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ICFO
The Institute
of Photonic
Sciences

Erasmus+

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

MASTER THESIS PROPOSAL

Dates: April 2021 - September 2022

Laboratory: Quantum Optics Theory/Ultrafast Dynamics Quantum Solids

Institution: ICFO – The Institute of Photonic Sciences

City, Country: Castelldefels, Spain

Title of the master thesis: Coherent X-ray Imaging of Dynamics in Quantum Materials

Name of the master thesis supervisor and co-supervisor: Dr. Allan Johnson and Prof. Maciej Lewenstein

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Keywords: ultrafast, femtosecond, quantum materials, phase change materials, X-rays, lensless imaging, computational imaging

Summary of the subject (maximum 1 page):

The behaviour of many physical and biological systems is ultimately governed by their dynamics at the nanoscale. Optically driven quantum materials are expected to exhibit complex nanoscale phase dynamics, including domain nucleation, wall motion, and the emergence of non-equilibrium phases.

We have recently developed the first method capable of measuring nanoscale phase dynamics in quantum materials at the femtosecond time scale [1,2], using X-ray coherent diffractive imaging spectroscopy at a free electron laser (unpublished). In this project you will analyse data already taken at synchrotron and X-ray facilities in order to understand the laser-induced phase transition in vanadium dioxide (VO_2) and vanadium trioxide (V_2O_3). Using iterative reconstruction algorithms you will convert raw diffraction patterns into real-space spectrograms and analyze the spatial dynamics of the nanoscale domains during both the thermal and laser-driven transitions, shedding light on the fundamental mechanisms of phase transitions. There may be opportunities for travel to facilities for additional experiments.

[1] A.S. Johnson et al., Sci. Advances 7 (33), eabf1386 (2021)

[2] L. Vidas et al, Nano Letters 18 (6), 3449-3453 (2018)

Additional information (if needed):

* Required skills: Python programming, Fourier optics

* Miscellaneous: Ultrafast optics a plus