Abstract Submitted
for the MAR05 Meeting of
The American Physical Society

Quantum Theory of LLL Cold-Atom Vortices[1] C.B. HANNA, A.J. SUP, Boise State University, A.H. MACDONALD, University of Texas at Austin
— In the lowest-Landau-level (LLL) approximation, interacting bosons can be described without further approximation in terms of vortex positions. We report on the quantum theory of LLL vortices in trapped cold-atom systems. For this system, the harmonic theory of vibrating vortices is equivalent to the Bogoliubov theory of weakly interacting cold atoms. We find that a proper description of the vortex system requires the inclusion of invisible vortices located outside the high-atomic density region of the atom cloud. The vortex degrees of freedom have non-local commutation relations, which leads to kinetic vortex-vortex coupling in the semi-classical equations of motion. The excitation spectrum includes collective vortex vibrations and single-particle excitations, and a low-energy "zero mode" whose energy vanishes for a trap with perfect circular symmetry. We discuss the effects of small trap asymmetry on this zero mode, and calculate its influence on quantum fluctuations within the Bogoliubov approximation.

[1]This work was supported by the Welch Foundation and by the NSF under grants DMR-0115947, DMR-0206681, and EPS-0132626.

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Date submitted: 22 Dec 2004 Electronic form version 1.4