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Long-range Prethermal Time Crystals FRANCISCO MACHADO, GREGORY D. MEYER, University of California - Berkeley, DOMINIC ELSE, University of California - Santa Barbara, CHRISTOPHER OLUND, University of California - Berkeley, CHETAN NAYAK, Station Q - Microsoft Research, University of California - Santa Barbara, NORMAN Y. YAO, University of California - Berkeley
— Driven quantum systems have recently enabled the realization of a discrete time crystal — an intrinsically out-of-equilibrium phase of matter. One strategy to prevent the drive-induced, runaway heating of the time crystal is the presence of strong disorder leading to many-body localization (MBL). A more elegant, disorder-less approach is simply to work in the prethermal regime where time crystalline order can persist to exponentially long times. One key difference between prethermal and MBL time crystals is that the former is prohibited from existing in one dimensional systems with short-range interactions. In this work, we demonstrate that long-range interactions can stabilize a one dimensional prethermal time crystal. By numerically studying the pre-thermal regime, we find evidence for a phase transition out of the time crystal as a function of increasing energy density. Finally, generalizations of previous analytical bounds for the heating time-scale of driven quantum systems to long-range interactions will also be discussed.

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