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Pairing of Fermions with Unequal Spin Populations

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Ultracold atomic fermions hold great promise for simulating important, and in some cases, unsolved models of condensed matter physics. In addition to being clean and well-characterized, the physical parameters of ultracold atomic gases are readily tunable. Notably, the tunability of interactions via a Feshbach resonance has enabled the realization of the BEC-BCS crossover in a two component Fermi gas. The spin polarization of an atomic gas may also be varied by creating a population imbalance of the two components.[2,3] I will discuss our *in-situ* measurements of the real-space density distributions of polarized mixtures of ^{6}Li atoms.[3,4] We identify three distinct phases: two contain an unpolarized, fully paired core, while the third is the polarized normal phase. At the lowest temperatures, the gas phase separates into an unpolarized superfluid core with the unpaired atoms residing in a fully polarized normal shell. In this case, the boundary between the superfluid and normal phases is sharp, consistent with a first-order phase transition, and the core is distorted by what is believed to be surface tension between the superfluid and normal components. At slightly higher temperature, the transition between the phases is continuous, resulting in a partially polarized shell structure, without distortion. These observations are consistent with a tricritical point in the phase diagram.

[1]Work done in collaboration with G.B. Partridge, Wenhui Li, Y.A. Liao, R.I. Kamar, M. Haque, and H.T.C. Stoof.
[2]M. W. Zwierlein *et al.*, *Science* **311**, 492 (2006).
[3]G. B. Partridge *et al.*, *Science* **311**, 503 (2006).
[4]G. B. Partridge *et al.*, *Phys. Rev. Lett.* **97**, 190407 (2006).