Quantentransport in topological materials

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PhD may follow: Yes

Summary :

The main purpose of the internship is to understand at the fundamental level the different unconventional phenomena that are present in newly discovered 3D topological semimetals using original experimental studies. Thus, the trainee will be involved in characterization measurements (resistivity, thermoelectric power, specific heat ...) at very low temperature and high magnetic field, the analysis of the data, and in the improvement of the experimental device. It will also be able to collaborate with the other people of the laboratory who make complementary measurements on these same compounds and it will be possible to carry out to carry out experiments on large instruments (LNCMI ...).

Full description :

Conventionally, band theory classifies materials as insulators, semiconductors or metals based on the presence (or not) and the size of an energy gap between the conduction band and the valence band. The semimetals are metals that are between semiconductors and metals. They are characterized by a weak overlap in energy between the valence band and the conduction band at particular points of the Brillouin zone, the most famous example being the graphene (2D). The 3D equivalent of graphene is the topological semi-metal grouping Dirac semimetal (Cd3As2, Na3Bi...) and Weyl semi-metal (TaAs, NbAs ...). The particular points of the Brillouin zone, for which the conduction and valence bands are touching, are called nodes Weyl (or Dirac points). Near these points, the energy dispersion as function of the electronic wave vector k is linear in the three directions of space forming Dirac cones. The richness of these materials comes from the presence of these Weyl nodes around which the electron wave function will acquire an exotic topological phase or Berry phase. Topological aspects are eagerly looked for such because they produce new phenomena such as topological surface states and could be used for future applications in spintronic and quantum transport. The main objective of the project is to understand at a fundamental level the various unconventional phenomena that are present in the topological 3D semimetals with original experimental studies. The PhD student will have the possibility to participate in crystal growth. We will also try to grow thin films of these materials and to performed detailed studies depending on the geometry of the samples. Uniaxial and hydrostatic pressure will be used to fine-tune the Fermi level. The candidat will have to perform various kinds of measurements (resistivity, thermoelectric power, specific heat...) at very low temperature and high magnetic field, data analysis, and improving the experimental device. To attend the quantum limit of these materials, experiments will be performed at the high magnetic field laboratories in Grenoble and Toulouse.

Requested skills :

instrumentation, experimental physics, solid state physics