

ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

MUR DM 118 - Modelling spontaneous generation of frequency combs states in quantum cascade lasers.

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Dipartimento DET
Supervisor	COLUMBO LORENZO LUIGI - lorenzo.columbo@polito.it
Contact	GIOANNINI MARIANGELA - mariangela.gioannini@polito.it COLUMBO LORENZO LUIGI - lorenzo.columbo@polito.it
Context of the research activity	Modelling spontaneous generation of frequency combs states in quantum cascade lasers and study of their classical and quantum correlation properties for applications to high resolution spectroscopy and/or quantum information/communication. Progetto finanziato nell'ambito del PNRR – DM 118/2023 - CUP E14D23001730006
Objectives	<p>The PhD student will simulate and theoretically analyze the coherent multi-mode dynamics and in particular the formation of Optical Frequency Combs (OFCs) in bipolar semiconductor lasers emitting in the Mid-IR and THz region of the electromagnetic spectrum known as Quantum Cascade Lasers (QCLs) both in the standard Fabry-Perot and in the novel ring configurations. OFCs are a set of equidistant optical lines characterised by low phase and amplitude noise that in recent 20 years have witnessed a rapid progress in applications to high-precision spectroscopy, frequency synthesis, high-data rate optical communications etc..</p> <p>Although their classical and quantum correlation properties are candidate to play an important role in many applicative contexts as in quantum technology, the latter have been scarcely studied so far. The research work of the PhD student will help to fill this gap in the Mid-IR and THz and it will also provide a better understanding of the physical mechanisms behind the OFCs spontaneous formation in the system.</p> <p>In the framework of a novel national network on QCLs meant to create a solid link among the main theoretical and experimental groups working on QCLs from devices modelling to their implementation and characterization, the PhD</p>

student will collaborate with leader researchers in the QCL scientific community at Consiglio Nazionale delle Ricerche – (Istituto di Nanoscienze in Pisa and Istituto Nazionale di Ottica in Firenze) where QCLs are realized and their emission states are characterized and at the Politecnico di Bari where, almost ten years ago, a now consolidated reference model for the study of QCLs dynamics and the OFC formation was proposed and implemented. Moreover, a visiting period of the PhD student may be foreseen at outstanding international research Institutes and Universities such as Harvard University (Cambridge, USA) and Telecom Paris (Paris, France) within already well-established collaboration programs. The project will be carried on under the scientific supervision of Prof. Lorenzo Luigi Columbo and Prof. Mariangela Giovannini at the Department of Electronics and Telecommunications (DET) of the Politecnico di Torino.

Skills and competencies for the development of the activity

- Solid knowledge of modern optics and optoelectronics.
- Experience in numerical calculus using Matlab.
- Good level of English, spoken and written.
- Good attitude towards team-work.