Master 2: *International Centre for Fundamental Physics*

INTERNSHIP PROPOSAL

(One page maximum)

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Thesis possibility after internship: YES
Funding: EDPIF

Controlling pure dephasing processes in condensed matter quantum emitters.

Most of the protocols for advanced quantum secured telecommunications or optical quantum computing are based on the availability of reliable sources of single indistinguishable photons. Such photons are not only individual but they also share identical wavefunctions. Condensed matter emitters (such as semi-conducting nano-structures, single molecules in a matrix or color centers in large gap materials) are valuable for such applications due to their higher integrability in devices. Nevertheless, they all suffer from the random interaction with their environment (such as phonons or fluctuating charges in the surrounding matrix…), which is highly detrimental for the purity of the single-photon source. In fact, such fluctuations are responsible for pure dephasing (random phase jumps of the emission) and spectral diffusion that all yield significant line broadening in the luminescence of the emitters. Several strategies can be used to reduce this broadening such as quasi-resonant excitation, low-temperature operation and coupling of the emitter to a nano-cavity (either dielectric or plasmonic) in order to reduce the incoming excitation power. Nevertheless, to assess the efficiency of these approaches, it is necessary to have a reliable tool to distinguish between the different microscopic processes and thus to observe the dynamics of spectral diffusion over a large span of time-scales, which is not possible with regular spectroscopic tools.

To this end, it was recently proposed to use photon correlation Fourier interferometry [1]. The basic idea is to use a Michelson interferometer and to detect the intensity correlations between the two arms as a function of time delay by means of a pair of fast photo-detectors coupled to a correlation board. This way, sudden phase or frequency shifts can be distinguished from intensity fluctuations.

The goal of this internship is to develop this experimental technique using the new superconducting ultrafast photon detectors recently purchased in our group and to study spectral diffusion in a new type of single-photon source based on tailored colored centers in carbon nanotubes [2, 3].

[1] X. Brokman et al., Optics exp. 14, 6333 (2006) .
[2] X. He et al, Nat. Mat. 17 663 (2018)
[3] Jeantet et al Nano Lett. 17 4184 (2017)

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES
Soft Matter and Biological Physics: NO
Quantum Physics: YES
Theoretical Physics: NO