DAMOP10-2010-020124

Abstract for an Invited Paper
for the DAMOP10 Meeting of
the American Physical Society

Pairing and Superfluidity in Strongly Interacting Fermi Gases[1]

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Ultracold Fermi Gases are ideal model systems to study strongly interacting fermions. Of particular interest is the crossover regime between two limiting cases of fermionic superfluidity, Bose-Einstein condensation of diatomic molecules and BCS superfluidity of pairs bound by many-body interactions. I will describe experiments investigating the interplay of fermionic pairing and superfluidity in this regime with an ultracold gas of fermionic 6Li atoms. By varying the spin populations and temperature in a two component mixture we study the homogeneous phase diagram of the gas at unitarity, where the only relevant energy scale is the Fermi energy. The phase diagram shows first and second order phase transitions merging at a tricritical point. A zero temperature phase transition from a superfluid to a mixed normal state is observed at a critical spin polarization known as the Chandrasekhar-Clogston (CC) limit. Next pairing correlations are studied with radio-frequency (rf) spectroscopy. Strong correlations are found above the critical temperature but also at spin polarizations above the CC limit. Limitations due to final state interactions are overcome by creating new superfluid spin mixtures. The rf dissociation spectra then allow us to determine the spectroscopic pair size. The pairs are the smallest found in fermionic superfluids, highlighting the importance of small fermion pairs for superfluidity at high critical temperatures. Finally, by observing a peak due to thermally excited quasiparticles, the pairing gap is directly determined from the rf spectra.

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