Hole–hole attraction in quantum simulations of doped antiferromagnets

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Unravelling the origin of unconventional superconductivity is one of the driving forces behind quantum simulations with ultracold Fermions in optical lattices. In these strongly correlated materials, the necessary pairing of charge carriers is often assumed to be related to the competition between antiferromagnetic correlations and dopant motion.

With our quantum gas microscope, we can see this interplay of spin and charge in snapshots of the many-body wavefunction. We find strong competition between a magnetically mediated hole-hole attraction and repulsion due to Pauli blocking. In a mixed-dimensional system, where we restrict the hole motion to one dimension while keeping the spin order two-dimensional, attraction dominates and we directly image tightly bound pairs of holes and find signatures of the formation of stripes. In the standard Hubbard model, we find first evidence for loosely bound hole pairs, when the system is cooled into the pseudo gap regime.

I will give an overview of our experimental progress and discuss some theoretical concepts towards a microscopic understanding of the phases related to high-temperature superconductivity.