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CV quantum networks at telecommunication wavelengths

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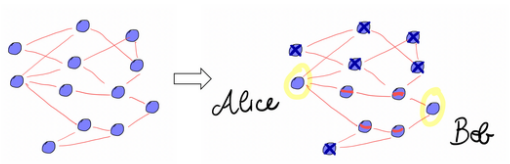
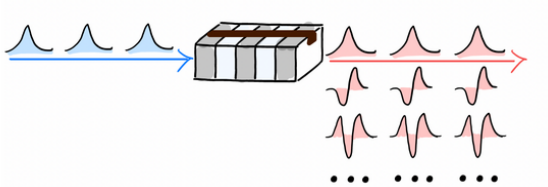
Photonics quantum networks are essential resources for quantum communication and information protocols, they represent an essential part of the future quantum internet where quantum states of light will allow for the efficient distribution and manipulation of information. We explore continuous-variable (CV) entangled states, where entanglement correlations appear between quadratures of the electromagnetic field. In particular we are interested in structures with complex networks topology. Complex network structure appears in fact in many natural and technological networks and may play a role for future quantum information technologies.

For all transfer of information over appreciable distances, telecommunication wavelengths offer the most reliable solution. As parametric process pumped by optical frequency comb deterministically generate multimode entangled networks, we recently setup a quantum optic experiment based on a femtosecond laser at telecom wavelength and non-linear waveguides [2].





The generated quantum states will be exploited for multiparty quantum communication protocols and quantum routing in complex networks [3,4] both with Gaussian and non-Gaussian statistics [5]. This will be induced via non-Gaussian operations like mode-dependent single-photon subtraction or addition [6]. Theory of CV complex networks and quantum protocols can be included in the PhD project.

The project is intended to be inserted in the initiative of the Quantum Information Center Sorbonne (QICS). It in fact covers instances concerning quantum communications.

Applicants should have a Master diploma in Physics. Familiarity with quantum information and/or experimental optics will be valuable.

[1] Y. Cai, J. Roslund, G. Ferrini, F. Arzani, X Xu, C. Fabre, and N. Treps, *Multimode entanglement in reconfigurable graph states using optical frequency combs* Nature Communications 8, 15645 (2017)
[2] V. Roman-Rodriguez, B. Brecht, K. Srinivasan, C. Silberhorn, N. Treps, E. Diamanti, and V. Parigi *Continuous variable multimode quantum states via symmetric group velocity matching*, New Journal of Physics 23 (4), 043012 (2021)
[3] F. Centrone, F. Grosshans, and V. Parigi, *Cost and Routing of Continuous Variable Quantum Networks* arXiv preprint arXiv:2108.08176 (2021)
[4] F. Sansavini, and V. Parigi *Continuous variables graph states shaped as complex networks: optimization and manipulation* Entropy 22 (1), 26 (2020); and D. Fainsin et al. in preparation
[5] M. Walschaers, S. Sarkar, V. Parigi, and N. Treps, *Tailoring Non-Gaussian continuous-variable graph states*, Physical Rview Letters 121 (22) 220501 (2018)
[6] G. Roeland, S. Kaali, V. Roman-Rodriguez, N. Treps and V. Parigi arXiv: 2110.14488 (2021)