

INTERNSHIP PROPOSAL

Laboratory name: Laboratoire de Physique des Solides
CNRS identification code: UMR8502
Internship director's surname: Richard Deblock, Sophie Guéron
e-mail: richard.deblock@universite-paris-saclay.fr Phone number: 0169155313
Web page: <https://equip2.lps.u-psud.fr/meso/>
Internship location: Laboratoire de Physiques des Solides
Bât. 510, 1 rue Nicolas Appert 91405 ORSAY Cedex, France
Thesis possibility after internship: YES Funding: YES

Revealing topological helical edge states in topological insulators

Topological Insulators (TIs) hold great promise for making novel electronic devices, thanks to the existence at their boundaries of topologically protected conduction channels. Due to strong correlation of electrons spin and momentum, backscattering is prevented leading to ballistic transport. These edge states thus constitute highway for electrons. Unfortunately, the expected topological protection has turned out to be less robust than anticipated, notably due to the existence of conduction in the bulk. This complicates the fundamental study of the edge states, and motivates the search for different TIs.

During this internship/PhD, we will explore more recently discovered topological materials that are better suited to the discovery of 1D states, because they have fewer trivial states or their topological character is tunable. This is the case of Bi₄Br₄, a second TI with high bulk gap and WTe₂ in the few layer limit. The internship/PhD will involve nanofabrication and quantum transport experiments at low temperature. With normal electrodes, the quantization of the longitudinal conductance is a hallmark of ballistic transport, which is difficult to measure due to the many trivial states and/or the disordered nature of contacts obtained on 1D states. Nonetheless, mesoscopic signatures such as Aharonov-Bohm oscillations demonstrated 1D ballistic transport. We will strive to demonstrate quantized conductance, particularly in gateable TIs. With superconducting contacts induced superconductivity strongly enhances the relative contribution of the topologically protected edge states. This allows probing the location of supercurrent-carrying states by Josephson interferometry and measuring the current-phase relation of the junction in an asymmetric DC squid setup. This provides valuable information on the ballisticity. Finally, contact in the tunnel regime will allow probing the density of states of the system and its energy levels via Coulomb Blockade spectroscopy.

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