SciDAC-4 and Nuclear Physics

I. What’s so special about computational NP?
II. The 3 NP SciDAC-4 Projects. (In breakout session.)
III. Comments / Questions?
I. What’s so special about computational NP?

- It is a well-defined mathematical problem, and is **tractable** using MC. (The right answer, with errors -> 0.)

**NP** = the study of forms of matter dominated by the **strong interaction**.

Theory = **QCD**, quarks and gluons, a simple quantum field theory. (Bring in electroweak effects if needed.)

Solvable using \( \exp(-S) \) Monte Carlo methods on a spacetime Lattice, “LQCD”; observables obtained from numerical correlation functions.

- The results are immediately comparable to ongoing NP experiments, and are **NEEEDED by** those **experiments** for planning purposes.

**e.g.s of LQCD predictions**: \( q,g \) confinement into hadrons; hadron spectra; “nuclear” forces between hadrons; multihadron bound states “nuclei”; hot QCD EOS (working); (light) nuclear reactions; hadronic \( \text{m.e.s} \) and decays.

Probs due to small \( m_{u,d} \) (~there now), \( \mu \) ne 0 \( (N_q \) ne \( N_{\bar{q}}) \). (Working on it.)
II. The 3 NP SciDAC-4 Projects

3. NUCLEI
**Nuclear Computational Low Energy Initiative**
PI Joseph Carlson (LANL)
[very effective, venerable, and amazingly prolific NP SciDAC Collab. UNEDF -> NUCLEI -> NUCLEI. Nuclei, properties, reactions, decays …; Nuclei R Us.]

2. LQCD
**Computing the Properties of Matter with Leadership Computing Resources**
PI Robert Edwards (TJNAF)
[direct calculations of experimental observables needed NOW by NP experiments from the QFT of the strong interaction, QCD.]

1. TEAMS
**Towards Exascale Astrophysics of Mergers and Supernovae**
PI William Raphael Hix (ORNL)
[nuclear astrophysics returns to SciDAC! Origins of nuclei, r-process, “multimessenger” calculations of various signals of candidate events, including CCSNe, neutron star pair mergers, and gravity waves!]
III. Comments / Questions?

Come to the breakout session!