Contribution ID: **106** Type: **Poster**

Towards quantum simulations with strontium atoms

Monday, 11 September 2023 22:40 (20 minutes)

Cold atom platforms with single particle/spin detection and control offer fascinating opportunities for emerging quantum technologies.
Among quantum simulators atoms trapped in programmable optical tweezer arrays and excited to Rydberg states are nearly ideal systems to study quantum spin models. The short cycle time typically below one second makes modern protocols developed to characterize entanglement within reach of such platforms and opens interesting perspectives for quantum computation. Yet, simulating fermions on such systems remains a long standing goal. In addition, current system sizes are limited to a few hundreds of particles in one and two dimensions and the study of three-dimensional problems on arbitrary lattice structures is still to be explored.
A complementary platform for quantum simulation is a quantum gas microscope where large fermionic or bosonic clouds are trapped in optical lattices. Whereas quantum statistics and itinerant models are natively implemented in these experiments, the current lack of programmability and long cycle time are limiting their capabilities. Our vision to overcome these challenges in quantum simulation is to combine atom manipulation using optical tweezers with quantum gas microscopy on a unique quantum simulation platform with high repetition rate.
We report here on the development of such novel quantum simulator operating with strontium with which we aim to study topological phases in three-dimensional frustrated spin systems as well as the SU(N) Fermi-Hubbard model.

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Session Classification: Poster Session II

Track Classification: Quantum Simulation with Single Atom Resolution