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Microscopy of a Quantum Gas in a 2D Optical Lattice WASEEM BAKR, AMY PENG, MING TAI, RUICHAO MA, GREGOR JOTZU, JONATHON GILLEN, SIMON FOELLING, MARKUS GREINER, Harvard University — Ultracold quantum gases in optical lattices provide a rich experimental toolbox for simulating the physics of condensed matter systems. With atoms in the lattice playing the role of electrons or Cooper pairs in real materials, it is possible to experimentally realize condensed matter Hamiltonians in a controlled way. To realize the full potential of such quantum simulations, we have created a quantum gas microscope (NA = 0.8) which can spatially resolve the atoms in the optical lattice at the single site level, and project arbitrary potential landscapes onto the atoms by combining the high resolution optics with static holographic masks or a spatial light modulator. The high resolution microscope operates with the atoms trapped in a two dimensional optical lattice at a distance of 10 microns from a glass surface that is part of the microscope. We have experimentally verified a resolution of $\sim$ 600 nm, providing the capability to study the phase diagram of the Bose Hubbard model by measuring occupation number at individual sites.

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