CEA - Saclay 91191 Gif-sur-yvette Cedex
Service de Physique de l'Etat Condensé
SÉMINAIRE

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Mercredi 20 octobre 11h15

Orme des Merisiers SPEC Salle Itzykson, Bât.774

An ultrabright solid state source of entangled photon pairs

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A single semiconductor quantum dot (QD) is a promising system to achieve a solid-state source of single photons or of entangled photon pairs. The main advantage of QD based sources over attenuated classical sources is the possibility to generate exactly one photon for each excitation pulse. However, to be of practical value for quantum cryptography or quantum computing, one needs to efficiently extract and collect the photons emitted by the QD. Controlling the radiative lifetime of a QD in the weak coupling regime (Purcell effect) is a way to make sure that the photons emitted by the QD are funnelled into a cavity mode. This idea has motivated many works to fabricate coupled QD-cavity devices. For the last few years, the main challenge has been to control both the spectral and spatial matching between a single QD and a cavity mode. We have developed an in-situ lithography technique that allows deterministically coupling a single QD to a pillar cavity mode [1]. Using this technique, we have demonstrated the scalable fabrication of a large number of deterministically coupled QD cavity devices, each of them operating as a very bright single photon source. The radiative recombination of two electron-hole pairs trapped in a QD can also lead to the emission of entangled photon pairs [2]. Extracting polarization entangled photon pairs requires achieving simultaneous Purcell effect for both optical transitions of the QD as well as gathering several critical conditions to make sure that the Purcell effect is not detrimental to the entanglement. We have found a new geometry which gathers all these requirements: a photonic molecule consisting in two coupled identical pillars. By deterministically inserting a single QD into a photonic molecule, we have fabricated the brightest source of entangled photon pairs to date [3]. We also show that the implementation of Purcell effect increases the degree of entanglement of the photon pairs and allows limiting decoherence induced by the solid state environment of the QD. Our results open the way toward the implementation of linear quantum computing using solid state sources.

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

[2] Young, R. J. et al., New Journal. Phys. 8, 29 (2006).

[3] A. Dousse et al, Nature 466, 217 (2010).

A coffee break will be served at 11h00. The seminar will be given in English.
