Light-ion physics with EIC

C. Weiss (JLab), Initial Stages 2021, Weizmann Institute, Israel, 10-15 Jan 2021
Summary for Panel Discussion “Light ions and future experiments”

- Light-ion capabilities
- Light-ion physics topics
- Synergies light ↔ heavy ions
- Discussion points
**Light ions: EIC capabilities**

- **CM energy** $\sqrt{s_{ep}} = 20–100(140)$ GeV
  
  Lower by $\sqrt{Z/A}$ for ions

- **Luminosity** $\sim 10^{34}$ cm$^{-2}$ s$^{-1}$
  
  Rare processes, exceptional configurations
  Multi-variable final states
  Polarization observables

- **Polarized beams**
  
  Polarized proton and 3He
  Possibly pol deuteron at special energies

- **Forward detection of $p, n, A'$**
  
  Charged – spectrometer, neutral – ZDC

  Exclusive and diffractive processes
  Nuclear breakup and spectator tagging
  Coherent nuclear scattering

Ref: EIC pCDR public version 2019 [Webpage]
Light ions: Physics

- Neutron structure
  
  Flavor decomposition $\Delta q$, spin, GPDs/TMDs?
  Singlet-nonsinglet separation in QCD evolution?

- Nuclear interactions
  
  Hadronic: Short-range correlations, NN core, non-nucleonic DoF?
  
  Partonic: Nuclear modifications of partonic structure?
  EMC effect $x > 0.3$, antishadowing $x \sim 0.1$,
  quarks/antiquarks/gluons, spin/flavor, dynamical mechanism?

  $\leftrightarrow$ Initial state in heavy ion reactions

- Coherent phenomena
  
  Nuclear shadowing at $x \ll 0.1$?
  Onset of coherence, contributions of $N = 2, 3, \ldots$ nucleons?
  $\leftrightarrow$ Shadowing/saturation in heavy ion reactions

  Measurements: Inclusive, breakup/tagging, coherent recoil
  Theory input: Initial-state wave functions, final-state interactions
Light ions: Developments

- Emerging program: Topical workshops
  “Polarized light ion physics with EIC,” 5-9 Feb 2018, Ghent U., Belgium [Webpage]
  “Exploring QCD with light nuclei at EIC,” CFNS Stony Brook, 21-24 Jan 2020 [Webpage]

- EIC simulations with light ions: Physics and detector, Yellow Reports
  Groups BNL, JLab, ANL, MIT, Florida International U., Perugia, Saclay, . . .
  Forward detector design driven by light ion tagging/breakup measurements
  Materials: EIC User Group Yellow Report Initiative [Webpage]

- Theory effort: Nuclear structure in high-energy processes with light ions
  Light-front methods, nuclear spectral functions, final-state interactions, polarization
  Emerging collaboration with low-energy nuclear structure community
Light ions: Discussion points

• What can eA(light) contribute to understanding eA/pA/AA(heavy)?
  
  Nuclear modifications of partonic structure – characterization, mechanism?
  
  Nuclear final-state interactions in DIS processes – simpler environment?
  
  Coherent phenomena in high-energy scattering – onset of coherence; \( N = 2,3,\ldots \) nucleons?
  
  Synergies and complementarity in physics reach?

• Are there specific requests/proposals for EIC eA(light) measurements?

• What are the prospects for pA(light) high-energy measurements?

  Synergies with eA(light) at EIC – same physics question, different probe?