysis
- Interface with $e+A$ event generators

Resources requested:

Project is numerically intensive. Dedicated post-doc + 1 student (currently on “warm-up” project)

One long term visitor - jointly shared with Ullrich -- interface with event generator simulations

1 week “strategy” workshop + short term visitors

Preliminary budget: ~ \$400 K over **3 years** for dedicated theory eRHIC e+A studies