# Correlations between axial and lateral emission of coupled quantum dot-micropillar cavity

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## Abstract

Quantum dot (QD)-microcavities are excellent candidates to study light-matter interaction in the framework of cavity quantum electrodynamics (cQED) as well as for realization of non-classical light sources and high $\beta$-lasers [1]. To obtain comprehensive insight into cQED phenomena and dissipative decay channels we developed unique 90° excitation/detection scheme (Fig. a) to study QD-micropillars [2]. This technique provides direct access to lateral loss channels not possible otherwise. Moreover, it enables to distinguish between emission into cavity mode (CM) and leaky modes (LM) probing the directionality of emission and statistics of the emission events.

Applying the simultaneous axial/lateral detection scheme enabled to observe pronounced anti-correlation between single QD emission coupled to CM or LM, controlled by the Purcell effect in the weak coupling regime (Fig. b). It provides two independent ways to determine the Purcell factor: From the enhancement of axial emission (8.1±2.1) or inhibition of lateral emission (6.7±0.7) in quantitative agreement within estimated errors. Such correlations are not observed in the strong coupling regime due to presence of entangled light-matter states.

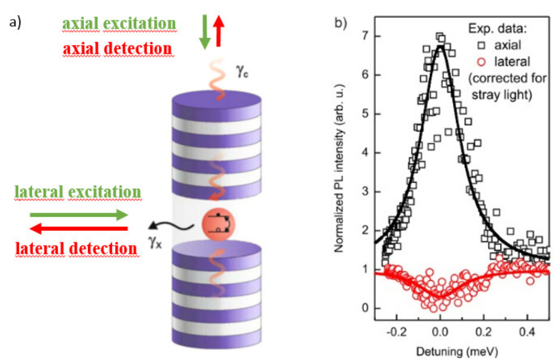


**Figure**: *a) schematic view of the experimental configuration; b) normalized PL intensity as a function of detuning between the QD and the CM detected in axial (black squares) and lateral (red dots) direction.*

Our 90° detection scheme gives important insight into laser action of high-β microlasers. Here, the ratio between intensity of emission detected in axial and lateral direction is a very sensitive indicator of laser action. Indeed, this ratio increases in a characteristic way at laser threshold which is of great importance for the identification of stimulated emission in case of large β-values where it is difficult to define it otherwise. The experimental studies are supported by calculations within a microscopic laser model, describing the coupling between N identical multilevel emitters to a CM via Jaynes-Cummings-like dipole Hamiltonian [3].

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