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Emergent dynamical phases in non-Markovian open quantum systems HIL FUNG HARRY CHEUNG, YOGESH S PATIL, MUKUND VENGALATTORE, Cornell University — We experimentally realize a parametrically driven two-mode system in the presence of non-Markovian system-reservoir interactions. We show that non-Markovian interactions modify the phase diagram of this system resulting in the emergence of a novel broken symmetry phase in a new universality class that has no counterpart in a Markovian or equilibrium system [1]. We further study the critical dynamics of the transition into this emergent phase by linearly quenching the system from the disordered phase to the ordered phase. We demonstrate that the initial growth of order has a universal behavior conforming to conventional dynamical critical theory. For cyclic quenches across criticality, the system exhibits a dynamical hysteresis due to the divergent relaxation time and non-adiabatic dynamics in the vicinity of the critical point. While the hysteresis area in equilibrium continuous phase transitions scales as a single power law with the quench rate, we observe the scaling exponent in this non-Markovian system depends on the quench rate, suggesting that non-Markovian system-bath interactions may lead to timescale-dependent critical exponents. Such reservoir-engineered systems and dynamical phases can shed light on universal aspects of dynamical phase transitions in non-equilibrium systems, and aid in the robust generation of entanglement and quantum correlations at finite temperatures with potential applications to quantum metrology.

[1] H. F. H. Cheung, Y. S. Patil and M. Vengalattore, arXiv: 1707.02622

Hil Fung Harry Cheung
Cornell University

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