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Excitations of a driven condensate in a cavity: dynamics of the roton-like mode BARIS OZTOP, MANAS KULKARNI, HAKAN TURECI, Princeton University — Recent experiments have demonstrated the superfluid-supersolid quantum phase transition (PT) of an optically driven Bose-Einstein condensate (BEC), via the observation of a roton-like softening of a mode in the Bogoliubov excitation spectrum [1,2]. This phenomenon is usually studied within two-mode approximation for the BEC which results in Dicke-like effective model. In this system, the long-range interactions between the atoms are mediated by cavity photons and the strength of the interactions is controlled by pump power. In this work, we investigate the effect of including the full spectrum of atomic modes. We find a finite lifetime for the roton-like mode below the threshold that is strongly pump-dependent. The corresponding decay rate and critical exponents for the PT are calculated.

[1] K. Baumann, C. Guerlin, F. Brennecke and T. Esslinger, Nature, 464, 1301 (2010).
[2] R. Mottl, F. Brenneck, K. Baumann, R. Landig, T. Donner and T. Esslinger, Science, 336, 1570 (2012).

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