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Toward quantum simulations for nuclear physics with qubits and qumodes (25+5)

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The strong force in nature, described by the theory of quantum chromodynamics (QCD), governs the interaction of quarks and gluons, which constitute the main building blocks of the visible universe. Since its development over five decades ago, various fundamental questions have remained unanswered despite significant theoretical and experimental efforts: How do the dynamics of quarks and gluons give rise to emergent structures such as nucleons and nuclei? What is the phase diagram of nuclear matter and what are the real-time and non-equilibrium dynamics at collider experiments and in the early universe? While significant progress has been made on the theory side using perturbative techniques and lattice QCD, the answers to some of the most challenging questions are beyond the capabilities of classical computing. Advances in quantum computing coupled with the development of innovative algorithms motivate the exploration of quantum simulations to address these questions. In this talk, I will discuss recent progress toward quantum simulations for fundamental particle and nuclear physics covering both discrete (qubit) and continuous variable (qumode) approaches.

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