NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2022-2023

A bright source of entangled photon pairs

General Scope:
Entangled photons pairs are a key resource for quantum information processing, in particular for quantum communications. For example, they enable the realization of quantum relays that can extend the distance of quantum key distribution. To be useful, a source of entangled photon pairs has to be bright and tunable, emit indistinguishable photons, and operate on-demand to allow scaling up to many pairs.

This project targets the first demonstration of such a source. On-demand, polarization-entangled photon pairs will be emitted by a semiconductor quantum dot, by exploiting the biexciton-exciton radiative cascade. The cancelation of the excitonic fine structure splitting will be obtained by applying suitable strain [1,2], using piezo-electric actuators and an original electrostatic technique (cf figure). A tapered nanocavity will simultaneously ensure the efficient extraction of both exciton and biexciton photons [3,4] and provide a broadband spontaneous emission speed-up, in order to achieve photon indistinguishability.

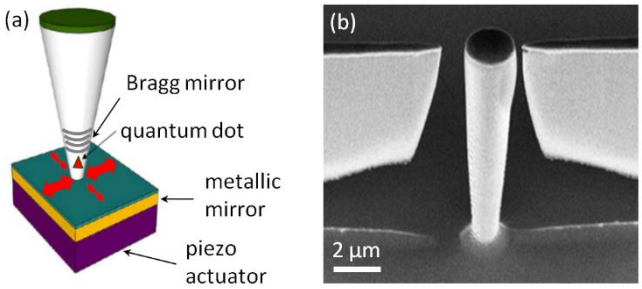

Figure 1 (a) scheme representing the tapered photonic wire containing a quantum dot sandwiched between two mirrors. The piezo actuator will perform the strain tuning of the quantum dot. (b) Scanning electron image showing that the strain tuning will also be performed by electrostatic actuation via closeby electrodes.

Research topic and facilities available:
This is a project connected to a recently obtained ANR grant (IPOD). During the internship, the work will consist in setting up the photon correlation system that will evaluate the fidelity of the entangled photons. Most of the equipement (cryostat, lasers, spectrometer) is already available and will be complemented thanks to the ANR support.

References
[1] I. Yeo et al, Nature Nano **9**, 106 (2014)
[2] D. Tumanov et al, APL **112**, 123102 (2018)
[3] M. Munsch et, Phys. Rev. Lett. 110, 177402 (2013)
[4] H.A. Nguyen et al, Phys. Rev. B **97**, 201106(R) (2018)

Possible collaboration and networking: The samples are fabricated by our colleagues (J. Claudon and J.M. Gérard) from CEA Grenoble. The project involves original samples, and it will therefore be carried out in very close interaction with them.

Possibility to go on with a PhD ? Yes

Required skills: The internship will consist in experimental work in optics and spectroscopy. Good background in optics, and quantum physics is recommended.

Beginning of the internship : early 2023

Contact: Jean-Philippe Poizat,, Institut Néel – CNRS, Phone: 04 56 38 71 65
e-mail: jean-philippe.poizat@neel.cnrs.fr

More information: http://neel.cnrs.fr