Exploiting 1D exciton-phonon coupling for tunable single photon source with carbon nanotube

Y. Chassagneux [1], ***A. Jeantet*** [1], ***T. Claude*** [1], ***C. Voisin*** [1]

[1] *Laboratoire Pierre Aigrain, Département de physique de l'ENS, École normale supérieure, PSL Research University, Université Paris Diderot, Sorbonne Paris Cité, Sorbonne Universités, UPMC Univ. Paris 06, CNRS, 75005 Paris, France*

Carbon nanotubes have emerged as original nano-emitters for future single-photon sources in the telecom wavelengths [1]. Coupling the nanotube to a micro-cavity brings a invaluable handle to control single-photon emission, regarding the rate, the yield, the directionality and the extraction. All those features are related to the so-called Purcell effect that results from the interaction of a quasi-two-level system with a high Q and low mode-volume cavity. Due to the 1D geometry of carbon nanotubes, the coupling to the phonon bath is strongly enhanced resulting in the well-known phonon wings [2,3]. This additional degree of freedom brings a very rich physics that can be exploited to enlarge the bandwidth of the source in view of multiplexing. A consequence of the non-Markovian decoherence induced by the phonon bath is the asymmetry between the phonon-assisted absorption and emission processes [4]. Using those transitions in the Purcell regime can lead to an enhanced single-photon efficiency above the standard limit imposed by the emitter and cavity intrinsic losses. We developed a widely tunable cavity technique, based on laser-engineered optical fibers to investigate this effect. We measure the single-photon emission properties both in cw and time-resolved and explain the strong asymmetry of the efficiency with respect to the detuning.

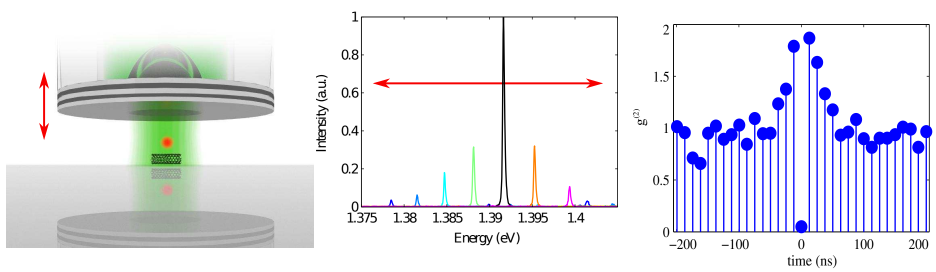

Figure 1: (left) Schetch of a single carbone nanotube coupled to a fibered Fabry-Perot cavity. (center) Emission spectra of cavity coupled nanotube for different cavity length. (right) Intensity correlation function for a nanotube coupled to a cavity in resonance with the ZPL.

References

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