# 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 : December 19, 2018*

**Responsable du stage** / *internship supervisor*:

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|---|---|
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**Nom du Laboratoire** / *laboratory name*: **INSTITUT LANGEVIN**

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| Code d'identification :UMR7587 | Organisme :ESPCI |

Site Internet / *web site*: https://www.institut-langevin.espci.fr/subwavelength_physics_swap

Adresse / *address:* **1 rue JUSSIEU, 75005 Paris**

Lieu du stage / *internship place*: **Institut LANGEVIN, 1 rue JUSSIEU, 75005 Paris**

## *FROM THE NEAR FIELD OF NANO-ANTENNAS TO THE FAR FIELD OF INFRARED METASURFACES*

Developments in nanostructuring capabilities has led to fascinating effects in optics such as black gold, invisibility, negative refraction. Metasufaces made of arrays of cleverly designed nano-antennas allow one to tailor the optical response of a surface (reflectivity, absorption, transmission) while requiring only a surface texturing with a thickness of 1/100 of the wavelength. It is possible to produce a surface which is perfectly absorbing at selected wavelengths, while being reflecting in other regions of the spectrum. The main challenges to address now are to tailor the spectral, angular, and polarization responses with a higher level of complexity for applications such as infrared detection, stealth, radiative cooling,



*Metasurface made of an array of nano-antennas*

etc. This requires to design and organize nano-antennas to produce a metasurface with an optimized measurable response in the far field. The most classical way is to produce a periodical array, but some applications require to suppress any signature of a grating in the far field response, or to optimize the interaction between the nano-antennas, and thus to control their near-field properties. **To reach this goal, it is crucial to study the behavior of single nano-antennas or the near-field interactions within a small group of nano-antennas.**
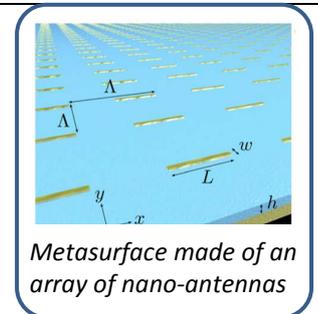
The proposed research project will be developed within a collaboration between Institut LANGEVIN and ONERA/DOTA (Patrick Bouchon and Riad Haidar). The student will benefit of complementary competences from the two institutes: Institut LANGEVIN develops unique near-field and far-field investigation methods, while ONERA/DOTA has high competences in modeling and fabrication of nano-antennas and metasurfaces. **So far, we have characterized the electromagnetic properties of a single nano-antenna in the infrared by measuring its thermal emission, both in the near field and in the far field using super-resolved imaging [1] and a recently developed method of infrared spatial modulation spectroscopy [2]. The PhD project that we propose will be the continuation of this work: our goal is now to deepen our knowledge of single antennas with different geometries, and to investigate how they couple together when they are placed in near-field interaction. The research activities of the student involve conception and modeling, the development of novel experimental techniques, and the experimental near-field and far-field measurements of systems with single or a small number of coupled antennas.**

[1] Y. De Wilde et al., NATURE, 444, 740 (2006).

[2] C. Li et al., PHYSICAL REVIEW LETTERS, 121, 243901 (2018).

Methods and techniques: Advanced infrared microscopy and spectroscopy methods at sub-λ scales, electromagnetic modeling and conception of nano-antennas.

**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*: **Half the fellowship is already available from ONERA, and will be consolidate by a second half (DGA, Labex, ONERA, or ED PIF).**

| Lumière, Matière, Interactions | X | Lasers, Optique, Matière | X |
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