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Towards a Quantum Gas Microscope for Fermionic Atoms
LAWRENCE CHEUK, VINAY RAMASESH, MELIH OKAN, MATTHEW NICHOLS, WASEEM BAKR, MARTIN ZWIERLEIN, Massachusetts Institute of Technology — Experiments with ultracold fermionic atoms in optical lattices represent uniquely controllable realizations of many body physics. We present progress toward the construction of such an experiment, the Fermi gas microscope, which will allow for fluorescence detection of fermions in optical lattices with single-site resolution. Our experiments employ fermionic potassium and lithium atoms, with bosonic sodium used as a sympathetic coolant. Once the fermionic species are cooled to quantum degeneracy, they will be loaded into a single layer of an optical lattice and imaged with single-site resolution. Such local probing should reveal microscopic density or spin correlations difficult to distinguish in traditional bulk measurements. High-resolution probing will also allow detecting sharply localized quantum states such as edge states at the boundary of topological states of matter. Finally, microscopy will enable local manipulation and engineering of many-fermion states, e.g. for entropy redistribution in a quantum gas or for designing quantum circuits.

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