Master QLMN (Quantum, Light, Materials and Nano Sciences)

Proposition de stage / Internship proposal

Date de la proposition :

Responsable du stage / *internship supervisor*:

Nom / *name*: Fabre

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Nom du Laboratoire / *laboratory name*: LTCI

Etablissement / *institution* : Telecom Paris Code d'identification :

Site Internet / *web site*: https://www.telecom-paris.fr/

Adresse / *address:* 19 place Marguerite Perey, 91300, Palaiseau

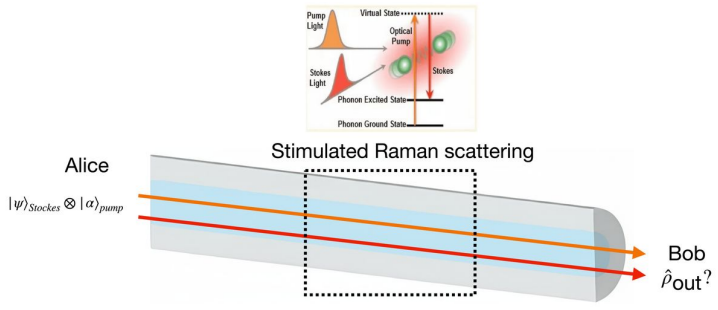
Lieu du stage / *internship place*: Telecom Paris

Titre du stage / *internship title*: Impact of stimulated Raman scattering on time-frequency single photon encoding for quantum communication protocols

Résumé / *summary*

The frequency (or time-of-arrival) degree of freedom of a single photon represents a continuous variable used for encoding quantum information [1,2,3]. Frequency is less susceptible to noise in optical fibers, waveguides, and free space, making it a strong candidate for future quantum information processing. Unlike polarization, frequency is unaffected by birefringence, does not require phase stabilization, and is immune to nonlinear effects at the single-photon level. Given the high cost and impracticality of deploying new fiber infrastructure, the project explores how quantum communication can be integrated into existing classical networks by having the coexistence of quantum and classical signals within one optical fiber.

This project investigates the development of a quantum channel mediated by stimulated Raman scattering (SRS), when there is coexistence of one classical field and a frequency encoded single photon state. We will employ a light-matter interaction model to analyze how SRS-induced field distortion impacts the frequency encoding of single photons, including two-color and grid-state encodings [3]. The resulting spectral modifications will be quantified by their effect on quantum communication performance, specifically the quantum bit error rate (QBER) and the asymptotic key rate.



References:

[1] N. Fabre, A. Keller, and P. Milman, *Time and Frequency as Quantum Continuous Variables*, Phys. Rev. A **105**, 052429 (2022).

[2] Descamps, E., Fabre, N., Keller, A. & Milman, P. Quantum metrology using time-frequency as quantum continuous variables: Resources, sub shot-noise precision and phase space representation, Phys. Rev. Lett. 131, 030801 (2023).

[3] *Fabre, N. & Felicetti, S. Parameter estimation of time and frequency shifts with generalized HOM interferometry. Phys. Rev. A **104**, 022208 (2021).*

[4] Image adapted from **31**. 10.1002/ett.3930.

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : Oui** **Si oui, financement de thèse envisagé ou acquis /** *financial support for the PhD* **? ED, F&T**			
Financement acquis / *Secured funding*		Nature du financement */Type of funding*	
Financement demandé / *Requested funding*		Nature du financement */Type of funding*	