INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Laboratoire de Physique des Solides
CNRS identification code: UMR8502
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Thesis possibility after internship: YES Funding: YES

Revealing topological helical edge states in the topological insulator Bi_4Br_4

Topological Insulators (TIs) hold great promise for making novel electronic devices, thanks to the existence at their boundaries of topologically protected conduction channels. 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 with a reduced contribution of the non-topological bulk states. Among newly discovered TIs, Bi_4Br_4 appears to be a very promising material, with a large bulk gap (larger than 100 meV), and experimental indications of a Second Order Topological Insulator (SOTI) character. SOTIs are topological insulators with (d-2)-dimensional topological states, d being the dimension of the bulk. In the case of Bi_4Br_4, current should be carried without dissipation at the hinges of the crystal or at the edge of atomic terraces by helical states, which are counter-propagating ballistic states with a spin orientation locked to that of the propagation direction.
We propose during this internship to explore these hinge states using an atomic force microscope (AFM) with advanced imaging modes that could reveal edge states at room temperature. Preliminary experiments have shown that the conducting AFM mode can evidence edge conduction paths in a Bi4Br4 crystal. One of the tasks will be to distinguish surface from edge conduction. A different mode, the Electrostatic Force Mode, will also be employed to determine if the transport through these edge states is ballistic, by visualizing where the potential drops in a crystal with an applied voltage bias.
The intern may also join quantum transport experiments at low temperature. Such experiments, either dc or ac, will mostly be performed in the regime of induced superconductivity through the SOTI, and signatures of the helical states should appear in the form of quantum interferences induced by a magnetic field.

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