Towards single-atom-resolved detection of strongly correlated fermions in an optical lattice

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Motivated by the recent achievement of single-site-resolved imaging and manipulation of strongly correlated bosonic systems in an optical lattice [1,2], we illustrate our progress to realize single-atom imaging for fermionic ^{40}K. Detecting and manipulating strongly correlated fermionic systems at the level of a single atom will further exploit the potential of ultracold atoms as a quantum simulator for the Fermi-Hubbard model.

Atoms from a two-stage magneto-optical trap of ^{87}Rb and ^{40}K are loaded into a magnetic trap, before evaporative cooling and transport in an optical trap delivers a quantum degenerate gas to a 3-dimensional optical lattice. By selective removal of atoms from all lattice planes but the one at the focal plane of a NA = 0.68 microscope objective, we will resolve the distribution and evolution of atoms across individual sites of the 2D lattice using fluorescence imaging. We plan to use this novel detection method to characterize, e.g., temperature, spin-structure, or entropy distribution of quantum phases such as fermionic Mott insulators, Band insulators, metallic phases or Néel antiferromagnets.

References

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