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Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme

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Strongly Interacting Fermi Gases under the Microscope

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Abstract

Strongly interacting fermions govern the physics of e.g. high-temperature superconductors, nuclear matter and neutron stars. The interplay of the Pauli principle with strong interactions can give rise to exotic properties that we do not even understand at a qualitative level. In recent years, ultracold Fermi gases of atoms have emerged as a pristine platform for the creation and study of strongly interacting systems of fermions. Near Feshbach resonances, such gases display superfluidity at 17% of the Fermi temperature. Scaled to the density of electrons in solids, this corresponds to superfluidity far above room temperature. Confined in optical lattices, fermionic atoms realize the Fermi-Hubbard model, believed to capture the essence of cuprate high-temperature superconductors. In recent experiments on two-dimensional Fermi gases under a microscope, we observe metallic, Mott insulating and band insulating states with single-site, single-atom resolution. The microscope allows for the site-resolved detection of charge and spin correlations, revealing the famous Pauli and correlation hole for low and intermediate lattice fillings, and correlated doublon-hole pairs near half filling. These correlations should play an important role for transport in the Fermi-Hubbard model.