北京大学量子材料科学中心
International Center for Quantum Materials, PKU

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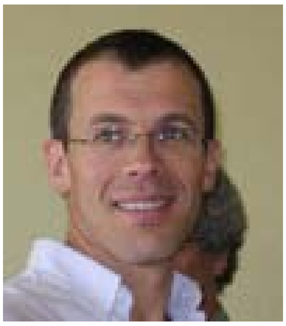
Electrical Control of the Spin Coherence in Semiconductor Quantum Wells



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Time: 4:00pm, Apr. 5, 2012(Thursday)
时间：2012年4月5日 （周四）下午4:00
Venue: Room 607, Conference Room A , Science Building 5
地点：理科五号楼607会议室

Abstract

The control of electron spin in semiconductors for potential use in transport devices or quantum information applications has attracted a great deal of attention in recent years. In nanostructures made of III-V or II-VI semiconductors, the absence of inversion symmetry and the spin-orbit coupling are responsible for the lifting of the degeneracy for spin up and down electrons states in the conduction band. This splitting plays a crucial role for the spin relaxation mechanisms. As it depends strongly on the crystal and nanostructure symmetry, it can be efficiently tailored as explained below.

We have measured the electron spin relaxation time in (111)-oriented GaAs quantum wells (QW) by time-resolved photoluminescence and time-resolved Kerr rotation spectroscopy. By embedding the QWs in a PIN or NIP structure we demonstrate the tuning of the conduction band spin splitting and hence the spin relaxation time with an applied external electric field applied along the growth direction.

The application of an external electric field of 50 kV/cm yields a two-order of magnitude increase of the spin relaxation time which can reach values larger than 30 ns; this is a consequence of the electric field tuning of the spin-orbit conduction band splitting which can almost vanish when the Rashba term compensates exactly the Dresselhaus one [1].Experiments performed under transverse magnetic fields demonstrate that in addition to the spin lifetime, the spin coherence time can be significantly increased. The role of the Dresselhaus cubic terms on both the temperature dependence of the effect and the anisotropy of the spin relaxation will be discussed. The tuning or suppression of the electron spin relaxation demonstrated here for GaAs/AlGaAs quantum wells is also possible in many other III-V and II-VI zinc-blende nanostructures since the principle relies only on symmetry considerations.

[1] A. Balocchi , Q. H. Duong, P. Renucci, B. L. Liu, C. Fontaine, T. Amand, D. Lagarde, X. Marie, Phys. Rev. Letters **107**, 136604 (2011)

About the Speaker

Xavier Marie is Professor at the National Institute of Applied Sciences (INSA- University of Toulouse). He has joined the French University Academy in 2005 ("Institut Universitaire de France"). He was the Director of the Laboratory of Physics and Chemistry of Nano-Objects (LPCNO ; CNRS UMR 5215) that he created from 2007 to 2010. He is currently the Director of the Laboratory of Excellence *NEXT* (Nano, EXtreme measurements and Theory) which brings together 200 permanent researchers from 6 laboratories in Toulouse. After a Master of Science at the University of Essex (UK) and a french engineering Degree he received his PhD degree in 1991 in Toulouse working on Optical Spectroscopy of quantum wells.