A Quantum-gas Microscope for Fermionic 40-potassium

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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 several years ago, a fermionic quantum-gas microscope has proven more challenging. We recently demonstrated single-site- and single-atom-resolved florescence imaging of fermionic potassium-40 atoms in a quantum-gas microscope setup using electromagnetically-induced-transparency cooling [1]. 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.

Our fermionic quantum-gas microscope will provide the possibility to probe quantities that are difficult to access directly, such as spin-spin-correlation functions or string-order. It would allow the study of, e.g. the Fermi-Hubbard Model, in particular out-of-equilibrium dynamics, the spreading of correlations and the build-up of entanglement in many-particle fermionic quantum systems.

References:

[1] E. Haller, J. Hudson, A. Kelly, D. Cotta, B. Peaudecerf, G. D. Bruce, S. Kuhr, Single-atom imaging of fermions in a quantum-gas microscope, Nature Physics 11, 738 (2015).