Single-atom imaging of fermions in a quantum-gas microscope

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Abstract

Single-atom-resolved detection in optical lattices using quantum-gas microscopes has enabled a new generation of experiments in the field of quantum simulation. While such devices have been realised with bosonic species, a fermionic quantum-gas microscope has remained elusive. We demonstrate single-site- and single-atom-resolved fluorescence imaging of fermionic potassium-40 atoms in a quantum-gas microscope setup, using electromagnetically-induced-transparency cooling. We detected on average 1000 fluorescence photons from a single atom within 1.5 s, while keeping it close to the vibrational ground state of the optical lattice. A quantum simulator for fermions with single-particle access will be an excellent test bed to investigate phenomena and properties of strongly correlated fermionic quantum systems, allowing for direct measurement of ordered quantum phases and out-of-equilibrium dynamics, with access to quantities ranging from spin-spin correlation functions to many-particle entanglement.

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