INT-18-3 Probing Nucleons and Nuclei in High Energy Collisions
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Week 1: Generalized Parton Distributions
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October 1–5, 2018

• Context
  Present high-energy facilities
  Future Electron-Ion Collider EIC

• Objectives

• Plan Week 1
Context: High-energy scattering

Electromagnetic probes

- JLab 12 GeV Upgrade
  4-Hall operation of accelerator demonstrated
  Physics running started, first results
  Expect results over next 5-10 years

- COMPASS $\mu^\pm$ beam

- LHC/RHIC ultraperipheral $pA/AA$
  Highest energies in EM scattering

Hadronic probes

- LHC $pp/pA/AA$: hard procs, final states,
  small-$x$ phenomena, multiparton interactions,
  jets, diffraction, nuclear effects

- RHIC $pp/pA/AA$ results, future $AA$ runs

- Meson beams COMPASS, JPARC
Context: Electron-Ion Collider

- CM energy $\sqrt{s_{ep}} \sim 20–100$ GeV
  - Factor $\sqrt{Z/A}$ in nuclei
- Luminosity $\sim 10^{33}–10^{34}$ cm$^{-2}$ s$^{-1}$
  - $\sim 10^2–10^3 \times$ HERA luminosity
  - Simulations for int. lumi 10–100 fb$^{-1}$
- Polarized protons and light ions
  - Polarized $d$ (JLEIC), $^3$He, others

[Parameters per EIC White Paper, NAS Study]

- Next-generation detectors
  - Central & ion endcap: Calorimetry, tracking, vertex detections, PID
  - Forward ion: Exclusive and diffractive $p$, coherent nuclear processes, nuclear breakup and spectator tagging
  - Forward electron: Low-$Q^2$ tagger for quasireal photoproduction
Context: EIC developments

- EIC White Paper 2014
  Based on 2010 INT program
- DOE NSAC Long-Range Plan 2015
  Recommended for future construction
- EIC User Group 2015
  >800 physicists, >170 institutions
  Increasingly active
- National Academy of Sciences Study 2018
  EIC science “compelling, fundamental, and timely”
- Next steps
  Conceptual design reports BNL & JLAB
  Toward CD0 “Mission need”
Objectives

Assess and update EIC nuclear physics program in light of recent theoretical and experimental developments and results of other facilities

• What “new physics” could be explored with EIC?

  New concepts or measurements [“New” relative to 2012/14 WP. Basic machine parameters as in WP/NAS]

  New approaches to accepted scientific goals

• What will be the role of EIC in the context of other facilities?

  Expected knowledge by the time EIC comes online

  Synergies and complementarity, e.g. global analysis, kinematic overlap

Format

Keep discourse as informal as possible
Presentations should summarize status, identify directions, pose questions
Discussions are most essential part — need everyone to participate
Results will be communicated in summary document
Week 1: Generalized parton distributions

• Spatial structure of hadrons in QCD
  Expression of nonperturbative dynamics
  Visualization
  Higher concepts: Wigner functions, GTMDs
  Connection with small $x$, $pp$

• Matrix elements of local operators  $(\text{spin} \geq 2)$
  Form factors of energy-momentum tensor
  Total/orbital angular momentum of $q, \bar{q}, g$
  D-Term, forces, pressure in hadrons
  Connection with Lattice QCD (local ops)

[Both aspects are essential to EIC physics program and will be discussed in Week 1]
Week 1: Agenda

Monday, Oct 1  GPDs in DVCS and related processes
DVCS theory and GPD extraction
DVCS experiments, DVCS at EIC
Timelike Compton scattering and GPDs

Kumericki
Sokhan, Fazio
Boer

Tuesday, Oct 2  GPDs and nucleon structure / Wigner functions
EM tensor FFs, Twist-3 GPDs and angular momentum
GTMDs, Wigner functions
Color correlations in nucleon

Schweitzer, Burkardt, Aslan
Schlegel, Pasquini
Miller

Wednesday, Oct 3  GPDs in meson production
GPDs in meson electroproduction, high-mass photoproduction
Heavy quarkonium production in QCD
Meson production at EIC

Kroll, Szymanowski
Qiu
Horn

Thursday, Oct 4  Nuclear GPDs / Small x / Connection with pp
Nuclear shadowing in exclusive processes
GPD measurements with 3He and neutron structure
GPDs and transverse geometry in pp scattering
Wigner functions in ep and pp

Guzey
Scopetta
Weiss
Yuan

Friday, Oct 5  GPDs in Lattice QCD / Path toward EIC
Parton distributions from LQCD, GPDs from LQCD
Model calculations of Euclidean correlators

Braun, Zhao
Metz

+ Topical discussions on each day