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Strongly Interacting Quantum Mixtures of Ultracold Atoms[1]
CHENG-HSUN WU, ARIEL SOMMER, IBON SANTIAGO-GOMEZ, PEYMAN AHMADI, MARTIN ZWIERLEIN, Department of Physics, MIT-Harvard Center for Ultracold Atoms, and Research Laboratory of Electronics, MIT, Cambridge, MA 02139 — In what forms does matter organize itself under the influence of interaction? This is the fundamental question of many-body physics, which arises at all length scales: from the dense quark matter present in the beginning of our Universe, to the atomic nucleus, the electrons inside a metal, and the inner workings of a neutron star. However, strong interactions between particles do not allow for a simple description of such systems. Strongly interacting mixtures of ultracold atoms will allow us to realize complex many-body systems relevant to the description of High-T_C and Giant Magnetoresistance materials and which cannot be simulated theoretically. We are constructing a new apparatus that will allow to cool three different species of atoms, two of them fermionic, ^{6}Li and ^{40}K, and one of them bosonic, ^{23}Na. A two-species Fermi-Fermi mixture close to a Feshbach resonance realizes an unusual form of fermionic superfluid with unequal masses. A mass- and number imbalanced Fermi mixture might give access to new states of fermionic matter, such as the Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) phase of Cooper pairs with non-zero momentum.

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