Institut de Nanociència i Nanotecnologia

UNIVERSITAT DE BARCELONA

Recent Advances on Spintronics

by Prof. Fèlix Casanova, CIC nanoGUNE (Donostia)

April 5th, 9.00-11.00h - Room 325 (3th Floor Faculty of Physics)

The integration of the spin degree of freedom in charge-based electronic devices has already revolutionized both sensing and memory capability in microelectronics. A second generation of devices is now envisioned in which pure spin currents (a diffusive flow of spins with no net charge flow) could be used instead, with several proposals that advance towards the integration of spin logics and memory. This could represent a post-CMOS paradigm in electronics with faster data processing speed, non-volatility and lower power consumption, with its enormous social and economic impact.

In this tutorial, which will be divided in two sessions, we will overview the concept of pure spin currents and how they can be i) generated/detected, ii) transported and iii) manipulated, which are the key ingredients for a functional spintronic device.

During the first session (9.00-9.50h), we will introduce the basic concepts to understand pure spin currents (two-current model, spin accumulation); explain electrical spin injection using ferromagnetic materials, one of the first and most used mechanisms of spin generation; discuss the mechanisms of spin transport in different materials; and review different approaches to manipulate spin currents (Hanle effect, Rashba effect). Finally, I will discuss some spin-based logic proposals.

During the second session (10.00-10.50h), we will focus on the spin Hall effect (SHE), which is a very relevant alternative to generate/detect pure spin currents. We will explain the different mechanisms giving rise to SHE and the relation with the well-known anomalous Hall effect; the different techniques used to quantify SHE; novel spin-dependent phenomena discovered by using SHE (such as spin pumping and spin Seebeck effect); and other spin-orbit coupling effects (Edelstein effect in interfaces and topological surfaces) that also allows spin-charge interconversion. Finally, I will discuss potential applications (spin-orbit torques, spin-orbit-based logic).

Biography:

Fèlix Casanova is an Ikerbasque Research Professor at CIC nanoGUNE (Basque Country). He obtained his Ph.D. in Physics from Universitat de Barcelona in 2004 with a study of the magnetocaloric effect. He was a postdoctoral researcher at the University of California, San Diego from 2005 to 2009, where he worked in a variety of projects in nanoscience, including nanoporous materials and spintronics in metals, and he acquired extensive experience in nanofabrication techniques. Since 2009, he is the coleader of the Nanodevices Group at CIC nanoGUNE, devoted to the electronic properties of systems in reduced dimensions. His current research interests are focused on spin-dependent phenomena (including spin transport and spin-orbit effects) in metals, insulators and novel two-dimensional materials. His pioneering studies on spin-charge interconversion in metals have led to an R+D contract with *Intel Corp.*, the world-leading microelectronics company. He is Editorial Board member of Physical Review Applied, published by the APS.

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