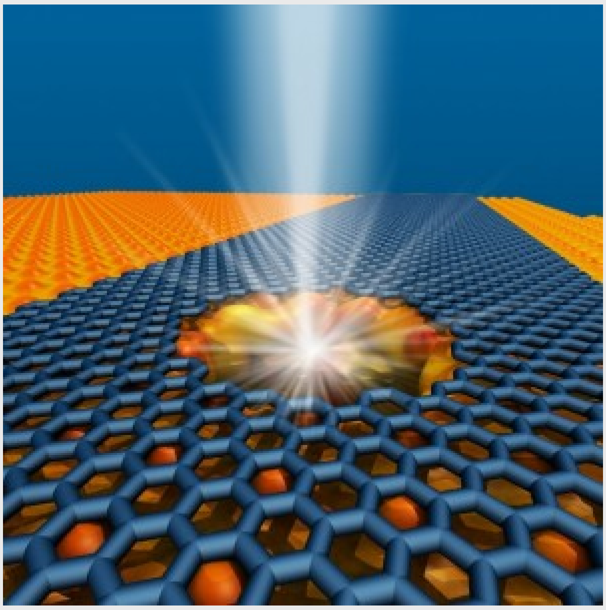
Transport in Atomically Resolved Graphene Nanoribbons

Date: Friday, 22nd November (2013).



Time: 12:00h
Place: Departamento de Física de la Materia Condensada, Facultad Ciencias, Módulo 3 , Aula de Seminarios (5ª Planta)
Prof. A.T. Charlie Johnson (Department of Physics & Astronomy; Director Nano/Bio Interface Center, University of Pennsylvania, USA).

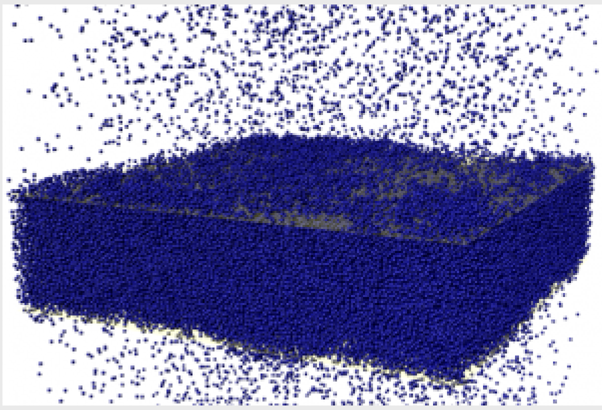
ABSTRACT:

Graphene has attracted intense research focus as an emerging material for high performance electronics components due to its superior intrinsic carrier mobility, thermal conductivity, and quasi-ballistic transport at room temperature. The Johnson group has advanced the synthesis of high quality large-area graphene by atmospheric pressure chemical vapor deposition, which has enabled experiments that would be difficult if not impossible to perform with exfoliated graphene material. Examples to be discussed include translocation of DNA through graphene nanopores and synthesis of single-crystal monolayer heterostructures of graphene and hexagonal boron nitride. Finally I will focus on recent experiments where graphene nanoribbons have been fabricated, structurally characterized with atomic resolution, and electrically probed, all in situ in an aberration-corrected transmission electron microscope.

More information on IFIMAC Website

Enhanced Surface Tension of Liquid-vapour Interfaces at Mesoscopic Scales

Wednesday, 17th April 2013. 15:00-16:00



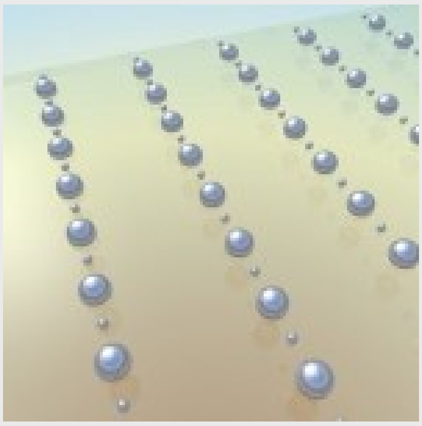
Felix Höfling
Max Planck Institute for Intelligent Systems, Stuttgart

ABSTRACT:

Due to the simultaneous presence of bulk-like and interfacial fluctuations the understanding of the structure of liquid–vapour interfaces poses a long-lasting and ongoing challenge for experiments, theory, and simulations. In this context, we have generated high-quality molecular dynamics data for a Lennard-Jones fluid mimicking long-ranged van der Waals attraction. Upon lowering the temperature from that of the critical point to that of the triple point, the wavenumber-dependent surface tension develops a maximum at non-zero wavenumber so that its functional form changes from concave to convex at mesoscopic length scales.

Signatures of Quantum Condensation in a Plasmonic Nanoparticle Array

Tuesday, 21st March 2013. 12:00-13:00



Said R.K. Rodríguez
Center for Nanophotonics, FOM Institute AMOLF, c/o Philips Research Laboratories, Eindhoven, The Netherlands

ABSTRACT:

We present experimental signatures of quantum condensation in a plasmonic system. We investigate a periodic array of metallic nanorods covered by a polymer layer doped with an organic dye at room temperature. Surface lattice resonances of the array – hybridized plasmonic/photonic modes – couple strongly to excitons in the dye, and bosonic quasi-particles known as plexcitons are formed. By increasing the plexciton density through optical pumping, we observe the emergence of Bogoliubov-Goldstone excitations on top of the strongly coupled plexciton band in the light emission dispersion diagram. The Bogoliubov-Goldstone mode shows signatures of thermalization and condensation, despite the nonequilibrium character of this driven and dissipative system.

Capillary Emptying and Wetting Transitions: Why the Tragedy of Spilling a Glass of Beer is Actually a Rare Interfacial Phase Transition

Wednesday, 27th February 2013. 12:00-13:00

Andrew O. Parry
Imperial College, London

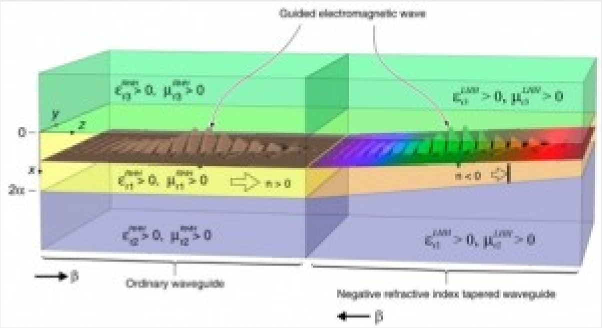
ABSTRACT:

Imagine a glass half full of delicious beer. What happens when we turn the glass slowly to the horizontal? – of course our nutritious breakfast spills. And yet later that morning a cocktail straw half full of pina colada does not spill when we hold that horizontally. Amazingly this basic aspect of capillarity, equivalent to understanding the shape of a meniscus in a horizontal capillary, has not been studied in depth. Here we show that the process by which a liquid spills from a tilted capillary is a macroscopic example of a phase transition involving the unbinding of the meniscus. The critical singularities describing this are identical to those for short ranged wetting transitions but occur on a scale set by the capillary length rather than the bulk correlation length.

[1] A.O. Parry, C. Rascon, E. Jamie, and D. Aarts, Phys. Rev. Lett. 108, 246101 (2012).

Modelling of Active Plasmonic and Metamaterial Systems in the Time-Domain

Tuesday, 26th February 2013. 12:00-13:00



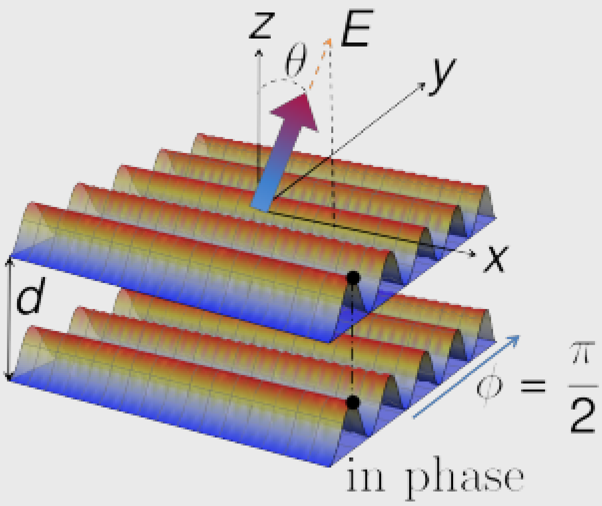
Joachim Hamm
Imperial College, London

ABSTRACT:

Advances in plasmonics and metamaterial research increasingly focus on device-functionalization with quantum-electronic materials, such as dyes, semiconductors or graphene. The field concentration around metallic nano-features serves as key mechanism to enhance light-matter interactions but also poses new modelling challenges. The presentation will highlight recent results based on the self-consistent modelling of photonic/quantum-electronic structures, such as gain-infiltrated active metamaterial structures. In addition it will offer an outlook to future work on the modelling of quantum-electronic metamaterials that include semiconductor media and graphene.

Density instabilities in 2D dipolar Fermi gases

Wednesday, 13th February 2013. 12:00-13:00



Francesca Maria Marchetti
Departamento de Física Teórica de la Materia Condensada, UAM

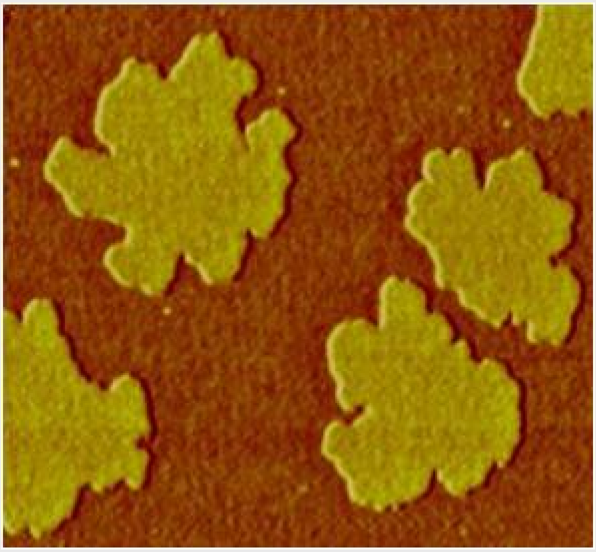
ABSTRACT:

Ultracold atomic gases have thus far provided a veritable playground in which to explore quantum many-body phenomena. Among the field's great successes, there is the ability to create tightly bound heteronuclear (Feshbach) molecules with a permanent electric dipole moment. In particular, the recent possibility to experimentally realise quantum degenerate dipolar Fermi gases, and confine them in 2D, paves the way for exploring many-body physics with long-ranged (dipole-dipole) interactions in low dimensional systems, with the advantage of having a cleaner and more tuneable analogue of the solid-state electron system. The central interest of this informal seminar will be the formation of density-wave phases, such as stripes, driven by the interplay between dipolar strong correlations and the architecture of the low dimensional system [1,2].

[1] M.M. Parish and F.M. Marchetti, *"Density instabilities in a two-dimensional dipolar Fermi gas"*, Phys. Rev. Lett. 108, 145304 (2012).
[2] F.M. Marchetti and M.M. Parish, *"Density-wave phases of bipolar fermions in a bilayer"*, Phys. Rev. B 87, 045110 (2013).

Advances in three-dimensional imaging, quantitative mapping and device fabrication by force microscopy

Wednesday, 6th February 2013. 12:00-13:00



Ricardo García
Instituto de Ciencia de Materiales de Madrid (CSIC)

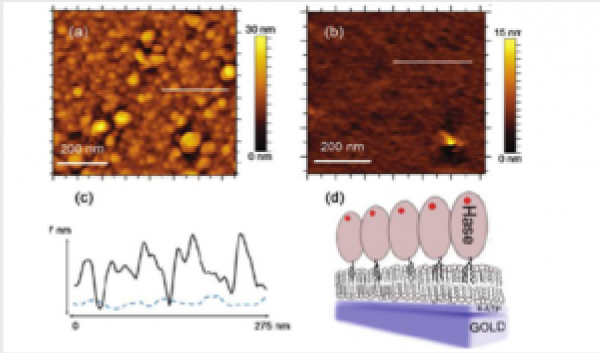
ABSTRACT:

Force microscopy is an enabling tool for nanoscience and nanotechnology. Three properties of the AFM help to explain its impact and relevance in Materials Science, the spatial resolution, the material sensitivity and the lithography potential. This presentation is divided in two sections. The first part is devoted to present a novel AFM method for high resolution and quantitative mapping of sof-matter interfaces [1-2]. Bimodal AFM is an emerging multifrequency technique that is characterized by a high signal-to-noise ratio and the ability to measure simultaneously different properties. Recent advances in the mapping of biomolecule and soft-matter properties (elastic and viscolastic properties) as well as the ability generate three dimensional maps of water layers adsorbed on proteins will be discussed. The last section is devoted to present the application of oxidation Scanning Probe Lithography to build molecular architectures and to fabricate silicon nanowire transistors and biomolecular sensors [3-4].

[1] R. Garcia and E.T. Herruzo, The emergence of multifrequency AFM, *Nat. Nanotechnol*. 7, 217-226 (2012).
[2] D. Martinez-Martin, E.T. Herruzo, C. Dietz, J. Gomez-Herrero, and R. Garcia, Noninvasive protein structural flexibility mapping by bimodal dynamic force microscopy, *Phys. Rev. Lett.* 106, 198101 (2011).
[3] M. Chiesa, P. P. Cardenas, F. Otón, J. Martinez, M. Mas-Torrent, F. Garcia, J. C. Alonso, C. Rovira, and R. Garcia, Detection of the Early Stage of Recombinational DNA Repair by Silicon Nanowire Transistors, *Nano Letters* 12, 1275 -1281 (2012).
[4] R.V. Martinez, M. Chiesa, R. Garcia, Nanopatterning of ferritin molecules and the controlled size reduction of their magnetic cores, *Small* 7, 2914-2920 (2011).

A force generating living polymer: experiments and theory to understand how it works

Wednesday, 30th January 2013. 12:00-13:00



Marisela Vélez
(*Instituto de Catálisis y Petroleoquímica (CSIC) and IMDEA Nanoscience, Madrid*)

ABSTRACT:
FtsZ is a bacterial cytoskeletal protein that polymerizes on the inner surface of the bacterial membrane and contributes to generate the force needed for cell division. In the presence of soluble modulators the individual protein monomers interact longitudinally to form filaments that can then aggregate to form higher order structures on a surface. This filament aggregates are dynamic and exchange monomers from the solution. The final outcome of this dynamic rearrangement on the surface is the generation of force that bends the cell membrane inward. Experiments on model systems using atomic force microscopy have allowed studying the dynamic behavior of individual filaments and, in combination with theoretical models that can explain the experimental results, we are gaining understanding at the molecular level about the force generation mechanism.

Paez , A., Mateos-Gil, P., Hörger, I., Mingorance, J., Rivas, G., Vicente, M., Vélez, M. and Tarazona, P. *"Simple modeling of FtsZ polymers on flat and curved surfaces: correlation with experimental in vitro observations"* (2009) PMC Biophysics, 2:8.
Mingorance, J., Rivas, G., Vélez, M., Gómez-Puertas, P., Vicente, M. *"Strong FtsZ is with the force: mechanisms to constrict bacteria"* Trends in Microbiology, 2010, 18(8) pp. 348 – 356.
Mateos-Gil,P; Marquez, I.; López-Navajas,P.; Jiménez, M.; Rivas,G.; Mingorance, J.; Vicente,M. and Vélez,M. *"FtsZ polymers bound to lipid bilayers through ZipA form dynamic two dimensional networks"* BBA – Biomembranes (2012) 1818: 806- 813.
Mateos-Gil, P.; Paez, A.; Hörger, I.; Rivas, G.; Vicente,M.; Tarazona, P.; and Vélez, M. *"Depolymerization dynamics of individual filaments of bacterial cytoskeletal protein FtsZ"* 2012 PNAS 109 (21) 8133-8138.

30 enero 2013. 12:00-13:00
A force generating living polymer: experiments and theory to understand how it works
Marisela Vélez(*Instituto de Catálisis y Petroleoquímica (CSIC) and IMDEA Nanoscience, Madrid*)
ABSTRACT:
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Paez , A.,   Mateos-Gil, P., Hörger, I., Mingorance, J., Rivas, G., Vicente, M., Vélez, M. and Tarazona, P.   *“Simple modeling of FtsZ polymers on flat and curved surfaces: correlation with experimental in vitro observations”* (2009) PMC Biophysics, 2:8.
Mingorance, J., Rivas, G., Vélez, M., Gómez-Puertas, P., Vicente, M. *“Strong FtsZ is with the force: mechanisms to constrict bacteria”* Trends in Microbiology, 2010, 18(8) pp. 348 – 356.
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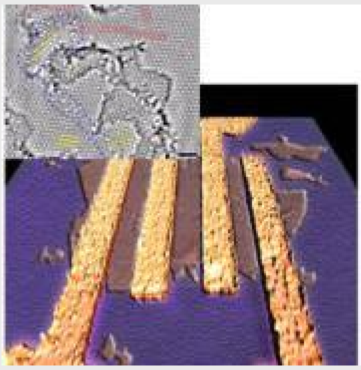
Mateos-Gil, P.; Paez, A.; Hörger, I.; Rivas, G.; Vicente,M.; Tarazona, P.; and Vélez, M. *“Depolymerization dynamics of individual filaments of bacterial cytoskeletal protein FtsZ”* 2012 PNAS 109 (21) 8133-8138.

The influence of defects in the electrical transport properties of metalorganic nanoribbons and in the mechanical properties of suspended graphene flakes

Wednesday, 23tn January 2013. 12:00-13:00



Julio Gómez Herrero
(*Departamento de Física de la Materia Condensada, UAM*)
ABSTRACT:

In this talk I will briefly discuss two different topics related with the influence of defects in nanoscale systems [1,2]. The first one is related to the electrical transport properties of MMX nanoribbons. MMX compounds can be seen as one dimensional metal organic polymers that include a bimetal unit (MM can be Mo, Pt,...) and a linker that is usually a halogen. In our case we will focus on a MMX based on platinum and iodine as the linker. These compounds present a significant electrical conductivity that has been traditionally studied in macroscopic crystals. In this talk I will describe the synthesis [3] and electrical transport properties [4] of MMX nanoribbons, the influence of defects [5] in their conductivity and the transition between the nanoscale and macroscale regime. The second topic deals with the influence of induced defects in the mechanical properties of suspended graphene flakes. Using and atomic force microscopy we indent graphene flakes with different densities of defects. The experiments show an extreme drop of the breaking force with the irradiation dose and an unexpected increase of the Young modulus of the flake for low defect densities.

[1] Gomez-Navarro, C., P.J. De Pablo, J. Gomez-Herrero, B. Biel, F.J. Garcia-Vidal, A. Rubio, and F. Flores, *Tuning the conductance of single-walled carbon nanotubes by ion irradiation in the Anderson localization regime.* Nature Materials, 2005. 4(7): p. 534-539.
[2] Sundqvist, P., F.J. Garcia-Vidal, F. Flores, M. Moreno-Moreno, C. Gomez-Navarro, J.S. Bunch, and J. Gomez-Herrero, *Voltage and length-dependent phase diagram of the electronic transport in carbon nanotubes.* Nano Letters, 2007. 7(9): p. 2568-2573
[3] Welte, L., U. Garcia-Couceiro, O. Castillo, D. Olea, C. Polop, A. Guijarro, A. Luque, J.M. Gomez-Rodriguez, J. Gomez-Herrero, and F. Zamora, *Organization of Coordination Polymers on Surfaces by Direct Sublimation.* Advanced Materials, 2009. 21(20): p. 2025-2028.
[4] Welte, L., A. Calzolari, R. Di Felice, F. Zamora, and J. Gomez-Herrero, *Highly conductive self-assembled nanoribbons of coordination polymers.* Nature Nanotechnology, 2010. 5(2): p. 110-115.
[5] Cristina Hermosa *et al., Intrinsic electrical conductivity of nanostructured metal-organic polymer chains.* Submitted.

Thermoelectric properties of Chromium Nitride

Wednesday, 16th January 2013. 12:00-13:00

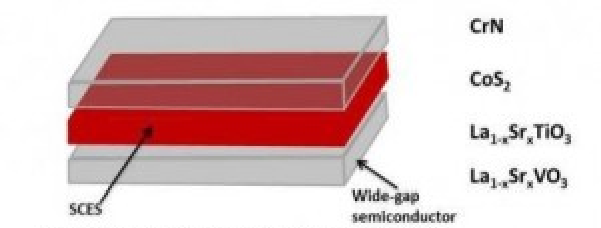


Figure: Multilayer structure combining layers of a Mott and band insulator

Francisco Rivadulla
(*Centro de Investigación en Química-Biológica y Materiales Moleculares, CIQUS, Universidad de Santiago de Compostela*)

ABSTRACT:

The possibility of converting waste heat into usable electrical energy made thermoelectricity a very active area of research in solid-state chemistry and physics during the last decades. More recently, after the development of physical methods for the growth of thin-films and multilayered structures, the activity re-energized due to the possibility of tuning independently the electrical and thermal conductivities in the nanostructures. However, the best performances are still based in classical Bi,Sb-Te, and similar alloys, and apart from zintl Yb14MnSb11 phases and some promising misfit Co-oxides, almost no new materials have been proposed in the last years.
In this talk I will describe the thermoelectric properties of cubic CrN. This system is a degenerate semiconductor with a fairly low resistivity and large thermoelectric power, which becomes antiferromagnetic below » 285 K. The thermal conductivity is surprisingly low when compared to TiN and other nitrides, although still too large for practical applications. Both the thermal conductivity and electrical resistivity are anomalous, due to the magnetostructural coupling of the system.
I will describe our efforts to increase the thermoelectric power factor by chemical doping, and through the fabrication of thin films. In this case we were able to increase the power factor by more than an order of magnitude, reaching » 15 mW/cmK2 at room temperature.