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ICFO
The Institute
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Sciences



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

MASTER THESIS PROPOSAL

Dates: April 2021 - September 2022

Laboratory: Atomic Quantum Optics (Mitchell group)
Institution: ICFO – The Institute of Photonic Sciences
City, Country: Castelldefels (Barcelona), Spain

Title of the master thesis:

Name of the master thesis supervisor and co-supervisor: Morgan Mitchell / Michael Tayler

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Phone number:

Mail address:

Keywords: Quantum sensing, atomic sensing, light-atom interactions, optical magnetometry.

Summary of the subject (maximum 1 page):

Our group studies the interactions between light and the quantized states of electrons in atoms. The electronic states of alkali atoms, in particular, can be extremely sensitive to magnetic fields, where fields down to 10^{-15} tesla can be detected. This high sensitivity enables atom-based magnetometers to make an impact in healthcare - such as imaging neural currents inside the brain, or detecting arrhythmic activity of fetal hearts - and other sectors including navigation and timekeeping.

Our lab develops new ways to improve atomic magnetometer performance, as well as new applications.

- (1) We use microfabricated atomic cells, targeted at wearable devices for the healthcare sector;
- (2) We develop “quantum enhancement” approaches, such as polarization squeezing, that have the potential to surpass standard quantum noise limits in magnetometers;



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- (3) We apply optimal signal-tracking approaches, such as a Kalman filtering, to magnetometry
- (4) We apply magnetometers to detect magnetic activity of biological systems, e.g, muscle
- (5) We apply magnetometers as sensors for magnetic resonance imaging (MRI) of soft matter
- (6) We investigate techniques to transfer alkali atoms polarization to nuclear spin species in inert gases (e.g. ^{129}Xe , N_2 , ^3He), for use in gas-phase imaging applications

The student will have the opportunity to learn about cutting-edge devices in quantum sensing and magnetometry within the environment of an international research team. The project will be experimentally focused, allowing the student to address a scientific question. Some fluency in programming is required (C/C++, python, MATLAB or Mathematica) for data analysis and to perform simulations of the experiment on a computer.

Please see the group webpage for recent publications <https://mitchellgroup.icfo.eu>

Additional information (if needed):

- * Required skills :
- * Miscellaneous :