Abstract for an Invited Paper
for the DAMOP07 Meeting of
The American Physical Society

**High-temperature superfluidity in an ultracold Fermi gas**[1]

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Fermionic superfluidity occurs in a wide variety of physical systems, ranging from superconductors and helium-3 to distant neutron stars. Its realization in ultracold atomic Fermi gases provides us with a unique model system for the study of strongly interacting fermions in a clean and highly controllable environment. We have observed superfluidity in a gas of fermionic lithium-6. Strong interactions between the fermions are induced via a Feshbach resonance. This leads to the highest transition temperature relative to the Fermi temperature ever reported for a fermionic superfluid or superconductor. Scaled to the density of electrons in a metal, the superfluid transition temperature would lie far above room temperature. By varying the interatomic interaction, we can explore the crossover between two limiting cases of fermionic superfluidity: A Bose-Einstein condensate (BEC) of tightly bound molecules and a Bardeen-Cooper-Schrieffer (BCS) superfluid of long-range Cooper pairs. Condensates of up to 10 million fermion pairs are observed in a regime where pairing is purely a many-body effect, the pairs being stabilized by the presence of the surrounding particles. Superfluidity and phase coherence is directly demonstrated throughout the BEC-BCS crossover via the observation of long-lived, ordered vortex lattices in rotating Fermi gases. Further, we establish superfluidity in Fermi mixtures with imbalanced spin populations, addressing a long-standing debate on the ground state of these systems. We observe the separation of the trapped gas into a superfluid region at equal spin densities, surrounded by a shell at unequal densities. Above a certain critical imbalance, a phase transition to the normal state is identified, the Chandrasekhar-Clogston limit of fermionic superfluidity.

[1]This work was performed at MIT, Cambridge, USA. Supervisor: Prof. W. Ketterle.