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Measurements of the Paired Fraction in the BEC-BCS Crossover[1]

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Pairing in fermionic systems is the essential ingredient of superfluidity and superconductivity. Feshbach resonances in atomic gases allow the interactions between atoms to be tuned continuously from weak to strong, causing the condensate of paired atoms to change from a BCS-like superfluid to a Bose-Einstein condensate of molecules. I will report quantitative measurements of the paired fraction of a two-spin Fermi gas of ^{6}Li atoms across the broad Feshbach resonance as a function of temperature. The paired fraction is determined by tuning a laser probe to resonance between the paired state and an excited molecular triplet level. A transition to the molecular state leads to a detectable loss of atoms, as in a previous experiment where the closed-channel fraction was measured by driving transitions to a molecular singlet level [2]. Atoms in a pair correlated state, either molecules on the BEC side of resonance or correlated pairs on the BCS side, will be excited at a rate independent of density, while the rate of excitation of unpaired atoms (photoassociation) is density-dependent. Depletion of pairs occurs rapidly, and is easily distinguished from photoassociation of unpaired atoms, enabling the determination of the paired fraction. By driving the dominant triplet transition, the rate of excitation can be much faster than pair reformation. This method may be used to quantitatively explore "preformed" pairing that occurs above T_c in high-temperature superconductors.

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[2]G.B. Partridge, K.E. Strecker, R.I. Kamar, M.W. Jack, and R.G. Hulet, *Phys. Rev. Lett.* **95** 020404 (2005).