DNP20-2020-000106

Abstract for an Invited Paper
for the DNP20 Meeting of
the American Physical Society

Quantum Computing and Lattice QCD[1]

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Integration of Quantum Information Science (QIS) into Nuclear Physics research is anticipated to disruptively enhance our ability to address our grand challenge problems. In the early 1980s, it was recognized by Feynman and others that simulations of quantum systems, from the earliest moments of the universe during which the matter-antimatter asymmetry emerged, to the matter at the core of neutron stars and in other astrophysical environments, to the structure and reactions of nuclei, lie beyond the capabilities of classical computation and ultimately requires simulations using quantum computers. Able to implement real-time time evolution on an exponentially large Hilbert space, future quantum simulators have the potential to quantitatively address these systems. Advances in the control of entanglement and superposition over increasingly large volumes of space-time have led to first devices for quantum simulation. Cold-atom, trapped-ion and superconducting qubit devices, and related programming languages, are becoming increasingly available to nuclear physicists for early explorations of analog, digital and hybrid simulations of model quantum systems. I will present the status of this emerging area, implications for QCD, and outline what the next 10 years may hold.

[1]Supported by US DOE NP DE-FG02- 00ER41132, US DOE ASCR ERKJ333, ORNL 4000158760, FNAL PO No. 652197.