DEPARTAMENT DE FÍSICA I ENGINYERIA NUCLEAR *NUMBER 16, SPRING 2014*

FENOMEN

NEWSLETTER OF THE DEPARTMENT OF PHYSICS AND NUCLEAR ENGINEERING

NEWS

EVENTS

General Meeting of the **European Fusion Education Network** (Fuse-Net), March 4th, 2014, ETSEIB-UPC, Barcelona.
Organizer: Javier Dies (NERG)

"WaterEurope" Interdisciplinary Conference about Water June 12th - 14th 2014, Zarragoza.
Co-Organizer: J. Martí (SIMCON)
http://www.cecam.org/workshop-1089.html

"**7th Workshop on Modelling and Simulation of Biological Systems**" June 26th, 2014, ESAB-UPC.
Organizers: Research Group on Computational Biology.

POSITIONS and AWARDS

Jordi Jose has been appointed as coordinator of the Astronomy and Astrophysics area of ANEP (Agencia Nacional de Evaluación y Prospectiva, Madrid) for 2014-2016.

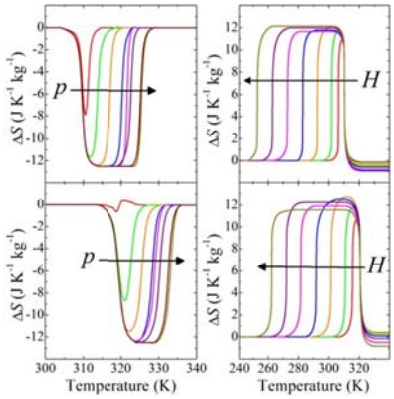
Sergí Macià (16 years old student of the INS Escola Industrial, Sabadell), under the supervision of **Clara Prats**, has received the **4th award for Microbiology** at the **Intel International Science and Engineering Fair (ISEF) 2014 Grand Awards**, held in Los Angeles in May 2014. The title of the preoject was **"From the antibiotic resistance acquisition by bacteria to the impact of the resistant tuberculosis on society through a computer modelling (IbM)"**.

RECENT PUBLICATIONS

Materials science

Giant barocaloric and magneto-caloric effects in Fe-Rh

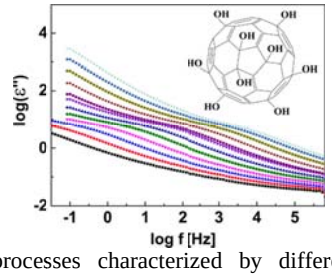
Caloric effects refer to adiabatic temperature changes (or isothermal entropy changes) that occur in a system when applying an external field. Close to the phase transitions such effects may become important. P. Lloveras, M. Barrio, J.Ll. Tamarit (GCM) and co-workers have carried out calorimetry experiments under pressure and magnetic field on $Fe_{49}Rh_{51}$, revealing giant baro and magnetocaloric strengths under weak external fields at the ferromagnetic-antiferromagnetic phase transition.



Such effects, occurring close to room temperature, show good reproducibility which makes Fe-Rh suitable for environmentally friendly solid-state cooling techniques. (*Phys. Rev. B* ***89****, 214105, 2014*)

Ultraslow dynamics of water in organic molecular solids

The molecular dynamics of water under confinement has been studied in several systems ranging from hydrated proteins and polymers, dense aqueous solution, porous inorganic systems and layered materials, but never so far inside hygroscopic molecular solids. R. Macovez (GCM) and co-workers employed impedance spectroscopy to probe the water dynamics inside two hygroscopic organic materials: fullerol and rhodamine. They found evidence for two main dynamic

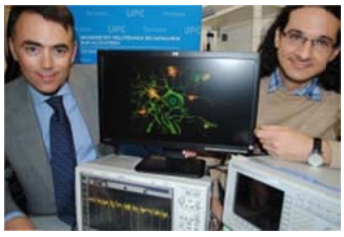


processes characterized by different time scales. The slower process is associated with the reorientation of water molecules directly attached onto organic molecules and counterions, while the faster one is the dynamic signature of water in higher hydration layers, either at grain boundaries (rhodamine) or inside interstitial clusters (fullerol). Both processes exhibit non-monotonic temperature dependence and decreasing spectral strength upon heating, similarly to what is reported in inorganic nano-porous systems such as porous silica. In fullerol a third, ultra-slow relaxation is observed at high temperature, which may be due to the reorientation of water–fullerol complexes. (*J. Phys. Chem. C 118, 4941–4950, 2014*).

Laser dynamics

Do lasers mimic neurons?

Complex systems displaying recurrent spike patterns are ubiquitous in nature. The understanding of these patterns organization is a challenging task. A. Aragoneses, S. Perrone, T. Sorrentino, M. C. Torrent and C. Masoller (DONLL) have experimentally studied the spiking output of a semiconductor laser with feedback.



By using symbolic analysis they have unveiled a nontrivial organization of patterns, revealing serial spike correla-

tions. Most importantly, they have identified a minimal model, which displays the same symbolic organization. This model, previously used to describe time correlation among sensory neurons, mimics the time correlations among optical spikes under different external stimulus. Since the model describes many dynamical systems, including neurons and cardiac cells, their results suggest that similar correlations of patterns can be found in other systems. (*Scientific Reports 4, 4696, 2014, http://bit.ly/1qnUyBL*).

Biophysics

Mighty small: observing and modelling individual microbes becomes big science

Does the individuality of microbes matter? Traditionally, microbes have been studied as a collective since their individual observation is very difficult. Nevertheless, microbes are discrete entities whose individuality may be crucial in many circumstances. The tremendous technological progress in recent years enables us to study bacteria and other tiny organisms at the level of single cells. In parallel, the individual-based modelling techniques have jumped from ecology to microbiology with success. C. Prats (MOSIMBIO-BIOCOM) and scientists from different research groups which are leader on individual-based modelling (IBM) and individual-based observation (IBO) have analysed the state-of-the-art of both approaches and identified the possibilities of their combination into a new paradigm: the microbial individual-based ecology (µIBE). (*Proceedings of the National Academy of Sciences of the USA, 110, 2013*).

Astrophysics

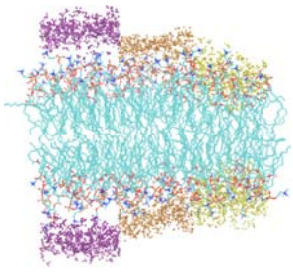
Classical novae and type I X-ray bursts: challenges for the 21st century

Classical nova explosions and type I X-ray bursts are the most frequent types of thermonuclear stellar explosions in the Galaxy. Both phenomena arise from thermonuclear ignition in the envelopes of accreting compact objects in close binary star systems. Detailed observations of these events have stimulated numerous studies in theoretical astrophysics and experimental nuclear physics. A. Parikh, J. Jose, and G. Sala (GAA) review theoretical efforts to better understand the energy production and nucleosynthesis in these explosions, with emphasis on studies directed at identifying nuclear physics quantities with uncertainties that significantly affect model predictions. (*AIP Advances 4, 041002, 2014*)

Chemical Physics

Diffusion and spectroscopy of water and lipids in bilayer membranes

Biological membranes are ubiquitous in nature as limiting structures of cells, separating cell contents from external environments, but allowing the passage of nutrients and wastes through them. The study of pure component membranes can help understand basic biological membrane functions and its interaction with the environment. J. Yang, C. Calero and J. Martí (SIMCOM) and coworkers have analyzed the microscopic structure and dynamics of water and lipids in a fully hydrated dimyristoylphosphatidylcholine phospholipid lipid bilayer membrane using all-atom molecular dynamics simulations based on

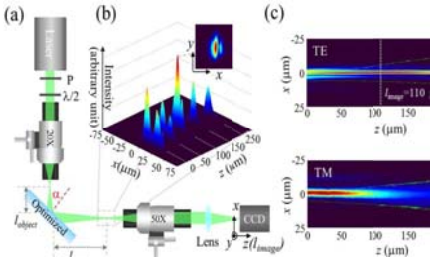


Molecular self-diffusion, reorientational motions, and spectral densities of atomic species reveal a variety of time scales playing a role in membrane dynamics. (*J. Chem. Phys. 140, 104901, 2014*).

Photonic Materials

Flat focusing mirror

The control of spatial propagation properties of very narrow light beams such as divergence, focusing or imaging are important challenges in optics and photonics. Y.C. Cheng, J. Trull, C. Cojocaru, R. Vilaseca and K. Staliunas (DONLL) in collaboration with Vilnius University (Lithuania) have experimentally demonstrated a new concept of flat focusing mirror.



The design of this special mirror is based on the properties of spatially modulated materials at micrometric scale (photonic crystals) and it can focus and reproduce transverse light patterns benefiting, at the same time, from lateral translational invariance. This device can largely increase the applicability of structured photonic materials for light beam propagation control in small-dimension photonic circuits. (*Scientific Reports 4, 6326, 2014*).

PhD THESIS

- **Sandro Perrone** "Exploiting nonlinearity and noise in optical tweezers and semiconductor lasers: from resonant damping to stochastic logic gates and extreme pulses". **Supervisors:** C. Masoller and R.Vilaseca
- **Gloria Molina Giralt** "Color and technology in historic decorated glazes and glasses" **Supervisors:** T. Pradell and J. Molera
- **Vitaly Gorlychev** "Design of a 4pi neutron detector for B-delay neutron detection experiments". **Supervisor:** G. Cortes
- **Enric Bargalló** "IFMIF accelerator facility RAMI analyses in the engineering design phase". **Supervisors:** J. Dies and C. Tapia
- **Andrés Aragoneses Aguado** "Experimental study of feedback-induced dynamics of semiconductor lasers: from symbolic analysis to subwavelength position sensing". **Supervisors:** C. Masoller and M.C. Torrent
- **Lina Maigyte** "Shaping of light beams with photonic crystals: spatial filtering, beam collimation and focusing". **Supervisors**: K. Staliunas and C. Cojocaru

Edited by:

Departament de Física i Enginyeria Nuclear
Edifici B5, 2ª planta
Campus Nord, UPC
C. Jordi Girona Salgado, 1-3
08034 Barcelona
phone: 93 401 6973