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# Building Solid-State Quantum Simulators for Applications in Lattice Gauge Theory (25+5)

*Tuesday, January 14, 2025 9:00 AM (30 minutes)*

We are developing a new platform for atom-based solid-state analog quantum simulation with unique application in simulating lattice gauge theory. The method uses STM lithography to precisely locate individual atoms on a patterned silicon substrate. These atomic structures are then encased in epitaxial silicon, stable in ambient over long periods of time, and can be measured at low temperature in a dilution refrigerator. We have demonstrated atomically precise patterning and devices whose performance relies on atoms placed with one silicon lattice site resolution including a single atom transistor, single electron transistor (SET) sensors, and individual charge and spin measurements using transport and RF reflectometry. Recently we demonstrated the analog quantum simulation of an extended Hubbard model. In these results 3x3 arrays of dopant atoms were fabricated with varying degrees of tunnel coupling to enable quantum simulations of a Hubbard model from a weakly coupled regime to a strongly coupled array. Currently we are fabricating 2x2 plaquettes as building blocks for the proposed quantum simulation of a model of relevance to nuclear physics. Our proposal uses a dynamical lattice of coupled nuclear spins and conduction-band electrons to realize a quantum field theory: an extended Jackiw-Rebbi model involving coupled fermions and quantum rotors. Classical simulations of this platform show the feasibility of using precision placed nuclear spins hyperfine coupled to electrons to observe dynamical mass generation and a confinement-deconfinement quantum phase transition in 1+1 dimensions, even in the presence of strong long-range Coulomb interactions.

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