Spécialité de Master « Optique, Matière, Plasmas »

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

Proposition de stage

Date de la proposition : 14/10/2014

Responsable du stage / *internship supervisor*: Carole Diederichs

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Nom du Laboratoire / *laboratory name*: Laboratoire Pierre Aigrain (LPA)

Code d'identification : UMR 8551 — Organisme : ENS, CNRS, UPMC, UPD

Site Internet / *web site*: www.lpa.ens.fr

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Lieu du stage / *internship place*: Département de Physique de l'Ecole Normale Supérieure, Paris

Generation of single indistinguishable photons from resonantly-driven semiconductor quantum dots

The project relies on the experimental study of the resonance fluorescence of semiconductor InAs quantum dots by optical spectroscopy and quantum optics experiments.

The semiconductor quantum dots are nanostructures where the three-dimensional electron confinement leads to a discrete energy spectrum comparable to that of atoms. This analogy with atomic physics currently stimulates the development of cavity quantum electrodynamics experiments in devices based on single quantum dots. In particular, these nanostructures are promising for achieving integrated indistinguishable single photon sources for eventual applications in quantum information. The most natural idea to develop such sources is to exploit the resonance fluorescence of the two-level system that constitutes the fundamental excitonic transition of a quantum dot.

With an original setup based on an orthogonal excitation-detection geometry which allows the selective study, at low temperature, of a single quantum dot inserted in a planar microcavity or in a photonic wire, the quantum dots are resonantly-driven in order to minimize the decoherence processes due to the coupling with their environment [1-3]. The photons are then emitted one by one and present high degrees of indistinguishability.

The objective of our work is to study the photon indistinguishability in the rarely studied resonant Rayleigh scattering regime where the QD emission spectrum can be much narrower than the natural linewidth imposed by the radiative limit while still exhibiting sub-Poissonian statistics [1]. We have recently shown in this regime that photon indistinguishability can be tuned by the excitation laser to unprecedented values in the same way of the photon coherence time [4]. The internship will consist in implementing interferometric and quantum optics experiments on order to distinguish the resonant elastic and inelastic components of the resonance fluorescence emission of a single QD and give a comprehensive study of the photon emission statistics and indistinguishability for both components.

[1] *Ultra-coherent single photon source*, H. S. Nguyen et al, Applied Physics Letters **99**, 261904 (2011).
[2] *Optically gated resonant emission of single quantum dots*, H. S. Nguyen et al, Physical Review Letters **108**, 057401 (2012).
[3] *Photoneutralization and slow capture of carriers in quantum dots probed by resonant excitation spectroscopy*, H. S. Nguyen et al, Physical Review B **87**, 115305 (2013)
[4] *Tuning the indistinguishability of photons from a solid state two-level system*, R. Proux et al, arXiv:1404.1244 (2014)

Methods and techniques: Optical spectroscopy (photon counting spectroscopy, confocal microscopy, time-resolved spectroscopy, Fourier-transform spectroscopy) – Quantum optics experiments (one- and two-photon interference experiments) – Cryogenic techniques – Lasers.

Candidate's skills: The student must have a strong background in solid state physics, quantum physics and motivation for experimental optics.

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

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

Lasers, Optique, Matière	x	Lumière, Matière, Interactions	x
Plasmas : de l'espace au laboratoire			