Dual Bose-Fermi Superfluids

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We report on the production and study of a mixture of Bose and Fermi superfluids. Such a mixture has long been sought in liquid helium where superfluidity was achieved separately in bosonic ^{4}He and fermionic ^{3}He. However due to strong interactions between isotopes, phase separation occurs when the ^{3}He concentration exceeds 6%, which, so far, has prevented reaching simultaneous superfluidity for both species. Using dilute quantum gases where interactions can be tuned, we have produced a Bose-Fermi mixture where both species are superfluid [1]. By exciting center of mass oscillations of the mixture we probe the collective dynamics of the system. Coherent energy exchange between the Bose and Fermi gas is observed with very small damping below a certain critical velocity. We compare this critical velocity for superfluid counterflow to a recent theoretical prediction [2,3]. Raising the temperature of the system slightly above the superfluid transition reveals an unexpected phase-locking of the oscillations induced by dissipation. Finally the lifetime of the Bose-Fermi mixture is governed by a very simple formula involving the fermionic two-body contact [4].

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