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Phase Separation in Bose-Superfluid Fermi Mixtures B. RAMACHANDHRAN, S.G. BHONGALE, H. PU, Department of Physics and Astronomy, and Rice Quantum Institute, Rice University, Houston, TX 77005, USA — We study the phase diagram of 3-dimensional mixtures of BEC and a two-component superfluid fermi gas, referred to as Bose-Superfluid fermi mixtures, at zero and finite temperature. At zero temperature, we identify regimes at equilibrium in which the mixture exists either as a pure superfluid phase coexisting with a mixed phase or as a single homogenous phase. We identify critical boson densities at which phase separation occurs for different values of the fermi-fermi interaction strength. As a potential application of this phase separation phenomenon, we consider BEC to be in a realistic cigar-shaped double-well trap acting as a probe of the superfluid state. We show that the critical boson densities obtained from the phase diagram can be used to map the spatial density profile of the bosons using Local Density Approximation (LDA) in the trap setting. We show a methodology to robustly detect the "local" value of the superfluid Gap parameter by observing the boson density profile in the trap. We also explore the more challenging problem of phase separation in these mixtures at finite temperature. We show that, under proper conditions, this spatial phase separation phenomenon occurring in the presence of the BEC probe can be used to potentially detect the onset temperature of the BCS superfluidity.

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