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Observation of a Discrete Time Crystal[1] A. KYPRIANIDIS, J. ZHANG, P. HESS, P. BECKER, A. LEE, J. SMITH, G. PAGANO, Joint Quantum Institute and U. of Maryland Dept. of Physics, A. POTTER, Dept of Physics, U. of Texas at Austin, A. VISHWANATH, Dept of Physics, Harvard University, I.-D. POTIRNICHE, N. YAO, Dept of Physics, U. of California-Berkeley, C. MONROE, Joint Quantum Institute and U. of Maryland Dept. of Physics — Spontaneous symmetry breaking is a key concept in the understanding of many physical phenomena, such as the formation of spatial crystals and the phase transition from paramagnetism to magnetic order. While the breaking of time translation symmetry is forbidden in equilibrium systems, it is possible for non-equilibrium Floquet driven systems to break a discrete time translation symmetry, and we present clear signatures of the formation of such a discrete time crystal. We apply a time periodic Hamiltonian to a chain of interacting spins under many-body localization conditions and observe the system's sub-harmonic response at twice that period. This spontaneous doubling of the periodicity is robust to external perturbations. We represent the spins with a linear chain of trapped $^{171}Yb^{+}$ ions in an rf Paul trap, generate spin-spin interactions through spin-dependent optical dipole forces, and measure each spin using state-dependent fluorescence.

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