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Programmable Quantum Simulation of the Fermi-Hubbard Model

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Strongly correlated fermionic matter is at the heart of many open questions in quantum science, ranging from electon-Volt scale problems in condensed matter physics to Giga-electon-Volt dynamics in heavy ion collisions. Ultracold fermionic atoms are a unique platform, where the dynamics of interacting fermions can be probed using time- and particle-resolved correlation measurements.

In recent years, analog quantum simulators based on ultracold fermions have been able to shed light on the intricate interplay between charge and spin order, the dynamics of impurities and the emergence of pairing in Fermi-Hubbard models. To go beyond the state of the art, the next generation of machines will have to: i) Enable more programmable quantum simulation, ii) deliver correlation observables at higher data rates, and iii) prepare optical lattice systems at lower temperatures.

To this end, two new Fermi-Hubbard quantum simulators are currently under development at MPQ. The *FermiQP* project aims to combine analog quantum simulation with digital gate sequences to deliver highly programmable Hubbard models. On the other hand, the *UniRand* machine is geared towards performing generalized measurements using random unitary operators. On this poster, I will report on the progress of both new simulators

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