Internship M2 PPN

from 2026 April 1st to 2026 July 31th

Title of the project: Temporal Bragg Grating in nonlinear optical fibres

Supervisor(s): Théo Torres

Laboratory / Department / Team: ICB / Photonique / Safir

Collaborations: J. Fatome, B. Kibler

Summary:

Analogies play a crucial role in physics as they serve as powerful tools for understanding complex concepts, promoting understanding, and fostering creativity. A remarkable analogy is the concept of space-time duality in optics as it allows for the possibility to create temporal reflection [1], the pendant in the time domain to standard reflection from a mirror. Temporal reflections have allowed for the generalisation to the time domain of several spatial phenomena such as waveguiding, focusing and cavities.

The internship will focus on the numerical and experimental exploration of **temporal Bragg gratings (TBG) in optical fibers.** TBG are structures that are periodic in time allowing for the creation of photonic time cristal in optical fibers [2]. In optical fiber, a TBG can be generated from a train of fundamental solitons. We will model the system theoretically using the Non-Linear Schrödinger Equation and compute the band structure using Bloch's theorem. Experimentally, we will aim to observe the band/gap structure of the TBG generated in a single mode fibre at telecom wavelength.

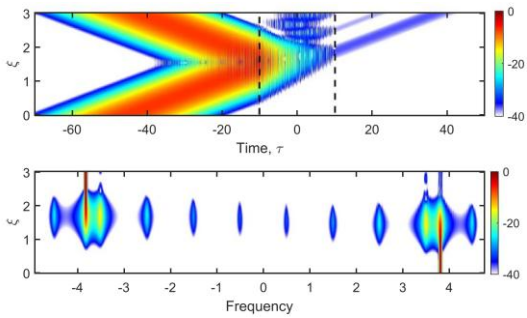

Figure 1 : Example of total temporal reflection from a probe pulse falling inside a momentum gap of TBG taken from [1].

This project will provide advanced training in nonlinear fibre optics, analytical and numerical modelling of spatiotemporal systems and experimental methods in optical fibres.

References:

[1] G.P. Agrawal, "Propagation of optical pulses in a spatiotemporal dispersive medium." Journal of Optics 27.4 (2025).

[2] M. Asgari, *et al*, "Theory and applications of photonic time crystals: a tutorial," Adv. Opt. Photon. 16, 958-1063 (2024).

Type of project (theory / experiment): Theory/Experimental

Required skills: Theoretical (Wave propagation, Bloch theory), **Experimental** (Nonlinear fibre optics)