Universal Digital Quantum Simulation with Trapped Ions

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This paper aims at introducing the first few models of quantum simulation using trapped ions. In particular, the simulation is performed under the digital framework, and the unitary evolution of qubit under arbitrary hamiltonian is modeled using Trotter approximation. In the paper blueprint to simulate systems of up to 6 spin- ½ particles (two-level ions) is demonstrated. Linear paul trap was utilized to trap the ions. With the help of beams (both and on and off-resonant) that implements unitary gate operations, the evolution of coupled spins is modeled. The fidelities are calculated by comparing the result to the Quantum Process Tomography (QPT). Limitations in the simulation were observed: the leading source of error was laser intensity fluctuation. The promising result of this quantum simulation opens door to quantum simulation of even larger quantum systems in the future.