



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: Polarized Light Applications and Technologies

Institution: Universitat de Barcelona

City, Country: Barcelona, Spain

Title of the master thesis: Spatial Dispersion in Natural Crystals

Name of the master thesis supervisor and co-supervisor: Supervisor Oriol Arteaga (co-supervisor: Subiao Bian)

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

Email address: oarteaga@ub.edu

Phone number: 645452569

Mail address: Dep. Física Aplicada, Universitat Barcelona

Keywords: spatial dispersion, polarization, polarimetry, dielectric function

Summary of the subject (maximum 1 page):

Spatial dispersion (SD) represents a cutting-edge frontier in material science, describing how a material's dielectric response varies with wavevector, even when the frequency remains constant. This phenomenon challenges the assumption that materials with highly symmetric crystal structures always respond isotropically to electromagnetic waves. SD implies that the electromagnetic behavior of a material depends not only on the wavelength but also critically on the direction of wave propagation—an aspect often overlooked in isotropic media.

In metamaterials, where the structural elements are on the scale of the wavelength, SD effects are prominent and have been extensively studied. However, in conventional materials, with constituent particles far smaller than the wavelength of light, these effects are traditionally weak and largely disregarded. What makes this field particularly exciting and challenging today is recent polarimetric evidence revealing measurable SD effects even in single crystals. These findings push the limits of what we understand about light-matter interactions in natural materials, marking a rare opportunity to pioneer new measurement techniques and theoretical frameworks. Engaging with SD in standard materials not only advances our grasp of fundamental optical properties but also opens up possibilities for novel applications in photonics and material design.



Objectives:

This primarily experimental work will involve conducting polarization-resolved measurements on single crystals. The objective is to discern SD parameters that impact the material's dielectric properties while differentiating them from other factors, such as stress. We have suitable polarimeters available for these measurements and have also established a new theoretical framework for simulations, enabling a thorough investigation into the material's electromagnetic response.

Additional information (if needed):

* Required skills: Interest in all aspects related to the polarization of light. Good programming and experimental skills in optics are desirable.

* Miscellaneous: After completing the Master Thesis, there is the possibility of developing a PhD thesis in the field of polarized light / polarimetry. Funding opportunities are possible depending on the interest and commitment of the candidate.