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Quantum nonlinear dynamics of collective spin models using measurement-based feedback control in ultracold atoms MANUEL MUNOZ-ARIAS, PABLO POGGI, Center for Quantum Information and Control, University of New Mexico, POUL JESSEN, College of Optical Sciences, The University of Arizona, IVAN DEUTSCH, Center for Quantum Information and Control, University of New Mexico — We propose a measurement-based feedback scheme to control the collective spin dynamics of an ultracold atomic ensemble. The protocol consists of a weak (unsharp) measurement of one component of the collective spin followed by feedback in which an unitary evolution is applied conditioned on the measurement outcome. By proper choice of the feedback policy and measurement strength, we can simulate basic paradigms of quantum nonlinear dynamics including the chaotic Kicked Top and the Lipkin-Meshkov-Glick (LMG) model. We develop an analytical description of the dynamics under the Gaussian approximation, and explicitly show that, by an appropriate choice of the feedback, the regular, mixed and chaotic classical features of the classical Kicked Top phase space emerge from the noisy dynamics as the size of the spin ensemble increases. We characterize the chaos by studying the corresponding classical Lyapunov exponents. Through an appropriate feedback policy, in a Trotter-like fashion our protocol can recover the classical LMG model, with the well-known bifurcation process. We characterize this dynamics by performing an adiabatic passage and study the implications for robust quantum simulation

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