Observation of discrete time-crystalline order in a disordered dipolar many-body system

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The interplay of periodic driving, disorder, and strong interactions has recently been predicted to result in exotic “time-crystalline” phases, which spontaneously break the discrete time-translation symmetry of the underlying drive. Here, we report the experimental observation of such discrete time-crystalline order in a driven, disordered ensemble of $\sim 10^6$ dipolar spin impurities in diamond at room-temperature [1]. We observe long-lived temporal correlations at integer multiples of the fundamental driving period, experimentally identify the phase boundary and find that the temporal order is protected by strong interactions; this order is remarkably stable against perturbations, even in the presence of slow thermalization [2]. We provide a theoretical description of approximate Floquet eigenstates of the system based on product state ansatz and predict the phase boundary, which is in qualitative agreement with our observations. [1] S. Choi et al, arXiv:1610.08057 [2] G. Kucsko et al, arXiv:1609.08216

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