Research Grants for PhD students from the China Scholarship Council

Information Form (please read the guidelines carefully on the website www-csc.utt.fr)

Supervisor's name : MERCHIERS Given names : Olivier

Status (prof., assistant prof., …) : Assistant Professor, at INSA Lyon

Laboratory : Micro and nanoscale heat transfer (MiNT) group Website address : https://cethil.insa-lyon.fr/en/node/52

Institution : CETHIL (Centre for Energy and Thermal Sciences of Lyon) - National Institute for Applied Website address : https://cethil.insa-lyon.fr/en

Scientific competence of the supervisor:

Thermal radiation, electromagnetic approach, infrared spectroscopy, radiative energy harvesting and conversion

Two major publications in the field proposed for the PhD :

1. Thermal radiation at the nanoscale and applications, P.-O. Chapuis, B.J. Lee, A.W. Rodriguez, Applied Physics Letters 123, 220401 (2023)
2. Temperature-dependent and optimized thermal emission by spheres, K.L. Nguyen, O. Merchiers, and P.-O. Chapuis, Applied Physics Letters 112, 111906 (2018)

Website address of the personal page : https://cethil.insa-lyon.fr/fr/content/merchiers-olivier

Supervisor's email : olivier.chapuis@insa-lyon.fr

Description of the research work proposed for a PhD ***Topic # (see list) :*** I-15

Title : Thermal radiation at the nanoscale and implications for energy-conversion applications

Subject :

Thermal radiation is one of the main heat transfer mechanisms with heat conduction and heat convection, which exists even in absence of matter. It allows to harvest power, for instance from the sun by photovoltaic means. At usual macroscopic scale, one can neglect many electromagnetic features of the thermal-radiation carriers (photons) which are considered as particles, but this is not possible at nanoscale, where interference and sub-wavelength effects, including photon tunneling, enter into play. In particular, the heat exchanged between two bodies becomes huge when they are brought very close, in what is known as near-field thermal radiation exchange. Predicted 50 years ago, these effects have been demonstrated experimentally in the last ten years. Since important quantity of energy is exchanged, it is interesting to try to convert it in electricity, in energy-harvesting devices. We have demonstrated experimentally that devices with 15% efficiency can be used to harvest power as high as 10 kW.m-2 in near-field thermophotovoltaic devices (see Lucchesi et al., Nano Letters, 2021). We therefore measure in the same time the energy exchange between hot and cold bodies, and the power converted into electricity in a photovoltaic cell placed at the sample location. Such experimental work is backed by advanced numerical modelling based on electromagnetism and thermodynamics (see Legendre et al., arXiv:2402.07527, 2024).

Keywords :

Thermal radiation; electromagnetism; Fourier-transform infrared spectroscopy

Expected collaborations :

Institutions dealing with advanced electromagnetic approaches. Co-advising at CETHIL with P-Olivier CHAPUIS.

Background required from the applicant :

Mechanical, electrical engineering or physics. Numerical simulations. Electromagnetism.

Existence of a PDF file detailing the proposal ("yes" or "no") : no

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