WG Summary: "QCD at zero temperature"

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Physics topics:

- QCD at small x
- Quark/gluon structure of nuclei
- Hadronization and final states

- Physics topics addressed by experiments
  at both electron–hadron [HERA]
  and hadron–hadron colliders [RHIC, Tevatron, LHC]

  . . . Fundamental property of QCD: "Universality" of
  hard scattering processes, parton structure!

- Theorist: "Probing the CGC in ep/eA"

  $\downarrow$

  pA

- This summary emphasizes issues directly relevant
  to a future electron–ion collider (EIC)

I) QCD at small x

- QCD evolution and the gluon density
- Testing small–x dynamics in inclusive, diffractive, and exclusive scattering
- Transverse gluon imaging of the proton
- QCD evolution at high gluon densities (unitarity, non-linear evolution, CGC, etc.)
- Experimental probes of the high–density regime

- QCD evolution and the gluon density
  - BFKL evolution stabilized through DGLAP–like resummation: Reliable predictions of small–x behavior of $g(x)$ A. Stasto
  - Possible precise determination of $g(x)$ via σ_L in ep: "Natural" Rosenbluth separation EIC $\leftrightarrow$ HERA A. Caldwell

- Tests of small–x dynamics
  - Detailed tests of small–x dynamics in inclusive, exclusive, and diffractive ep/eA scattering (Q^2, W–dep., L/T) G. Watt, Ch. Weiss

    "Color transparency" . . . Interaction of small–size quark/gluon configurations with hadronic matter

  - Results for hard diffractive production from Tevatron and predictions for LHC (Higgs production) Ch. Mesropian, G. Watt

- Transverse gluon imaging of proton
  - Exclusive $J/\psi, \phi, \rho$ production in ep maps transverse spatial distribution of gluons in proton
    . . . Fundamental characteristic (gluon GPD), needed for modeling of pp collisions with hard processes G. Watt, Ch. Weiss
  - "Optical" model of unitarity limit in dipole–hadron interactions at high–energies: "Black–disk limit" T. Rogers

- QCD evolution at high gluon densities

  Progress in theoretical understanding of non-linear QCD evolution at high gluon densities: Geometric scaling, statistical interpretation, relation to Reggeon field theory A. Stasto, K. Tuchin

– Experimental probes of the high–density regime

- CGC predictions for hadron production (spectra, multiplicities, angular correlations, heavy quarkonia, dileptons) in pA/dA at RHIC
  K. Tuchin

- Can high–density regime be approached in eA at an EIC?
  Does $A^{1/3}$ enhancement overcome lower x compared to HERA?
  Discussion

II) The quark/gluon structure of nuclei

– Many aspects of nuclear PDFs still poorly understood:
Gluons, Q^2–dependence of shadowing (leading vs. higher twist)
. . . need eA DIS data!

– RHIC dAu and $AuAu$ data begin to constrain nuclear gluon density
R. Venugopalan, L. Bland

– Hard exclusive processes in coherent eA scattering as a new probe of the quark/gluon structure of the nucleus: First studies of feasibility of collider measurements (forward detectors, beam optics) Ch. Hyde–Wright

III) Hadronization and final states

– Use of hard processes to probe medium properties in AA requires detailed studies of hadronization mechanism in eA: Physical mechanism (energy loss vs. absorption), formation length/time, etc. Present data cannot discriminate between different mechanisms A. Accardi

– Heavy nuclei: A–enhanced higher–twist effects can modify partonic initial state of fragmentation X. Guo

– Gluon production in high–energy AA collision studied in CGC approach (semiclassical approximation) F. Gelis