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Investigations of quantum pendulum dynamics in a spin-1 Bose-Einstein condensate[1]

MICHAEL CHAPMAN, Georgia Institute of Technology

An inverted pendulum at rest is a prototype of unstable equilibrium and corresponds to a hyperbolic fixed point in the dynamical phase space. While mechanical pendulums operating at the quantum limit are currently unavailable in the lab, it is possible to study ultracold atomic many-body systems that have similar dynamical behavior. In this talk, I will describe our recent measurements of the non-equilibrium dynamics of a spin-1 Bose-Einstein condensate "pendulum" initialized to the hyperbolic fixed point of the phase space by quenching the system. Subsequent evolution of the quantum fluctuations lead to spin squeezing and non-Gaussian probability distributions that are in good agreement with exact quantum calculations. Additionally, we have demonstrated stabilization of the non-equilibrium dynamics by periodic application of phase shifts to the collective states of the system. These experiments demonstrate new methods of manipulating out-of-equilibrium quantum many-body systems, drawing together ideas from classical Hamiltonian dynamics and quantum squeezing of collective states.

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