## PROBIST - BIST Postdoctoral Fellowship Programme

PROBIST is a post-doctoral fellowship Program lead by the Barcelona Institute of Science and Technology. All together, 61 fellowships will be awarded and implemented in top research in the Barcelona and Tarragona area (Spain).

BIST brings closer together seven independent Catalan internationally recognized research centres.

PROBIST applicants will have complete research freedom. Applicants may subscribe to one or several generic research topics published with the calls. Once pre-selected they may design their research project proposal with a research group of their choice in the participating BIST centres. Successful candidates will be hosted by the selected research group. They will have full access to facilities, seminars and training programmes of the BIST centres. Networking activities shall facilitate inter-centre and inter-disciplinary exchange and collaborations. PROBIST will offer fellows the opportunity to opt for secondments from a pool of international institutions with which BIST centres have institutional agreements or collaborations.

## ICN2 has the following topics in this PROBIST Call:

### 1. Theory and Simulation Group

Group Leader: Pablo Ordejón

Keywords: Density Functional Perturbation Theory, phonons, thermal transport, thermoelectrics

Description: Development of computational tools for ab initio determination of electron-phonon interactions and their effects on thermal properties of materials. Applications to materials for thermal management and thermoelectric devices, ideally in contact with experimental groups at ICN2 and other collaborating centres.

### 2. Ultrafast Dynamics in Nanoscale Systems (UDNS) group

Group Leader: Klaas-Jan Tielrooij

Keywords: Ultrafast dynamics, nanoscale, 2D materials, charge transport, heat transport

Description: The ICN2 group 'Ultrafast Dynamics in Nanoscale Systems' studies phenomena that take place at short timescales (down to the femtosecond level) and spatially at the nanoscale. We experimentally study the interplay between light, charge, heat and spin using various state-of-the-art optical and optoelectronic techniques. We are particularly interested in systems with reduced dimensions, such as two-dimensional layered materials (graphene and related), which offer an interesting and rich playground with a host of ultrafast phenomena that can be tailored and combined at will through relatively straightforward nanofabrication and synthesis techniques. Part of our work is funded through a prestigious ERC Starting Grant on thermal transport in 2D materials. The understanding we establish through our experiments serves as a basis for exploring promising photonic and optoelectronic applications, in fields ranging from ICT to light harvesting.

## 3. Physics and Engineering of Nanodevices Group

Group Leader: Sergio O. Valenzuela

Keywords: Topological Insulators, 2D materials, 2D magnets, spin-orbit torque, molecular beam epitaxy

Description: Recent years have seen an unprecedented progress in the design and engineering of artificial materials using layered 2D materials and topological insulators. Such systems, dubbed van der Waal (vdW) heterostructures because of the characteristic weak interaction between its layers, comprise stacks of selected 2D materials to achieve specific functionalities. The improvement of the quality in the atomically smooth interfaces has further shown that the properties of the heterostructure can be fine-tuned by means of proximity effects. The PROBIST fellow will investigate the growth and structural properties of van der Waals heterostructures comprising topological insulators. The fellow will further study topological quantum effects and spin-torque transport properties when combined with (2D) ferromagnets, in close contact with our collaborators at Spintec (Grenoble), and correlate the results with the interface properties within the heterostructure and possible proximity effects. A working knowledge of instrumentation development, growth of materials by molecular beam epitaxy, structural and magnetic properties characterization (XRD, XMCD, etc) and high-field and low temperature transport are required as well as of device nanofabrication and implementation of spin generation and detection methods.

## 4. Advanced Electron Nanoscopy

Group Leader: Jordi Arbiol

Keywords: Atomic resolution AC-(S)TEM, EELS, 4D-STEM, Materials Science, Nanotechnology

Description: The postdoc hired with this position will be in charge of taking care of the follow up during the installation of the new double corrected STEM at the ICN2 platform to be installed in the ALBA Synchrotron. After being installed, the researcher in the position will take receive the training courses offered by the company who provides the STEM and the different detectors. After the training the applicant will take care of the training to the new users and also of offering help on the analyses, as well as developing his/her own research (possible topics of research to be discussed depending on the postdoc skills: e.g.: 4D-STEM mapping of the electron momentum in 1D and 2D quantum materials at the atomic scale, 3D in-situ analyses of energy nanomaterials, ...). We are searching for someone with proved experience on aberration corrected and monochromated STEM. Strong experience on EELS and 4D-STEM and the use of segmented and pixelated detectors.

## 5. Theoretical and Computational Nanoscience

Group Leader: Stephan Roche

Keywords: Topological quantum matter, spintronic, quantum transport simulations, quantum technologies

Description: The research will focus on exploring, from theoretical and computational perspectives, the spin transport properties in magnetic topological insulators, which are materials of current

considerable interest for developing novel paradigms in quantum metrology and in the context of quantum phases transition.

The project will include various objectives, including the modelling of three-dimensional models of (magnetic) topological insulators using effective Hamiltonians (such as the Fu-Kane-Mele model) and introducing the effect of magnetic impurities as well as magnetic proximity effects. These models will enable investigating the formation of the quantum anomalous Hall effect and its robustness to disorder or other device geometry considerations, as well as the spin dynamics of injected particles on the surface of magnetic topological insulators. The typical theoretical tools to be developed and used can be found in the following recent works of the host group (PM Perez-Piskunow, S Roche, Physical Review Letters 126 (16), 167701 (2021); Z. Fan et al. Physics Reports 903, 1-69 (2021).

The theoretical work will be conducted in close collaboration with the experimental group of S.O. Valenzuela at ICN2 and in the framework of an enlarged European consortium including pioneers of topological insulators physics

APPLICATIONS PROCEDURE: All the applications have to be via the PROBIST website: https://bist.eu/education/probist/