Abstract Submitted
for the DAMOP13 Meeting of
The American Physical Society

Experiments with a Single Bright Matter-Wave Soliton Incident on a Barrier[1] DAVID TAM, PAUL DYKE, JASON NGUYEN, RANDALL HULET, Rice University — The defining property of a soliton is the stability of its shape which arises due to nonlinear self-focusing. We collapse a quasi-1D BEC of ^{7}Li into a matter-wave soliton containing ∼60,000 atoms. The collapse is controlled by adiabatically ramping the single-particle scattering length from a large and positive value to slightly negative using the broad magnetic Feshbach resonance in the $|F = 1, m_F = 1\rangle$ hyperfine sublevel near 737 G.[2] Dipole oscillations in a weakly harmonic 1D potential are initiated by pulsing on a magnetic field gradient, enabling us to observe the soliton's motion over several oscillation periods. We investigate dynamic interactions of the soliton with a single attractive or repulsive optical defect created by a narrow light sheet at the trap center. A repulsive defect can split a single soliton into two, and on the subsequent interaction at the defect, may enable coherent recombination, thus realizing a matter-wave interferometer.

[1]Work supported by the NSF, ONR, and the Welch Foundation
[2]Strecker, K. E., Partridge, G. B., Truscott, A. G. & Hulet, R. G. Formation and propagation of matter-wave soliton trains. Nature 417, 150-153 (2002).

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Date submitted: 30 Jan 2013 Electronic form version 1.4