Superfluidity in 1D and 3D Spin-Imbalanced Fermi Gases

BEN A. OLSEN, MELISSA REVELLE, JACOB A. FRY, RANDALL G. HULET, Department of Physics & Astronomy and Rice Quantum Institute, Rice University, Houston, TX 77005 — The phase separation between superfluid and normal phases (both polarized and unpolarized) in trapped Fermi gases in the BEC-BCS crossover reveals the interplay between superfluid pairing, interactions, and dimensionality. We measure density profiles of both spins of a two-component, spin-polarized gas of $^6$Li atomic fermions cooled to $\sim 100$ nK. In a 3D gas, an unpolarized superfluid core is surrounded by a polarized shell. We observe gradual suppression of this core as interactions are weakened from unitarity. For a 1D gas in an optical lattice, the phase separation matches exactly-solved 1D models, where the central phase is partially polarized, and is predicted to exhibit FFLO correlations. By increasing the inter-tube tunneling rate, we investigate the dimensional crossover between 1D and 3D Fermi gases. In this regime, the FFLO order parameter is predicted to be correlated between tubes, and its modulation length constant over larger regions of the trap. These features are predicted to enhance the observable signatures of FFLO correlations; we report progress towards such measurements.

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