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Mixtures of Ultracold Fermions with Unequal Masses[1]

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The quantum phases of ultracold fermions with unequal masses are discussed in continuum and lattice models for a wide variety of mixtures which exhibit Feshbach resonances, e.g., mixtures of ^{6}Li and ^{40}K. The evolution of superfluidity from the Bardeen-Cooper-Schrieffer (BCS) to the Bose-Einstein condensation (BEC) regime in the continuum is analyzed as a function of scattering parameter, population imbalance and mass anisotropy. In the continuum case, regions corresponding to normal, phase-separated or coexisting uniform-superfluid/excess-fermion phases are identified and the possibility of topological phase transitions is discussed [1]. For optical lattices, the phase diagrams as a function of interaction strength, population imbalance, filling fraction and tunneling parameters are presented [2]. In addition to the characteristic phases of the continuum, a series of insulating phases emerge in the phase diagrams of optical lattices, including a Bose-Mott insulator (BMI), a Fermi-Pauli insulator (FPI), a phase-separated BMI/FPI mixture, and a Bose-Fermi checkerboard (BFC) phase. Lastly, the effects of harmonic traps and the emergence of unusual shell structures are discussed for mixtures of fermions with unequal masses.

[1] M. Iskin, and C. A. R. Sá de Melo, Phys. Rev. Lett **97**, 100404 (2006);
[2] M. Iskin, and C. A. R. Sá de Melo, Phys. Rev. Lett. **99**, 080403 (2007).

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