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### Quantum Simulations in Optical Lattices

We discuss recent progress on quantum simulations of many-body Hamiltonians with ultracold Bosons and Fermions in optical lattices. Recently developed quantum gas microscopes provide a new level of detection and control over these systems and we present two experiments enabled by this technology. First, we report on the characterization of the far-from-equilibrium behavior of closed disordered quantum systems, where we observed a drastic change in the equilibrium properties of the system. For low disorders, the system apparently thermalizes, while our experiments support the existence of a non-thermalizing many-body localized phase at higher disorders. In a second experiment we observed the onset of longer-ranged antiferromagnetic correlations in Fermi- Hubbard chains, demonstrating the simultaneous detection of all local degrees of freedom of the model. These recent developments on lattice fermions readily enable the study of doped systems and the local measurement of the interplay of spin and charge, believed to underlie the physics of high- $t_c$  superconductors.

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