DAMOP05-2005-000012

Abstract for an Invited Paper
for the DAMOP05 Meeting of
the American Physical Society

Pairing of fermionic atoms in a strongly interacting quantum gas

CHENG CHIN, Universitt Innsbruck

The formation of composite bosons by pairing fermions leads to intriguing phenomena in physics, with superconductivity and ^{3}He superfluidity being prominent examples. In ultracold gas of fermionic atoms, formation and condensation of diatomic molecules are recently realized near magnetically tunable Feshbach resonances. This achievement opens exciting possibilities to explore the crossover from molecular Bose- Einstein condensate (BEC) to fermionic superfluid in the Bardeen- Cooper-Schrieffer (BCS) state. We report on the observation of the pairing gap in an ultracold gas of ^{6}Li atoms by a precision radio frequency spectroscopy. Starting with a molecular Bose-Einstein condensate, we control the two-body interactions and monitor the binding energy of the atom pairs as the system enters the BEC-BCS crossover regime. The dependence of the pairing gap on the temperature and the Fermi energy in the crossover regime provides strong evidences that a molecular Bose-Einstein condensate with positive scattering lengthes can be smoothly and isentropically converted into a fermionic superfluid with negative scattering lengthes. We propose a mean-field approach to describe the atom pairs in the strong interaction regime. By introducing an effective potential which characterizes the overlap of the pair wave functions, the mean field equation allows us to calculate the chemical potential and the equation of states. The results excellently agree with the recent quantum Monte Carlo calculations. We show that the smooth crossover from the bosonic mean field interactions between molecules to the Fermi pressure among atoms is associated with the evolution of the atomic correlation function.