DAMOP17-2017-001125

Abstract for an Invited Paper
for the DAMOP17 Meeting of
the American Physical Society

I.I. Rabi in Atomic, Molecular & Optical Physics Prize Talk: Strongly Interacting Fermi Gases of Atoms and Molecules

MARTIN ZWIERLEIN, Massachusetts Inst of Tech-MIT

Strongly interacting fermions govern physics at all length scales, from nuclear matter to modern electronic materials and neutron stars. The interplay of the Pauli principle with strong interactions can give rise to exotic properties that we do not understand even at a qualitative level. In recent years, ultracold Fermi gases of atoms have emerged as a new type of strongly interacting fermionic matter that can be created and studied in the laboratory with exquisite control. Feshbach resonances allow for unitarity limited interactions, leading to scale invariance, universal thermodynamics and a superfluid phase transition already at 17% of the Fermi temperature. Trapped in optical lattices, fermionic atoms realize the Fermi-Hubbard model, believed to capture the essence of cuprate high-temperature superconductors. Here, a microscope allows for single-atom, single-site resolved detection of density and spin correlations, revealing the Pauli hole as well as anti-ferromagnetic and doublon-hole correlations. Novel states of matter are predicted for fermions interacting via long-range dipolar interactions. As an intriguing candidate we created stable fermionic molecules of NaK at ultralow temperatures featuring large dipole moments and second-long spin coherence times. In some of the above examples the experiment outperformed the most advanced computer simulations of many-fermion systems, giving hope for a new level of understanding of strongly interacting fermions.