Cold nuclear physics white paper status and prospects

Will Detmold, MIT
Cold nuclear physics white paper structure

- Bosses: Robert Edwards, Will Detmold
- Contributors: Kostas Orginos, Martha Constantinou, Huey-Wen Lin, Sergey Syritsyn, Michael Engelhardt, Jo Dudek, Phiala Shanahan, Stefan Meinel, David Richards

- Main physics topics
  1. Hadron Spectroscopy
  2. Hadron Structure
  3. Nuclear Spectroscopy, Structure and Interactions

- Links to other WPs (νA interactions, fundamental symmetries)
Experimental drivers for cold NP

- Highlight relevance of LQCD to NP experimental program

- Existing Facilities: CEBAF @ Jefferson Lab, RHIC @ BNL, ATLAS@ ANL

- Future Facilities
  - Facility for Rare Isotope Beams (FRIB) @ Michigan State
  - Electron-Ion Collider (EIC) @ BNL or JLab
Hadron spectroscopy

- Stable light and strange hadrons
  - Precision: isospin breaking effects and EM splittings,…
- Excited state resonances in scattering phases shifts
- Major experimental motivation from COMPASS, GlueX, CLAS12, BES III, LHCb
- Heavy mesons and baryons
  - Spectroscopy of singly/doubly/triply charm/bottom baryons
  - XYZ states: tetraquarks, pentaquarks,…
Form factors of nucleons (and pions, kaons, etc)

- Aim for full flavour separation, all types of local currents

- Proton charge radius

- Axial/pseudoscalar FFs (defer to νA WP)

- Resonance transition form factors: mesons & baryons

- Input for GlueX and CLAS12

- Moments of PDFs, GPDs

- Momentum, spin decomposition of proton
Hadron structure

- Bjorken-\(x\) dependence of PDFs
  - Explosion of interest
  - Many developments
- Transverse momentum dependent parton distributions
  - 3D imaging of the proton
- Gluonic aspects of all of the above
  - Focus of EIC: “understanding the glue that binds us all”
Nuclear spectroscopy

- push to physical mass/understand quark mass
dependence of nuclei
- extend to larger A; $p$-shell nuclei
- Further develop the connections to EFT for relating FV
energy levels to infinite volume physics

Nuclear interactions

- YN scattering and nnn interactions relevant in n-stars
- Electroweak interactions: $np \rightarrow d\gamma$, $pp \rightarrow d\nu\gamma$, extensions
to three body systems
Nuclear Structure

- EMC-like nuclear effects in charges, (moments of) PDFs,…
- Explore the spatial structure of nuclei through form factors
- Non-nucleonic aspects of nuclear structure: exotic glue

Nuclear input for neutrino physics and fundamental symmetries

- Point out connections leaving details to the other WPs
Input from the community

- Plans are to summarise state of field and discuss new opportunities in each area
- Other topics to cover?
  - Additional overlaps/links to other WPs?