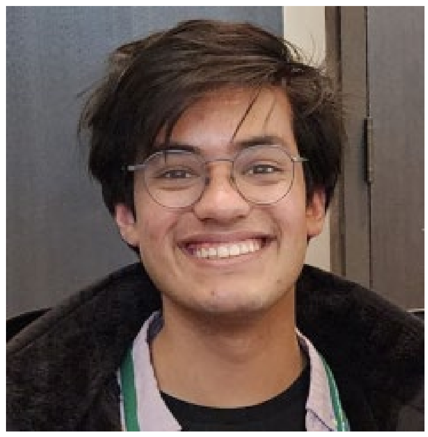
COMPUTATIONAL RESEARCH in BOSTON and BEYOND SEMINAR

Quantum Spin Lakes: Non-Equilibrium Spin Liquids for Near-Term Quantum Device



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ABSTRACT:

Dynamical parameter sweeps are ubiquitously used for exploring ground state phase diagrams in analog quantum simulators. However, conventional lore dictates that the presence of unavoidable quantum phase transitions---at which a time-evolving quantum system falls out of equilibrium---limits the ability of these sweeps to prepare interesting equilibrium ground states. In this talk, we counter this lore and show that there are situations where the non-equilibrium nature of a dynamical sweep can enable the creation of exotic states of matter, even in the absence of the desired ground states. For instance, we highlight a non-equilibrium mechanism wherein a simple Hamiltonian parameter sweep can project out anyons and prepare quantum spin liquid (QSL) states, despite the ground state of the Hamiltonian failing to be a QSL. We show that this mechanism sheds light on recent experimental and numerical observations of the dynamical state preparation of the ruby lattice spin liquid in Rydberg atom arrays. Moreover, this theory suggests a tree tensor network-based numerical tool that quantitatively reproduces the experimental data two orders of magnitude faster than conventional brute-force simulation methods. Time permitting, we highlight that even spin liquid states that are unstable in equilibrium---namely, 2 + 1D U(1) spin liquid states---become accessible by such non-equilibrium dynamics.

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