



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: SPLIT-RING RESONATORS FOR VIRTUAL PHOTON
ENGINEERING

Name of the master thesis supervisor and co-supervisor:

Frank Koppens, Ekaterina Khestanova

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

Email address: Frank.Koppens@icfo.eu, Ekaterina.khestanova@icfo.eu

Phone number:

Mail address:

Mediterranean Technology Park

Av. Carl Friedrich Gauss, num. 3

08860 Castelldefels (Barcelona), Spain

Keywords:

Summary of the subject (maximum 1 page):

The electromagnetic field vacuum fluctuations are one of the key features of quantum field theory and have significant implications for our understanding of nature at all levels: from the atomic (Lamb shift in hydrogen atom) to the fundamental structure of the universe (dark energy is hypothetically related to the vacuum field fluctuations). The proposed project is aimed at harnessing the virtual vacuum field photons via their confinement in split-ring resonators [1]. This involves finite-element simulations of split-ring resonators of a specific geometry, their fabrication by means of optical and electron beam lithography and further testing with the available spectroscopy techniques. Further these confined virtual photons may be used to tackle new ground states in the quantum paraelectric SrTiO₃ [2, 3].

[1] Appugliese et al., Science, 2022, Vol 375, Issue 6584, pp. 1030-1034

[2] Ashida et al., Physical Review X, 2020, Vol 10, Issue 4, pp. 041027

[3] Curtis et al., Phys. Rev. Research, 2023, Vol 5, Issue 4, pp. 043118



UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

UAB
Universitat Autònoma
de Barcelona



UNIVERSITAT DE
BARCELONA

ICFO



Erasmus+

Objectives:

Additional information (if needed):

* Required skills:

* Miscellaneous: