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Emergence of novel dynamical phases in a non-Markovian open quantum system YOGESH S PATIL, HIL FUNG HARRY CHEUNG, MUKUND VENGALATTORE, Cornell University — We experimentally realize a driven dissipative continuous phase transition in a parametrically driven two-mode system with non-Markovian system-bath interactions. We show that due to the influence of these non-Markovian interactions, the phase diagram is significantly modified and results in an emergent phase characterized by a dynamic order parameter with a novel broken $U(1) \times \mathrm{Z}_{\mathbf{2}}$ symmetry. Further, 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 that conforms to a conventional dynamical critical theory. Moreover, we observe a dynamical hysteresis in the system for cyclic quenches across criticality because of the divergent relaxation time and non-adiabatic dynamics near the critical point. While in equilibrium continuous phase transitions the area of this hysteretic cycle scales as a single power law with the quench rate, we observe the scaling exponent here to depend 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 help shed light on the universal aspects of dynamical phase transitions in non-equilibrium systems, and aid in the development of techniques for the robust generation of entanglement and quantum correlations at finite temperatures.
[1] H. F. H. Cheung, Y. S. Patil and M. Vengalattore, arXiv: 1707.02622

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