Abstract Submitted
for the MAR08 Meeting of
The American Physical Society

Phase Coherence and Superfluid-Insulator Transition in a Disordered Bose-Einstein Condensate[1] YONG P. CHEN[2], J. HITCHCOCK, D. DRIES, M. JUNKER, C. WELFORD, R. G. HULET, Department of Physics and Astronomy and Rice Quantum Institute, Rice University, Houston TX 77005 USA — We have studied both the transport and phase coherence properties of a Bose-Einstein condensate (BEC) of ^{7}Li atoms subject to a disordered potential with tunable strength (V_D). The BEC is created in an elongated optical trap, while the disordered potential is produced by laser speckle. We probe transport of the disordered BEC by either slowly or abruptly offsetting the trap relative to the disordered potential. At high V_D, we observe pinning of the disordered BEC and suppression of its dipole excitation, consistent with the transition to an insulator. We use *in-situ* imaging to detect density modulation, while time-of-flight (TOF) imaging is used to probe phase coherence. At moderate V_D, we observe small density fluctuations in the *in-situ* images, and random but *reproducible* interference patterns in the TOF images. This interference reflects phase coherence in the disordered BEC and is interpreted as *speckle for matter waves*. At higher V_D, the TOF interference contrast diminishes while the *in-situ* density fluctuations increase, signifying a fragmented "granular" condensate with little phase coherence. [1]Supported by NSF, ONR, NASA, Welch and Keck Foundations. [2]Now at Purdue University.

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Date submitted: 27 Nov 2007 Electronic form version 1.4