Strongly Interacting Gases of Atoms and Molecules

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Abstract

Ultracold Fermi gases of atoms and molecules are fascinating new platforms to realize paradigmatic forms of strongly interacting fermionic matter. I will present three recent experiments relating to three different ways to induce strong interactions.
Firstly, we have realized a quantum gas microscope for fermionic 40K atoms trapped in an optical lattice, which allows one to probe strongly correlated fermions at the single atom level. We employ Raman sideband cooling, which leaves each atom predominantly in the 3D ground state of its lattice site, inviting the implementation of Maxwell's demon to assemble low-entropy many-body states.
Secondly, we have created chemically stable, strongly dipolar fermionic molecules, opening up prospects for observing a strongly interacting degenerate Fermi gas with dominant dipolar interactions.
Thirdly, via Feshbach resonances, one may access the unitary Fermi gas with universal properties directly relevant to neutron and nuclear matter. We still lack an accurate wave equation describing superfluid matter waves in these gases. I will present our observation of a cascade of solitary waves, from planar solitons to vortex rings and solitonic vortices, that can provide a test case for candidate wave equations.

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