Quantum Many-Body Physics with Ultracold Atoms

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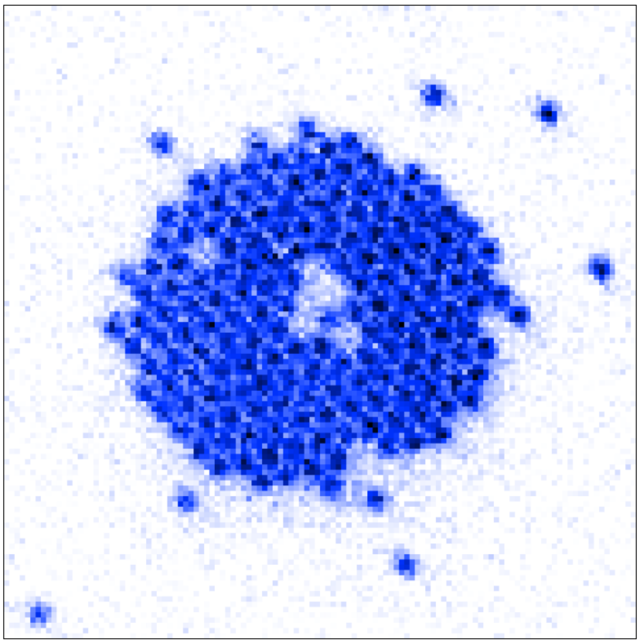

Figure 1: Site-resolved image of atomic Mott insulator in a triangular lattice

Single-particle control and detection of strongly correlated quantum many-particle systems has enabled a wide variety of applications including quantum simulation of condensed matter systems and quantum computing demonstrations. Exact numerical simulations on classical computers are intractable for most quantum many-body systems beyond a few particles. Quantum simulators can answer questions by implementing the Hamiltonian of interest, while digital quantum computers realize universal quantum computing using a set of gates.

In the first part of the talk, I will give an introduction into the field of quantum simulation using ultracold atoms with focus on quantum gas microscopy techniques which allow us to probe many-body systems at the single-particle level. Over the past years, we developed a platform to study geometrically frustrated Hubbard systems and reveal their quantum correlations. We prepared fermionic atomic Mott insulators on a triangular lattice, detected them with single-site resolution and measured spin-spin correlations. Currently we are working on upgrades to the experiment which enable the study of kinetic magnetism and exotic quantum phases.

The second part of the talk will cover the progress of our new experiment with ytterbium atoms in optical tweezers. I will discuss the advantages and disadvantages of the tweezer platform and present our plans to realize large entangled states.

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