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

Proposition de stage / Internship proposal

Date de la proposition : 15/09/26

Responsable du stage / *internship supervisor*:

Nom / *name*: Fabre

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Nom du Laboratoire / *laboratory name*: LTCI

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

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

Adresse / *address:* 19 place Marguerite Perey, 91120, Palaiseau

Lieu du stage / *internship place*: Telecom Paris

Titre du stage / *internship title*: Quantum error correction of time-frequency GKP states

Résumé / *summary*

Time-frequency is a promising degree of freedom for encoding and processing quantum information. In particular, frequency is remarkably robust to linear optical processes, making it an attractive resource for high-dimensional quantum information protocols. Although time and frequency are intrinsically continuous degrees of freedom, they can be discretized to encode high-dimensional quantum states, or qudits, and further reduced to two-dimensional subspaces to define qubits. One example is the time-frequency Gottesman-Kitaev-Preskill (GKP) state, in which a qubit can be encoded in the even and odd components of a frequency comb generated by an entangled photon-pair source. Such states are promising for applications in enhanced quantum metrology and quantum error correction. They also exhibit strong mathematical similarities with bosonic GKP codes, while being physically distinct.

In this internship, we aim to investigate and adapt quantum error-correction protocols to entangled time-frequency GKP states. A particular focus will be placed on realistic error sources, including incoherent errors arising from detector timing jitter, as well as quantum channels that induce broadening in the time and frequency domains. The goal will be to characterize the performance of error-correction protocols under these realistic noise processes and determine the number of correction cycles required to preserve the quality of the encoded state for a given quantum information protocol.

(1) Fabre, N. *et al. Phys. Rev. A* **102**, 012607 (2020). (2) Fabre, N. & Felicetti, S. *Phys. Rev. A* **104**, 022208 (2021). (3) Meguebel, M., Federico, M., Felicetti, S., Belabas, N. & Fabre, N. *Optica Quantum* **3**, 617 (2025).

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*	