PROPOSITION DE SUJET DE THESE

Intitulé : MetaRadar

Référence : **DPHY-DEMR-2026-4**
(à rappeler dans toute correspondance)

Début de la thèse : 01/10/2026	**Date limite de candidature :** 01/04/2026

Mots clés

Metasurface, modulation spatio-temporelle, diodes

Profil et compétences recherchées

Ingénieur ou Master II avec des connaissances en électromagnétisme et électronique

Présentation du projet doctoral, contexte et objectif

In 2000, the concept of metamaterial, *i.e.*, materials with properties beyond that of conventional materials, appeared. First in microwaves, then optics, all the way to acoustics and even mechanics. In the last 20 years, this concept has evolved on several occasions and has each time given rise to original inventions, such as the perfect lens [1] or the invisibility cloak [2]. In the last 10 years, the 2D version of metamaterials, metasurfaces, has become prevalent due to a much easier fabrication.

In microwaves, the search for unconventional properties has led to an increasing integration of electronics onto metasurfaces. First came passive electronic components, then active ones. At the beginning, integration of active electronics was meant to achieve controllable properties with a DC voltage by switching globally from one state to the other [3]. Afterwards, integration went further with the ability to switch locally, at the unit cell level, from one state to the other, *i.e.* space modulation [4]. Recently, application of an AC voltage, up to several MHz, allowed not just switching but continuous variation, *i.e.* time modulation [5]. Nowadays, space-time modulation, which can shape the entire space-time spectrum, is an intense topic of research for next-generation communication or defense systems.

The goal of this PhD is to investigate a radar architecture based on space-time-metasurfaces (STM) and recently proposed [6]. In this bistatic radar, both receive and transmit chains can be replaced by a specific metasurface. On the receiver end, analog signal processing can alleviate the need for high-speed ADCs while, on the transmitter end, waveforms can be changed in real-time. Possible avenues of investigation include, but are not limited to, full-polarization metasurfaces, noise waveforms, pre-distortion. Key technological bottlenecks will have to be identified to estimate the use cases best suited to this novel technology (vehicles, drones, etc.).

Références

[1] J. B. Pendry, « Negative refraction makes a perfect lens » (2000).
[2] D. Schurig *et al.*, « Metamaterial electromagnetic Cloak at Microwave Frequencies » (2006).
[3] Y. Dong and T. Itoh, « Metamaterial-based antennas » (2012).
[4] T. J. Cui *et al.*, « Coding metamaterials, digital metamaterials and programmable metamaterials » (2014).
[5] L. Zhang *et al.*, « Space-time-coding digital metasurfaces » (2018).
[6] S. R. Wang *et al.*, « Simplified radar architecture based on information metasurfaces » (2025).

Collaborations envisagées

SONDRA

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