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Fermionic Mott Insulators, Band Insulators, and Metals under the Quantum Gas Microscope

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Strongly correlated fermions pose some of the most difficult challenges to many-body theory. A prime example is the Fermi-Hubbard model, believed to hold the key to our understanding of high-temperature superconductors. It describes repulsive spinful fermions moving through a crystal lattice, a situation that can be realized in pristine fashion with ultracold fermionic atoms in optical lattices. The recent development of quantum gas microscopes for fermionic atoms now allows for a microscopic view of the phases encountered in the Fermi-Hubbard model, with a resolution at the single-atom, single-lattice site level. I will present our recent observation of the crossover between metallic, band insulating and Mott insulating phases in two-dimensional Fermi gases. The equation of state is directly obtained from density profiles, revealing an entropy per particle that is almost entirely dominated by the unobserved spin degree of freedom.