"Study of Metasurface Waveguides with a Method of Moments"

Keyword: Numerical methods, method of moment, metasurfaces, antennas, periodic problems.

A master internship position is offered at Sorbonne University, GeePs laboratory, in Paris (duration of 4 to 6 months, depending on candidate availability), with a possibility to pursue a PhD afterwards.

Context: Higher data rates and shared platforms among users are stimulating a revolution in technologies for the next 5G standards and satellite communications. New antennas are required at millimeter waves (30 GHz or higher), being wide-bandwidth, light-weight, low-cost. Unfortunately existing technologies are currently very bulky, lossy, heavy, and expensive.

To overcome these limitations, new devices based on artificial surfaces (metasurfaces) are emerging. Metasurfaces are formed by a periodic distribution of objects on a surface (Fig. 1), modifying the electromagnetic behavior of the waves propagating on it. Metasurfaces can realize artificial flat lenses, focusing the field where required (Fig. 2).

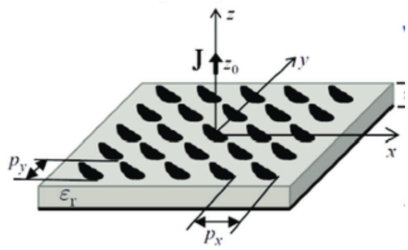

Fig. 1 Example of a periodic metasurface from [1].

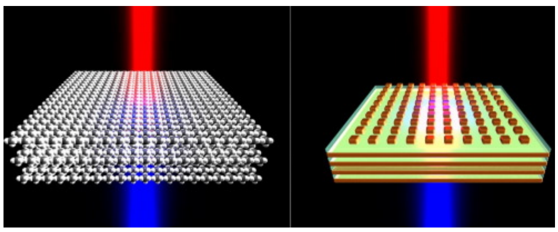

Fig.2 Metasurfaces modifying an incident field, from [2]

Internship: In this internship, a numerical method based on the Method of Moments (MoM) will be developed for the study of a parallel plate waveguide whose plates are covered with 1-D periodic metasurfaces. The code will discretize with a piecewise linear meshing a unit cell of the surface and enforce an electric-field integral equations with periodic boundary conditions (Fig. 3).

We want to use this code in order to find the modes (both bound and radiating) supported by the periodic metasurface. The code will be validated at first by illuminating the metasurface with a plane wave, and comparing the result with commercial software (such as CST). The bounded modes of a closed waveguide metasurface will be then be computed and validated with results available in literature. Finally, radiation from an open waveguide will be investigated.

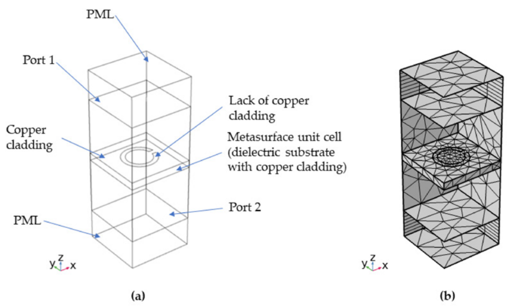

Fig. 3 Example of unit cell of a metasurface and its meshing with triangular basis functions from [3].

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Requirements

- The applicant should be enrolled in a master program with a strong background in electromagnetic devices or electromagnetic theory.
- She/he should have successfully validated a unit of Numerical Methods. Knowledge of MoM is not necessary, but would be helpful.
- The applicant should have good knowledge of C and Matlab.
- The candidate should be highly motivated, autonomous, and willing to pursue her/his career with a PhD.

Duration: 4 to 6 months.

Scholarship

A scholarship of about 600€ per month will be provided as well as guidance in finding an accommodation.

Place of the internship

The applicant will work at Sorbonne University, GeePs laboratory (https://www5.geeps.centralesupelec.fr/) at Campus Pierre et Marie Curie, located in Paris (Métro Jussieu).

Starting date

Anytime between January and April 2023 (The potential PhD should start afterwards, between September and November 2023).

Supervisor:

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[1] A. H Gangaraj and F. Monticone, "Molding light with metasurfaces: From far-field to near-field interactions," *Nanophotonics*. Vol. 7, 2018.
[2] A. Krasnok, M. Tymchenko, and A. Alù, "Nonlinear metasurfaces: a paradigm shift in nonlinear optics," *Materials Today*, vol. 21, no. 1, 2018.
[3] P. Lopato and M. Herbko, "Evaluation of Selected Metasurfaces' Sensitivity to Planar Geometry Distortions," *Applied Sciences*, vol. 10, no. 1, p. 261, Dec. 2019.