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 : October 8th, 2018

Responsable du stage / *internship supervisor*:

Nom / *name*: Delga — Prénom/ *first name* : Alexandre

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Nom du Laboratoire / *laboratory name*: III-VLab

Code d'identification : — Organisme : Thales Research and Technology

Site Internet / *web site*: www.3-5lab.fr

Adresse / *address:* 1 av Augustin Fresnel 91116 Palaiseau Cedex

Lieu du stage / *internship place*: Palaiseau

Titre du stage / *internship title*: **Electronic transport in the light-matter strong coupling regime for mid-Infrared quantum devices**

Context

Optoelectronic devices usually operate in a weak coupling regime, where quanta of light and matter are electrons and photons. Nevertheless, in strongly coupled quantum systems, the light-matter interaction becomes so strong that new quasi-particles called polaritons appear. These half-material half-light hybrid particles, originally discovered in excitonic semiconductor systems in 1992 [1], have since been extensively studied and demonstrated in other fields including inter-subband polaritons [2].

Despite numerous unique quantum properties (stimulated emission, Bose-Einstein condensation ...), today there are very few polariton-based devices outside of laboratories. Indeed, the electrical injection of this kind of systems remains an unresolved problem: in essence, we do not understand how to pass from a Hamiltonian of "bare" electronic states to that of states "dressed" by the light, following the famous terminology of Cohen-Tannoudji. And therefore we do not know how to design devices using this phenomenon. This is the subject of the thesis which this internship will be the first part.

The system considered will be that of quantum cascade detectors (QCDs) [3], which are a model system for which the weak coupling electronic transport is very well understood, and whose III-V Lab is one of the world specialists.

[1] C. Weisbuch et al, Phys. Rev. Lett. 69, 3314 (1992)

[2] L. Sapienza et al, Phys. Rev. Lett. 100, 136806 (2008)

[3] L. Gendron et al, Applied physics letters 85.14 (2004): 2824-2826.

Missions et objective of the internship

For years, the III-VLab has developed METIS, a unique software for transport simulation in semiconductor heterostructures, which will be the basic tool of the thesis. In order to tame the theory and this design tool written in C ++, the internship will first be devoted to developments in the light-matter weak coupling regime: non periodic stuctures, optical noise…

This simpler problem will allow the candidate to master of all the aspects of "classical" numerical simulation and electronic transport in semiconductors, prerequisites necessary before the qualitative leap implied by the problem of transport in strong coupling. The candidate will have the opportunity to create the architecture of the functionalities he will introduce into the tool, from the definition of the user interfacing to the implementation of new algorithmic structures, as well as benchmark his/her prediction against actual measurement of QCD devices.

Your profile

Required skills: Interest for theory and simulation. Intellectual rigor and thoroughness, Semi conductor physics, Electronic transport.

Desired skills: Telecom Object oriented programming**,** Infrared, Quantum Cascade structures

Language : English, (French)

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : Yes, favored option**

Si oui, financement de thèse envisagé/ *financial support for the PhD***: CIFRE**

Lumière, Matière, Interactions		Lasers, Optique, Matière	

*Fiche à transmettre (fichier pdf **obligatoirement**) sur le site http://stages.master-omp.fr*