A highly efficient single photon - single quantum dot interface

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A quantum dot (QD) in a microcavity is a promising system to build a solid-state quantum network. It can be an efficient quantum light source as well as a quantum memory, a Bell-state analyser or a remote photon entangler when the QD embeds a spin. However, for these applications, one needs that every photon emitted by the QD is collected or, symmetrically, that every photon sent onto the device interacts with the QD. In this talk, we will present important steps we have recently made in this direction by deterministically inserting a QD in a cavity and controlling its spontaneous emission.

We first report on the fabrication of ultrabright sources of indistinguishable single photons using single QDs coupled to pillar cavities in the weak coupling regime. Large pillar cavities are used to obtain an external mode out coupling close to unity and to minimize dephasing processes in the QD surrounding. We compensate for large cavity mode volumes by precisely locating the QD at the maximum of the electromagnetic field using a deterministic lithography method [1]. By selecting QDs with high quantum efficiencies, we fabricate sources of indistinguishable single photons with measured brightnesses up to 0.78 collected photon per pulse, in a numerical aperture as small as 0.4. The Hong Ou Mandel experiment is implemented and demonstrates the indistinguishability of the photons with a mean wave-packet overlap up to 75%.

In a second part, we report on resonant reflectivity measurements performed under continuous wave excitation on high quality factor pillars operating in the strong coupling regime. Absolute reflectivity measurements show that the QD-micropillar system presents a coupling efficiency of 65 % and that the optical nonlinearity starts at an intracavity photon number around 0.2 only. Thanks to this very large coupling, we measure in real-time very small electrostatic changes around the QD down to the microsecond time scale.

[1] A. Dousse *et al*, Phys. Rev. Lett. **101**, 267404 (2008)