Master in Photonics – "PHOTONICS BCN"
Master ERASMUS Mundus "EuroPhotonics"

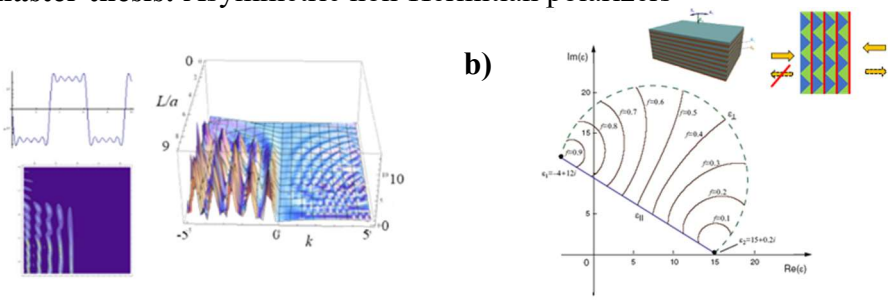
MASTER THESIS PROPOSAL

Dates: December 2023 – June 2024

Laboratory: DONLL group, Nonlinear Dynamics, Nonlinear Optics and Lasers
Institution: UPC, Universitat Politècnica de Catalunya
City, Country: Terrassa, Catalonia

Title of the master thesis: Asymmetric non-Hermitian polarizers

a) **b)**



Asymmetric reflection of polarized light, a) Above: refractive index profile in space and asymmetric reflection as a function of the transverse wavenumber and structural parameters b) Asymmetric polarizer

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Keywords: Non-Hermitian optical systems, Parity-Time symmetry, metamaterials, asymmetric polarizers

Summary of the subject:

Aim: asymmetric left-right reflectors and polarization-selectors based on non-Hermitian Photonics

Project. Classical polarizers are based on material anisotropies at the atomic or molecular level giving rise to dichroism and birefringence. Furthermore, structured materials and metamaterials presenting anisotropy can show effective permittivity strongly dependent on the orientation of light polarization relative to the metamaterial periodicities or to the orientation of asymmetric scatters.

Aside, structured media provide the momentum compensation for the scattering of waves. It is well-known that micro- and nano-scale modulations of the refractive index may lead to spatial control over light propagation. The management of the field propagation by photonic crystals (spatial modulations of the refractive index) has been a novel research line for the control of the light flow, giving remarkable light effects.

The advent of non-Hermitian Photonics, combining both, refractive index and the gain-loss profiles, represents a new platform for a smart control of light. Yet, non-Hermitian structures allow the introduction of directional couplings between waves leading to unidirectionalities in light management. Such directional couplings applied to a multidimensional space create directivity fields strongly enhancing the possibilities of light management. Thus, non-Hermitian photonics is amongst the most fertile grounds in optics [1].

From the recent work at the DONLL group [2,3], we now propose to design non-Hermitian metamaterials showing asymmetric reflections and transmissions along with polarization-sensible asymmetric reflectors.

[1] El-Ganainy, R., Khajavikhan, M., Christodoulides, D. N., & Ozdemir, S. K. (2019). The dawn of non-Hermitian optics. Communications Physics, 2(1), 37.
[2] Ahmed, W. W., Herrero, R., Botey, M., Wu, Y., & Staliunas, K. (2021). Inverse-design of non-Hermitian potentials for on-demand asymmetric reflectivity. Optics express, 29(11), 17001-17010.
[3] Ahmed, W. W., Herrero, R., Botey, M., Wu, Y., & Staliunas, K. (2020). Restricted Hilbert transform for non-Hermitian management of fields. Physical Review Applied, 14(4), 044010.

Additional information:

* Allowance only for candidates enrolling before the end of 2023.
* Workplace flexibility (in the working hours and dates).
* Recommended skills: Programming (C++, MatLab,..), self-motivated student.
* Miscellaneous: International environment with collaborations with foreign universities
* Possibility of joining the DONLL group for a PhD
* Expected outcome: one scientific publication