Université Lille Nord de France
Pôle de Recherche et d'Enseignement Supérieur

Ecole doctorale régionale Sciences Pour l'Ingénieur
Lille Nord-de-France - 072

Titre Thèse	Quantum nanophononics at low temperature: towards heat manipulation at the nanoscale	
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Financement prévu	Contrat Doctoral Etablissement	~~ULille~~ ☐ ~~UPHF~~ ☐ ~~Centrale Lille~~ ☐ JUNIA ☐
	Région – Autre ☐	Contrat de recherche ☐ Préciser : ANR HANIBAL
Financement acquis ? ☐ OUI	Contrats de Recherche ☐ Préciser ANR HANIBAL	Autre ☐ Préciser

Résumé du sujet :

General Scope: Phonons, just like electrons, are known to be quantum particles. In a macroscopic material, this quantum nature of the phonons is hidden by the fact that the typical size of the sample is by far larger than the typical wavelength of the phonons. Just like in optics, in this situation, no spectacular effect of the quantum nature of the phonons can be expected. But if you now reduce the dimensionality of a heat conductor down to the limit of the phonon wavelength, then the quantum nature of the phonons should dominate their behaviour: this is a new field of research in which new concepts are still emerging. In this internship, we will focus on how this confinement changes the phonon behaviour and thus the heat transport in 2D structures (membrane) or 1D (nanowires). As an example, let us ask what happens when the dimensions of the conductor are comparable with the wavelength of the phonons, how can we describe the transport of phonons in such structures? The answer is quite subtle, and is related to the transmission of the wavefunction of the phonons through the structure. The most direct evidence of such a wave-nature of the heat transport in such small systems would thus lie in the appearance of plateaus each time the width of the conductor equals an integer times the wavelength of the phonons. This evidence for the quantum nature of heat transport at low temperature is still not clearly experimentally given.

Research topic and facilities available: the topic of this thesis holds on the design, modeling and fabrication of crystalline silicon nanosctructures and thermal sensors. The measurements will be performed at room-temperature using Raman thermometry and at Low-T at Institut Néel, Grenoble. The candidate will get involved in the HANIBAL project. He will design and fabricate in a clean-room environment, the first building blocks of the sensors and nanostructures.

Possible collaboration and networking (HANIBAL ANR Project): Collaborations with both theoreticians and experimentalists: Natalio Mingo (CEA-Liten, Grenoble), Olivier Bourgeois (Néel, Grenoble).

Required skills: good background micro-nanotechnology, electronics, physics. Applicants should send a CV, and if available Master results record.

Starting date: Sept/Oct 2021.