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Dissipation Induced Structural Instability and Chiral Dynamics in a Quantum Gas KATRIN KROEGER, NISHANT DOGRA, Institute for Quantum Electronics, ETH Zurich, 8093 Zurich, Switzerland, MANUELE LANDINI, University of Innsbruck, 6020 Innsbruck, Austria, LORENZ HRUBY, FRANCESCO FERRI, RODRIGO ROSA-MEDINA, TOBIAS DONNER, TILMAN ESSLINGER, Institute for Quantum Electronics, ETH Zurich, 8093 Zurich, Switzerland — Dissipation is an intrinsic part of any physical system and can cause undesired effects of decoherence or act as a weak perturbation to the Hamiltonian dynamics. However, the interplay of dissipative and unitary processes can give rise to dynamical phase transitions and lead to instabilities. In this work, we experimentally realize a synthetic quantum many-body system with controllable unitary and dissipative interactions [N. Dogra et al., arXiv 1901.05974]. Our experiment is based on a spinor Bose-Einstein-Condensate placed inside a high finesse optical cavity. The two orthogonal quadratures of the cavity light field coherently couple the atomic cloud to two modes with different spatial atomic configurations, which consist of a modulation of either atomic density or spin. The dispersive effect from the finite cavity losses mediates a dissipative chiral coupling between the two modes. Bringing unitary and dissipative couplings into competition allows us to explore the systems macroscopic behavior at the boundary between stationary and non-stationary states. We observe chiral dynamics for dominating dissipative processes. Our observations can be explained by interpreting dissipation as a structure dependent force, in close analogy to mechanical non-conservative positional forces.

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