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Superfluidity in an Atomic Gas of Strongly Interacting Fermions

WOLFGANG KETTERLE, MIT

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 15% of the Fermi temperature, higher than in any superconductor. By tuning the strength of the interactions, the BEC-BCS crossover is realized. When the population of the two spin states is imbalanced, pairing is frustrated; and superfluidity is quenched at the Chandrasekhar-Clogston limit. These studies illustrate a new approach to condensed-matter physics where many-body Hamiltonians are realized in dilute atomic gases.