Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Oscillation and Instability of a Soliton in Superfluid Atomic Gas
LIANGSHENG ZHANG, DAVID HUSE, Princeton University — We use superfluid hydrodynamics and force equations to phenomenologically investigate the oscillation of a soliton in harmonic trap and the "snake" instability of a soliton in a uniform background. The results obtained are functions of missing mass m_s which characterizes the missing number of atoms inside the soliton and a "mobility" parameter C which determines the relation between the soliton velocity and the phase difference across it to leading order. It is found that by making $|m_s|$ and C small, the soliton will have a slower oscillation and tend to be more stable, as is seen in recent MIT experiment on the unitary Fermi gas [T. Yefsah, A. T. Sommer, M. J. H. Ku, L. W. Cheuk, W. Ji, W. S. Bakr, and M. W. Zwierlein, Nature 499, 426 (2013)]. We also use the hydrodynamic equations with perturbation theory to approximately solve Gross Pitaevskii equation and then use the solution to test our hydrodynamic approach to oscillation and instability in the case of Bose Einstein condensation with weak interactions.

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Date submitted: 15 Nov 2013 Electronic form version 1.4