PHYSICS AND ENGINEERING OF NANODEVICES

Led by ICREA Prof. Sergio O. Valenzuela, the Physics and Engineering of Nanodevices Group focuses on the development of novel devices, primarily spintronics, specifically designed to gain insight into physical properties of materials at the nanoscale, combining state of the art lithographic and chemical methods with magnetic and electrical transport characterisation.

BACKGROUND

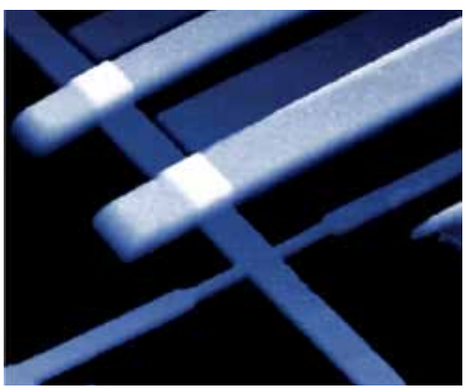
The Group's research is currently centred on spintronic devices. Spintronics introduces the spin degree of freedom into device design and has been predicted to enable a revolutionary class of electronics with functionalities exceeding current semiconductor technology. Conventional electronic devices are based on charge carriers and their associated energy, which limits their speed due to energy dissipation. Spintronics, which is based on spin orientation and spin coupling, promises much higher speeds, low power demands, non-volatility and higher integration densities. Current developments in the group focus on the use of electron and nuclear spins in novel metallic and semiconducting devices, which ultimately will employ quantum coherent control. Besides computation, there are abundant applications for controlled spin and magnetic dynamics, including biomedical instrumentation, including magnetic resonance techniques, sensors and imaging.

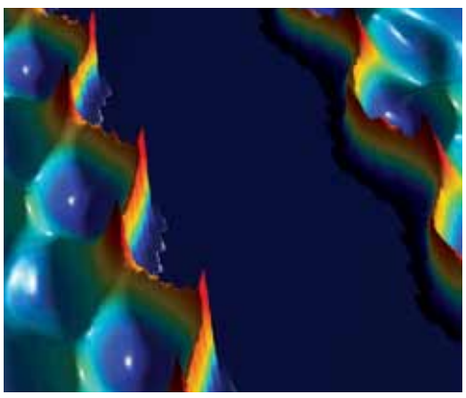
RESEARCH ACTIVITIES INCLUDE:

Metal-based Spintronics. Development of new methods to study electron spin dynamics in metallic nanostructures and the transport of electron spins through interfaces, the control of ferromagnet magnetization orientation using spin transfer torque, and the manipulation of nuclear spins by electron currents via the hyperfine interaction.

Semiconductor-based Spintronics. Manipulation, transport and storage of spin states in semiconductors by means of all-electronic spin injection and detection methods, to characterise the mechanisms affecting spin injection, accumulation and relaxation, the emergence of dynamic nuclear polarisation and the role of the hyperfine interaction, and to employ the attained knowledge to find effective means of accomplishing quantum coherent control of a single spin or an ensemble of spins in solid state materials.

Graphene spintronics. Development of new concepts for spin control in graphene. A key objective is to engineer radically new ways to achieve spin manipulation for the realisation of logic gates acting on the spin of the electrons. This requires the implementation of novel device fabrication methods, in particular, to gain insight into the intrinsic/extrinsic mechanisms that determine the spin lifetime of electrons in graphene.





ICREA PROF. SERGIO VALENZUELA
GROUP LEADER

Prof. Valenzuela obtained his PhD in Physics in 2001 at the University of Buenos Aires, Argentina, and later went on to be a Postdoctoral Fellow and Research Associate at Harvard University and a Research Scientist at the Massachusetts Institute of Technology (MIT). Since July 2008, he is an ICREA Research Professor and Leader of the Physics and Engineering of Nanodevices Group at the Catalan Institute of Nanotechnology (ICN) in Barcelona, Spain. He is also an Associate Professor at the Physics department of the Autonomous University of Barcelona (UAB), since September 2008. His research studies focus on the unique properties of materials when sample dimensions are reduced to the nanometer range. Such studies are motivated both by their intrinsic scientific interest and by their potential importance for electronic applications and rely on innovative devices or innovative implementations of known devices. Recent research has spanned topics on spintronics, quantum computation with superconducting circuits and nanoelectromechanical systems (NEMS). He is a recipient of the 2009 IUPAP Young Scientist Prize in Magnetism for his contributions in the field of spintronics.