Quantum Gas Microscopy of Ultracold Atoms in an Optical Lattice

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Ultracold atoms in optical lattices are an ideal system for the quantum simulation of condensed matter systems, offering high tunability of parameters in dissipation-free systems. With quantum gas microscopy, we are now able to initialize, manipulate and probe strongly-interacting many-body systems on a single-particle level.
In this talk, I will give an overview of our experimental system and discuss our progress towards the quantum simulation of real materials. We have for the first time realized quantum magnetism in an optical lattice and report on microscopic studies of a quantum phase transition in antiferromagnetic Ising spin chains. We address the need for extremely low in-lattice temperatures with a new cooling technique: Using an orbital-dependent interaction, we demonstrate a number-filtering scheme that enables the algorithmic removal of entropy from a thermal cloud until it Bose condenses.
I will briefly discuss our recent studies of a tunnel-coupled bilayer system, including occupation-dependent transport between planes and the application for atom-resolved imaging beyond the limits of parity projection.