INTERNSHIP PROPOSAL

Laboratory name: Laboratoire Kastler Brossel
CNRS identification code: UMR 8552
Internship director'surname: Parigi
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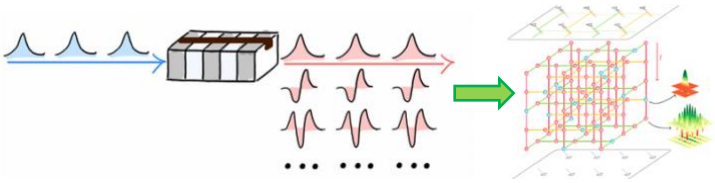
Internship location: 4 Place Jussieu

Thesis possibility after internship: YES Funding: YE
If YES, which type of funding: EU projects

Large Continuous Variable quantum networks for quantum information technologies

Photonics quantum networks are essential resources for quantum communication and information protocols, they represent an essential part of the future quantum internet where quantum states of light will allow for the efficient distribution and manipulation of information. We explore continuous-variable (CV) entangled states, where entanglement correlations appear between quadratures of the electromagnetic field. Such states can be deterministically generated by mixing several squeezed optical modes via linear-optics operations or, more generally, via mode-basis changes. We recently demonstrated the generation of spectrally multimode squeeze states of light at telecommunication wavelengths involving more that 21 frequency modes [1]. For all transfer of information over appreciable distances, telecommunication wavelengths offer the most reliable solution. The generated resource can then be used for frequency multiplexed cryptographic protocols [2]. Moreover, the resource shows promise as a compact solution for scalable entangled states in quantum computing. The 21 squeezed modes are in fact generated in a the single-pass configuration based on non-linear waveguides and a femtosecond laser source: this allows for supplemental pulse-based multiplexing [3]. Large three-dimensional structures, necessary for fault tolerant quantum computing [4] can then be explored along with non-Gaussian operations [5] for quantum information protocols.



The internship may concern the test of the pulse-resolving homodyne detection, that will allow for the temporal multiplexing, or the design of non-Gaussian operations (like single-photon subtraction) via photon counting with nanowire detectors. The internship can be followed by a PhD project. The project fits with the purposes of ERC project COCQOoN, the national acceleration strategy PEPR OQULUS ('ordinateur quantique à base de lumière en variables discrètes et continues') and the EU projet veriqub.

[1] V. Roman-Rodriguez, D. Fainsin, G. L Zanin, N. Treps, E. Diamanti, V. Parigi Spectrally multimode squeezed states generation at telecom wavelengths, arXiv:2306.07267 (2023)
[2] O. Kovalenko, Y.-S. Ra, Y Cai, V. C. Usenko , C. Fabre N. Treps, and R. Filip, Frequency-multiplexed entanglement for continuous-variable quantum key distribution Photonics Research Vol. 9, pp. 2351-2359 (2021)
[3] T. Kouadou, F. Sansavini, M. Ansquer, J. Henaff, N. Treps, V. Parigi, Spectrally shaped and pulse-by-pulse multiplexed multimode squeezed states of light, APL Photonics 8, 086113 (2023)
[4] J. E., Bourassa, et al. Quantum 5, 392 (2021).
[5] Ra, Y.-S., Dufour, A., Walschaers, M., Jacquard, C., Michel, T., Fabre, C., and Treps, N., Non-Gaussian quantum states of a multimode light field, Nat. Phys. 16, 144–147 (2020)

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

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