

Observation of a limit cycles phase in a recoil resolved atom-cavity system

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We are experimentally exploring the light-matter interaction of a Bose-Einstein condensate (BEC) with a single light mode of an ultra-high finesse optical cavity. The unique feature of our cavity is the small field decay rate ($\kappa/2\pi \approx 3.6$ kHz), which is very similar than the recoil frequency ($\omega_{rec}/2\pi \approx 3.6$ kHz) of the Rubidium atoms. This leads to a unique situation, where the cavity field evolves with the same timescale as the atomic density distribution. If the system is pumped transversally with an optical lattice, red detuned with respect to the atomic resonance, it is an implementation of the open Dicke model with the Hepp-Lieb dynamical phase transition [1]. For pump light blue-detuned with respect to the atomic resonance, we observed a limit cycles phase. Since the pump protocol is time-independent, the emergence of a limit cycle phase heralds the breaking of continuous time-translation symmetry and can be interpreted as a continuous time crystal. Our experiments are the first demonstration of the proposed limit cycles phase [2,3] and of a continuous time translation symmetry breaking.

References

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