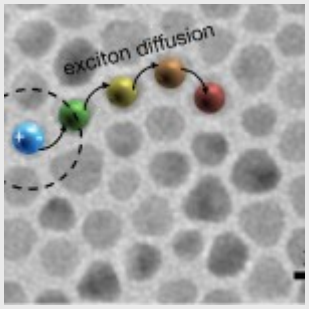
Photonics of Excitonic Nanomaterials: Understanding and Controlling the Flow of Energy



Title: Photonics of Excitonic Nanomaterials: Understanding and Controlling the Flow of Energy
When: Tuesday, 15 March (2016), 12:00h
Place: Departamento de Física de la Materia Condensada, Facultad Ciencias, Module 3, Seminar Room (5th Floor).
Speaker: Ferry Prins, Swiss Federal Institute of Technology, ETH Zürich, Zürich, Switzerland.

The excited state properties of nanoscale semiconductors are dominated by the dynamics of quantum confined electron-hole pairs known as excitons. Thanks to recent advances in the size and shape control of semiconductor nanomaterials, this confinement can now be tuned with high precision which has resulted in a rapidly expanding family of high-quality excitonic building blocks. However, while extensive research has been done to understand and control the excitonic properties of the isolated building blocks, comparatively little is known about exciton dynamics in nanoscale assemblies.

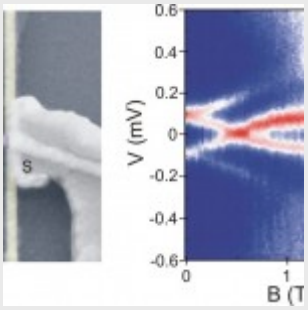
In the first part of the talk, I will present some of our recent efforts in trying to understand and control the exciton dynamics in nanomaterial assemblies. Specifically, I will discuss a new transient microscopy technique with which we can spatially resolve exciton diffusion in colloidal quantum-dot films. In addition, I will present our findings of anomalous excitonic energy-transfer dynamics between zero-dimensional colloidal quantum-dots and two-dimensional MoS2 monolayers.

In the second part of the talk, I will present new strategies for the assembly of excitonic building blocks into high quality wavelength-scale patterns using template stripping of colloidal quantum dot films. I will show that this technique can produce high-quality quantum-dot based grating structures that can significantly modify the optical properties of these films, yielding enhanced and highly directional outcoupling of fluorescence as well as reduced lasing thresholds.

More information on IFIMAC Website

Spin Texture of Sub-Gap Andreev Levels in Semiconductor Quantum Dots Proximity-coupled to Superconductors

When: Friday, 27 November (2015), 12:00h
Place: Departamento de Física de la Materia Condensada, Facultad Ciencias, Module 3, Seminar Room (5th Floor).
Speaker: Eduardo J. H. Lee, SPSMS, CEA-INAC/UJF-Grenoble, France.



Abstract:

The combination of superconductors and low-dimensional semiconductors embodies a rich, yet largely unexplored physics. In this hybrid system, macroscopic properties enforced by superconductivity can be controlled through electrically tunable microscopic degrees of freedom, inherent to a relatively small number of confined electrons. Here we consider the prototypical case of a quantum dot (QD), defined in a semiconductor nanowire, strongly coupled to a superconductor (S) and weakly to a normal-metal (N) tunnel probe. In this system, the ground state can be either a spinsinglet or a spin doublet, depending on a competition between the superconductivity proximity effect, Coulomb interactions and Kondo correlations. In this talk, I will present experimental results unraveling magnetic properties of the lowest-energy, subgap states associated with elementary excitations between the singlet and double states (Andreev levels) [1]. In a magnetic field, the Zeeman splitting of these sub-gap states is revealed. The splitting can induce a quantum phase transition, manifested as a zero-bias conductance peak, from the singlet state to a spin-polarized ground state. Implications of the present work to current research on Majorana fermions will be discussed.

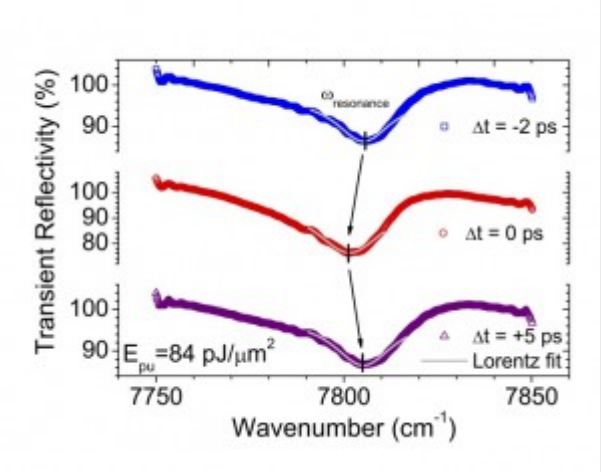
References

E. J. H. Lee, X. Jiang, M. Houzet, R. Aguado, C. M. Lieber and S.De Franceschi, Nature Nanotech. 9, 80, (2014).

More information on IFIMAC Website

Ultrafast switching of semiconductor microcavities

Wednesday, 10th October 2012. 12:00-13:00



Georgios Ctistis
Complex Photonic Systems, MESA+ Institute & Dept. of Science and Technology, University of Twente, The Netherlands

ABSTRACT:
The interest in all-optical switching of photonic nanostructures is rapidly increasing due to the inherent speed of the process. Achieving ultrafast all-optical switching promises both new developments in information technology and a novel control of fundamental cavity quantum electrodynamics (QED). Switching photonic nanostructures is achieved by changing the refractive index of the constituent materials. To date, the switching speed has been limited by material properties but not by optical considerations. We explore the ultimate fast switching of the cavity resonance in GaAs/AlAs in the telecom range. We exploit the instantaneously fast electronic Kerr effect by the judicious tuning of the pump and probe frequencies relative to the semiconductor bandgap, resulting in a shift of the cavity resonance by nearly one linewidth. The speed of the switching – both on and off – is only limited by the dynamics of the light in our cavity [1].
We explore the not-adiabatic regime of tuning of light in a single-resonance cavity. We observe that the frequency of probe light is changed to a value different from the cavity resonance. The light accumulates a phase shift while it is trapped in the cavity due to a fast change in the refractive index, induced by an earlier pump pulse. Consequently, all light trapped in the cavity obtains a frequency different from the cavity resonance. To our knowledge, such photonic not-adiabatic tuning has not been observed before [2].
[1] G. Ctistis, E. Yüce, A. Hartsuiker, J. Claudon, M. Bazin, J.-M.Gérard, and W. L. Vos, , Appl. Phys. Lett. 98, 161114 (2011).
[2] P.J. Harding, H.J. Bakker, A. Hartsuiker, J. Claudon, A.P. Mosk, J.-M. Gérard, and W.L. Vos, J. Opt. Soc. Am. B 29, A1 (2012).

Wednesday, 20 October 2010, 12:00-13.00

Prof. Fernando Flores
Departamento de Física Teórica de la Materia Condensada, UAM
ABSTRACT:
Our understanding of the fundamental properties of solid surfaces and interfaces has seen a great development in the last 30 years due mainly to some experimental developments such as synchrotron radiation and the scanning tunneling microscope. Inorganic semiconductor interfaces will be quickly reviewed in this talk with special emphasis on their physical and chemical properties, such as electronegativity, charge neutrality level and metal/semiconductor barrier height. Organic interfaces will be discussed in more detail considering the metal/organic junctions formed between Au and C60, TTF, TCNQ or PTCDA. The “organic energy gap problem” will be addressed, as well as the concept of the charging energy of the organic molecule: these quantities will be related to each other and to the metal/organic interface barrier height; examples for different organic/Au interfaces calculated using a first-principles DFT approach will be shown. The connection between the molecular (or the nanocontact) and the monolayer limits for these organic/metal interfaces will also be discussed. Finally, organic/organic interfaces will be reviewed using the concepts of the organic charge neutrality level and the interface screening.

Hard Superconductivity in Soft Quantum Films

Thursday, 14 June 2007, 12.00-13.00

Hanno H. Weitering
The University of Tennessee and Oak Ridge National Laboratory

Superconductivity is inevitably suppressed in reduced dimensionality. Questions of how thin superconducting wires or films can be before they lose their superconducting properties have important technological ramifications and go to the heart of understanding coherence and robustness of the superconducting state in quantum-confined geometries. In this talk, I will show how quantum confinement of itinerant electrons in a soft metal, Pb, can be exploited to stabilize superconductors with lateral dimensions of the order of a few millimeters and vertical dimensions of only a few atomic layers. These extremely thin superconductors show no indication of defect- or fluctuation-driven suppression of superconductivity and sustain enormous supercurrents of up to 10% of the theoretical depairing current density. Their magnetic hardness implies a superconducting critical state with strong vortex pinning that is attributed to quantum trapping of vortices. Our study paints a conceptually appealing, elegant picture of a model nanoscale superconductor with calculable critical state properties and surprisingly strong phase coherence. Finally, I will show how the quantum growth and superconductive properties of the films can be tailored by Fermi surface engineering, and I will discuss the possibility of multi-gap superconductivity in quantum-confined thin films. This work was done in collaboration with M.M. Ozer, J.R. Thompson, Yu Jia, and Z.Y. Zhang [1,2]. [1] M.M. Ozer et al., Nature Phys. 2, 173 (2006) [2] M.M. Ozer et al., Science, June 15 (2007)