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Phase separation in a spin polarized Fermi gas at the BEC-BCS crossover[1]

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A strongly interacting ultra-cold gas of fermionic ^{6}Li with unequal numbers of two spin components exhibits two distinct low temperature paired states.[2] Phase separation, where a uniformly paired core is maintained in the center of the trap by the expulsion of excess unpaired atoms, is observed at the lowest temperatures up to large number imbalance. Sharp boundaries, consistent with a first-order phase transition, are observed between the core and the unpaired atoms. Moreover, the superfluid core deforms markedly, becoming less elongated due to surface tension at the superfluid/normal boundary. At higher temperature, the core remains unpolarized up to a critical polarization, but does not deform. This temperature dependence is consistent with a tri-critical point in the phase diagram. Additionally, we are exploring the possibility that the large critical imbalance for loss of phase separation is a result of relatively small particle number (10^5) and high aspect ratio (30) elongated confinement.

To date, no evidence for the long sought Fulde-Ferrel-Larkin-Ovchinnikov (FFLO) state has been observed in ultracold atomic gases. It is predicted that in 3D the FFLO phase occupies a very small region of the phase diagram,[3] whereas in 1D, the stability of the FFLO state is believed to be enhanced. Though the current optical potential is elongated, it is still in the 3D regime, and so a 2D optical lattice potential has been constructed to provide an array of 1D tubes. We will present results of our studies of the polarized Fermi gas in this 1D geometry.

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[2]G. B. Partridge, Wenhui Li, Y. A. Liao, R. G. Hulet, M. Haque and H. T. C. Stoof, *Phys. Rev. Lett.* **97**, 190407 (2006)

[3]D. E. Sheehy and L. Radzihovsky, *Ann. Phys.* **322**, 1790 (2007)