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**Quantum simulation of non-equilibrium dynamical maps with trapped ions** PHILIPP SCHINDLER, Institut für Experimentalphysik, Universität Innsbruck, 6020 Innsbruck, Austria, MARCUS MÜLLER, Departamento de Física Teórica I, Universidad Complutense, 28040 Madrid, Spain , DANIEL NIGG, THOMAS MONZ, Institut für Experimentalphysik, Universität Innsbruck, 6020 Innsbruck, Austria, JULIO T. BARREIRO, LMU München, 80799 München, Germany, ESTEBAN A. MARTINEZ, MARKUS HENNRICH, Institut für Experimentalphysik, Universität Innsbruck, 6020 Innsbruck, Austria, SEBASTIAN DIEHL, PETER ZOLLER, Institut für Theoretische Physik, Universität Innsbruck, und IQOQI, 6020 Innsbruck, Austria, RAINER BLATT, Institut für Experimentalphysik, Universität Innsbruck, und IQOQI, 6020 Innsbruck, Austria — Dynamical maps are central for the understanding of general state transformations of physical systems. Prime examples include classical nonlinear systems undergoing transitions to chaos, or single particle quantum mechanical counterparts showing intriguing phenomena such as dynamical localization. Here, we extend the concept of dynamical maps to an open-system, many-particle context and experimentally explore the stroboscopic dynamics of a complex many-body spin model in a universal quantum simulator using up to five ions. We generate quantum mechanical long range order by an iteration of purely dissipative maps, reveal the characteristic features of a combined coherent and dissipative non-equilibrium evolution, and develop and implement various error detection and reduction techniques that will facilitate the faithful quantum simulation of larger systems.

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