Nonequilibrium quantum dynamics in optomechanical systems

YOGESH SHARAD PATIL, HIL F. H. CHEUNG, AIRLIA SHAFFER, KE WANG, MUKUND VENGALATTORE, Cornell University — The thermalization dynamics of isolated quantum systems has so far been explored in the context of cold atomic systems containing a large number of particles and modes. Quantum optomechanical systems offer prospects of studying such dynamics in a qualitatively different regime — with few individually addressable modes amenable to continuous quantum measurement and thermalization times that vastly exceed those observed in cold atomic systems. We have experimentally realized a dynamical continuous phase transition in a quantum compatible nondegenerate mechanical parametric oscillator. This system is formally equivalent to the optical parametric amplifiers whose dynamics have been a subject of intense theoretical study [1]. We experimentally verify its phase diagram and observe nonequilibrium behavior that was only theorized, but never directly observed, in the context of optical parametric amplifiers. We discuss prospects of using nonequilibrium protocols such as quenches in optomechanical systems to amplify weak nonclassical correlations and to realize macroscopic nonclassical states.


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