Research Topic for the ParisTech/CSC PhD Program

Subfield: Applied Physics, electromagnetism, optics and plasmonics

ParisTech School: Institut Langevin, ESPCI Paris, PSL

Title: Wave propagation in artificial media structured at subwavelength scale

Advisor(s): Abdelwaheb Ourir (a.ourir@espci.fr), Agnès Maurel (agnes.maurel@espci.fr)

Short description of possible research topics for a PhD:

Artificial materials can provide properties beyond those found in nature. These materials are promising solution for the realization of original, efficient and miniaturized devices in microwaves and optics. Our team has realized theoretical and experimental research in this domain that spreads from fundamental explorations of physics to actual device design. We have developed efficient techniques for the modelization and the characterization of this type of materials, which allow us to propose nowadays original applications, for instance in telecommunications and imaging.

Theoretical consideration in the infrared domain is mostly achieved for corrugated surfaces of a real metal leading to the propagation of spoof plasmons. Although there have been papers considering spoof plasmon losses and geometry dependence, the question of how these effects modify propagation and localization of such waves is still open. The qualitative picture showing the dependence of spoof plasmon propagation on metal skin depth, which in addition to diffraction is the main channel of loss, is needed.

The candidate will be involved in the modelization and in the characterization of wave propagation in periodic artificial materials. He/She will study the propagation of waves in complex media, composed of an arrangement of many sub-wavelength cells, the arrangement being periodic or more complex. These media can be homogenized such that they are described in terms of homogeneous anisotropic properties. This approach will be used to provide the dispersion relations of artificial materials. Microwave and Infrared experiment will be achieved to characterize such propagation. The candidate will be working on our research projects. He/She will contribute particularly to the design and implementation of new devices based on these materials for different applications.

Required background of the student: The candidates need to be familiar with electromagnetism and optics. Knowledge of photonics and metamaterials is a plus.

Representative publications of the group:

A. Ourir, A. Maurel, S. Félix, J.-F. Mercier, and M. Fink, "Manipulating light at subwavelength scale by exploiting defect-guided spoof plasmon modes", Physical Review B 96, 125133, 2017.

A. Maurel, J-J. Marigo and A. Ourir, "Homogenization of ultrathin metallo-dielectric structures leading to transmission conditions at an equivalent interface", Journal of the Optical Society of America B, Vol. 33, No. 5, 2016.

A. Ourir, B. Gallas, L. Becerra, J. de Rosny and P. R. Dahoo, "Electromagnetically Induced Transparency in Symmetric Planar Metamaterial at THz Wavelengths", Photonics, , 2, 308-316, 2015.

A. Akarid, A. Ourir, A. Maurel, S. Félix & J-F. Mercier, "Extraordinary transmission through subwavelength dielectric gratings in the microwave range", Optics letters 39 (13), July 1, 2014.