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Collective phases of strongly interacting cavity photons RYAN WILSON, United States Naval Academy, Annapolis, MD 21402, MICHAEL FOSS-FEIG, KHAN MAHMUD, MOHAMMAD HAFEZI, Joint Quantum Institute Joint Center for Quantum Information and Computer Science, University of Maryland, College Park, MD 20742 — We study the steady state phases of the Bose-Hubbard model in the presence of dissipation and coherent driving, which in the limit of strong interactions maps onto a driven-dissipative XX spin-$\frac{1}{2}$ model with transverse and longitudinal fields. Using a site-decoupled mean-field approximation, we identify phases with antiferromagnetic and spin density wave order, in addition to limit cycle phases, where oscillatory dynamics persist indefinitely. We also identify collective bistable phases, where the system supports two steady states among spatially uniform, antiferromagnetic, and limit cycle phases. We compare these mean-field results to exact quantum trajectories for one dimensional cavity arrays. The quantum results exhibit short-range antiferromagnetic and spin density wave order, in good qualitative agreement with the mean-field predictions. In the bistable regime, this system exhibits real-time collective switching between macroscopically distinguishable states. We present a clear physical picture for these dynamics, and establish a simple relationship between the switching times and properties of the quantum Liouvillian.

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