3:30 pm • Friday October 14, 2011 • 2241 Chamberlin Hall • Coffee at 4:30 pm

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Quantum Phase Transitions and Scale Invariance of Atomic Quantum Gases

Department of Physics Colloquium

WISCONSIN

Atoms at ultralow temperatures are fascinating quantum objects, which can tunnel through barriers, repel or attract each other, and interfere like electromagnetic waves. This wavy behavior of ultracold atoms evidently illustrates the particle-wave duality as discussed in quantum physics. By loading repulsively interacting atoms into tiny optical cells (or optical lattices), we show that the wavy nature of the atoms can be completely suppressed. At the same time, the gaseous sample develops an interesting multi-layer structure with density plateaus, resembling a multi-tier wedding cake. Our observation of the cake structure in 2D ultracold gases [1] raises new prospects to investigate the dynamics and transport across the phase boundary [2] and to identify universal scaling laws in the (quantum) critical regime [3]. Surprising findings along these directions will be presented and discussed.

References:

[1] In situ Observation of incompressible Mott-insulating domains in atomic gases Nathan Gemelke, Xibo Zhang, Chen-Lung Hung, Cheng Chin Nature 460, 995 (2009)

[2] Slow Mass Transport and Statistical Evolution of An Atomic Gas Across the Superfluid-Mott Insulator Transition Chen-Lung Hung, Xibo Zhang, Nathan Gemelke, Cheng Chin Phys. Rev. Lett. 104.160403 (2010)

[3] Observation of scale invariance and universality in two-dimensional Bose gases Chen-Lung Hung, Xibo Zhang, Nathan Gemelke, Cheng Chin Nature (2011) doi:10.1038/nature09722

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