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Squeezing the Most of Heisenberg Using a Bose-Einstein Condensate

MICHAEL CHAPMAN, Georgia Tech

Heisenbergs uncertainty principle establishes a standard quantum limit of measurement precision that sets a bound on many precision measurements including atomic clocks and gravitational wave detectors. Using a special class of entangled quantum states known as squeezed states, it is possible to exceed the standard quantum limit. I will discuss experiments with spin-1 atomic Bose-Einstein condensates where dynamical evolution creates spin-squeezed states with uncertainties an order of magnitude below the standard quantum limit. These experiments demonstrate new methods of manipulating out-of-equilibrium quantum systems, and draw together ideas from classical Hamiltonian dynamics and quantum squeezing of collective states.