INTERNSHIP PROPOSAL

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Rare-earth-doped crystal spectroscopy for signal processing architectures

Rare-earth ion-doped crystals exhibit exceptionally narrow optical transitions at low temperatures (around 3K). These unique properties make them ideal for foundational quantum technology applications, including quantum memories, quantum sensors, and quantum-enabled signal processing architectures. Over the past decades, our team, in a long-standing collaboration with Thales Research & Technology and IRCP, has developed a number of state-of-the-art signal processing designs, including a [spectral analyzer demonstrator] at the industrial level and an [agile photonic filter].

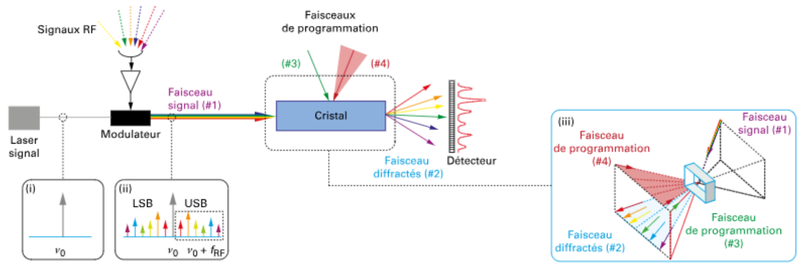

Figure : Rainbow spectral analyzer principle

Nevertheless, the development of cutting-edge architectures goes hand-in-hand with ongoing exploration of alternative materials, always with specific applications in mind. For example, we have investigated the [simultaneous introduction of 2 rare-earth species] in a given crystal, in order to enhance the processing bandwidth.

With this internship, we want to continue our exploration along two primary directions:
- Tm:YAG is used for the rainbow spectral analyzer developed at TRT. Its main weakness is linked to the sensitivity of the atomic population lifetimes to temperature. Our partner IRCP will soon be able to provide us with Tm:YGG samples which could represent a game-changer for the rainbow demonstrator. The high-resolution spectroscopy of this crystal under a weak magnetic field will help confirm the potential of such a compound.
- Another spectral analyzer design is based on the recording and subsequent readout of the RF spectrum in the absorption profile of a rare-earth ion-doped crystal. In Er:YSO, two transitions at 1.5µm and 980nm share the same ground state. By addressing these two transitions, one could perform simultaneous recording and reading of RF spectra with perfectly overlapping beams, alleviating the geometric constraints of the design.

The internship will be mostly experimental work. High-resolution spectroscopy, including absorption profile measurements and spectral holeburning experiments, will be conducted to assess these materials and approaches.

Methods and techniques: Spectral hole burning, stable lasers, closed-cycle cryostats.

The applicant should have background knowledge in one or several of the following fields: quantum mechanics, light-matter interaction, laser physics, condensed matter physics. A taste for experimental physics and teamwork is expected, as well as a good level of English. Basic programming skills are appreciated (e.g. Matlab).

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