Abstract for an Invited Paper
for the MAR07 Meeting of
The American Physical Society

The important role of temperature in BCS–Bose-Einstein condensation crossover phenomena with population imbalance[1]

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Any comparison between theory and experiment in the cold Fermi gases requires that one include the effects of non-zero temperature T. In this talk we show how to include finite T in a way which is compatible with the generalized BCS-like ground state, assumed in essentially all $T = 0$ calculations of gases with population imbalance. We use a pairing fluctuation theory of BCS–Bose-Einstein condensation (BEC) based on a T-matrix formalism. Distinguishing this theory from strict mean-field theories is our self-consistent treatment of incoherent, finite-momentum pairs along with single fermions. This leads to a pseudogap in the fermion excitation spectrum at finite T which is necessary in order to arrive at physically meaningful transition temperatures $T_c(p)$, where p is the polarization. We present phase diagrams in the p-T plane with variable scattering length, $1/k_F a$, and identify the regions where bulk superfluidity, normal phases and phase separation appears. For the trapped Fermi gases, we present particle density profiles for general $1/k_F a$ as well as a detailed comparison with recent measurements at both MIT and Rice University. We find reasonably good agreement with these experimental data.

1. C.-C. Chien, Q.J. Chen, Y. He, and K. Levin, *Intermediate temperature superfluidity in an atomic Fermi gas with population imbalance*, Phys. Rev. Lett. 97, 090402 (2006).

2. Q.J. Chen, Y. He, C.-C. Chien, and K. Levin, *Stability conditions and phase diagrams for two component Fermi gases with population imbalance*, cond-mat/0608454; Phys. Rev. A 74, 06xxxx (2006).

3. C.-C. Chien, Q.J. Chen, Y. He, and K. Levin, *Finite temperature effects in trapped Fermi gases with population imbalance*, Phys. Rev. A 74, 021602(R) 2006.

[1]Supported by NSF Grant No. PHY-0555325 and NSF-MRSEC Grant No. DMR-0213745