DAMOP09-2009-000134

Abstract for an Invited Paper
for the DAMOP09 Meeting of
the American Physical Society

Observation of Spin Polarons in a Tunable Fermi Liquid of Ultracold Atoms[1]

MARTIN ZWIERLEIN, Massachusetts Institute of Technology

We have observed spin polarons, dressed spin down impurities in a spin up Fermi sea of ultracold atoms via tomographic RF spectroscopy. Feshbach resonances allow to freely tune the interactions between the two spin states involved. A single spin down atom immersed in a Fermi sea of spin up atoms can do one of two things: For strong attraction, it can form a molecule with exactly one spin up partner, but for weaker interaction it will spread its attraction and surround itself with a collection of majority atoms. This spin down atom dressed with a spin up cloud constitutes the spin- or Fermi polaron. We have observed a striking spectroscopic signature of this quasi-particle for various interaction strengths, a narrow peak in the spin down spectrum that emerges above a broad background. The spectra allow us to directly measure the polaron energy and the quasi-particle residue Z. The polarons are found to be only weakly interacting with each other, and can thus be identified with the quasi-particles of Landau's Fermi liquid theory. At a critical interaction strength, we observe a transition from spin one-half polarons to spin zero molecules. At this point the Fermi liquid undergoes a phase transition into a superfluid Bose liquid.

[1]This work was supported by the NSF, an AFOSR-MURI, and the Alfred P. Sloan Foundation.