



Master in Photonics – “PHOTONICS BCN” Master ERASMUS Mundus “EuroPhotonics”

MASTER THESIS PROPOSAL

Starting full time from April 2025

Presentation at the end of July or beginning of September 2025

Laboratory: Quantum Nano-Optoelectronics (QNOE)

Institution: ICFO (The Institute of Photonic Sciences)

City, Country: Castelldefels (BARCELONA), Spain

Title of the master thesis: EXPLORATION OF RHOMBOHEDRAL MOIRÉ STRUCTURES IN 5L, 6L GRAPHENE LAYERS

Name of the master thesis supervisor and co-supervisor:

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(for external proposals a co-supervisor from the Master program and a collaboration agreement is needed)

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Keywords:

Summary of the subject (maximum 1 page):

Recent developments in the study of rhombohedral 5L, 6L, and higher-layer graphene structures have garnered significant interest within the scientific community. At the latest conference, prominent researchers dedicated comprehensive discussions to the properties of 5L graphene coupled with hexagonal boron nitride (hBN), highlighting numerous open questions that remain in this field. This project proposes to explore these rhombohedral structures through Scanning Near-field Optical Microscopy (SNOM) and Raman spectroscopy, building on recent findings (referenced in arXiv:2401.17779).

The primary goal of this Master's project is to identify and isolate rhombohedral 5L, 6L graphene layers to explore their electronic properties, particularly focusing on higher Chern number bands ($|C|=5$). These bands are hypothesized to be ideal quantum geometric platforms, which, under strong interactions, can break degeneracy and generate $|C|=1$ Chern bands hosting Fractional Quantum Anomalous Hall (FQAH) states at very low temperatures. Initial experiments will involve



using a single metallic local back gate to apply a non-zero displacement field, allowing for preliminary investigations into the feasibility of stabilizing fragile phases with light, potentially at higher temperatures. This approach, while ambitious, leverages cutting-edge techniques and recent discoveries in light-induced ferroelectricity, offering a promising avenue for groundbreaking research in quantum materials.

Objectives:

Additional information (if needed):

- * Required skills:
- * Miscellaneous: