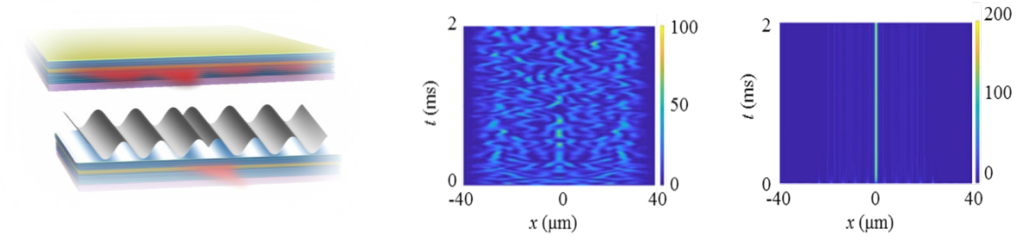
MASTER IN PHOTONICS – "PHOTONICS BCN"
Master ERASMUS+ "EUROPHOTONICS"

MASTER THESIS PROPOSAL

Dates: December 2023 - June 2024

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

Title of the master thesis: PT-Symmetric arrays of Edge Emitting Lasers



Schematic of a BAS-laser array with a PT-axisymmetric geometry with a bright and narrow output beam. Turbulent output in unmodulated EELs and localized field output in modulated EELs

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

Keywords: Semiconductor Lasers, PT-symmetry, Non-Hermitian Photonics

Summary of the subject:

Aim: Asymmetric coupling between neighboring lasers in a semiconductor laser array.

Project. Controlling the flow of electromagnetic fields has been the subject of an intensive research over the time. In recent years, the research of the DONLL group has been working in non-Hermitian Photonics for a smart control of light [1,2,3,4].

Non-Hermitian Photonics, an in particular PT-symmetric systems [5] has recently attracted a significant attention deriving from the parity and time symmetry breaking in complex optical systems, referred as PT-symmetric systems. Those systems may eventually hold a nontrivial effect: the unidirectional flow of light. This new concept provides a powerful mechanism to dynamically shape probe fields, and such precise control may have potential novel implications in actual physical systems.

In the DONLL research group, we also explore applications of non-Hermitian Photonics into the actual laser technology [3] and optical fibers [4].

The proposed project goes precisely in this last direction of implementing this new concept into actual Edge Emitting Laser (EEL) arrays. The project aims at improving the brightness of these EEL arrays by implementing a PT-axisymmetric geometry in their coupling to shape and stabilize the output beam, as schematically shown in Fig. (a). Preliminary numerical results with a simple paraxial model already led to promising results for the case of a Broad Area Semiconductor lasers, see Fig. (b).

This study is in the framework of international collaborations of the DONLL group, eventually involving several photonic companies from Lithuania and Catalonia. Thus, the candidate is expected to collaborate with international partners.

[1] 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.
[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] Pardell, J. M., Herrero, R., Botey, M., & Staliunas, K. (2021). Non-Hermitian arrangement for stable semiconductor laser arrays. Optics express, 29(15), 23997-24009.
[4] Akhter, M. N., Ivars, S. B., Botey, M., Herrero, R., & Staliunas, K. (2023). Non-Hermitian Mode Cleaning in Periodically Modulated Multimode Fibers. Physical Review Letters, 131(4), 043604.
[5] El-Ganainy, R., Khajavikhan, M., Christodoulides, D. N., & Ozdemir, S. K. (2019). The dawn of non-Hermitian optics. Communications Physics, 2(1), 37.

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