The Role of Interactions in Disorder Induced Damping of Dipole Oscillations of a Bose-Einstein Condensate

SCOTT POLLACK, D. DRIES, T.A. CORCOVILOS, R.G. HULET, Rice Quantum Institute and Department of Physics and Astronomy, Rice University, Houston, TX 77005 — We investigate the damping of dipole oscillations of a $^7$Li Bose-Einstein condensate (BEC) in a disordered optical potential. In our highly tunable system we vary the disorder strength $V_D$, the initial velocity of the BEC, and the chemical potential $\mu$ by adjusting the $s$-wave scattering length $a$ via a Feshbach resonance. We observe the breaking of superfluid flow, for values of $V_D$ as small as 0.1 $\mu$, and cessation of motion for $V_D \sim \mu$. Counter-intuitively, at supersonic velocities the flow becomes asymptotically dissipationless regardless of the disorder strength. We test the validity of the scaling $V_D/\mu$ over several decades of $a$, including values of $a$ as small as 0.01 $a_0$, where magnetic dipole effects dominate. We also report on observations of dissipative flow of nearly non-interacting ideal quantum gases and bright matter-wave solitons.

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