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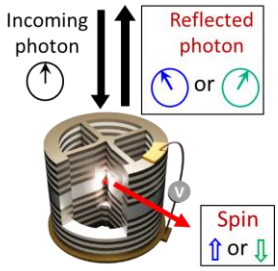
PhD offer: a spin-photon interface for quantum entanglement and quantum logic operations

This PhD project is funded by the Innovative Training Network ITN QUDOT-TECH (www.qudot-tech.eu) that aims to construct a solid-state platform for on-chip quantum information processing. In this framework, our group aims at **controlling the interaction between light and matter at the most fundamental quantum level**: qubits. We recently developed **an efficient interface between a single material qubit** (the spin of a single charge) and a **single photonic qubit** (the polarization of a single photon). Our interface uses the spin qubit carried by a semiconductor hole, confined in a nanometer-scale InAs quantum dot (QD). This quantum dot is deterministically coupled to an electrically-contacted pillar microcavity : such technology invented in C2N has already allowed developing high-efficency sources of quantum light[1] , and demonstrating the first optical nonlinearity reaching the single-photon level[2].

As we recently demonstrated, a photon reflected by such a QD-cavity structure can experience a drastically-enhanced rotation of its polarization, which allows **mapping the spin quantum state onto a photonic polarization state**[3]. Since then, we have implemented a technique allowing the complete tomography of a polarization qubit in the Poincaré sphere[4], and we recently demonstrated **the optical probing of a single spin using single photons**. In such experiment every single detected photon leads to a measurement back-action on the spin qubit.



In this offer, we propose to explore **both theoretically and experimentally** the numerous perspectives of such a spin-photon interface for quantum information. A major objective will be to demonstrate **new forms of spin-photon entanglement and photon-photon entanglement**, and develop **quantum logic gates mediated by the spin-photon interaction**. We will also perform **fundamental quantum measurements** and study the dynamics of a single spin in a solid-state matrix.

The PhD salary is **~2200€ net per month** (+ family allowance if applicable). During its PhD the successful candidate will also benefit from an **additional funding for several visiting trips (typically 1 month each) in the partner teams (incl. Cambridge, Basel, Grenoble, Copenhagen)**.

Requested profile: **we welcome highly-motivated applicants with excellent background in quantum physics, optics, and/or solid state physics, and with a taste for theoretical as well as experimental research**. Applications (CV, transcript of studies, statement of motivation) should be sent by email to Loïc Lanco (loic.lanco@univ-paris-diderot.fr)

Funding conditions : Candidates must not have resided or carried out their activities - work, studies, etc.- in France for more than 12 months in the 3 years immediately before starting the PhD.

Planned starting date: 06/2020

[1] Somaschi et al, **Nature Photonics 10**, 340 (2016)
[2] De Santis et al, **Nature Nanotech. 12**, 663 (2017)
[3] Arnold et al, **Nature Commun. 6**, 6236 (2015)
[4] Anton et al, **Optica 4**, 1328 (2017)