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Observation of High-Temperature Superfluidity in a Gas of Fermionic Atoms

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Ultracold quantum degenerate Fermi gases provide a remarkable opportunity to study strongly interacting fermions. In contrast to other Fermi systems, such as superconductors, neutron stars or the quark-gluon plasma of the early Universe, these gases have low densities and their interactions can be precisely controlled over an enormous range. A major goal has been the realization of superfluidity in a gas of fermions. Our observation of vortex lattices in a strongly interacting rotating Fermi gas provide definitive evidence for superfluidity. By varying the binding energy between fermion pairs, we have studied the crossover from a Bose–Einstein condensate of molecules to a Bardeen-Cooper-Schrieffer superfluid of loosely bound pairs. The crossover is associated with a new form of superfluidity. The observed transition temperatures normalized for the density of the gas by far exceed the highest transition temperatures achieved in high-Tc superconductors. Recently, we have extended those studies to interacting Fermi gases with imbalanced spin populations and observed a quantum phase transition at a critical imbalance, which is the Pauli limit of superfluidity.