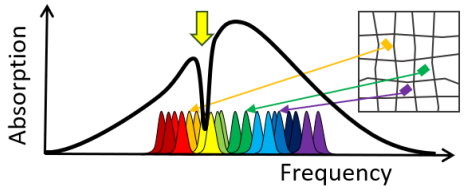
Post-doc position at Institut Langevin

Strain coupling in doped crystals for vibration measurement and quantum optomechanics

The laboratory and the team: Institut Langevin is a joint research unit between ESPCI Paris and CNRS, founded by Mathias Fink in 2009, bringing together researchers from different backgrounds, all driven by the same passion: the study of all possible types of waves. The post-doctoral researcher will join the Atomic Processors team led by Anne Louchet-Chauvet. The team has an internationally recognized expertise in the design and development of original signal processing architectures based on rare-earth-doped materials and high-resolution spectroscopy, with historic applications related to radar technology. The team recently pioneered ultra-sensitive, broadband, cryogenic accelerometry with rare-earth-doped crystals.

Contexts and objectives of the project: We aim to develop rare-earth ion-doped crystals (REICs) as a new hybrid optomechanical platform for quantum science and technology. The project builds upon two key mechanisms of light-matter interaction in these materials: spectral hole burning (SHB) and ions' natural coupling to strain within their host matrix. SHB enables to circumvent the inhomogeneous broadening, characteristic of solid-state quantum emitter ensembles, and fully benefit from the exceptional coherence of rare-earth ions at low temperature [Thiel2011]. Strain coupling results in the sensitivity of the optical transition to mechanical strain (referred to as "*piezospectroscopic effect*"), a sensitivity that can be enhanced by the narrow linewidth of transitions in these systems [Louchet2019]. This coupling is accompanied by a fundamental back-action mechanism, named "*piezo-orbital effect*" [Louchet2023].



Spectral holeburning : a monochromatic laser selectively excites a subset of ions within the inhomogeneously broadened absorption profile.

The project will be organized into two complementary topics:

- A technological topic, leveraging the unique sensitivity of REICs to strain, aiming to develop a high-performance, inertial accelerometer sensor operating at cryogenic temperatures. An enhanced method for detecting atomic line shifts is already being deployed.
- A fundamental topic, with the aim of demonstrating the piezo-orbital effect at low temperatures in REICs. This effect corresponds to the deformation of the doped crystal due to the excitation of the ions it contains. It will be jointly measured using an optical method and through the optimized measurement of piezospectroscopic shifts developed in the first topic.

Start date and duration: The position will start during the summer of 2024 (October 1st at the latest), for a duration of 2 years.

Candidate profile: The candidate should hold a PhD in physics and have strong experimental skills in laser physics and atomic physics. An experience in the field of precision measurements and/or optomechanics will be highly appreciated.
We encourage everyone regardless of age, gender, sexual orientation, religion, disability and ethnicity to apply for the position.

Contact: Send your CV, publication list, motivation letter and references to **Anne Louchet-Chauvet** anne.louchet-chauvet@espci.fr

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