UNIVERSITÉ CÔTE D'AZUR

Master thesis proposal

Institut de Physique de Nice
17, rue Julien Lauprêtre
06200 Nice
Director: Guillaume Huyet

Title: Quantum memories in rare-earth ion-doped crystals with integrated architectures

Keywords: Quantum memories, Quantum optics, Light-matter interaction, Integrated photonics

Scientific description: Real-field deployments of quantum communication networks are a striking demonstration of the high potential of quantum technologies. Using photon as a carrier, they enable the safe exchange of bits information with quantum certified security. Within such networks, a key feature is however still missing: the ability to store and retrieve the photonic information on demand for synchronization purposes. Together with the Atomic Frequency Comb (AFC) protocol [1], rare-earth (RE) ion-doped crystals is one of the most advanced platform in terms of storage time (> one hour [2]), multiplexing ability [3], storage at the single photon level [4], fidelity and efficiency.
The objective of this internship is to push the performances of the storage to unprecedented levels thanks to the development of an innovative architecture, based on integrated photonics. To this extent, a ridge structure consisting in a hybrid architecture RE/silica (currently under investigation at Inphyni) will be used.
During this internship, optical and spectral properties of the RE ion-doped waveguide crystals will be studied, and the AFC protocol will be implemented towards demonstration of storage of photonic excitations in the structure.

[1] Afzelius et al., Phys. Rev. A 79, 052329 (2009)
[2] Ma et al., Nat. Com. 12, 2381 (2021)
[3] Businger et al., Nat. Comm. 13, 6438 (2022)
[4] Ortu et al., NPJ Quant. Inf. 8, 1-7 (2022)

Techniques/methods in use: The internship applicant will beneficiate from the brand-new facilities of Institut de Physique de Nice, and will participate to the setup of the quantum memory activity involving high precision optics, electronics and cryogenics. The applicant will work in a favourable environment thanks to the recently funded ANR project WAQUAM (2022-2026) and PEPR Qmemo project (2022-2027). The RE ion-doped crystal-based waveguides are still under investigations, but promising results in several fabrication steps were already obtained. At the time of the beginning of the internship, most of the elements will be in place for the first atom-light manipulation in the lab, placing the applicant in a comfortable position to master a wide panel of experimental skill towards a PhD on the topic.
Applicant skills: Basic experimental physics, Quantum optics
Industrial partnership: ~~Y~~/N
Internship supervisor(s) (name, email, phone, …): Jean Etesse, jean.etesse@inphyni.cnrs.fr, +33489152846
Internship location: Institut de Physique de Nice, 17 rue Julien Lauprêtre, 06200 Nice
Possibility for a Doctoral thesis: Y/~~N~~