CO.CO.MAT

Thomas Lompe
(Center for Ultracold Atoms, MIT-Harvard)

From few to many: Exploring quantum many-body systems one atom at a time

Experiments with ultracold gases have been extremely successful in studying many body systems, such as Bose Einstein condensates or fermionic superfluids. In our experiments we have developed new experimental techniques to deterministically prepare few-particle systems of ultracold fermions in the ground state of a tunable optical potential. This makes it possible to use ultracold atoms to study many-body physics in a bottom-up approach, i.e. to start from the fundamental building block of a system and watch how many-body effects emerge as one gradually increases the system's size.
As a first experiment we have investigated this crossover from few to many-body physics by studying quasi one-dimensional systems consisting of a single impurity interacting with an increasing number of identical fermions. Starting from a two-particle system and increasing the number of majority atoms one by one we observed a fast convergence of the normalized interaction energy towards the many-body limit calculated for a single impurity immersed in a Fermi sea of majority particles.
Since then we have expanded our apparatus to prepare systems of two fermionic atoms in a double well potential. This gives us a single-site addressable realization of a ground-state Fermi-Hubbard system which we have used to observe the crossover into the Mott-insulating and charge-density-wave regimes. By adding a third well to the system this approach can be used to directly observe antiferromagnetic correlations in the system.

17. Juni 2014, 10:00 Uhr

Universität Ulm, Raum 45.2.304
Albert-Einstein-Allee 45 (Uni West), 89081 Ulm