

Using quantum hardware to explore nuclear physics

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Strongly interacting many-body quantum systems are computationally inefficient to model due to the exponential scaling of resources required with system size and QCD is no exception. The fermionic sign problem and a non-trivial interplay of dynamics at different energy scales make calculations at finite density and real-time dynamical phenomena intractable for even today's exa-scale computers. Quantum computers present an opportunity to address classically intractable problems by leveraging state-superposition and entanglement to achieve information densities that scale exponentially with system size. However, achieving a large-scale, fault-tolerant, universal quantum computer remains challenging with today's state-of-the-art quantum hardware. Quantum simulation offers an alternative approach to gaining insight into classically intractable theories by pairing precise (though imperfect) control of a quantum system with aspects of the system's natural behavior. In this talk, I will review leading quantum hardware platforms with an emphasis on how they have been applied to calculations in nuclear physics. I will also report on our progress developing and co-designing a quantum simulation platform that is tailored to address non-perturbative phenomena in QCD. Our work builds upon recent advances in the manipulation of neutral atoms trapped in optical tweezer arrays.

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