Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 29 Oct 2018

Responsable du stage / *internship supervisor*:

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Nom du Laboratoire / *laboratory name*:

Code d'identification : UMR 8551 Organisme : Laboratoire Pierre Aigrain

Site Internet / *web site*: www.lpa.ens.fr

Adresse / *address:* Ecole Normale Supérieure, 24 rue Lhomond, 75005 Paris

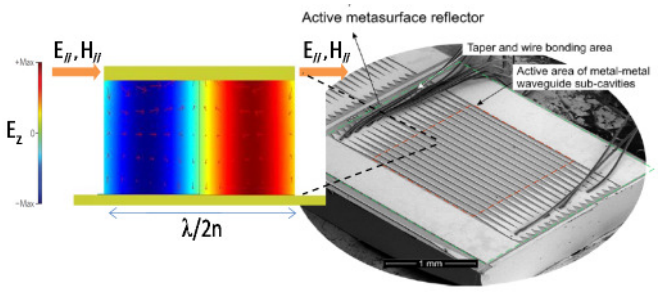
Lieu du stage / *internship place*: Ecole Normale Supérieure, 24 rue Lhomond, 75005 Paris

Titre du stage / *internship title*: **Meta-material Terahertz amplifier**

Résumé / *summary*

Context: THz waves (1-10 THz) are non-ionizing radiation that can potentially find applications in a variety of domains. The most promising at this time are THz imaging and spectroscopy since THz rays interact with matter with unique fingerprints. Although there have been many technological advances both academically and in industry, **there is currently no practical amplifiers of THz radiation available**.

Internship Subject: Although quantum cascade lasers (QCLs), novel sources based on intersubband transitions, operate in the THz frequency range, QCL-based amplifiers cannot be reliably implemented because it is exceedingly difficult to implement anti-reflection coatings for the laser facets. Hence, a vertical geometry appears to be a potential solution for a THz amplifier. However, vertical emission cannot be directly exploited in QCLs because intersubband transitions are only coupled to transverse magnetic (TM) waves, i.e. with electric field perpendicular to the surface. A solution is to implement sub-wavelength diffractive structures, like photonic crystals or metasurfaces, to couple a normal incident wave to TM waves in the active medium (see below figure). Following this analysis, the goal of this project is to realize a **broadband Vertical Cavity Semiconductor Optical Amplifier (QC-VCSOA)** based on a THz QCL structures. It will consist of an active medium made of an electrically pumped microstructured semiconductor/metal hetero-structure. This proposal will be based on the engineering the bandstructure of QCLs for broad spectral gain and its refractive index dispersion to realise new structures for the amplification of short THz pulses. The potential student will acquire skills in design of complex quantum and electromagnetic structures, and an experimental background in condensed matter and ultrafast physics in newly accessible spectral regions.



Meta-surface geometry. Resonator array integrated with THz QCL for vertical based THz amplifier (figure source: L. Xu et al, Appl. Phys. Lett. 107, 221105 (2015). Inset: **Schematic of wavelength dimensioned resonator.** A 1D metal-active region-metal 1D resonator with size λ/2n supports a fundamental mode that radiates vertically as a dipole

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : YES**

Si oui, financement de thèse envisagé/ *financial support for the PhD*: **ANR funded (funding obtained)**

Lumière, Matière, Interactions	x	Lasers, Optique, Matière	x