Abstract Submitted
for the DAMOP10 Meeting of
The American Physical Society

Studies of 1D gases away from integrability[1] AARON REINHARD, JEAN-FELIX RIOU, PHILLIP SCHAFER, DAVID WEISS, The Pennsylvania State University — We have studied atoms in optical lattices to address the fundamental question of what is needed for a many-body quantum system to approach a thermal distribution. Specifically, we prepare Rb atoms in an array of 1D tubes formed by a 2D optical lattice in so-called quantum Newton's cradle states,[2] and then observe their time evolution. When the lattice is very deep, we can only set lower limits on the collision-dependent evolution of the momentum distribution. When the lattice is shallow enough that some atoms can populate the second vibrational band after a two-body collision, we find that the system thermalizes at a rate proportional to the inter-tube tunneling rate. For intermediate lattice depths, we observe collision-dependent evolution, but to final momentum distributions that seem to retain a memory of the initial state. Such partial thermalization is reminiscent of classical physics described by the KAM theorem.

[1]We acknowledge support from the NSF, ARO, and DARPA.
[2]Kinoshita *et. al*, "A quantum Newton's Cradle," Nature **440**, 900 (2006)

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Date submitted: 26 Jan 2010 Electronic form version 1.4