INTERNSHIP PROPOSAL

Laboratory name: Laboratoire de Physique des Solides
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Thesis possibility after internship: YES
Funding: YES

Fluctuations of supercurrent carried by topological insulator edge states

Discovery of topological matter has triggered an intense research work motivated by the emergence of promising features among which the existence of helical ballistic edge states. For 2D systems or 3D high order topological insulators (TI), they form one dimensional conducting channels on the edges with two time-reversed spin-momentum-locked states which do not backscatter. A given projection of the spin is locked to the propagation direction, theoretically preventing any backscattering. The topological protection manifests itself in the supercurrent which appears when the TI is connected to superconducting electrodes. Our project aims at investigating the poorly understood dynamics of helical edge states, determining their relaxation mechanisms and the robustness of their topological protection in superconducting junctions as well as in isolated TI.

We have proved that finite-frequency supercurrent response to a magnetic flux as well as the supercurrent noise at equilibrium contain clear signature of the relaxation mechanism in the GHz regime for non-topological junctions. For topological edge states, the expected millisecond lifetime calls for experiments below the MHz to detect the current fluctuations.

We propose for the internship to use our new ultrasensitive GMR-based (Giant Magnetoresistance) magnetic field sensor to detect the supercurrent carried by the helical edge states as well as its fluctuations at equilibrium. Using nanolithography, the student will fabricate and deposit the junctions made from TI material (WTe_2, BiBr) on the GMR sensor fabricated in a CEA lab. The GMR response is then measured at very low temperature in a dilution refrigerator (mK) with low noise electronic technics.

Methods and techniques:

The experiments will combine different techniques available in our group:

1-Nanofabrication using conventional technique

2 – Characterization of the samples with AFM, SEM observation and possibly STEM.

3 - Low temperature magnetotransport measurements in a cryo-free dilution refrigerator equipped with a 3-axis magnet.

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: YES