Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 09/11/2015

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Measurement of the transmission of a resonantly-driven semiconductor single quantum dot

The semiconductor quantum dots (QD) are nanostructures where the three-dimensional electron confinement leads to a discrete energy spectrum comparable to the atoms one. This analogy with atomic physics notably stimulates the development of integrated sources of indistinguishable single photons for applications in quantum information. The most natural idea to develop such QD-based sources is to exploit the resonance fluorescence of the two-level system that constitutes the fundamental excitonic transition.

With an original setup based on an orthogonal excitation-detection geometry which allows the selective study, at low temperature, of a single QD inserted in a planar microcavity, the QDs can be resonantly-driven in order to minimize the decoherence processes due to the coupling with their environment [1-3]. In such configuration, we showed that the photons present in fact high degrees of indistinguishability [4].

In the longterm perspective of integrating such sources in photonic circuits based on photonic waveguides for example, one has also to assess the transmission signal of a single QD. The objective of the project is then to adapt the current experimental setup in order to measure the transmission signal of a resonantly-driven QD embedded in a wire-etched microcavity. The detection of the transmission of the QD resonance fluorescence which is superimposed with the excitation laser along the wire is challenging. The idea is here to exploit the optically-gated resonant emission effect [2] where the resonance fluorescence is modulated by an external non-resonant laser. The use of an adapted sample where the resonance fluorescence can be gated by an external electric field will be also explored. The statistical property and the indistinguishability of the transmitted photons will be analysed by quantum optics experiments.

Methods and techniques: Optical spectroscopy – Quantum optics experiments (HBT and HOM experiments) – Cryogenic techniques – Laser.

[1] H. S. Nguyen et al, *Ultra-coherent single photon source*, Applied Physics Letters **99**, 261904 (2011).
[2] H. S. Nguyen et al, *Optically gated resonant emission of single quantum dots*, Physical Review Letters **108**, 057401 (2012).
[3] H. S. Nguyen et al, *Photoneutralization and slow capture of carriers in quantum dots probed by resonant excitation spectroscopy*, Physical Review B **87**, 115305 (2013).
[4] R. Proux et al, *Measuring the Photon Coalescence Time Window in the Continuous-Wave Regime for Resonantly Driven Semiconductor Quantum Dots*, Physical Review Letters **114**, 067401 (2015)

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : YES**

Si oui, financement de thèse envisagé/ *financial support for the PhD***: ED PIF (564), DGA**

Lumière, Matière, Interactions	**YES**	Lasers, Optique, Matière	**YES**