

Master internship position (M2)

Internship location: Institut de Physique de Nice (INPHYNI)
17 rue Julien Lauprêtre, 06200 Nice, FRANCE
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Salary: ~ 600 €/months

PhD thesis possibility after internship: **YES** (ANR project under review)

Helicity-Preserving Scattering and the Onset of Localization in Disordered Microwave Media

Context The HELIX project aims to explore the role of helicity conservation in electromagnetic transport through disordered media. Recent theoretical work suggests that when scattering preserves the helicity (handedness of circular polarization) of electromagnetic waves, Anderson localization can be inhibited, leading to a form of topological delocalization. This phenomenon has never been experimentally tested. The proposed internship will contribute to the preliminary design and modeling steps required to build a microwave platform capable of investigating this effect.

Objectives The intern will participate in the initial phase of the project, focusing on the design and characterization of helicity-preserving scatterers (dual or quasi-dual meta-atoms) in the microwave regime. The work will involve both theoretical and numerical aspects: understanding the conditions for duality symmetry and helicity preservation, simulating electromagnetic scattering by individual resonators, and studying the collective response of small disordered assemblies.

Work program Review the fundamental concepts of electromagnetic duality, helicity, and Anderson localization. Use numerical simulation tools (open-source solvers) to calculate the scattering matrices of proposed resonators combining electric and magnetic dipolar modes. Evaluate helicity conversion metrics and identify geometries that minimize helicity relaxation. Investigate how disorder (random spatial arrangements) modifies scattering and transport properties. If time allows, compare the numerical predictions with available experimental data from the microwave laboratory.

Expected outcome The internship will provide the first quantitative assessment of candidate scatterer designs suitable for helicity-preserving random media. It will yield simulation data and analysis tools that will directly guide the fabrication of prototypes and the subsequent experimental phase of the HELIX project.

Supervision and environment Hosted at INPHYNI (Université Côte d'Azur, Nice), the intern will work within the Waves in Complex Systems group, and will benefit from collaborations provided by two Brazilian theory teams. The internship will combine training in wave physics, computational electromagnetism, and topological photonics, offering the student a solid introduction to both the conceptual and experimental dimensions of modern wave localization studies.

Profile We are looking for candidates who are highly motivated to conduct research and have a keen interest in fundamental physics, particularly wave physics.