UNIVERSITÉ CÔTE D'AZUR

INPHYNI
INSTITUT DE PHYSIQUE DE NICE

cnrs

Master internship position (M2)

Internship location: Institut de Physique de Nice (INPHYNI)
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Salary: ~ 600 €/months
PhD thesis possibility after internship: **YES** (Funding under review)

Critical scaling of the bandgap appearance in 2D disordered photonic materials

Context Historically, photonic crystals and the concept of photonic bandgap were introduced in the seminal works of Yablonovitch and John in the 1980s[1]. Even if natural examples exists (for instance in the blue iridescent wings of the Morpho butterfly), the first experimental realizations were done in the microwave regime by drilling holes in epoxy resin[2], and over the last 15 years, significant progresses in the micro and nano fabrication have been achieved enabling the availability of 3D materials with gaps or pseudo-gaps in the near-infrared[3]. Nevertheless, despite a considerable amount of work reporting the measurement of photonic band gaps in different regimes (optical, infrared or microwave), an explanation of when to expect or not to expect a band gap is still lacking. Furthermore, even when a bandgap does exist, it is unclear exactly at which frequency it will occur and how wide it will be.

Objectives Using bandgap computation and critical scaling, LFP and GA already have preliminary results in this direction[4] and the efforts need to be pursued. In particular, following the previously cited paper that deals with the bandgap frequency and width fluctuations in two-dimensional hyperuniform dielectric materials, we propose to explore the idea of a possible continuous phase transition in the appearance of the bandgap.

Work program The intern will first have to review the fundamental concepts of bandgap formation in photonic crystals and be familiar with finite size analysis of critical phenomena. He will then use numerical band solver to compute the statistics of frequency and frequency widths of the bandgaps for different disorder. If time allows, he will also deals with different ways of introducing correlated disorder in the 2D systems, or even pursue the study in 3D.

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 a collaboration with the Soft Matter and Photonics group based in Fribourg through a recently funded International Research Project (2027-2030, funded by CNRS) between the two groups. The internship will combine training in wave physics, computational physics, and statistical physics, offering the student a solid introduction to modern wave transport 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 and statistical physics.

[1] E. Yablonovitch. *Phys. Rev. Lett.* **58**, 2059 (1987); S. John. *Phys. Rev. Lett.* **58**, 2486 (1987).
[2] E. Yablonovitch, T. J. Gmitter, and K. M. Leung. *Phys. Rev. Lett.* **67**, 2295 (1991).
[3] S. Aeby, G. J. Aubry, L. S. Froufe-Pérez, and F. Scheffold. *Adv. Opt. Mater.* **10**, 2200232 (2022).
[4] L. S. Froufe-Pérez, G. J. Aubry, F. Scheffold, and S. Magkiriadou. *Opt. Express* **31**, 18509 (2023).