DEPARTAMENT DE FÍSICA I ENGINYERIA NUCLEAR *NÚM. 13, TARDOR 2012*

FENOMEN

NEWSLETTER OF THE DEPARTMENT OF PHYSICS AND NUCLEAR ENGINEERING

NEWS

FELLOWSHIPS

- One PhD and one postdoc fellowships are offered by DONLL on "Stochasticity in nonlinear complex systems", (jordi.g.ojalvo@upc.edu).
- Two PhD EuroPhotonics PhD Program fellowships are available at DONLL on "Nonlinear optics for ultra-short laser pulse characterization" (crina.maria.cojocaru@upc.edu) and "Gain and index modulated broad-area semiconductor lasers" (ramon.herrero@upc.edu).

EVENTS

- The Annual Research Meeting of FEN will take place on January 31st 2013 at the Institut d'Estudis Catalans, Carme, 47, Barcelona (http://www.fen.upc.edu).
- "WATERSPAIN 2013", Zaragoza February 7&8, 2013. Co-organizers: E. Guàrdia and J. Martí (www.icmab.es/waterspain2013)

INVITED PROFESSORS

- A. Krivchikov, National Academy of Science of Ukraine, "Excitation in glasses and disordered phases" (July-December 2012), hosted by GCM.
- D. Laria, Comisión Nacional de Energia Atómica & Univ. de Buenos Aires, "Protons Aquosos Nanoconfinats" (May-July 2012), at SIMCON.

Unveiling the transit of Venus

On June 6th 2012, at 6 AM Venus passed between the Earth and the Sun. This rare phenomenon, that will not be visible again until 2117, was captured in Barcelona by G. Astrakharchik.

RECENT PUBLICATIONS

Astrophysics

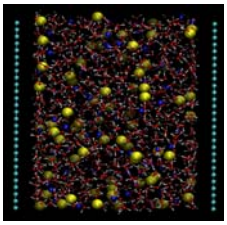
Sizing up a neutron star

The observational determination of mass and radius of an accreting neutron star provides constraints on the still unknown equation of state of neutron star matter. G. Sala, J. José, A. Parikh, R. Longland (GAA), L.C. Pardo (GCM) and researchers from M.P.I für Extraterrestrische Physik and ESA, have determined the mass and radius of the neutron star in the peculiar Rapid Burster, using data obtained by NASA satellite Swift. (*Astrophys. J.* 752, 2012)

Chemical physics

Specific ion effects in electrolyte solutions

J.Sala, E.Guàrdia, J.Martí (SIMCON) have studied the reliability of molecular dynamics simulations using polarizable models for water and ions. They revealed excellent agreement with experimental data and valuable information on ion and water dynamics, very difficult to obtain from experiments. Large anionic species (figure) in aqueous solution within a graphene slab show a tendency to occupy the whole space available, whereas light ions (fluoride) stay far from interfaces. (*Phys.Chem. Chem.Phys.* **14**, 2012).



Science & technology of cultural heritage

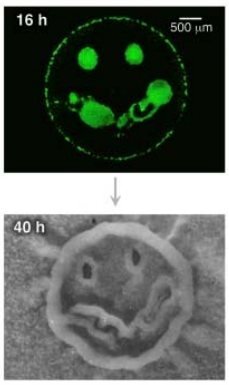
Shine like the gold

Lusters are composite thin layers of metal nanoparticles in glass displaying peculiar optical properties. The origin of the golden-shine shown by those layers has been subject of discussion. T. Pradell (GCM) and co-workers have analyzed lusters by different experimental methods and performed numerical simulations to evaluate their optical properties. They have shown that the metallic shining effect is mainly controlled by the diffusivity of metallic ions in the glass substrate, while color is mostly dependent on the relative concentrations of Ag and Cu in the initial mixture. This study establishes connections between Middle Age Alchemy and Nanotechnology. (J. Appl. Phys. **112**, Sept. 2012).

Systems biology

Dying to get wrinkles

Bacterial biofilms form intricate 3D structures that protect them from liquid and gas penetration (and thus from antibiotic treatments). P. Rue and J. Garcia-Ojalvo (DONLL) together with colleagues from the University of California San Diego, have shown that these structures are seeded by a pattern-forming process that accumulates dying cells in certain regions of the biofilm. As a result, macroscopic wrinkles (hundreds of cells in height) arise from lateral mechanical stresses that are driven by cell death. (*Proc. Nat. Acad. Sci. USA.*, Sept. 2012).



Condensed matter

Relaxation and aging in glasses: a zoom at atomic scale

When coherent light is scattered from a disordered system it gives rise to a random diffraction pattern, known as "speckle", which is related to the exact spatial arrangement of the scatterers in the system. Synchrotron and free-electron laser sources can provide sufficient coherent flux to obtain speckle patterns using X-rays, thus opening the possibility to measure slow dynamics at the atomic scale. E. Pineda (GCM) and co-workers used X-ray Photon Correlation Spectroscopy to unravel the relaxation dynamics of a Mg-based metallic glass. They observed a complex hierarchy of dynamic processes characterized by distinct aging regimes, showing a strong analogy with the aging of soft glassy materials such as gels and concentrated colloidal suspensions. (*Phys. Rev. Lett.* 109, 2012, and "Spotlight on science" by the ESRF).

OUR PEOPLE

Pol Lloveras, condensed matter phys.

Large caloric effects have been observed in ferroic materials in the vicinity of phase transitions, under application of external fields. This points to environmentally friendly cooling systems. Adequate operating ranges, reproducibility and small hysteresis are unavoidable requirements for technological application. To improve capabilities one can use the crossed response between different physical magnitudes. By joining GCM group, I aim to carry out an experimental study of the multicaloric behavior of ferroelectrics under simultaneous hydrostatic and electric fields.

Pol Lloveras obtained his PhD in Physics from the Univ. of Barcelona in 2010. After a postdoc at École Polytechnique (Paris) he joined FEN in Sept. 2012 under a UPC postdoc grant.

Paolo Nicolini, computational chemist

I joined the SIMCON group and I found a mellow and stimulating atmosphere from the beginning. My research is focusing on the development of classical force fields for water. I exploit the force matching algorithm, a technique able to parameterize a force field starting from a reference MD trajectory. The aim is twofold: first, we address the issue of well reproducing the ab initio physical properties. In addition, we try to find the essential "ingredients" for the model. The latter scope will be helpful on the methodological point of view, when more accurate calculations will be available.

P. Nicolini obtained his PhD in Chemistry at Univ. of Florence and joined FEN in March 2012.

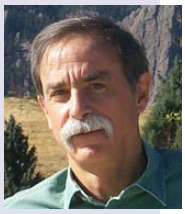
SIDE NOTE (Ramon Vilaseca)

50 years of nonlinear optics

The invention of the laser in 1960 quickly led to new advances in science and technology. The high power and monochromaticity of laser light produced new effects on matter, which are no longer proportional to light intensity: they are known as “nonlinear effects”. In 1961, Franken et al. observed that the red light from a ruby laser partially transformed, within a quartz crystal, into ultraviolet light. This was against the (linear) Classical and Quantum Optics known at that moment, which prevented any change in the frequency of light. Shortly after, in 1962, Bloembergen et al. published the first theoretical article establishing the fundamentals of the new field of ***Nonlinear Optics***. Nowadays, this field is part of all books on Optics. Without it, we could not understand, for instance, how short pulses of laser light propagate in matter and affect the atoms, how they form solitons, etc. Nonlinear Optics allows generating light at new frequencies, producing attosecond pulses, improving material and biomedical analysis and spectroscopy, material and information processing, etc. Much research is being done in Nonlinear Optics nowadays.

Last October an international Symposium celebrating the 50th anniversary of Nonlinear Optics was held at the Institute of Photonic Sciences (ICFO, Barcelona). Two Nobel Prizes, Nicolaas Bloembergen "father" of Nonlinear Optics (92 years old), and Charles Townes, one of the inventors of the Maser and Laser (97 years old) attended the event.

The Nobel laureates in Physics 2012



The Nobel Prize in Physics 2012 was awarded to **Serge Haroche** (left), from College de France and Ecole Normale Supérieure, Paris) and **David J. Wineland** (right) from NIST, Boulder, and Univ. of Colorado, USA), ***"for ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems".*** Both researchers work with single atoms or ions interacting with photons, investigating the quantum effects that appear and their possible applications. S. Haroche (disciple of Nobel laureate C. Cohen-Tannoudji, who, in turn, was disciple of Nobel Prize A. Kastler) works with neutral atoms excited to Rydberg states and interacting with few microwave photons resonating in an extremely high quality factor cavity, investigating so called "Cavity Quantum Electrodynamics" effects. On the other hand, D. Wineland works with cold ions stored in electric traps and interacting with optical photons. The ion vibrations within the trap are quantized and very well controlled. In both cases, they cleverly manipulate these systems, producing quantum superpositions of mixed states (photon↔atom, photon↔ion, electron↔center-of-mass states, states of two or more ions,…), quantum “entangled" states, etc. For instance: Haroche has made “nondemolition” quantum measurements of the number of photons in a cavity. Wineland has implemented atomic clocks with a precision of 10^{-17} (two orders of magnitude better than that of the famous Cs atomic clock frequency standard!). He has also been the first to carry out experimentally a two-qubit operation (CNOT), useful for future quantum computing. Both have implemented “Schrödinger’s cat” quantum experiments. Thanks to their experiments, Quantum Mechanics looks now more promising for new real applications…"

RESEARCH PROJECTS GRANTED

- "Stochasticity in Nonlinear Complex Systems" (PI: J. García Ojalvo), Ministerio de Economía y Competitividad.
- “Nanoscale computer simulation of condensed phases: molten salts, ionic solutions and molecular liquids” (PI: E. Guardia), Ministerio de Economía y Competitividad.
- “Bioaerosoles atmosféricos: niveles, transporte e impactos (BATMAN) (PI: M. Alarcon), Ministerio de Economía y Competitividad.
- “In-situ pulse characterization in nonlinear random materials” and “Control of frequency conversion in nonlinear photonic crystals” (PI: J. Trull), RDECOM, USA.

PhD THESIS

- **Jonàs Sala Viñas** “Confinement Effects on the Structure and Dynamics of Water and Aqueous Ionic Solutions”, Supervisors: E. Guardia and J. Martí, May 9th 2012.
- **Antonio Relaño Castillo** “AsisSPH: Devising and validating an axisymmetric smoothed particle hydrodynamics code”, Supervisor: Domingo Garcia, June 6th 2012.
- **Oscar Lorente Espin** “Hawking radiation in NS5 and Little String Theory”, Supervisor: Pere Talavera, Sept. 20th 2012.

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