INTERNSHIP PROPOSAL

Laboratory name: **Laboratoire Kastler Brossel – Quantum Networks Team**
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Thesis possibility after internship: YES
Funding: YES, Doctoral school/group funding

Entanglement distribution in the Paris quantum testbed

In the broad context of quantum communications, one stream of research aims at creating a so-called Quantum Internet. Among other applications, ranging from extending the baseline of telescopes to clock synchronization and sensor networks, the creation of a Quantum Internet would enable long-distance quantum information transfer. Central to this endeavor is the concept of **quantum repeater**. It consists in dividing a long communication channel into various shorter segments over which entanglement can be faithfully distributed. Adjacent segments are then connected by entanglement swapping operations. To be scalable, this approach requires **quantum memories**, which enable quantum states to be stored at each intermediate node.

In this context, the **LKB team** has been developing non-degenerate sources of entangled photon pairs compatible with both telecom networks, and an atomic quantum memory. This quantum memory based on a cold atomic ensemble in the group enables qubit storage with an overall efficiency close to **90% mark for entanglement storage between two memories**.

The work is now focusing on two directions. A first one is to improve the figures of merit, including the efficiency, and to interface it with an atomic quantum memory. A second one is the implementation of quantum networking protocols, from photonic teleportation on a dedicated fiber network on the Jussieu campus, to the demonstration of a **50-km telecom quantum repeater link relying on two distant quantum memories and frequency non-degenerate photon pair sources.** These efforts enter into the context of the French Initiative on Quantum Information, including the Paris Region quantum testbed where memories can be deployed, and the European Flagship project "Quantum Internet Alliance" that aims at developing a pan-European quantum internet. Part of the work will be led in collaboration with the startup company Welinq.

A few references:
Efficient reversible entanglement transfer between light and quantum memories, Optica 7, 1440 (2020)
See also the story about this work in IEEE spectrum: Quantum memory milestone boosts quantum internet future
Highly-efficient quantum memory for polarization qubits in a spatially-multiplexed cold atomic ensemble, Nature Communications 9, 363 (2018)

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