DAMOP09-2009-000886
Abstract for an Invited Paper
for the DAMOP09 Meeting of
the American Physical Society

Superfluid Transport Through Random Disorder[1]

RANDALL HULET[2], Department of Physics and Astronomy and Rice Quantum Institute, Rice University

Disorder plays an important role in the transport of particles in a variety of contexts, including electronic materials, granular superconductors, and liquid helium in porous media. We use optical speckle to create a disordered potential, and explore its effect on a Bose-Einstein condensate (BEC) of ^{7}Li. The BEC presents a highly idealized environment, where most of the relevant parameters, such as the disorder strength and length scale, the interparticle interaction strength, and even the particle velocity may be precisely controlled. We have shown that the scattering length in ^{7}Li can be controlled over a range of nearly 7 decades by using a Feshbach resonance with a shallow zero-crossing [S. E. Pollack *et al.*, arXiv:0811.4456]. Of particular interest is the regime of Anderson localization where very weak interactions produce a condensate healing length that is comparable to the disorder length scale. We investigate superfluid transport by exciting dipole oscillations of the condensate through sudden displacement of the harmonic trapping potential. Weak disorder damps the dipole oscillations at a rate dependent upon disorder strength, initial velocity, and atomic interactions. We find a universal behavior in which the damping rate varies with disorder strength scaled to condensate chemical potential, and velocity scaled by the Landau critical velocity. We also study localization by suddenly removing the axial confining potential, allowing the condensate to freely expand in one-dimension in the presence of disorder.

[1]Supported by NSF, ONR, the Keck Foundation, and the Welch Foundation.
[2]Work done in collaboration with D. Dries and S. E. Pollack.