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Exploring Dynamical Phase Transitions with a Cavity-QED Platform[1] DYLAN YOUNG, JUAN MUNIZ, JILA, NIST, University of Colorado Boulder, DIEGO BARBERENA, ROBERT LEWIS-SWAN, JILA, CTQM, NIST, University of Colorado Boulder, JULIA CLINE, JILA, NIST, University of Colorado Boulder, ANA MARIA REY, JILA, CTQM, NIST, University of Colorado Boulder, JAMES THOMPSON, JILA, NIST, University of Colorado Boulder — Rich quantum spin models and phases can arise from cavity-mediated interactions between laser-cooled atoms confined inside an optical cavity. These systems can offer unique opportunities to study out-of-equilibrium dynamical phases of matter precluded from existence at equilibrium. Here, we report the observation of distinct dynamical phases of matter in a nearly unitary implementation of the collective XY spin model with transverse and longitudinal fields simulated via an ensemble of one million ^{88}Sr atoms. We probe the dependence of the associated dynamical phase transitions on parameter space, system size and initial state. In the spirit of quantum simulation our observations can be linked to similar dynamical phases featured in a range of related systems, including the Josephson effect in superfluid helium, coupled atomic and solid-state polariton condensates, with complementary types of control including the magnitude and sign of Hamiltonian parameters. Moreover, our system offers potential for the generation of metrologically useful entangled states in optical transitions, which can enable real metrological gains via quantum enhancement in state-of-the-art atomic clocks.

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