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Critical phenomena and the universality of the Kibble-Zurek mechanism in driven dissipative systems HIL FUNG HARRY CHEUNG, YOGESH S PATIL, Cornell University, TAMIRO VILLAZON, Boston University, ADITYA G DATE, California Institute of Technology, ANUSHYA CHANDRAN, ANATOLI POLKOVNIKOV, Boston University, MUKUND VENGALATTORE, Cornell University — Due to the interplay between coherent evolution and dissipation, open quantum systems can exhibit new phases of matter and novel critical behavior that is not captured by the standard classification of equilibrium phase transitions. We experimentally realize a driven dissipative phase transition in an optomechanical system and investigate the validity of the Kibble-Zurek hypothesis, which relates the non-equilibrium dynamics to the equilibrium behavior. While this hypothesis has been studied in equilibrium phase transitions, we report the first quantitative study of the Kibble-Zurek hypothesis in a driven dissipative system. Further, we dynamically impose non-Markovian system-bath interactions via continuous measurement and feedback, and find that the critical behavior can be substantially modified with significant changes to the critical exponents, e.g. the critical exponent $\nu z = 1.50(9)$ compared to the Markovian exponent $\nu z = 1$. We further verify a quantitative scaling law that relates the growth of order as a function of temperature and quench rate that is valid over the entire range of the quench. Our results show that non-equilibrium quench dynamics can be used to extract universal exponents in drive dissipative systems, opening new avenues to study the theoretically challenging cases of system-bath interactions and their influence on critical phenomena.

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