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An emergent atom pump driven by global dissipation in a quantum gas (ONSITE presentation)

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Exposing a many-body system to external drives and losses can fundamentally transform the nature of its phases, and opens perspectives for engineering new properties of matter. How such characteristics are related to the underlying microscopic processes is a central question for our understanding of materials.

A versatile platform to address it are quantum gases coupled to the dynamic light field inside an optical resonator. This setting allows to create synthetic many-body systems with cavity-mediated long-range atom-atom interactions. If these are sufficiently strong, the system undergoes a structural phase transition to a crystal of matter and light. By engineering the involved light field modes, we study in real-time the dynamics of a first-order phase transition between two such superradiant crystals.

The polaritonic nature of our system further allows us to bring coherent and dissipative couplings into competition. When the dissipation via cavity losses and the coherent timescales are comparable, we find a regime of persistent oscillations where the cavity field does not reach a steady state. In this regime the atoms experience a potential that periodically deforms itself, even without providing an external time dependent drive. Eventually, the dynamic lattice triggers a pumping mechanism. We show complementary measurements of the light field and of the atomic transport, proving the connection between the emergent non-stationarity and the pump.

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