

**Call for application for research scholarships  
for post-graduate international candidates  
RESEARCH PROJECT N. 52**

**Title:**

**Topological Materials and applications to Spintronics**

**Scientific responsible (name, surname, role)**

Fabrizio Dolcini, Aggregate Professor ([fabrizio.dolcini@polito.it](mailto:fabrizio.dolcini@polito.it))

**Short description of the research activity (max 250 words)**

Topological Materials are currently on the spotlight of research in Physics. Theoretical predictions and experimental observations have shown that some materials with strong spin-orbit coupling exhibit, at the boundary of an insulating bulk, the appearance of conducting electronic channels where the direction of motion is tightly connected to the spin orientation. This phenomenon, which can be mathematically described as a topological transition of the Hamiltonian, is expected to yield a dramatic boost to spintronics, the research field exploiting the spin degree of freedom of electrons -rather than charge- to encode information and perform operations. The advantage is that spin is much less affected by dissipation and decoherence than charge, tackling the problem of device heating, allowing to design smaller transistors and capacitors, and increasing the possibility to realize error-free computation in the near future.

The purpose of this project is to develop a theoretical modelling for these materials aiming to compare with experiments of leading international laboratories and to propose setups to observe novel effects. In particular, taking into account both the hottest topics of the international community at the actual starting time of the training period, and the interests of the applicant, the research will focus on spin-orbit 1D nanowires, edge states of 2D quantum spin-Hall systems or Weyl 3D semimetals. We shall primarily look at out-of-equilibrium properties (electron and spin current, thermal transport, noise), in stationary and/or time-dependent regimes.

**Specific requirements (experiences, skills)**

The research project should be carried out within the Nanophysics and Quantum Systems group at DISAT. The applicant should be a highly qualified and motivated student, interested in theoretical physics, with a sound background in Quantum Mechanics and possibly in Condensed Matter Physics. The research project will definitely involve analytical calculations based on Schrödinger and/or Dirac Hamiltonians (depending on the system and the regimes), but it may also involve the writing of computer codes for numerical computations/simulations. An expertise in computer programming will thus be positively acknowledged. Interested students are requested to contact Dr. Fabrizio Dolcini ([fabrizio.dolcini@polito.it](mailto:fabrizio.dolcini@polito.it))

**Website of the research group (if any)**

[www.polito.it/nqs](http://www.polito.it/nqs)

**Keywords (min 3, max 6)**

Condensed Matter Theory, Topological materials, Spintronics, Electron Transport, Dirac fermions

**Research Area (max 1)**

Physics