Disorder-driven superradiance of a noninteracting Bose-Einstein condensate in an optical cavity

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The intriguing Dicke superradiance phase can be realized by Bose or Fermi gases coupled to cavity light fields, where the emergence of superradiance is driven by a self-organized density wave order. One may conjecture that, as the disorder potential which tends to destroy the atomic density wave order is introduced into the systems, the emergence of superradiance would be depressed. In this paper, we investigate the superradiance transition of a noninteracting Bose-Einstein condensate (BEC) subjected to a one-dimensional quasi-periodical superlattice potential and coupled to a transversely-pumped optical cavity. Surprisingly, we find that the tendency to the superradiant phase is remarkably enhanced, with the threshold pumping strength decreasing significantly with the strength of the incommensurate potential. More importantly, the threshold would become zero when the delocalization-to-localization transition point is approached, strongly suggesting that the superradiance can happen at arbitrary small pumping strength for the localized states. We demonstrate that the Lifshits tail of disorder induced low-lying excitations play crucial roles in the mechanism of disorder-driven superradiances. These results facilitate the studies of the rich phenomena of disordered Bose gases in a cavity.

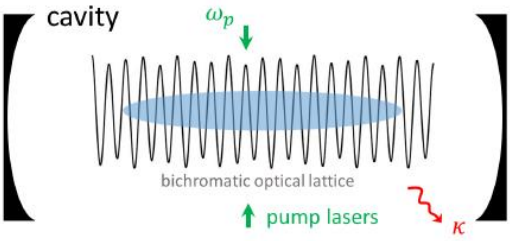

FIG.1: Schematic diagram of the system.

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