Master 2 "Systèmes Complexes, Optique, Lasers (SCOL)": Research Training 2022-2023
Master 2 "Matter Molecules and their Environment(MME)": Research Training 2022-2023

Appel à sujet de stage recherche / Call for research training subject

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Topic: Dynamics of Complex Systems (in accelerator based light sources)

Master 2: select the master and the most appropriate option

x Master 2 SCOL	□ Master 2 MME (GP-SCP)
X Option Complex Systems (GP-IKS)	□ Option Condensed Matter
	□ Option Condensed Matter/Pharma
	□ Option Dilute Matter and Spectroscopy
	□ Option Atmospheric Sciences
	□ Option Modeling at the molecular & atomic scales

Control of spatio-temporal instabilities in relativistic electron-bunches circulating in storage rings

Relativistic electron-bunches (i.e. bunch composed of electrons with velocities near the light velocity) are used worldwide as light sources, to produce intense and broadband synchrotron radiation (from THz frequencies to hard X-rays). In these systems, complex phenomena as instabilities appear commonly, in particular due to the interaction of the electrons with their own radiation. Usually this phenomena impose limitations on this type of sources, but sometimes they can also be used as advantages.

In our group, a part of our activities concern the investigation of such complex phenomena in so-called *storage rings*, which are one of most used facilities to produce synchrotron radiation. In these storage rings, when a high number of electrons are used, *micro-structures* appears spontaneously inside an electron-bunch, and permits the emission of a very strong THz radiation, but often with very high fluctuations (and thus not directly usuable as a THz source for synchrotron radiation users).

The subject of this research training concerns the manipulation and the control of the electron-bunch dynamics during this instability, to produce intense or/and regular THz emission. On this subject, important first results were recently obtained, in the frame of a collaboration between the PhLAM laboratory and the Synchrotron SOLEIL (the national synchrotron radiation source) [1]. Thanks to numerical simulations and experimental studies, we have show that it is possible to stabilize some electron-bunch state, using a feedback loop, and thus produce intense and stable THz radiation.

The objective of this training is to investigate – in a first time with numerical simulations – the effects of different type of feedback loops, in order to understand and increase the efficiency of such control

method. Depending on the obtained numerical results, it will be possible to prepare experimental studies at the Synchrotron SOLEIL.

[1] *Stable coherent terahertz synchrotron radiation from controlled relativistic electron bunches*, C. Evain, C.Szwaj, E. Roussel, J. Rodriguez, M. Le Parquier, M.-A. Tordeux, F. Ribeiro, M. Labat, N. Hubert, J.- B.Brubach, P. Roy & S. Bielawski, Nature Physics 15, 635 (2019).

Key words: (no more than 1 line)