Emerging long-range magnetic phenomena in a quantum gas coupled to a cavity

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Dissipative and coherent processes are at the core of the evolution of many-body systems. Their interplay can lead to new phases of matter and complex non-equilibrium dynamics. However, probing these phenomena microscopically in a setting of controllable coherent and dissipative couplings proves challenging.

We realize such a system using a ^{87}Rb spinor Bose-Einstein condensate (BEC) strongly coupled to a single optical mode of a lossy cavity. Two transverse laser fields incident on the BEC allow for cavity-assisted Raman transitions between different motional states of two neighboring spin levels. Adjusting the drive imbalance controls coherent dynamics and dissipation, with the appearance of a dissipation-stabilized phase and bistability [1]. By characterizing the properties of the underlying polariton modes, we give a microscopic interpretation of our observations. Moreover, we realize dynamical superradiant currents in a spin-textured lattice in momentum space [2]. Real-time, frequency-resolved measurements of the leaking cavity field allow us to locally resolve individual tunneling events and cascaded dynamics. Together, our results open new avenues for investigating spin-orbit coupling in dissipative settings and dynamical gauge fields in driven-dissipative settings.

References

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