

Bogoliubov excitations of a polariton condensate in dynamical equilibrium with an incoherent reservoir

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Condensates of exciton-polaritons are nowadays routinely observed in experiments [1]. A generic consequence of their driven-dissipative nature is that they can coexist with an incoherent excitonic reservoir. Here, I shall present a joint theory-experiment work [2] in which we study Bogoliubov excitations of a polariton condensate in dynamical equilibrium with such a reservoir.

We develop a generalized Bogoliubov theory for a polariton condensate in a microcavity embedding \mathcal{N} quantum wells. In doing so, we highlight that the reservoir can consist of both excitonic high-momentum polaritons and optically dark superpositions of excitons across the different optically active layers. We show that the presence of the reservoir modifies both the energy and the amplitudes of the Bogoliubov quasiparticle excitations due to the non-Galilean-invariant nature of polaritons.

Our theoretical findings are supported by our experiment, where we directly detect the Bogoliubov excitation branches of an optically trapped polariton condensate in the high-density regime. From the extraction of the densities we unveil a locking of the reservoir and condensate densities leading to a saturation of the condensate fraction. By analyzing the measured occupations of the excitation branches, we extract the Bogoliubov amplitudes across a range of momenta and find a good agreement with our generalized theory.

[1] Rev. Mod. Phys. 82, 1489 (2010), Rev. Mod. Phys. 85, 299 (2013), Microcavities (2017).

[2] M. Pieczarka, O. Bleu, E. Estrecho, M. Wurdack, M. Steger, D. W. Snoke, K. West, L. N. Pfeiffer, A. G. Truscott, E. A. Ostrovskaya, J. Levinsen, M. M. Parish, Phys. Rev. B 105, 224515 (2022).