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

MASTER THESIS PROPOSAL

Full time from April 2026 (it can start part time from February 2026)
Presentation date to be chosen: end of July or beginning of September 2026

Laboratory: Department of Electronics and Biomedical Engineering
Institution: Universitat de Barcelona (UB)
City, Country: Barcelona, Spain

Title of the master thesis: Experimental characterization of magneto-optomechanical resonators

Name of the master thesis supervisor and co-supervisor:
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Keywords: Cavity Optomagnonics, quantum magnonics

Summary of the subject (maximum 1 page):
The ability to measure low amplitude and broadband frequency range magnetic fields has revealed to be crucial for nanoscale magnetic applications and plays an important role in many areas such as geology, space exploration, biology and medical imaging.
Recently, we [Ref1] have demonstrated the ability of using an optomechanical systems to detect very small forces induced by a magnetic field with pico-Tesla sensitivity.
Numerous opportunities may arise based on the above experiment. From a fundamental point, magnons (spin-waves) are gathering increasing attention in condensed matter physics (e.g. magnonics and spin caloritronics areas) as a means of processing spin information and managing heat in nanoscale structures [Ref2]. Our hybrid-system can be also exploited to understand further the physics of phonon-magnon coupling in YIG or other ferromagnetic and magnetostrictive materials.
The student will perform an experimental characterisation of the magneto-phononic-photonic systems such as:

1) A basic experimental characterisation of the magneto-optiomechanical resonators using an optical tapered fiber for optical excitation and detection.
2) A study of the coupled system composed of the spherical optical-mechanical resonators [Ref3] coupled to a YIG magnetic resonator.

References (https://scholar.google.es/citations?user=mpGW1zwAAAAJ&hl=en; (http://navarrourrios.com/Publications.html)):

[1] M. F. Colombano, G. Arregui, F. Bonell, N. E. Capuj, E. Chavez-Angel, A. Pitanti, S.O. Valenzuela, C. M. Sotomayor-Torres, D. Navarro-Urrios, M. V. Costache, "Ferromagnetic resonance assisted optomechanical magnetometer", Physical Review Letters, 125, 147201 (2020)

[2] F. Giustino, …, M. V. Costache, …, S. Roche., "The 2021 quantum materials roadmap ", Journal of Physics: Materials 3 (4), 042006 (2021)

[3] A. Toncelli, N. E. Capuj, B. Garrido, M. Sledzinska, C. M. Sotomayor-Torres, A. Tredicucci, and D. Navarro-Urrios, "Mechanical oscillations in lasing microspheres", Journal of Applied Physics, 122, 053101 (2017); doi: http://dx.doi.org/10.1063/1.4997182

Objectives:

- To perform a complete optical characterization of the of an yttrium iron garnet (YIG) sphere and detect the optical transduction of thermally activated magnons.
- To perform a complete optical characterization of glass spheres coupled mechanically to ferromagnetic substrates and detect the optical transduction of thermally activated magnons.
- To demonstrate the optical transduction magnons excited resonantly using a microwave antenna.

Outcomes:

Getting prepared for a PhD project and/or position. The final master report can culminate in a publication.

Additional information (if needed):

* Required skills: Some knowledge of waveguide, fibre optic and RF operation is recommended. The work will be primarily experimental, so good skills and interest in doing laboratory work is also recommended.