Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

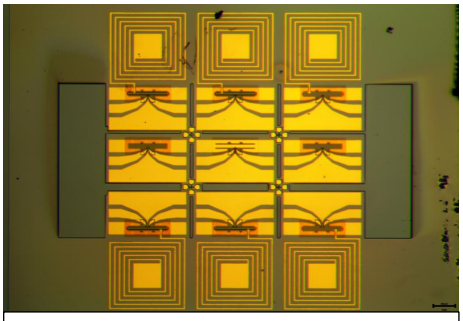
(One page maximum)

Laboratory name: Laboratoire de Physique de l'ENS
CNRS identification code: UMR 8023
Internship director'surname: E. Bocquillon / B. Plaçais
e-mail: erwann.bocquillon@ens.fr Phone number: 01.44.32.25.46
Web page: https://www.lpens.ens.psl.eu/erwann-bocquillon/
Internship location: LPA, ENS 24, rue Lhomond, 75005 Paris

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding:

Dynamics of topological edge states

In recent years, a new class of materials called topological insulators has emerged, with spectacular properties inherited from the topological properties of their band structures. Electron transport occurs in these materials via boundary spin-polarized conducting states while the bulk remains insulating. In two-dimensions, the quantum spin Hall and quantum anomalous Hall effects, with their unidimensional edge states at zero magnetic field, fall in this category. The extraordinary properties of these materials have opened prospects for novel spintronics without ferromagnets exploiting the spin polarization of the edge states, or for the emergence of exotic Majorana quasiparticles which could serve as a platform for topological quantum computation.



GHz resonators made of topological edge states

In this context, the purpose of the project is to explore the dynamics of topological edge states, in the normal regime in which spin currents can be created, or in proximity with a superconductor where Majorana excitations should emerge. Our investigations will combine standard low-frequency measurements with dynamical transport techniques in the GHz range, which offer a very powerful toolbox to explore topological matter. Recent developments in our group [1] have for example shown that microwave techniques enables to identify, isolate and enhance the response of topological edge states.

This internship will aim at implementing further time- and frequency-resolved measurements to unveil the properties of edge plasmons in QSH and/or QAH resonators in a normal regime, before expanding them, on a longer term, to hybrid devices mixing edge states and superconductors.

The implementation of this project is supported by an ERC Starting Grant and a DIM SIRTEQ grant. A collaboration with the Molenkamp group (University of Würzburg) gives access to HgTe quantum wells, a system that has offered clear and diverse signatures of topological transport.

[1] M.C. Dartiailh *et al.*, Physical Review Letters **124**, 076802 (2020)

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: NO