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Dual Bose-Fermi Superfluids

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We study the dynamics of superfluid counterflow in a Bose-Fermi mixture of lithium atoms. First, by tuning the interaction strength we measure the critical velocity v_c of the system in the BEC-BCS crossover in the low temperature regime and we compare it to the recent prediction of Castin *et al.*, Comptes Rendus Physique,**16**, 241 (2015). Second, raising the temperature of the mixture slightly above the superfluid transitions reveals an unexpected phase-locking of the oscillations of the clouds induced by dissipation. Finally, we investigate the lifetime of the Bose-Fermi mixture. We show theoretically and experimentally that, for weak inter-species coupling, the loss rate is proportional to Tan's contact parameter. At unitarity where the fermion-fermion scattering length diverges, we show that the loss rate is proportional the $4/3$ power of the fermionic density. This study demonstrates that impurity-induced losses can be used as a quantitative probe of many-body correlations.