# Ultrashort spontaneous emission pulses from quantum dots induced by cavity switching

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We report about the spontaneous emission (SE) of an ensemble of InAs quantum dots (QDs) embedded in a semi-conductor AlAs/GaAs micropillar cavity. The cavity experiences a dynamical modification of its resonance frequency (so-called cavity switching). Ultrashort light pulses (FWHM ~10 ps) can be generated, not being limited, as usually, by the much longer exciton lifetime in the QDs (typically ~1 ns).

To date, various mechanisms (free-carrier injection [1], Kerr effect [2]) have been used to control the resonance frequency of microcavities. An optical pulse induces an ultrafast and reversible change in the cavity refractive index, which results in a dynamical modification of its resonance frequency. In our experiment, we employ a pulsed Ti:sapphire laser, tuned over the GaAs bandgap. Generated free carriers ensure both a switching of the pillar modes and a pumping of the QDs.

Figure 1 displays a temporal and spectral analysis of the micropillar emission obtained with a streak camera. When a QD transition frequency is in resonance with the cavity mode frequency, a fraction β of its SE is funneled into the resonant cavity mode. This light leaves the cavity in a highly directive way and is most efficiently detected. Therefore, the broadband emission of the QD ensemble probes the dynamic position of the pillar modes. An image such as figure 1 highlights a six linewidth shift of the mode induced by the pumping pulse, and its relaxation back to its initial frequency within about 50ps as a result for free-carrier recombination.

Provided spectral filtering of the micropillar emission is performed (e.g. at around 1.400eV in fig 1), an ultrashort light pulse (here 15 ps FWHM) is generated. The duration of this pulse is only limited by the switching-off dynamics, i.e. NOT by QD SE dynamics.

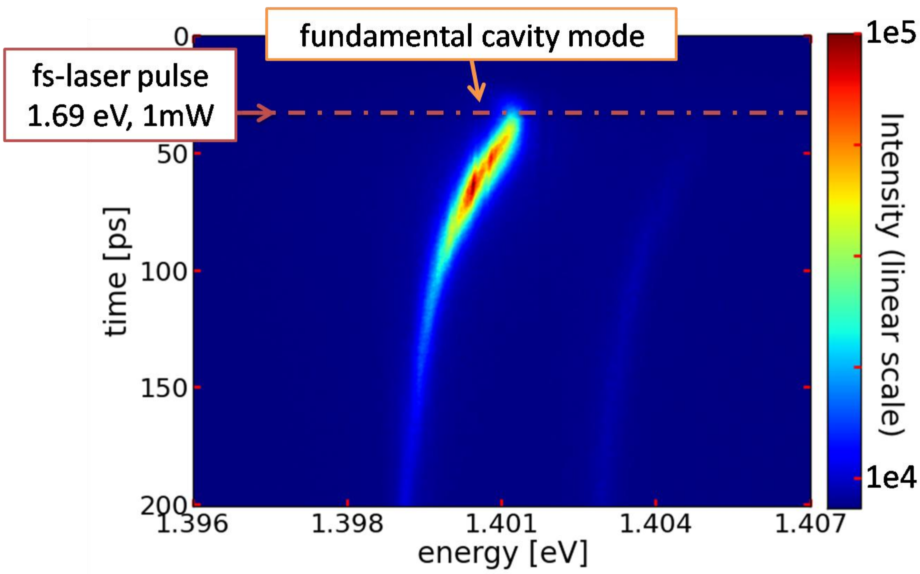


Figure 1: Time and spectrally resolved luminescence of an ensemble of InAs QDs embedded in a switched micropillar (diameter ~ 3µm). The fundamental and the first high order pillar mode are visible on this graph.

Beyond this first result, cavity switching could be used to tailor in real time the (Purcell-enhanced) SE rate of a QD [3], with potential application to the shaping of the temporal envelope of single photon pulses [4].

**References**


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