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Rabi Oscillations of a Single InAs Quantum Dot Assisted by a Photonic Crystal Nanobeam Cavity.

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Manipulation of quantum bits, which are ideally coherently driven two-level systems, is recently the subject of an important research effort. In solid state physics, such a two-level system can be realized by the ground state transition of a single quantum dot (QD). The QD is embedded in a photonic crystal nanobeam cavity in order to enhance the resonant pulse excitation. We report here on the control of the frequency and damping of Rabi oscillations[1] (RO) by controlling the detuning (δ) between the QD energy and the cavity mode.

We developed a low temperature micro-PL setup where the optical excitation is orthogonal to the PL detection, based on a 1D-nanobeam waveguide [Fig. 1] that contains InAs QDs. A gas deposition technique allows us to control δ and, as a consequence, to control the value of the Purcell factor (Fp) that depends on δ. As seen on Figs. 2, an increase of Fp leads to an increase of the Rabi frequency as expected from the electric field enhancement. Such high Rabi frequencies are interesting for devices showing low excitation power. But on the other hand, the damping of the oscillations increases as well, as a consequence of the decoherence induced by the Purcell effect. These effects will be discussed in the presentation.

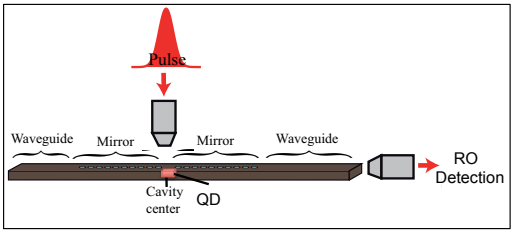

Figure 1. Sketch of the excitation and detection scheme.

One objective is to realize a single photon source triggered by a low power pulse with a high extraction efficiency of the resonance fluorescence[2].

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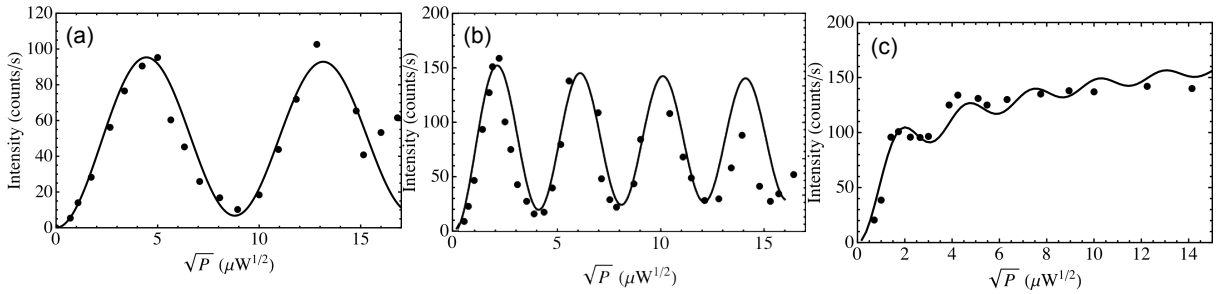

Figure 2. Rabi oscillations obtained from time-integrated resonant luminescence (black dots) as a function of the square root of the laser power for a quality factor of 9000 and the following Purcell factors (a) Fp = 1, (b) Fp = 10, and (c) Fp = 25. The solid line represents the calculated intensity.

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