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Single-site resolved studies of a bilayer quantum degenerate gas RUICHAO MA, PHILIPP PREISS, MING TAI, Harvard University, WASEEM BAKR, Massachusetts Institute of Technology, JONATHAN SIMON, MARKUS GREINER, Harvard University — Ultracold atoms in optical lattices are a versatile platform for quantum many-body simulation with the promise of insights into quantum magnetism, superconductivity, and superfluidity. In recent years, quantum gas microscopes with single-site resolution have opened the door to local observation and manipulation of strongly correlated two-dimensional quantum gases. Here we present techniques for extending study to two tunnel-coupled planes. Using an axial superlattice we prepare a bilayer system, with full control of the inter-plane tunnel coupling and detuning. We observe coherent inter-plane population transfer with single-site resolution in both planes. A collisional energy blockade in the bilayer system allows us to go beyond parity imaging and unambiguously identify site occupations from zero to three atoms. We have obtained site-resolved images of the "wedding-cake" Mott insulator structure and antiferromagnetic ordering in a quantum Ising model. Further applications include spin-dependent readout and in situ phase imaging.

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