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Rahul Trivedi: Simulating many-body physics with noisy quantum devices

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Quantum computers offer a promising solution to the task of simulating many-body physics. A scalable fault-tolerant quantum computer with a large supply of logical qubits would allow us to answer many interesting questions about physical systems. In the near term we can only access noisy physical qubits, and this has raised an important theoretical question of identifying the limitations and applicability of near-term quantum hardware.

I will first consider the circuit model of quantum computations, with the goal of the quantum circuit being to find the ground state of a specific Hamiltonian. Assuming that the circuits are interrupted by depolarizing errors, I will provide methods to lower bound the energy that can be achieved by the circuit and discuss the implications of these lower bounds on the ability of NISQ devices to find Hamiltonian ground states.

In the next part of my talk, I will consider less pessimistic noise models (e.g. coherent errors) and I will show that for certain many-body physics problems, unencoded quantum computations or analogue quantum simulators could be practical. I will provide theoretical evidence that some many-body problems (related to both dynamics and equilibrium properties), are stable to errors and are likely solvable without error correction thus making them prime candidates for near-term experiments.