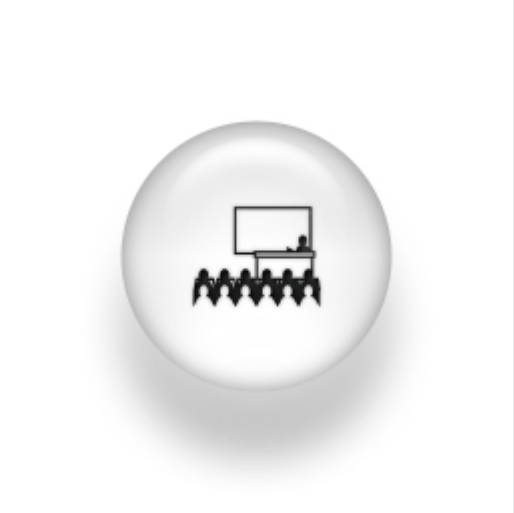
Molding the flow of Terahertz radiation using plasmonic metamaterials

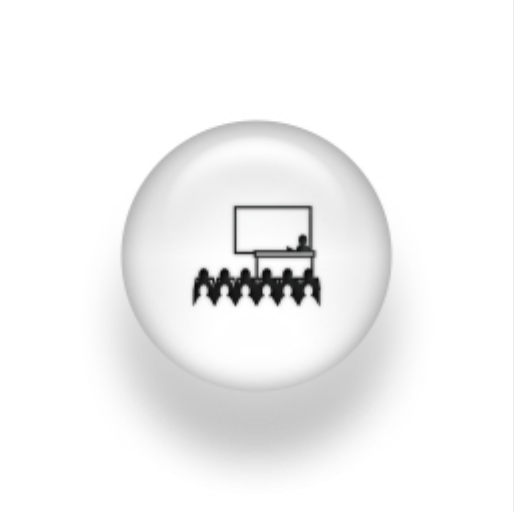
Wednesday, 11 May 2011. 12:00-13.00



Prof. Jorge Bravo-Abad
Dpto. de Fisica Teórica de la Materia Condensada, UAM
ABSTRACT:
Controlling the flow of terahertz (THz) radiation has become a critical challenge in the path towards electronics and photonics convergence at the nanoscale. In this talk, we present our recent findings on how electromagnetic fields at THz frequencies can be tailored using plasmonic metamaterials. Specifically, we consider a novel class of metamaterial in which the constituent meta-atoms are single subwavelength apertures tailored to work as nanoresonators in the THz frequency regime [1]. In addition, we present some on-going work on how simple structures formed by deep-subwavelength metallic barriers embedded in single THz nanoresonators offer a rich playground for studying fundamental wave phenomena at nanometric length scales.
[1] M. Bahk, H.R. Park, K.J. Ahn, H.S. Kim, Y.H. Ahn, D.S. Kim, J. Bravo-Abad, L. Martin-Moreno, and F.J. Garcia-Vidal, Physical Review Letters 106, 013902 (2011).

Spin transport in graphene

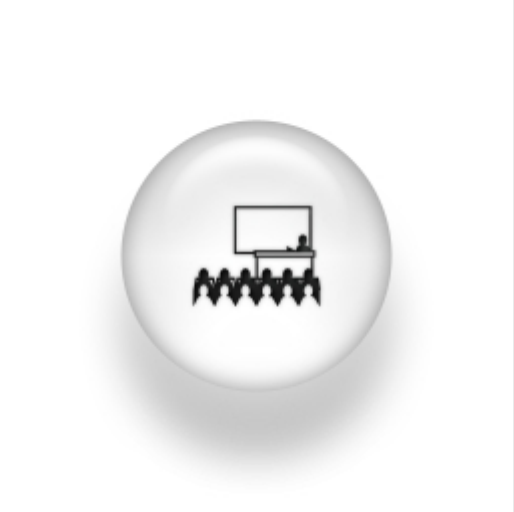
Wednesday, 4 May 2011. 12:00-13.00



Prof. Juanjo Palacios
Departamento de Fisica de la Materia Condensada, UAM
ABSTRACT:
In this talk I will review our recent work on two topics related to spin transport in graphene:
1) First, I will discuss some fundamental (some would say academic) issues related to the conductance quantization expected for 2D topological insulators in the context of graphene nanoribbons. In particular, I will explore the extent to which disorder and (the lack of) inversion symmetry play a role in this manifestation of the topological nature of grahene with strong spin-orbit coupling.
2) Second, I will discuss our proposal to unveil magnetism in hydrogenated graphene. The reasons why magnetic phenomena in graphene remain elusive are still unclear, but are definitely rooted in two issues: 1) the formation of individual magnetic moments, which is plagued with technical and fundamental difficulties, and 2) the underlying antiferromagnetic correlations inherent to graphene, which do not favor the observation of a collective behavior. I will present a critical analysis of the first issue and propose a way to unveil the antiferromagnetic correlations based on spin-dependent features in the conductivity of bulk graphene, chemically modified by hydrogen adatoms.

Ring-shaped nanomagnets: from quantum effects to spin-cluster qubits

Friday, 29 April 2011. 12:00-13.00



Prof. Filippo Troiani
Istituto Nanoscienze-CNR, S3, Modena (Italy)
ABSTRACT:
Molecular nanomagnets represent a wide class of spin cluster, whose structural and magnetic properties can be widely engineered by chemical synthesis [1]. Historically, much attention has been devoted to high-spin molecules (the so-called *single-molecule magnets*) with anisotropy barriers, where the magnetic memory is ultimately limited by the quantum tunneling of magnetization. The present talk will be concerned with a different class of molecules, namely antiferromagnetic spin rings, that have recently attracted a widespread interest also in view of their possible use in quantum-information processing. In this perspective, three different aspects will be considered. Firstly, recent progress in the control on intermolecular coupling between ring-shaped nanomagnets will be discussed [2]. Such capability represent a first, crucial requirement on the way of growing a scalable hardware based on the nanomagnet as a building block, and has enabled the demonstration of (equilibrium-state) entanglement between pairs of rings [3]. Secondly, the electron-spin decoherence in single nanomagnets and coupled rings will be considered. In both cases, decoherence results from the dynamics of the nuclear bath, and specifically from the build-up of quantum correlations between electron and nuclear spins. Based on a microscopic model of the molecules, we show how the chemical elements and the physical processes that drive decoherence can drastically depend on the specific linear superposition of interest [4]: as an illustrative example, we compare the cases of singlet-triplet superpositions in ring dimers with that of the Bell states. The final part of the talk will be devoted to a novel approach to the use of antiferromagnetic spin rings in quantum information processing, based on the use of electric fields as a means for the manipulation of the quantum state [5]. Here, the computational degree of freedom is not the spin projection – as in most spin-based approaches – but spin chirality. Magnetically frustrated systems – such as homometallic odd-numbered rings – with antisymmetric exchange (Dzyaloshinskii-Moriya) interaction present ground-state multiplets with well defined chirality. The general conditions for the existence of such spin-electric coupling in spin rings will be discussed, and preliminary results will be presented on hyperfine-induced decoherence

of spin chirality.

References

[1] D. Gatteschi, R. Sessoli, and J. Villain, Molecular nanomagnets (Oxford University Press, Oxford, 2007).

[2] G. Timco, S. Carretta, F. Troiani, F. Tuna, R. J. Pritchard *et al.*, Nat. Nanotechnol. 4, 173 (2009).

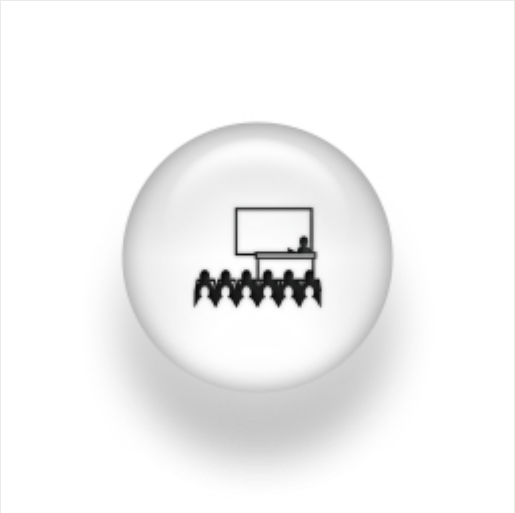
[3] A. Candini, G. Lorusso, F. Troiani , A. Ghirri, S. Carretta *et al.*, Phys. Rev. Lett. 104, 037203 (2010).

[4] A. Szallas and F. Troiani, Phys. Rev. B 82, 224409 (2010).

[5] M. Trif, F. Troiani, D. Stepanenko, and D. Loss, Phys. Rev. Lett. 101, 217201 (2008).

Torsion and anchoring of protein filaments

Wednesday, 13 April 2011. 12:00-13.00



Prof. Pedro Tarazona

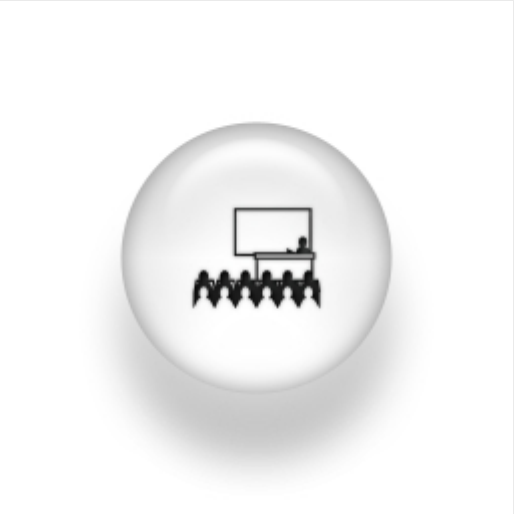
Departamento de Fisica Teórica de la Materia Condensada, UAM

ABSTRACT:

This informal seminar presents a possible explanation for the polymorphism observed in FtsZ protein filaments anchored on mica. The competition between a spontaneous torsion of the filament an a preferential anchoring on the surface is modeled as a physical pendulum equation, with multiple solutions associated to the number of untwisted rounds.

Density Functional Theory - OpenMX

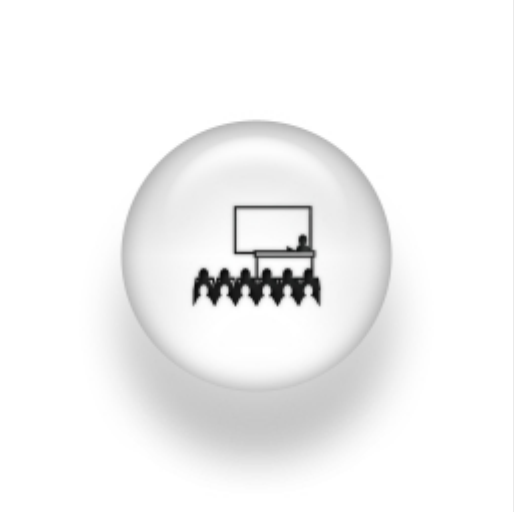
Thursday, 7 April 2011, 12:00-13.00



Prof. Taisuke Ozaki
Japan Advanced Institute of Science and Technology (JAIST)
ABSTRACT:
During the last three decades continuous efforts have been devoted to extend applicability of the density functional theory (DFT) to large-scale systems, leading to realization of more realistic simulations close to experimental conditions. In this talk, I will introduce our recent developments of low-order scaling methods for eigenvalue problem and evaluation of exact exchange energy towards the direction [1-5]. It is demonstrated that a linear-scaling Krylov subspace method [1], combined with effective screening medium (ESM) method [6], enables us to simulate a bias induced chemical reaction in lithium battery. Moreover, a numerically exact low-order scaling method is presented [2,3], which directly evaluates selected elements of density matrix using a nested dissection approach. Finally, an exchange functional by a range-separated exchange hole, whose computational cost is linear-scaling, is proposed to calculate the exact exchange energy [4]. I will also summarize the OpenMX project [5] in an east Asian community to develop a platform for large-scale DFT simulations.
[1] T. Ozaki, PRB 74, 245101 (2006).
[2] T. Ozaki, PRB 75, 035123 (2007).
[3] T. Ozaki, PRB 82, 075131 (2010).
[4] M. Toyoda and T. Ozaki, PRA, in press.
[5] http://www.openmx-square.org/
[6] M. Otani and O. Sugino, PRB 73, 115407 (2006).

The glass transition and the universal properties of glasses

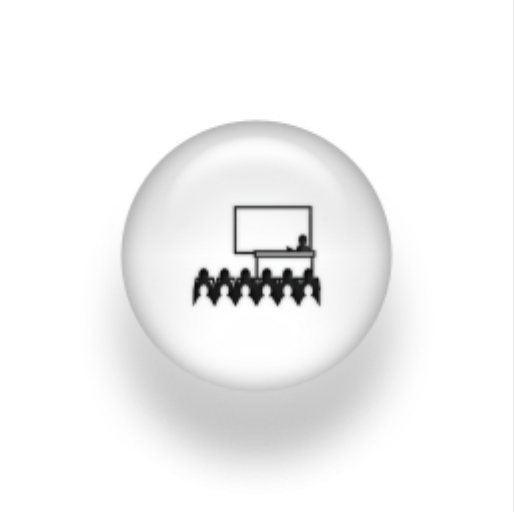
Wednesday, 6 April 2011, 12:00-13.00



Prof. Miguel Angel Ramos
Departamento de Fisica de la Materia Condensada, UAM
ABSTRACT:
Although glass is a well-known and widely used material by mankind since thousands of years ago, the very nature of the glassy state and its (often universal) physical properties remain an issue of vivid debate within the scientific community. In the first part of this talk, I will present a general overview (necessarily limited and personally biased) about the state-of-the-art understanding of the glass state, focused on three major aspects: (i) thermodynamic vs kinetic theories for the glass transition; (ii) relaxational processes and dramatic slowing down of the dynamics of supercooled liquids; (iii) universal low-temperature properties of glasses and other disordered solids. In the second part of the talk, I will present and discuss earlier and recent experiments performed by our research group on simple glass-forming monohydroxy alcohols (ethanol, propanol, butanol…) at low temperatures, including specific heat, thermal conductivity, Brillouin scattering and X-ray diffraction measurements. By doing this, we find an interesting benchmark to explore some relevant issues concerning molecular glass-forming liquids and the glass transition phenomenon. These include the role played by the molecular aspect ratio in vitrification/crystallization kinetics, the reported appearance of particular cases of polymorphism and “polyamorphism”, and by using different isomers the influence of the hydrogen-bond position on lattice dynamics and hence on low-temperature properties of glasses.

PForces and currents in carbon nanostructures

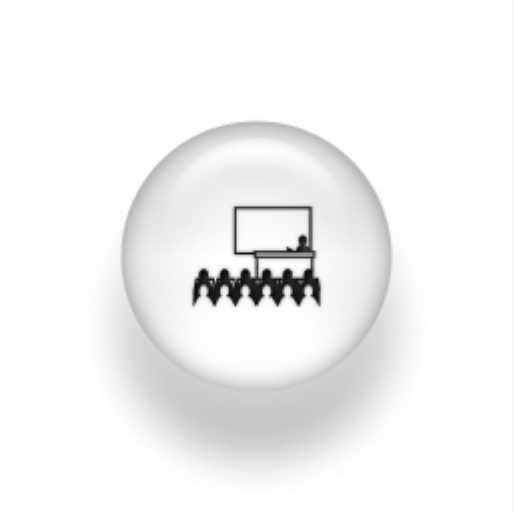
Wednesday, 30 March 2011, 12:00-13.00



Prof. Pablo Pou
Dpto. de Fisica Teórica de la Materia Condensada, UAM
ABSTRACT:
STM [1] and FM-AFM [2] have been used for many years to study low-dimensional carbon materials. The simple honeycomb structure shared by these materials represents both a perfect testing ground and a fundamental challenge for scanning microscopy imaging. Graphite can be imaged with atomic resolution with Scanning Probe Microscopy even in ambient conditions but, after 25 years of research, still there is no consensus whether the maxima in the atomic scale images correspond to atoms or to the hollow sites. We have carried out a study that combines DFT total-energy calculations with NEGF methods for electronic transport in order to determine the interaction and the tunneling current between a large set of SPM tips with nanotubes, graphite and graphene [3]. Our results explain the rich variety of image patterns observed in both AFM and STM experiments in terms of two factors: (i) the tip-sample distance and (ii) the chemical reactivity of the tip. Furthermore, we demonstrate, contradicting the usual interpretation, that short-range chemical forces and not van der Waals interactions are the responsible for the atomic-scale contrast on the FM-AFM images.
Finally, we have extended our study to defects in these materials, which, instead of a problem, result on novel and promising electronic properties. For example, vacancies in a graphene layer support localized magnetic moments [4]. We present a study of the forces and currents on a graphene layer on Pt considering explicitly the presence of vacancies [5].
[1] Park et al, APL 48,112 (1986)
[2] Holscher et al, PRB 62, 6967 (2000); Hembacher et al, PRL. 94 056101 (2005); Albers et al, Nat Nano 4, 307 (2009); Gross et al, Science 325, 1110 (2009)
[3] Ondraceck et al, PRL (2011).
[4] Ugeda et al, PRL 104, 096804 (2010).
[5] Ugeda et al, submitted to PRL (2011).

Phase-controlled transport in periodically-driven optical lattices

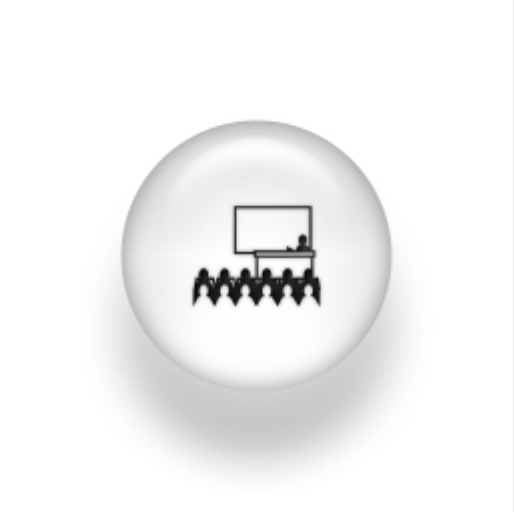
Wednesday, 23 March 2011, 12:00-13.00



Prof. Alfredo Levy Yeyati
Departamento de Fisica Teórica de la Materia Condensada, UAM
ABSTRACT:
Electronic transport at subgap energies between a normal and a superconducting región is possible by means of the so-called Andreev processes. Great progress in the fabrication of hybrid nanostructures combining graphene or carbon nanotubes with superconducting electrodes is allowing to explore Andreev transport in novel situations. In this talk I shall present some recent work by our group on this topic. After discussing briefly the peculiar properties of Andreev reflections in graphene I shall concentrate in the analysis of two recent experiments involving superconductors and carbon nanotubes. I shall first discuss experiments aimed to produce entangled electron pairs from the splitting of Cooper pairs using carbon nanotubes double quantum dots [1]. I shall present microscopic calculations which allow to determine the splitting efficiency in terms of material and geometrical parameters. Finally I shall discuss the appearance of Andreev bound states in carbon nanotubes coupled to superconducting leads and the possibilities opened by its recent experimental detection [2].
[1] L. Herrmann, F. Portier, P. Roche, A. Levy Yeyati, T. Kontos and C. Strunk, Phys. Rev. Lett. 104, 026801 (2010).
[2] J.D. Pillet, C.H. L. Quay, P. Morfin, C. Bena, A. Levy Yeyati and P. Joyez, Nature Phys. 6, 965–969 (2010).

Phase-controlled transport in periodically-driven optical lattices

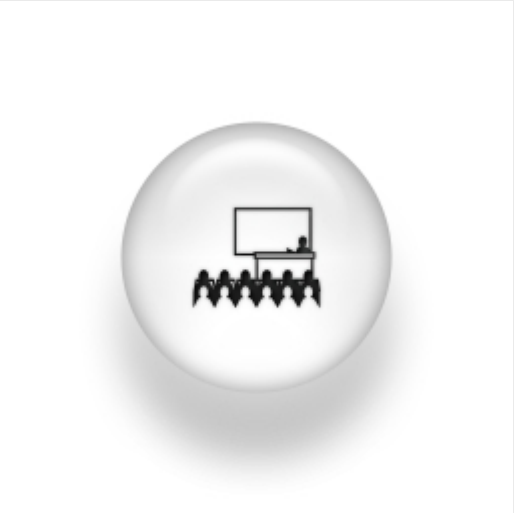
Wednesday, 16 March 2011, 12:00-13.00



Prof. Charles Creffield
Departamento de Fisica de Materiales, Universidad Complutense de Madrid
ABSTRACT:
Bose-Einstein condensates held in optical lattice potentials provide an almost ideal arena for the study of coherent quantum phenomena. This allows an unusual means of control to be obtained by directly harnessing quantum interference effects. In this talk I will show how periodically-driving the condensate by “shaking” the lattice can produce a phenomenon termed “coherent destruction of tunneling”, in which the value of the intersite tunneling becomes renormalised. I will first show how this can be used to induce directed motion, and to precisely split and recombine particle wavepackets. I will then go on to consider the response of interacting systems, and show that this form of control is remarkably stable against the growth of unwanted perturbations, pointing to the attractive possibility of using these systems for quantum information tasks.

Shaping a quantum field with dissipation

Wednesday, 9 March 2011, 12:00-13.00



Prof. Diego Porras

Departamento de Fisica Teórica, Universidad Complutense de Madrid
ABSTRACT:
I will present some on-going work on analogs of laser cooling of particles in the physics of single quantum emitters coupled to light. In a variety of physical systems ranging from cavity QED to plasmonics, the ability to drive the frequency of an atom leads to the possibility to taylor the atom-light coupling in such a way that non-classical states of quantum fields are generated by a dissipative process.