Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

Laboratory name: Laboratoire de Physique de l'Ecole Normale Supérieure (LPENS)
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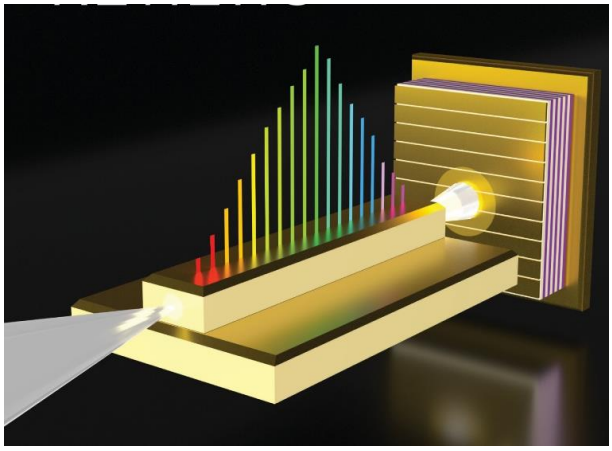
Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: Ecole Doctoral

THz Quantum Optics with Quantum Cascade Lasers

Quantum technology (QT) platforms, capable of exploiting non-classical states of atoms, light and solid-state systems, have been recently conceived in a variety of strategic fields, such as communication, computation, information, sensing and metrology. Successful achievements in the visible and in the near-infrared parts of the electromagnetic spectrum, has led to recent advancements in miniaturized and compact geometries. This, in turn, has enabled the implementation of highly-integrated quantum platforms and motivated the extension of QT to non-conventional spectral regions, whose peculiar features are still underexploited. In this regard, QT migration to the terahertz (THz) frequency range is technologically challenging, although of huge technological potential. In fact, the peculiar features of THz radiation, e.g. transmissivity through otherwise opaque materials, or robustness with respect to Rayleigh scattering, can potentially allow a plethora of frontier applications, such as quantum-secured fast digital data transfer in opaque or harsh environments (dust, smog, particulate) or quantum-enhanced sensitivity in spectroscopic and metrological THz setups.



Here we will develop a miniaturized solid-state platform for generation, detection and complete characterization of non-classical squeezed states of THz frequency light. This will exploit THz quantum cascade laser (QCL) frequency combs (FCs) as nonlinear sources and cavity-coupled coherent detectors. QCLs are the most efficient miniaturized lasers at THz frequencies. FC generation, based on four-wave mixing (FWM) processes that take place within the gain medium, render QCLs as ideal candidates for the generation of multi-mode squeezed states of light, due to the presence of quantum-correlated side-band modes.

The successful achievement of the project goals will be, by nature, disruptive, assessing fundamental knowledge in the strategic fields of THz photonics and QT.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: NO