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Pairing and Phase Separation in a Polarized Fermi Gas¹

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BCS pairing can only occur when the Fermi energies of the individual particles are equal. There has been great interest, however, in the consequences of mismatched Fermi energies that may arise in several important situations, including magnetized superconductors or cold dense quark matter at the core of neutron stars. Pairing is qualitatively altered by the Fermi energy mismatch, and there has been considerable speculation regarding the nature and relative stability of various proposed exotic phases. We have created a two-component gas of ⁶Li atoms in which the relative Fermi energies are altered by changing the relative numbers of each component ³. The BEC/BCS crossover with tunable interactions is realized via a Feshbach resonance. Above a critical number polarization, which depends on the interaction energy, the gas separates into a superfluid paired core surrounded by a shell of normal unpaired atoms. Below the critical polarization the gas exists in a paired state with asymmetric Fermi surfaces. The critical polarization is largest in the BEC regime, and becomes small in the BCS regime. We also measure the universal interaction parameter β for a strongly interacting Fermi gas to be -0.54 (5), in good agreement with recent Monte-Carlo calculations.

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