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"Observation of hole ordering mediated by antiferromagnetic correlations in mixed-dimensional Hubbard models"

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LMU, Theresienstr. 39, B 349

Zoom: https://lmu-munich.zoom.us/j/6502513704?pwd=TmIuWVhURVcyd3d3MmJwdWI3WEIldz09, ID: 650 251 3704, Passcode: 016254

Abstract: Unraveling the origin of unconventional superconductivity is one of the driving forces behind quantum simulations with Fermions in optical lattices. In these strongly correlated materials, the necessary pairing of charge carriers is often assumed to be related to the interplay of antiferromagnetic correlations and dopant motion. Despite impressive recent progress in the numerical treatment of the Hubbard model[1,2,9], many open questions remain in particular about the pseudo-gap regime and the relation of striped phases to superconductivity.
With our Lithium-6 quantum gas microscope, we can image strongly correlated many-body Fermi systems with full spin and density resolution and study individual holes' local distribution and spin environment [3,4]. In addition, the microscope and a new phase-stable superlattice enable us to engineer large classes of Hubbard-like Hamiltonians with control on the level of individual sites.
In antiferromagnets with weak doping, individual holes form magnetic polarons whose motion is strongly reduced due to the magnetic background. Pairs of dopants can overcome the frustrating effect but we find strong competition between this magnetically mediated hole-hole attraction and repulsion due to Pauli blocking [5,6]. The binding energy for hole pairing in normal two-dimensional Hubbard models is thus strongly reduced below the magnetic energy scale J.
However, in a mixed-dimensional system [7], where we restrict the hole motion to one dimension while keeping the spin order two-dimensional, we directly image tightly bound pairs of holes and find binding energies on the order of the spin exchange energy J [5]. Upon increased doping, we observe repulsion between hole pairs in one spatial direction and currently investigate the formation of stripes [8], which we expect to form already at our current experimental temperatures in the mixD configuration. Such stripes form the ground state of the normal Hubbard model [1] and recent numerical results show that with a diagonal hopping term they support the emergence of d-wave superconductivity [9].

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