CONTRATOS PREDOCTORALES 2022 SEVERO OCHOA

PROJECT TITLE / JOB POSITION TITLE:

Light-matter interactions in quantum solid-state nanodevices

JOB POSITION RESEARCH LINE:

RL, General.- FUNCTIONAL OR MULTIFUNCTIONAL NANOSTRUCTURED MATERIALS

RESEARCH PROJECT / RESEARCH GROUP DESCRIPTION:

The manipulation of quantum states using light is of interest for applications in quantum technologies, particularly, the control of spin states in solids and molecules using electromagnetic fields. Recently, we found optical signatures of spin-inversion driven by light in some manganites (Ref. [1]). Furthermore, using a group-theoretical approach, we have been able to describe accurately the microscopic processes that enable a control of the spin using electromagnetic fields (Ref. [2]). Crucial ingredients are spin-orbit coupling and Jahn-Teller instabilities related to strong coupling of electronic and phononic degrees of freedom. In the present project we intend to further develop this research along the following directions:

a) Use (magneto)-optical spectroscopy to analyse the properties of a wide range of materials in which spin-orbit coupling and Jahn-Teller physics is relevant. These include, among others, single and multilayered manganites, cuprates and heavy transition metal compounds. The objective is to identify materials where spin-photon coupling is most efficient.

b) Study the dynamics of light-matter interactions in these solids using ultrafast optical spectroscopy. The objective is to analyse the lifetime of optically induced excitations and their dynamics down to the femtosecond scale. This will be done in the frame of an ongoing collaboration with Dr. Allan Johnson (ICFO).

c) Develop nano/mesoscopic devices that exploit electromagnetic control of spin states. We propose electric transport modulation by electromagnetic fields at resonance frequencies where spin inversion occurs. The objective is to develop quantum nanodevices where spins are controlled by light.

The present project aims at expanding the range of quantum materials, with emphasis on the use of light to modulate and control their properties.

[1] Casals et al., Phys. Rev. Lett. 117, 026401 (2016)

[2] A.S. Miñarro, G. Herranz, arXiv:2207.06501 (Phys. Rev. B in press)

Campus de la Universitat Autònoma de Barcelona
08193 Bellaterra, Catalunya, Espanya
Telf.: +34 935 801 853
Fax.: +34 935 805 729

JOB POSITION DESCRIPTION:

All required infrastructure and equipment is found at the host Institution (ICMAB-CSIC) and its immediate environment, as well as through a collaboration with ICFO. The successful candidate will be trained in materials synthesis and nanodevice fabrication. This involves growth of thin films (nanometer scale) by pulsed laser deposition with in-situ RHEED, and access to the ICMAB clean room for device fabrication down to 100 nm and below, using optical and electron-beam lithography. The host group has also an extended experience in measuring electrical transport under magnetic fields for nanodevice characterization. The host laboratory also includes optical setups that allow (magneto)-optical spectroscopy and imaging, using light in the visible and near infrared in a wide range of frequencies (400 – 900 nm). (Magneto)-optical spectroscopy will be carried out as a function of temperature (10 – 320 K). The lab also includes a confocal microscope that allows diffraction-limited lateral resolution (a few hundreds of nanometers). Ultrafast optical collaboration will be done in collaboration with Dr. Allan Johnson at ICFO. The ultrafast dynamics of quantum materials at ICFO has an amplified titanium sapphire laser system and optical parametric amplifiers allowing for ultrafast spectroscopy with down to 30 fs temporal resolution at wavelengths from 400-2700 nm. Supercontinuum probing from 500-750 nm simultaneously allows tracking a range of excitations simultaneously in an optical cryostat enabling measurements down to 77K.

The supervisor of the project will provide all the necessary means for the successful candidate to attend schools and relevant international scientific meetings and workshops. Candidates should be fluent in English, with a background in optics and condensed matter physics. Programming and mathematical skills as well as enthusiasm for Science are more than welcome.

GROUP LEADER:

Dr. Gervasi Herranz Casabona, https://orcid.org/0000-0003-4633-4367, Google Scholar
Email: gherranz@icmab.cat
Research project / Research Group website: https://mulfox.icmab.es/, https://gherranz.wordpress.com/