DEPARTAMENT DE FÍSICA I ENGINYERIA NUCLEAR **NUMBER 15, AUTUMN 2013**

FENOMEN

NEWSLETTER OF THE PHYSICS AND NUCLEAR ENGINEERING DEPARTMENT

NEWS

FELLOWSHIPS

- PhD EuroPhotonics Program fellowship available at DONLL for the project "Gain and index modulated broad-area semiconductor lasers" (ramon.herrero@upc.edu).

EVENTS

- **"Annual Research Meeting of FEN"**, February 6th 2014, at the Institut d'Estudis Catalans, Carme 47, Barcelona.
  Organizers: E. Guàrdia, J. José, C. Cojocaru (http://www.fen.upc.edu).

- **"ICTP-SAIFR School in Nonlinear Optics and Nanophotonics",** San Paulo, Brazil, November 25th - December 6th, 2013.
  Co-organizer: C. Masoller (DONLL) (http://www.ictpsaifr.org/?page_id=3616)

- **"6th 'Rio de la Plata' workshop on laser dynamics and nonlinear photonics",** Montevideo, Uruguay, December 9th to 12th, 2013. **Co-organizer:** C. Masoller (DONLL) (http://www.fisica.edu.uy/~cris/workshop.htm)

INVITED PROFESSORS

- **Dr. R. Céolin,** Faculté de Pharmacie, University Paris Descartes, from June 30th to August 5th 2013, hosted by GCM.

- **Dr. Hou Jiayu**, Ancient Ceramics Laboratory, The Palace Museum, Beijing, China. Project: "Causes and mechanism of the Jun furnace transmutation glaze", from June 1st to July 31st 2013, hosted by GCM.

NEW GRANTED PROJECTS

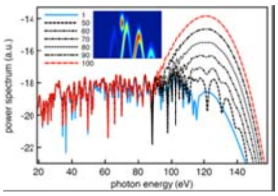
- "Second and third order nonlinear optical phenomena in metal-dielectric and plasmonic nanostructures: experimental analysis", granted by RDECOM, USA, (09/2013–09/2015). PI: C. Cojocaru (DONLL).

RECENT PUBLICATIONS

Laser physics

A new method for high intensity x-ray laser light generation

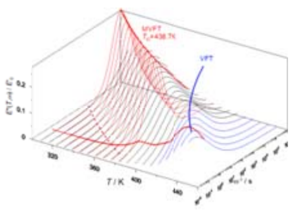
High-intensity coherent radiation in the extreme ultraviolet (XUV) and x-ray range of the electromagnetic spectrum can only be generated at present in high-cost infrastructures such as synchrotrons. The availability of tabletop x-ray lasers with high photon energies has however been largely pursued over the last two decades. C. Serrat (DONLL) proposes a new method for the amplification of coherent XUV radiation using high-harmonic generation (HHG). By synchronizing intense IR and weak XUV pulses, forward XUV scattering from the non-stationary electronic wave packet promoted by the intense IR driving field is strongly enhanced. Based on this effect, he predicts large amplification of XUV radiation in the cutoff spectral region of HHG. (***Physical Review Letters 111, 2013***).



Condensed matter

Effect of the relaxation state on the slow dynamics of metallic glasses

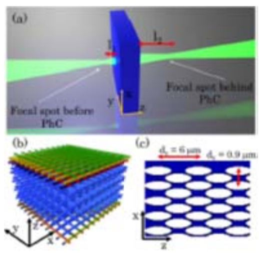
The relaxation state of metallic glasses is critical to their mechanical properties. E. Pineda (GCM) and co-workers used mechanical spectroscopy to study the low frequency relaxation spectrum of relaxed and rapidly quenched ribbons of Mg-based metallic glass. The glassy dynamics was interpreted in terms of a complex elastic modulus well-described by a Cole-Cole relaxation function. The differences between as-quenched and relaxed samples were described by a simple model of two glassy states with different fictive temperatures and relaxation functions with different broadening parameters. The comparison between hyper-quenched and relaxed samples was used to examine the origin of the low temperature "excess wing" of internal friction commonly observed in glassy metals. The results offer a description of the relaxation dynamics of metallic glasses that will help the understanding of some related processes such as the mechanical deformation and the physical aging. (***Acta Materialia 61, 2013***).



Photonic crystals

Flat lenses and mirrors at micrometric scale

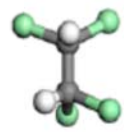
Periodic modulation of the material refractive index at the wavelength scale, ubiquitous to photonic crystals (PhCs) leads to an extensive control of the dispersion properties, offering the possibility to manipulate the light propagation. L. Maigyte, Y. Cheng, K. Staliunas, J. Trull, R. Vilaseca and C. Cojocaru (DONLL), in collaboration with researchers from Vilnius University, have experimentally shown that a narrow laser beam can be focused when it is transmitted or reflected by a PhC. They have built flat lenses capable to focus beams at visible frequencies at 50-70 μm behind the crystal. Different geometries of PhCs produce controlled focusing and imaging in reflection. These micrometric structures act as a transversely invariant flat focusing mirrors or lenses and can be used to control the propagation of the light in a photonic circuit. (***Physical Review A 87, 2013*** and ***Optics Letters 38, 2013***).



Materials science

The molecular world in solid state

M. Barrio, J.L. Tamarit (GCM), in collaboration with Université Bordeaux (French) and Univ. Nacional de Córdoba and IFEG-CONICET (Argentina) have highlighted the huge variety in which the molecular world is presented in the solid state through the study of the polymorphic behavior of (Cl_2HC-$CHCl_2$). Polymorphs appear as combinations of different conformations, *trans* and *gauche*, of the molecule. (***Crystal Growth and Design, 13, 2143, 2013***).



The Nobel laureates in Physics 2013

Long life to the Standard Model

The Standard Model (of fundamental particles and interactions) is a very elegant theory that models in a very precise way electromagnetic weak and strong interactions among the fundamental fermions constituents of matter, six leptons and six quarks, using four bosons as force carriers, photon, Z, W and gluon, and one Higgs boson. The standard model is a Gauge Invariant Quantum Field Theory. The early implementations predicted massless intermediate bosons which lacked the capacity to describe the short range of the weak interaction. In 1964 three independent groups: Brout and Englert; Higgs; and Guralnik, Hagen, and Kibble, developed a model that allow force carriers to acquire mass; it is the so called Higgs Mechanism (in justice the Englert–Brout–Higgs–Guralnik–Hagen–Kibble mechanism). "Higgs mechanism" refers to the generation of masses for the W±, and Z weak gauge bosons through electroweak symmetry breaking.

The Nobel Prize in Physics 2013 was awarded jointly to ***François Englert*** (left) and ***Peter W. Higgs*** (right) ***"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider"***

François Englert (Etterbeek, Belgium, 6 November 1932) is Professor emeritus at the Université libre de Bruxelles (ULB). He graduated as an electromechanical engineer in 1955, and in 1959 was awarded his PhD in physical sciences from the ULB.
He has worked at Cornell University and ULB, and in 1984 was appointed as a Sackler Professor at Tel-Aviv University. He serves as a Distinguished Visiting Professor at the Chapman University's Institute for Quantum Studies since 2011.
Peter Ware Higgs (Newcastle upon Tyne, UK, 29 May 1929) is Professor emeritus at the University of Edinburgh. He was awarded his PhD in 1954 at King's College. Higgs has worked at Imperial College London, University College London and University of Edinburgh.

Francisco Calviño (GREENER)

The Nobel laureates in Chemistry 2013

Multiscale modelling

The Nobel Prize in Chemistry 2013 has been awarde to ***Martin Karplus***, Université de Strasbourg and Harvard University (left), ***Michael Levitt***, Stanford Univ. School of Medicine, (center) and ***Arieh Warshel***, Univ. of Southern California, (right) ***"for the development of multiscale models for complex chemical systems"***.

They have developed powerful tools for the modelling of highly complex molecular systems and processes extremely difficult to access by experimental techniques. These methods combine the quantum and classical mechanical theories. On one side, quantum models are capable of consider electrons and atomic nuclei as particles, but they include a huge number of degrees of freedom that make most systems out of reach. Conversely, classical models contain much fewer degrees of freedom, losing quantum accuracy, but increasing several orders of magnitude the simulations time scales. The key idea is to describe only part of the system with full quantum accuracy, including its interactions with the surrounding described with classical mechanics.

The work of the Nobel laureates focus on how to calculate the energy of a real system in an efficient way, for systems where relatively large changes in electronic configuration are strongly coupled to a surrounding suffering weak perturbations. Karplus and Warshel started in the 70's calculating the π-electron and vibrational spectra of chromophores. They modelled the effects of σ-electrons and nuclei with a classical approach, whereas π-electrons were represented with a quantum chemical approach. Later, Warshel and Levitt have constructed a general scheme for the separation between electrons to be described classically and others that are explicitly appearing in the quantum model. Today this has been used not only for the study of complex processes in biochemistry and organic chemistry but also for heterogeneous catalysis and computation of vibrational spectra of macromolecules in liquid solution, that has bridged experiments and theory in a very efficient way and solve some unsolvable problems.

Jordi Martí (SIMCON)

PhD THESIS

- **P. Rue** "Transient and stochastic dynamics in cellular processes", Supervisors: J. Garcia Ojalvo and M. Torrent, July 25th 2013.
- **B. Santcristobal** "Neuronal oscillations: from single-unit activity to emergent dynamics and back", Supervisor: J. Garcia Ojalvo, July 22nd 2013.
- **J.P. Rigla** "Design and characterization of magnetic systems in race-track microtrons". Supervisor: Y. A. Koubychine, Oct. 9th 2013.
- **M. Montaña** "Optimization of alpha emitter's determination in water. Behavior of radionuclides in water treatment plants". Supervisor: A. Camacho and I. Vallés, July 24th, 2013.

NEW PhD STUDENTS

- **Alessandro Barardi,** Marie Curie grant (J. Garcia Ojalvo and M.C. Torrent).
- **Seyedamir Hosseini**, research project grant (M.D. Martinez and X. Lana).
- **Maciej Jedynak,** Marie Curie grant (J. Garcia Ojalvo, A. Pons).
- **Shubham Kumar**, FPI grant (K. Staliunas).
- **Efstratia Mitsari**, FPI grant (R. Macovez and J.L. Tamarit).
- **Pragya Tripathi,** FI grant (J.L. Tamarit and R. Macovez).
- **Gloria Molina,** research project grant (T. Pradell and J. Molera)
- **Giulio Tirabassi,** Marie Curie grant (C. Masoller).
- **Natàlia López,** research Project grant (M.A. Duch).
- **Adrián Schiffer**, FPI-UPC grant (J. Lorca).
- **Husam Tareq Majeed,** Iran Gov. grant (M. Alarcon).
- **Bingxia Wang,** Europhotonics PhD grant (J. Trull and C. Cojocaru).

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