INTERNSHIP PROPOSAL

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Thesis possibility after internship: YES
Funding: several possibilities envisioned: QuantEdu France Project, DGA, DIM SIRTEQ

AlGaAs sources of quantum states of light: fundamental research and applications to quantum networks

Scientific project: The generation of nonclassical states of light in miniature chips is a crucial step toward practical implementations of future quantum technologies. For the sake of practicality and scalability, these quantum sources should be easily produced, operate at room temperature, and be electrically excited and controlled. The work of the QITe team is focused on AlGaAs-based quantum photonic devices: indeed, this platform presents a strong case for the miniaturization of different quantum components in the same chip: strong second-order nonlinearity and electro-optic effect, direct bandgap, generation of entangled photons in the telecom band [1]. After the demonstration of the first electrically driven device working at room temperature [2] and the exploitation of the broadband character of the generated polarization entangled state for the implementation of flexible quantum networks [3], in this project, the QITe team will push ahead on several fronts:

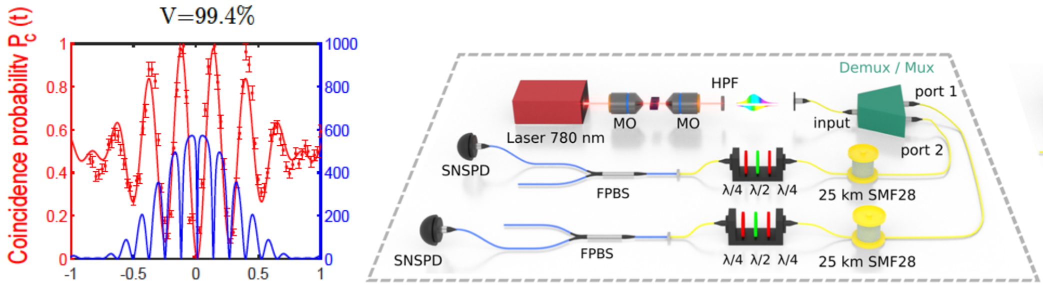

Figure: Left : Hong Ou Mandel Interferogram and Fisher Information for a Schrödinger cat-like state used in quantum metrology protocols[4]. Right: Experimental setup of a flexible entanglement distribution network [3].

- we will study the quantum properties of the state emitted by electrically injected devices and we will add novel on-chip functionalities for the state manipulation, like electro-optics-based phase shifters.
- in collaboration with the theoreticians of our group, we will exploit the assets of the states emitted by our devices (wide spectral band, frequency anti-correlations, cavity effects) for fundamental studies in quantum metrology [4]and quantum computing [5].
- in collaboration with the team Quantum Information (LIP6) we will work on the deployment of the national quantum communication testbed and we will test the performances of our devices in real-world metropolitan quantum networks.

This project will combine device design and fabrication, quantum optics measurements, and theory and applications to QI protocols. It will benefit from the collaboration with the Center of Nanosciences and Nanotechnologies and will take place in the framework of the national Quantum Communication Testbed Project and of the European Quantum Secure Networks Partnership.

[1] F. Baboux, G. Moody and S. Ducci Optica Mini-Review 10, 917 (2023)
[2] F. Boitier et al. Phys. Rev. Lett. 112, 183901 (2014)
[3] F. Appas et al. npj Quantum Information 7, 118 (2021)
[4] O. Meskine, E. Descamps et al. https://arxiv.org/abs/2309.10633 (2023)
[5] N. Fabre et al. Phys. Rev. A 102, 023710 (2020)

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

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