Laboratoire Kastler Brossel
Physique quantique et applications

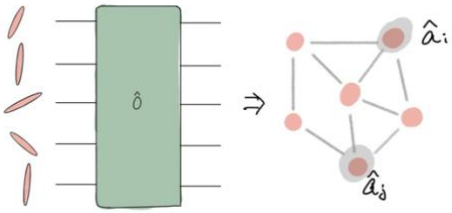
veriqub

European Innovation Council

Post-doctoral position
Resources and verification in photonic quantum computing

A postdoctoral position is open at Laboratoire Kastler Brossel to work on the theory of photonic quantum computing.

The project is focused on gaining new insights into the essential resources required for photonic quantum computing. Your role will involve identifying novel physical properties that are necessary (or sufficient) to achieve a quantum computational advantage using light. Additionally, you will investigate how established resources, such as phase-space negativity, entanglement, and stellar rank, can be effectively combined in photonic quantum computers. Upon identifying these resources, you will contribute to developing experimentally feasible methods to verify their presence.

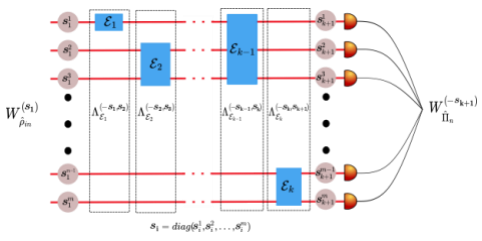


The multimode quantum optics group at LKB carried out leading research in the study of multimode Gaussian [1] and non-Gaussian [2,3] states of light, useful in quantum information protocol on a large scale. The group has a strong experimental focus, but is also engaged in purely theoretical activities aiming at developing quantum technologies in the continuous-variable framework.

In a nutshell

Why to apply:
- you are passionate about transforming theoretical insights into experimental reality
- you will benefit of an international team of researchers' expert in Continuous Variable quantum information (theory and experiment)
- you will be in a group at the core of many national and international research networks

Our specific view:
- Photonic quantum computing with continuous variables
- Close interplay between quantum information theory and quantum optics experiments [3]
- Exploring the entanglement properties of non-Gaussian quantum states of light [4]
- Combining a wide range of theoretical techniques: phase-space methods [5], stellar representation [6], quantum estimation theory [7], algebraic geometry, graph theory, semi-definite and linear programming, machine learning [8], et cetera



Environment

As a whole, the group has a tradition of working together with a diverse range of people from varied backgrounds. This diversity often leads to fruitful scientific input from different points of view, and it allows the group to explore new avenues. Furthermore, the moderate size of our group gives PhD students and postdocs the opportunity to discuss with PIs on a daily basis. This gives rise to a dynamical atmosphere with a lot of space for discussion.

Your work fits in the EIC pathfinder project VeriQuB, in which we collaborate with groups from Inria (France), Chalmers (Sweden), University of Milan (Italy), and INL (Portugal). This framework provides support to enlarge your scientific network and establish new international collaborations.

Practical information

Candidates must hold an internationally recognized PhD in a field related to theoretical quantum physics. A good background and past research track record in either theoretical quantum optics or quantum information theory is required.

Application procedure: Inquiries and applications should be sent by email to Mattia Walschaers **(mattia.walschaers@lkb.upmc.fr)**. Applications should include a detailed CV and two names of potential referees.

Salary: Monthly **net** salary (after-tax) between 2200€ and 2900€, depending on experience
Application deadline: Preferentially apply before June 15th 2025.

Starting date: flexible

Duration: 2 years

References

[1] J. Roslund, R. Medeiros de Araújo, S. Jiang, C. Fabre, and N. Treps *Wavelength-multiplexed quantum networks with ultrafast frequency combs,* Nat. Photon. **8**, 109–112 (2014)
[2] M. Walschaers *Non-Gaussian Quantum States and Where to Find Them* PRX Quantum **2**, 030204 (2021)
[3] 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)
[4] C. E. Lopetegui, M. Isoard, N. Treps, and M. Walschaers, *Detection of mode-intrinsic quantum entanglement* arXiv:2407.18095 – *Accepted for publication in Optica Quantum*
[5] M. Frigerio, A. Debray, N. Treps, and M. Walschaers, *Resourcefulness of non-classical continuous-variable quantum gates*, arXiv:2410.09226
[6] U. Chabaud and M. Walschaers, *Resources for Bosonic Quantum Computational Advantage*, Phys. Rev. Lett. **130**, 090602 (2023)
[7] M. Frigerio, M. G. A. Paris, C. E. Lopetegui, M. Walschaers, *Joint estimation of position and momentum with arbitrarily high precision using non-Gaussian states,* arXiv:2504.01910
[8] X. Gao, M. Isoard, F. Sun, C. E. Lopetegui, Y. Xiang, V. Parigi, Q. He, and M. Walschaers, *Correlation-Pattern-Based Continuous Variable Entanglement Detection through Neural Networks*, Phys. Rev. Lett. **132**, 220202 (2024)