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The phase-diagram of a superfluid two-component Fermi gas[1]

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What is the benefit of realizing superfluidity in a gas a million times more dilute than air? Such systems consist of well-separated atoms which can be observed and manipulated with the control and precision of atomic physics, and which can be treated with first-principles calculations. By implementing scattering resonances, we have realized the strong-coupling limit of the Bardeen Schrieffer-Cooper (BCS) mechanism and observed a normalized transition temperature of 20% of the Fermi temperature, higher than in any superconductor. When the population of the two spin states is imbalanced, pairing is frustrated; and superfluidity is quenched at the Chandrasekhar-Clogston limit. When the fermions can form molecules, we observe the emergence of bosonic behavior, and an imbalanced two-component Fermi system can be described as a boson-fermion mixture. Pairing correlations have been studied by rf spectroscopy, determining the fermion pair size and the pairing gap energy in a resonantly interacting superfluid. These studies illustrate a new approach to condensed-matter physics where many-body Hamiltonians are realized in dilute atomic gases.

[1]Work done in collaboration with Yong-Il Shin, Andre Schirotzek and Christian Schunck.