

Rabi Oscillations of a Quantum Dot Exciton Coupled to Acoustic Phonons Revealed by Four-Wave Mixing Spectroscopy

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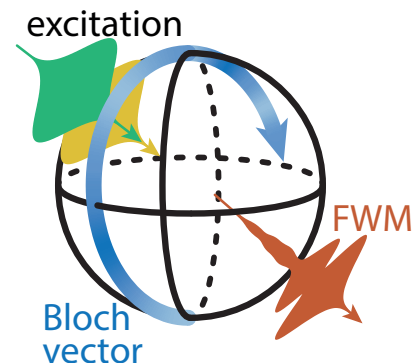
For near resonant optical excitations, the discrete but rich energy spectrum of single quantum dots (QDs) can be restricted to the lowest exciton state. In this case, the exciton forms a two-level system. Its quantum state dynamics can be measured and controlled via heterodyne four-wave mixing (FWM) micro-spectroscopy. While in a two pulse sequence we resolve the coherence dynamics, a three-pulse measurement probes the population dynamics.

We have recently shown that after the excitation of a QD on a sub-picosecond timescale the exciton loses part of its coherence within a few picoseconds [1]. This effect is due to the emission of a phonon wave packet, which is attributed to the pure dephasing coupling between the exciton and acoustic phonons. In a two pulse FWM configuration, we have analyzed this phonon induced dephasing, depending on the temperature.

I will focus on two novel effects that are studied by systematically varying the pulse areas of the two driving laser pulses [2]: (A) The strength of the phonon induced dephasing depends on the pulse area of the first pulse. (B) For large pulse areas additional oscillations of the FWM signal emerge due to the optically driven Rabi oscillations during the interaction with the first laser pulse. In the spectral domain these oscillations translate into the Autler-Townes splitting between the dressed states.

We further investigate a similar QD embedded in a micropillar cavity operating in the weak coupling regime.

We impinge the top facet of this photonic structure with sub-picosecond laser pulses and take advantage of a high quality factor to stretch the pulse duration above 10 ps. The elongated pulses allow to better resolve the Rabi oscillations and reach larger pulse areas. By performing the analogous study also with three driving pulses the population dynamics during the Rabi oscillations are resolved. For all investigated scenarios we achieve an excellent agreement between experiment and theory.



[1] T. Jakubczyk, V. Delmonte, et al., *ACS Photonics* **3**, 2461 (2016).

[2] D. Wigger, C. Schneider, et al., *Optica* **5**(11), 1442 (2018).