INTERNSHIP PROPOSAL

(One page maximum)

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CNRS identification code: UMR 7162
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Thesis possibility after internship: YES
Funding: TBD If YES, which type of funding:

A new optical collection system to enhance ion–photon entanglement

Recent advances in quantum physics have given rise to cutting-edge fields such as quantum computing, quantum simulation, and quantum communication, driving the rapid development of quantum technologies. Our research team has strong experience with two complementary quantum platforms: laser-cooled trapped strontium ions [2] and single photons generated by spontaneous parametric down-conversion (SPDC) in semiconductor chips. Using deep learning, we have recently designed a new source of such photons [1], whose pairs combine a photon at 1092 nm, matching a transition of the $^{88}Sr^{+}$ ion, with a telecom photon at 1550 nm.

This internship proposal is at the intersection of these two areas, with the goal of developing a hybrid quantum platform. The project addresses one of the key challenges in quantum communication networks: creating a seamless connection between static qubits (trapped ions) and flying qubits (single photons). A major limit on the ion–photon entanglement rate is the small fraction of the ion's light that is actually collected.

The intern will work directly on the experimental setup dedicated to trapping the strontium ions and collecting their light (strontium lab), and will implement a new optical collection system in order to increase the entanglement rate between ion and photon. The work covers the optical design and simulation then the construction and characterization of the system on a single trapped ion: the 1092 nm photons entangled with the internal states of the ion will be coupled into a single-mode fiber, while the 422 nm fluorescence will be used to image and detect the ion. The 1092 nm photons will be brought to the photonic lab where Bell measurements with the new source can be performed.

The successful applicant will be integrated in a dynamic team with 3 permanent staff and 3 PhD students in a motivating scientific environment. The master's internship is planned to start in spring 2027, and can be ideally followed by a PhD thesis.

[1] I. P. De Simeone, G. Maltese, V. Cambier, J.-P. Likforman, M. Ravaro, L. Guidoni, F. Baboux and S. Ducci, "Deep-Learning-Designed AlGaAs Interface Linking Trapped Ions to Telecom Quantum Networks", arXiv:2603.12846 (2026).

[2] V. Martimort, S. Guesne, D. Drapier, V. Tugayé, L. Gros-Desormeaux, V. Cambier, A. Douillet, L. Guidoni and J.-P. Likforman, "Incoherent repumping scheme in the $^{88}Sr^{+}$ five-level manifold", Phys. Rev. A 113, 063109 (2026).

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: NO