Coherently-driven quantum dot exciton strongly coupled to a fundamental mode of a micropillar cavity

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We address experimentally and theoretically a coherently-driven quantum dot exciton (QD X) strongly-coupled with a micropillar cavity mode (Fig.(a)). We used a 90° excitation-detection configuration to drive QD X directly. This makes our work fundamentally different from previous studies focusing on cavity-mediated excitation and the regime of laser field weakly probing the system. We show that resonance fluorescence (RF) in this regime is determined by the strength of light-matter coupling g and hence, by the efficiency of the excitation transfer between the bare X and the cavity mode. Investigated system exhibits dramatically different character depending on the amplitude of the external laser field Ω, showing vacuum Rabi doublet when the system is weakly probed and a Mollow triplet-like spectrum in high excitation regime. Both limiting cases are well-known examples of light-matter interaction with a two-level system. Structure under investigation offers unique opportunity to realize and observe both in the same physical system. Moreover, the amplitude of the driving laser field allows for a controlled transition between them, where the resonant laser field dresses a strongly-coupled X-photon. Of particular interest is the unexplored intermediate regime, in which the QD X interaction with the external laser and with the confined light field of the microcavity are equally important. This is proven by observing injection pulling of the polariton branches by an external laser. We identify the different excitation regimes via the energy shift of the incoherent response of the coupled X-cavity mode system under resonant QD X excitation which we prove to be a direct measure of the driving amplitude. This intermediate interaction regime is of particular interest since it connects the purely quantum mechanical Jaynes-Cummings ladder and the semi-classical Autler-Townes ladder (Fig.(b)). Exploring the driving strength-dependence we establish a robust fingerprint of the transition to be the maximum in the RF signal.

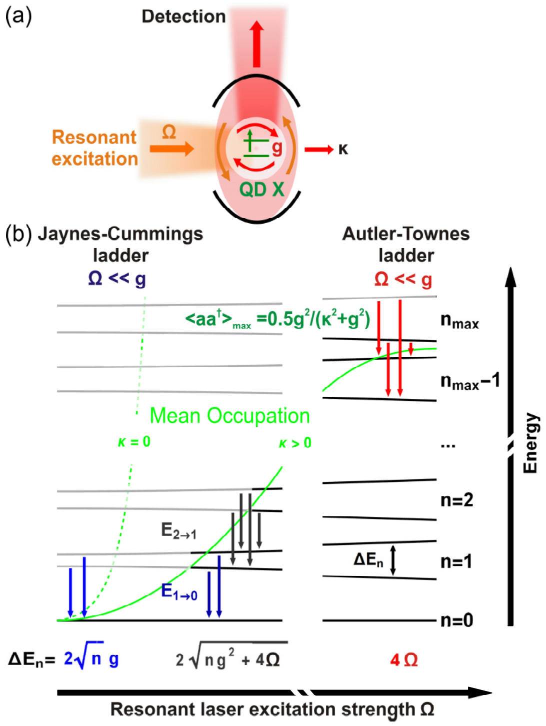

Fig. (a) Scheme of resonantly excited coupled QD-microcavity system (b) Level scheme of the laser-dressed QD X-microcavity system.

[1] C. Hopfmann et al., *Phys. Rev. B* **95**, 035302 (2017).