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Thesis on the study of the dynamics of coherent and stable Brillouin lasers

Starting date: October-December 2024
Supervisor: Pascal Besnard
Financial support: acquired
Team: Photonic Systems at Foton Institute, Lannion France
Key-words: Brillouin lasers, frequency noise, coherency, tunable lasers, optical injection, optical feedback

Context

In many photonic systems, the emitter is a laser source, whose noise becomes the main system limitation, even if it can be considered low. Many laboratories in the world study coherent sources to address different areas of applications: fundamental research (quantum, gravitational waves...), defense, telecommunications, environment...

Subject

One of the research topics of Institut Foton is coherent sources. Expertise has been acquired in the fabrication of coherent sources. Our most recent work involves the study of state-of-the-art Brillouin lasers. We have produced highly coherent sources in the C-band, revealing the physics of synchronization using an ultra-coherent source. This type of source offers significant scientific and industrial advances (fundamental study of synchronization processes, instrumentation, optical sensors, quantum sources, etc.).

Research Program

The goal of this work is first to define a laser architecture that can be combined with metrological stability (sub-mHz linewidth for a 200 mHz jitter over a 10 s measurement time). A major objective will be to study the dynamics of these laser sources in terms of modulation, optical feedback and optical injection. The use of highly coherent mode-locked sources will be implemented pending the use of a metrological signal (EQUIPEX T-REFIMEV).

M. Sahni, S. Trebaol, L. Bramerie, M. Joindot, S. Ó Dúill, S. Murdoch, L. Barry, and P. Besnard, "Frequency noise reduction performance of a feed-forward heterodyne technique: application to an actively mode-locked laser diode," Opt. Lett. 42, 4000-4003 (2017).
A. Sebastian, I. V. Balakireva, S. Fresnel, S. Trebaol, and P. Besnard, "Relative intensity noise in a multi-Stokes Brillouin laser," Opt. Express 26, 33700-33711 (2018).
A. Sebastian, S. Trebaol, P. Besnard, "Intracavity Brillouin gain characterization based on cavity ringdown spectroscopy," OSA Continuum, OSA Publishing, 2019, 2 (12), pp.3539-3545.
A. Karuvath, A. Sebastian, P. Besnard, "C-Band tunable Brillouin fiber-laser with sub-Hz intrinsic linewidth," oral presentation Paper 12142-56, Photonics Europe, Strasbourg 2022.

Qualifications

Candidates should have good knowledge in the areas of optics and laser physics. A previous experience in laser physics would be greatly appreciated. The ideal profile would combine interest for experimental work and for modelling and simulation works. Good interpersonal and communication skills in French or English are required. The applicant must hold an internationally recognized Master degree.

Partenariat

Stability will be provided by an atomic transition reference within the framework of an ANR project (Institut Foton, THALES TRT, CNRS LPL UMR7538). This will prepare the experimental and theoretical tools to receive an optical reference signal, allowing us to move towards precise measurements. This optical reference signal of an optical clock is distributed by the French EQUIPEX T-REFIMEV project.

About the Institut Foton (CNRS, UMR6082)

The Institut FOTON is a research unit of the French National Centre for Scientific Research (CNRS) associated to University of Rennes and the National Institute for Applied Sciences (INSA) of Rennes. FOTON is composed of three research teams: the "Optoelectronics, Heteroepitaxy and Materials" (OHM) team, the "laser Dynamics, microwave photonics, Polarimetry, terahertz, imaging" (DOP) team located in Rennes, and the "Photonic Systems" (SP) team located in Lannion. The two cities are located approximatively 170 km apart, in the province of Brittany, Western France. Photonic Systems team (~55 people) is involved in research on laser physics, and in particular on the experimental demonstration of new functionalities that could potentially contribute to overcoming the challenges related to sensors sensitivity, telecom capacity and guided optics (fibers and integrated photonics) in particular for sensing and nonlinear applications. The team has established reputation in the area of laser physics and mid-IR integrated photonics. All the simulation and experimental tools required for the project completion are available within the Photonic Systems Team in Lannion.

The successful candidate will carry out research in Lannion (France).

More information about Institut FOTON can be found at: https://www.institut-foton.eu/en/.

Contact

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Application procedure

Your application should include:

- Cover Letter
- Detailed CV
- Name and contact details of two potential referees with recommendation letters
- Grade transcripts
- List of publications, if applicable