XXXVII Reunión Bienal
de la Real Sociedad Española de Física

Real
Sociedad
Española de
Física

R.S.E.F.

15-19 de julio de 2019

Zaragoza

CONTENTS

WELCOME ADDRESS

The Biennial Meeting of the RSEF visits the Ebro capital for the first time since 1950. The organizers represent most of the departments and research centers from the University of Zaragoza and from CSIC that are active in the different branches of Physics. Thanks to them, and to your active participation, the Biennial Meeting will present the best of research, technology transfer, dissemination and teaching and will devote an especial effort to support young and female researchers. Last, but not least, the meeting also includes a very appealing open program named “Physics for everybody”, which will bring Science closer to society. We wish you a pleasant and very fruitful stay in Zaragoza.

The organizing committee

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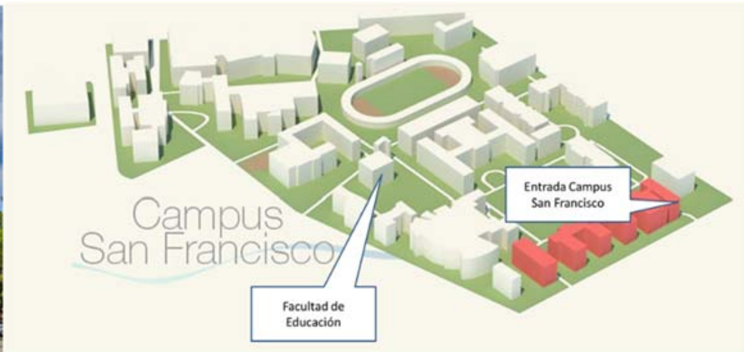
GENERAL INFORMATION

Venue

Facultad de Educación, Campus San Francisco, Universidad de Zaragoza



Plano Campus San Francisco, Universidad de Zaragoza

Facultad de Educación, Campus de San Francisco. Universidad de Zaragoza. Pedro Cerbuna 12, 50009 – Zaragoza (Spain)

How to get there:
By tram – “Plaza de San Francisco” stop
By bus – Line 35, 42, Ci1: “Violante de Hungría/Escuela Idiomas” stop
Line 22, 35, 38: “San Juan Bosco 7” stop

Conference rooms

The **plenary sessions** take place at the **conference hall (floor -1)**

The **specialized symposia** take place at the following rooms (numbers refer to their capacities)

Room 0.4: 70; **Room 0.5**: 70; **Room 0.6**: 70; **Room 0.7**: 70; **Room 0.8**: 70; **Room 1.3**: 70; **Room 1.4**: 72; **Room 1.5**: 36; **Room 1.6**: 32; **Room 1.8**: 54; **Conference hall**: 280; “**Sala de juntas”**: 50

The **commercial exhibition and poster area** are located at the main hall (ground floor)

WiFi connection

A free internet access will be available via the ID “CongresoRSEF”. The password will be provided to all registered attendees.

Coffee breaks and lunches

The **coffee breaks** of the morning, plenary sessions will be served next to the conference hall (floor -1) while those of the afternoon sessions will be served at the main hall, next to the **poster area**

The **lunches** will be served at the **Facultad de Ciencias canteen (floor -1)**. Tickets will be provided to all registered attendees at the technical secretariat upon arrival.

Social events

Welcome and farewell cocktails

Date: Monday, July the 15th, 19:00 and Friday, July the 19th, 13:30

Place: Conference venue (Facultad de Educación), main hall (ground floor)

Conference dinner

Date: Wednesday, July the 17th, 21:30

Place: Restaurante Aura. Avenida José Atarés 7, Zaragoza

How to get there:
By tram – “La Chimenea” stop
By bus – Line 23, 42: “Valle de Broto/Ranillas” stop

Please, do not forget to bring the dinner ticket to the restaurant. If you have indicated any food allergy, please contact the waiter assigned.

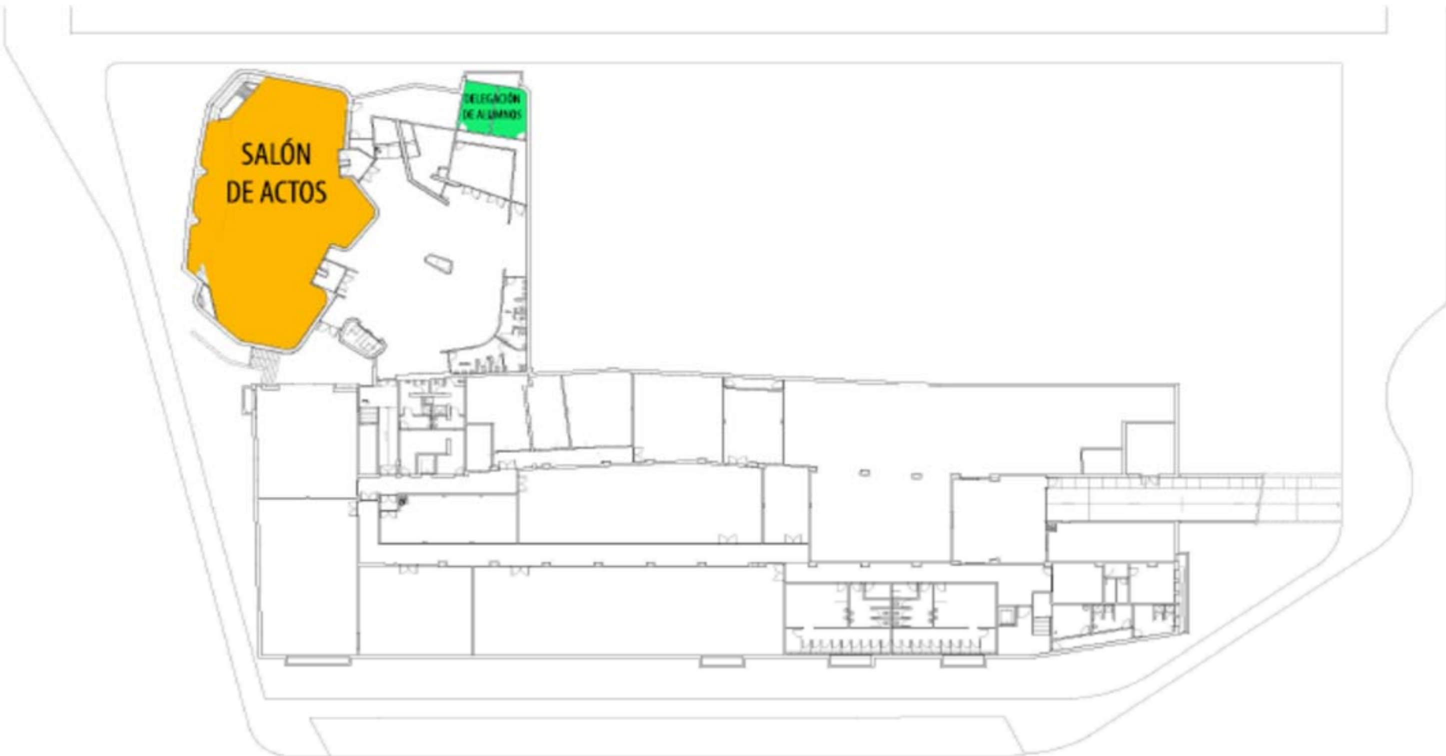
Restaurante Aura

SCIENTIFIC PROGRAMME

Plenary sessions

Monday, July the 15th – Friday, July the 19th, morning

Conference Hall ("Salón de actos")



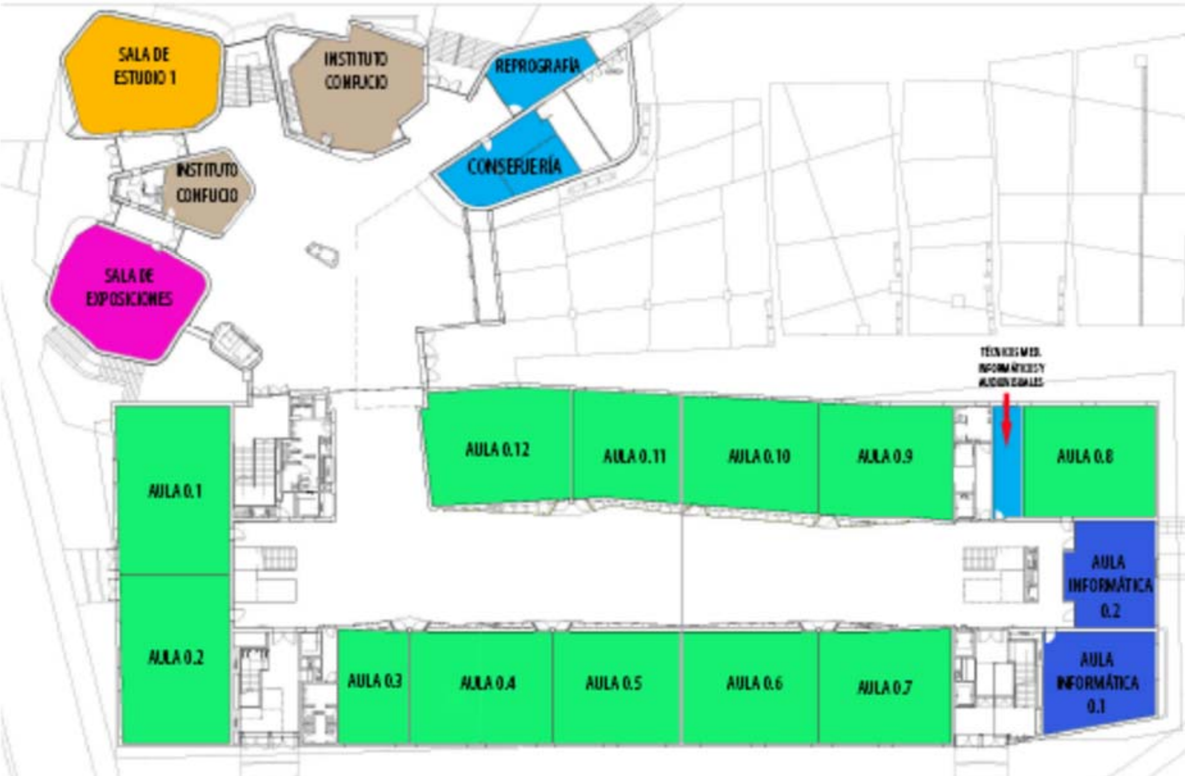
Floor -1

Morning programme at a glance: Plenary sessions.

Time	Lunes, 15 de julio	Martes, 16 de julio	Miércoles, 17 de julio	Jueves, 18 de julio	Viernes, 19 de julio
8:30	**Registration**				**María Luisa Sarsa.** Results on dark matter annual modulation from ANAIS-112 experiment
9:00	**Opening**	**María José García.** Production of Exotic Nuclei	**Jozef Ongena.** A novel scheme for efficient energy transfer to ions using ion-cyclotron waves: applications in terrestrial and space plasmas	**Hernán Míguez.** Multifunctional Optical Materials	
9:10					**Mathias Fink.** Multi Illumination approaches for Biomedical Imaging: From Ultrasound to Optics
9:40		**Petra Rudolf.** See atoms move in real time	**José Ignacio Latorre**	**Stefano Spagna.** Harnessing light as a probe of matter: Q-works new creation	
9:50	**Peter Bruggeman.** Low Temperature Plasmas: a Unique Non-Equilibrium State for Tackling Grand Societal Challenges				**Leo Gross.** On-surface synthesis by atomic manipulation studied with atomic force microscopy
10:20		**Round table.** Women in Physics	**Round table.** Disseminating Quantum Physics	**Round table.** Physics in and for the Industry	
10:30	**Dan Frenkel.** Counting the Uncountable: Entropy, granular Entropy and Information				**Gabriela González.** Gravitational Waves Astronomy
11:10	**COFFEE**	**COFFEE**	**COFFEE**	**COFFEE**	**COFFEE**
11:40	**Francisco González Redondo.** Julio Palacios y la Edad de Plata de la Física Española	**Laura Greene.** Correlated Electrons: The Dark Energy of Quantum Materials	**Mónica Vázquez.** Gamma-ray Astrophysics	**Mario Rasetti.** Topological Data Field Theory: structure and applications	**RSEF meeting and closing**
12:20	**Video-abstracts awards**	**Paul Scheier.** Helium nanodroplets – from basics to applications	**José Manuel Vaquero.** Uncertainties in the reconstruction of long-term solar activity: What about the Maunder minimum?	**María Moreno Llácer.** The Large Hadron Collider and its search for the building blocks of the Universe	
13:00		**Young investigators awards**	**Edwin Herrera.** Manipulating vortices using tilted magnetic fields	**Noé Jiménez.** Focused ultrasound beyond phase-arrays	
13:20	**LUNCH**	**LUNCH**	**LUNCH**	**LUNCH**	**FAREWELL COCKTAIL**

Specialized symposia

Monday, July the 15th – Thursday, July the 18th, afternoon



Ground floor

Floor 1

Afternoon programme at a glance: Symposia and other activities

<table>
<tr><th>Time</th><th>Monday, July the 15th</th><th colspan="2">Tuesday, July the 16th</th><th colspan="2">Wednesday, July the 17th</th><th colspan="2">Thursday, July the 18th</th></tr>
<tr><td>15:00</td><td>SYMPOSIA</td><td colspan="2">SYMPOSIA</td><td colspan="2">SYMPOSIA</td><td>SYMPOSIA</td><td>MEETING FEIASOFI</td></tr>
<tr><td>16:30</td><td rowspan="2">COFFEE & POSTERS</td><td colspan="2" rowspan="2">COFFEE & POSTERS</td><td colspan="2">COFFEE & POSTERS</td><td colspan="2" rowspan="2">COFFEE & POSTERS</td></tr>
<tr><td>17:00</td><td></td><td rowspan="3">Round table
“La transición energética 2030 en España”</td></tr>
<tr><td>17:30</td><td>SYMPOSIA</td><td colspan="2">SYMPOSIA</td><td>SYMPOSIA</td><td>SYMPOSIA</td><td rowspan="2">FEIASOFI
Round table
“El papel de la mujer en la física y la Edad de Plata de la física en España a través de la figura de Miguel A. Catalán Sañudo”</td></tr>
<tr><td>18:15</td><td>SYMPOSIA</td><td>SYMPOSIA</td><td>Round table
Opportunities in Superconductivity. A view from Spain</td><td>SYMPOSIA</td><td>SYMPOSIA</td></tr>
<tr><td>19:00</td><td>WELCOME COCTAIL</td><td colspan="6" rowspan="3">OPEN PROGRAMME: “FÍSICA PARA TOD@S”

Patio de la Infanta, Ibercaja</td></tr>
<tr><td>19:15</td><td>OPENING OF THE EXPOSITION
“Julio Palacios y la Edad de Plata de la Física Española”</td></tr>
<tr><td>20:30</td><td>Superconductivity on stage
(Plaza San Felipe)</td></tr>
<tr><td>21:30</td><td></td><td colspan="2"></td><td colspan="2">DINNER (Restaurante Aura)</td><td colspan="2"></td></tr>
</table>

List of symposia (Monday to Thursday) with their locations

Monday, July 15th	Tuesday, July the 16th	Wednesday, July the 17th	Thursday, July the 18th
XXIX Encuentro Ibérico de Enseñanza y Divulgación de la Física (**room 1.8**)	XXIX Encuentro Ibérico de Enseñanza y Divulgación de la Física (**room 1.8**)	XXIX Encuentro Ibérico de Enseñanza y Divulgación de la Física (**room 1.8**)	Didáctica e Historia de la Física (**room 1.8**)
Superconducting Materials (**room 0.4**)	Superconducting Materials (**room 0.4**)	Applied Photonics (**room 0.4**)	Physics of Complex systems (**Room 0.4**)
Frontiers of Molecular Physics (**room 0.5**)	Frontiers of Molecular Physics (**room 0.5**)	Molecular Nanoscience and Molecular Materials (**room 0.5**)	Molecular material son Surfaces (**room 0.5**)
	Astrophysics and Astroparticles (**room 0.6**)	Astrophysics and Astroparticles (**room 0.6**)	
Nuclear Physics + Medical Physics (**room 0.7**)	Nuclear Physics (**room 0.7**)	Nuclear Physics (**room 0.7**)	
Theoretical and Particle Physics (**room 0.8**)	Theoretical and Particle Physics (**room 0.8**)	Física de la Atmósfera y el Océano (**room 0.8**)	Theoretical and Particle Physics (**room 0.8**)
Thermodynamics and Thermal Physics (**room 1.3**)	Medical Physics (**room 1.3**)	Medical Physics (**room 1.3**)	
Plasma Physics (**room 1.4**)	Plasma Physics (**room 1.4**)		
Quantum Information (**room 1.5**)	Quantum Technologies (**room1.5**)	Quantum Optics and Nonlinear Optics (**room 1.4**)	
	Women in Physics (**room 1.6**)		
Frontiers of Magnetism (**conference hall**)	Energy and Sustainability (**conference hall**)	Energy and Sustainability (**conference hall**)	Energy and Sustainability (**conference hall**)
			Meeting of FEIASOFI (**Sala de juntas**)

Symposium S1: XXIX Iberian Meeting on Physics Education and Dissemination. Room 1.8 (first floor)

Time	Monday, July 15th	Tuesday, July 16th	Wednesday, July 17th
15:00	**Manuel Fiolhais y Rogério Nogueira** Potenciales catastróficos (CONF)	**Jenaro Guisasola** (Coordinador) **Simposio:** Problemas de Enseñanza y Aprendizaje de la Física en Universidad y Bachillerato **Participantes:** **Manuel A. González, Miguel A. González, Fernando Rosado, Alfonso Gómez, Jon Gabilondo, Josu M. Igartúa, Pablo Nacenta, Marisa Amieva, Jordi Colomer**	**José M.ª Pastor y Carmen Carreras** Presentación del informe: El estado de la enseñanza de la Física en la educación secundaria (CONF)
16:00	**Chantal Ferrer-Roca** Experiencias de innovación de Física en enseñanza secundaria y universidad (CONF)		**Mariano Santander** F = -nabla V y sus descendientes: Tres siglos de física y el principio de menor acción (CONF)
16:30	**CAFÉ + Carteles** S1-P1. 3738: **Ana María Gayol**. The Influence of Physical Propierties in Flexography S1-P2. 3791: **Pablo Palacios.** Actividades de Gamificación en el Aula: Fislets S1-P3. 3849: **Pascuala García-Martínez.** Innovative Education Networking for Optics and Photonics Active Learning. S1-P4. 3901: **Antonio David García Gil**. Integración de los Laboratorios docentes LABFIS en las Redes Sociales. S1-P5. 4025: **Joao Mesquita**. Physics Fever - Understanding if videogames are authentic to the laws of physics. S1-P6. 4101: **Joan Josep Suñol**. Experiencias con mentores en Física propedéutica. S1-P7. 4126: **Iván Sánchez Soto**. Eficacia de las preguntas en desarrollo de habilidades cognitivo-lingüísticas, estrategias y tipo de aprendizaje en Física. S1-P8. **Iñigo Rodríguez-Arteche et al**. "¿De qué depende la temperatura en el interior de un edificio? Propuesta indagativa sobre arquitectura bioclimática		
17:30	**Germán Ros Magán** STEAM for Primary Education: on the convenience, training of pre-service teachers and examples based in project-based learning	**Elena Pinilla** Nuevas formas de divulgar ciencia (CONF)	**Iván Sánchez Soto** Evaluación de diez años de experiencia con Aprendizaje Basado en Problemas en Física
17:45	**Javier Ablanque** Ideas preconcebidas de Física en alumnos del Máster Universitario de Formación del Profesorado de Secundaria		**Francisco Javier Salgado Remacha** Análisis de las competencias adquiridas y del perfil de los estudiantes en Grados de Física y de Óptica y Optometría. Conclusiones y análisis final
18:00	**Guadalupe Mtez.-Borreguero** Análisis comparativo del nivel de conocimiento del docente en formación y el alumnado de primaria sobre contenidos básicos de física	**Daniel Aguirre Molina** Aprendiendo ciencia con visión europea: Erasmus+ "Atelier for STE(A)M".	**Martín Pérez** Integración curricular (bloque i) de electricidad y magnetismo, cálculo multivariable y ecuaciones diferenciales en un ambiente de aprendizaje basado en retos
18:15	**Pablo Nacenta Torres** Diseño y desarrollo de un taller inclusivo sobre las propiedades de los fluidos	**Milagros Mateos-Núñez** ¿Influye en los resultados del alumnado de primaria la inclusión de imágenes en cuestionarios de física?	**Arturo C. Martí** Your smartphone: a Physics lab in your hands
18:30	**Joaquim Anacleto** Thermal capacity: how should we teach?	**Manuel Alonso-Sánchez** Problemas de Relatividad para desarrollar la competencia científica en el Bachillerato	**Juan A. Monsoriu Serra** Análisis de la dinámica de un yoyó utilizando el giroscopio de un smartphone
18:45	**Leni Bascones** La Iniciativa 11 de Febrero en la Enseñanza y Divulgación de la Física	**Matilde Ariza Montes** Craftsmanship: genuine intercessor of the pedagogy of Physics	**Asamblea General de miembros de la DEDF**
19:00			
19:30		**Proyección: El enigma de Agustina** **(Espacio Cultural Patio de la Infanta)**	

Symposium S2: Didactics and History of Physics (GEDH). Room 1.8 (first floor)

Time	Thursday, July 18th
15:00	**José Antonio Martínez Pons** Tres experimentos de física *low cost*
15:15	**Jenaro Guisasola** Problemas de enseñanza y aprendizaje de la física en Universidad y Bachillerato
15:30	**Gabriel Pinto Cañón** Año Internacional de la Tabla Periódica (2019): Una oportunidad para abordar contextos de didáctica e historia de la física y la química
15:45	**Carlos Untiedt** Introducción a la Computación Cuántica en el Grado de Física: Un caso práctico
16:00	**Luis Moreno Martínez** Física en las aulas (1915-1939): Observar, construir y medir para adquirir el hábito científico
16:15	**Alfredo Surroca Carrascosa** Mercator and his 1569 spherical chart. How did he designed?
16:30	**COFFEE** S2-P1**. Antonio Marzoa Domínguez.** Una introducción práctica a los sistemas ópticos reales: diseño y construcción de telescopios y microscopios en laboratorios de grado y máster S2-P2. **Antonio Marzoa Domínguez.** El patrimonio de instrumentos científicos de la facultad de física de la Universitat de Barcelona
17:00	**Posters (Flash talks)** **Antonio Marzoa** Una introducción práctica a los sistemas ópticos reales: Diseño y construcción de telescopios y microscopios en laboratorios de Grado y Máster **Antonio Marzoa** El patrimonio de instrumentos científicos de la Facultad de física de la *Universitat de Barcelona*
17:15	**Gabriel Barceló** Miguel A. Catalán Sañudo: La dramática historia de un científico español nacido en Zaragoza, hace ciento veinticinco años
17:30	**Round table. Chairman: Gabriel Barceló** El papel de la mujer en la física y la Edad de Plata de la física en España a través de la figura de Miguel A. Catalán Sañudo **Juana Bellanato, Belén Villacampa, M. Pilar García, Gabriel Barceló**
18:00	**Closing of the Symposium**

Symposium S3: Superconducting Materials. Room 0.4 (ground floor)

Chairs: Ramón Aguado, Leni Bascones, Agustín Camón **Chairs**: Isabel Guillamón, José M. de Teresa

Time	Monday, July 15th	Tuesday, July 16th
15:00	**Ion Errea (invited).** Near room temperature superconductivity in hydrides	**Miguel Ángel Alario.** Crystal Structure and Hole Doping Relations in Overdoped Mo3Cu0.7Sr2RECu2Oy (RE= Pr, Nd, Gd, Tm and Yb) Superconducting Materials
15:15		**Raquel Fernández Martín**. Spin-orbital interplay in the mechanism of superconductivity of iron superconductors.
15:30	**Fernando Gallego.** Tunable interfacial superconductivity in multiferroic tunnel junctions	**María José Calderón.** Exploring correlations in twisted bilayer graphene
15:45	**Sebastian Bergeret.** Transport properties of superconductors with spin-dependent fields	**Beilun Wu.** Angular dependence of magnetoresistance up to 22T in topological materials
16:00	**Posters introduced as flash talks (posters 1-7, 3+2 minutes, Monday)** S3-P1. **Victor Rollano**. Superconducting vortices moving on a periodic pinning potential created by magnetic multilayer nanostructures: Commensurability vs Little Parks effects. S3-P2. **Fernando Peñaranda**. Conditions for the existence of a topological protected phase in full shell proximitized nanowires. S3-P3. **Marta Fernández Lomana**. Magnetoresistance of the superconductor LaRu2P2	**Mariela Menghini.** Vortex dynamics on superconducting and non-superconducting periodic arrays
16:15	S3-P4. **David Sánchez Manzano**. High temperature long-range proximity effect in YBa2Cu3O7 / La7Sr0.3MnO3 planar structures. S3-P5. **Esteban Paredes**. For induce and measure high currents in HTC superconductors rings. S3-P6. **Alejandro Fernández Rodríguez**. Tuning the electronic structure of High Temperature Superconducting films by field induced oxygen diffusion.	**Pablo Orús**. Vortex transport in superconducting W-C nanostructures.
16:30	**COFFEE + POSTERS (Monday to Thursday)** **Flash talks (Monday, continued)** S3-P7. **Cosme González**. Controllable Switching of the Superconductivity of a Tungsten STM Tip on Epitaxial Graphene	S3-P8. **Isabel Guillamón**. Quasiparticle interference and vortex lattice imaging in pure and Ni-doped $CaKFe_4As_4$ S3-P9. **Hermann Suderow**. Observation of a gel of quantum vortices in a superconductor S3-P10. **Jordi Alcalá**. Nano-engineered YBCO Superconducting tapes for Fusion Applications S3-P11. **María Teresa Magaz Pérez**. Exploring new materials for superconducting Kinetic Inductance Detectors S3-P12. **Laura Greene**. Field-induced Gap-like Structure in the Heavy-fermion Superconductor $CeCoIn_5$ S3-P13. **R.M. Jáudenes**. Fabrication of Mo/Au-based Transition Edge Sensors
17:30	**Carlos Pobes.** Development of Transition Edge Sensors (TES) for soft X-ray detection	**Jaume Gázquez.** A combined microscopy and first-principles approach for understanding the defect landscape of YBa2Cu3O7-x at the single-atom level
17:45	**M. José Martínez.** Practical nanoSQUID sensors	**Rosa Córdoba.** Direct-write method to fabricate 3D superconducting nanotubes
18:00	**Marina Calero.** Development of Superconducting Lumped Element Resonators for molecular spin quantum processors	**Round table** Opportunities in Superconductivity. A view from Spain **Teresa Puig (chair), María José Calderón, Lourdes Fábregas, Laura Greene, Xavier Obradors and Hermann Suderow**
18:15	**Joffre Gutiérrez.** Coated Conductor technology for the beam screen of high energy circular colliders	
18:30	**Rafael Navarro.** Effect of UV picosecond pulse laser irradiation of Nb surfaces on their magnetic flux pinning	
18:45	**Juri Banchewski.** Ultrafast transient liquid assisted growth of high current density superconducting films	

Symposium S4: Applied Photonics. Room 0.4 (ground floor)

Chairs: Elena Pinilla, Maribel Gómez

Time	Wednesday, July 17th
15:00	**Pablo Alonso** Nano-optics in 2D materials (**invited**)
15:30	**Javier Martín** Tuning of the optical properties of single photon sources by elastic strain engineering (oral)
15:50	**Fernando Jiménez** Fabrication of MoS_2 p-n Homo-junctions via Direct Nanopatterning (oral)
16:10	**Juan José Esteve** Quenching of the exciton recombination in strained few-layered monochalcogenides (oral)
16:30	**POSTERS + COFFEE** S4-P1. **Víctor Marzoa**: Optical characterization of few-layer molybdenum disulfide mechanical resonators S4-P2. **Augusto Beléndez**: Wave-couplers for see-through applications on photopolymers S4-P3. **Jorge Omar Álvarez Pérez**: Propiedades láser de monocristales $Yb:Ca_3(NbGa¤)_5O_{12}$ con desorden estructural S4-P4. **Victoria Esteso**: Optical interference effects on the Casimir-Lifshitz force between plane-parallel systems with multilayer nanostructures S4-P5. **Cruz Méndez**: VEGA laser facility: current system capabilities and near future improvements S4-P6. **Pascuala García Martínez**: Highly efficient generation of arbitrary vector beams S4-P7. **Jorge Parra**: Indium tin oxide for a new generation of photonic devices S4-P8. **Fernando López Tejeira**: Dipole resonances of sub-wavelength dielectric spheres in the optical range: approximate conditions for moderate- and high-refractive-index materials
17:10	**Miguel Anaya.** Premio de tesis experimental. Optical design of metal-halide perovskite-based materials and devices (**invited**)
17:40	**Elena Cabello Olmo** Tamm plasmons for controlled emission of nanophosphors (oral)
18:00	**Laura Mercadé** Towards large coupling rate in optomechanical crystal cavities with a full phononic bandgap (oral)
18:20	**José María Miranda Muñoz** Flexible optically disordered materials for LED coatings (oral)
18:40	**Flash Talks** 1. **Victoria Esteso**: Optical interference effects on the Casimir-Lifshitz force between plane-parallel systems with multilayer nanostructures 2. **Jorge Parra**: Indium tin oxide for a new generation of photonic devices 3. **Pascuala García Martínez**: Highly efficient generation of arbitrary vector beams 4. **Cruz Méndez**: VEGA laser facility: current system capabilities and near future improvements 5. **Fernando López Tejeira**: Dipole resonances of sub-wavelength dielectric spheres in the optical range: approximate conditions for moderate- and high-refractive-index materials

Symposium S5: Frontiers in Molecular Physics. Room 0.5 (ground floor)

Chairs: Paul Scheier, José Campos

Chairs: José Bretón, Tomás González-Lezana

Time	Monday, July 15th	Tuesday, July 16th
14:45-14:50	**Welcome** (J. Campos Martínez, M. Bartolomei, M. I. Hernández, T. González Lezana)	
14:50-15:10	**FERNÁNDEZ, José A. (U. País Vasco)** Molecular aggregation in cold environments: The tyranny of –OH and the democratic -NH_2	**CERNICHARO, José (CSIC):** Broad band molecule rotational spectroscopy for laboratory Astrophysics
15:10-15:30	**HALBERSTADT, Nadine (CNRS, Toulouse):** Dynamics of doped helium nanodroplets	**FALVO, Cyril (U. Paris Sud):** Simulating the structural diversity and infrared response of carbon clusters across the planar to fullerene transition
15:30-15:50	**PÉREZ DE TUDELA, Ricardo (Ruhr U., Bochum):** Dissociation of acids in tiny water droplets	**SENENT, Mª Luisa (CSIC):** Spectroscopy of relevant non-rigid molecules of astrophysical interest: Ethylene glycol and dimethyl-ether
15:50-16:10	**ALCARAZ-PELEGRINA, José M (U. Córdoba):** Quantum Monte Carlo simulations in Graphical Processing Units	**HUARTE, Fermín (U. Barcelona):** Quantum dynamics of H_2 in SWCNTs: Eigenstates, diffusion and surface coupling
16:10-16:35	**Discussion** **Flash talks** S5-P1. **MELLADO ALCEDO, David (U. Granada)**: A linear polar molecule in a two-color laser field: A symmetry analysis S5-P2. **MORCILLO, Milagros F. (U. Córdoba)**: Quantum trap for atomic states: A case study	**LÓPEZ, María J. (U. Valladolid):** Structural transformations of supported Pd clusters induced by hydrogen adsorption **Discussion**
16:35-17:10	**COFFEE + POSTERS** S5-P3. **ALVIRA, Elena (U. La Laguna)**: Molecular dynamics simulation of the interaction between isoleucine enantiomers and β-cyclodextrin with different solvents S5-P4. **GONZÁLEZ-LEZANA, Tomás (CSIC)**: Combined theoretical and experimental studies of atom-diatom reactions S5-P5. **CAMPOS MARTÍNEZ, José (CSIC)**: A multi-proton cooperative mechanism for graphene permeation of protons S5-P6. **BARTOLOMEI, Massimiliano (CSIC)**: Cisplatin physisorbed on graphene oxide prototype: A computational study S5-P7. **GONZÁLEZ-LEZANA, Tomás (CSIC)**: Experimental and theoretical investigations of Cs + ions solvated in He N clusters S5-P8. **HERNÁNDEZ, Marta I. (CSIC)**: Solvation of Cs + in hydrogen/deuterium: A joint experimental-computational study	
17:10-17:30	**LESARRI, Alberto (U. Valladolid):** Probing intermolecular forces in weakly bound aggregates by supersonic jet microwave spectroscopy	**PIRANI, Fernando (U. Perugia):** The stereodynamics of elementary processes controlled by anisotropic intermolecular forces
17:30-17:50	**VÁZQUEZ, Saulo (U. Santiago de Compostela):** Functional group-based corrections for the calculation of noncovalent interactions by semiempirical quantum mechanical methods	**COLETTI, Cecilia (U. Chieti-Pescara):** On the role of long-range interactions in the dynamics of $OH+H_2$ collisions
17:50-18:10	**DÍAZ, Cristina (U. Autónoma de Madrid):** Molecular diffraction under fast grazing incidence: A suitable tool for surface analysis?	**LOMBA, Enrique (CSIC):** Disorder hyperuniform states: New properties from well known materials
18:10-18:30	**LOMBARDI, Andrea (U. Perugia):** Models for CO_2 adsorption and separation by carbon-based membranes	**HERNÁNDEZ-ROJAS, Javier (U. La Laguna):** Simulating adamantine clusters: Atomistic versus coarse-grained models
18:30-18:50	**ALONSO, Julio A. (U. Valladolid):** Bimetallic clusters: Mixing at the nanoscale	**MARQUES, Jorge (U. Coimbra):** Microsolvation of ions by using state-of-the-art methods based on artificial intelligence
18:50-19:00	**Discussion**	**Discussion**

Symposium S6: Molecular Materials and Molecular Nanoscience. Room 0.5 (ground floor)

Chairs: Angela Sastre, Fernando Luis

Time	Wednesday, July 17th
15:00	**Guillem Aromí** Molecules of lanthanide ions as multiqubit quantum gates (**invited**)
15:20	**Fernando Luis** Spin dynamics of Dy_2 molecules deposited onto micro-SQUID sensors
15:33	**Ana Arauzo** Slow relaxation of polymeric $\{Tb_2Ba(a\text{-}fur)_8\}n$ down to mK temperatures
15:46	**Olivier Roubeau** 2D nanosheets of metalloporphyrin spin qubits for integration into hybrid quantum computing devices
15:59	**Alvaro Gómez** Spin dynamics in spin-bath models
16:12	**Alberto Jiménez. PhD award talk** Tailoring the absorption and emission properties of nanomaterials through their photonic environment (**invited**)
16:32	**NANOMOLMAT meeting** **COFFEE + POSTERS** S6-P1. **David Ausín Neira.** Doping effects on physical-chemical properties of several ionic liquids and their mixtures with water and salts S6-P2. **Javier Rubín.** Antiferromagnetic chains of Fe_3 magnetic clusters in $\{Fe_3YO_2\}$ butterfly molecules
17:15	**Eugenio Coronado** Smart molecular/2D heterostructures (**invited**)
17:35	**Samuel Mañas** Magnetism in 2D Molecular Materials: controlling the surface properties by a rational design
17:48	**Enrique Burzurí** Bridging molecular spin Qbits to superconducting circuits through carbon nanotubes
18:01	**Mario Peláez** In-situ Graphene Oxide Thermal Behaviour via TEM/EELS: Water Desorption, Reduction and Graphitisation
18:14	**Marco Evangelisti** Molecular magnetocooling
18:27	**Angela Sastre** Towards the Synthesis of Advanced Molecules for the Generation of Energy
18:40	**Nicolás Agrait** Electron and Heat Transport in Molecular Junctions (**invited**)

Symposium S7: Molecular materials on surfaces. Room 0.5 (ground floor)

<table>
<tr><th>Time</th><th colspan="2">Thursday, July 18th</th></tr>
<tr><td>15:00-15:30</td><td colspan="2">Sabine Maier
Bottom-up fabrication of atomically precise molecular nanostructures through on-surface synthesis (invited)</td></tr>
<tr><td>15:30-15:45</td><td colspan="2">Carlos Romero-Muñiz
Non-covalent molecular interactions studied by atomic force microscopy: hydrogen and halogen bonds</td></tr>
<tr><td>15:45-16:00</td><td colspan="2">Leyre Hernández López
Metalorganic network spectroscopy: dependence on coordination atoms</td></tr>
<tr><td>16:00-16:15</td><td colspan="2">Percy Roger Palacios
The role of molecule-surface interactions on the chemical stability of fluorinated fullerenes on coinage metals at room temperature</td></tr>
<tr><td>16:15-16:30</td><td colspan="2">Amelia Domínguez-Celorrio
Organic optical switches covalently linked to magnetic ions</td></tr>
<tr><td>16:30-16:55</td><td rowspan="2">COFFEE + POSTERS
S7-P1. Fernando Bartolomé: 2D Phases and Fe Magnetic Moment upon Oxidation of Fe-Phtalocyanine mono- and multilayers on Ag(110)
S7-P2. Ignacio Piquero & Jorge Lobo: Organic Quantum dot arrays: Tunable energy and mass renormalization by homothetic porous networks
S7-P3. Pablo Casado: Molecular Beam Epitaxy Growth of 2H- and 1T\'- $MoTe_2$ Islands on Graphene/Ir(111)
S7-P4. Michael Joel Spilsbury Fuentes: Investigation of enantiosensitive adsorption of chiral organic molecules on magnetic substrates by electron spectroscopies
S7-P5. Carlos Untiedt: Quantum saturation of capacitance in metals
S7-P6. Alejandro Berdonces-Layunta: Chemical instability of semiconductor graphene nanoribbons</td><td>3-minutes short presentations of Posters, plus 2 minutes questions</td></tr>
<tr><td>16:55-17:15</td><td>Coffe break & visit to posters</td></tr>
<tr><td>17:15-17:45</td><td colspan="2">Dimas G. de Oteyza
Magnetism in on-surface synthesized hydrocarbon structures (invited)</td></tr>
<tr><td>17:45-18:00</td><td colspan="2">Niklas Friedrich
Spin Signals in Electronic Transport through Functionalized Graphene Nanoribbons</td></tr>
<tr><td>18:00-18:15</td><td colspan="2">Nerea Ruiz del Arbol
On-Surface synthesis role and the case of p-aminophenol</td></tr>
<tr><td>18:15-18:30</td><td colspan="2">Maria Tenorio
Bottom up synthesis of nitrogen doped graphene nanoribbons</td></tr>
<tr><td>18:30-18:45</td><td colspan="2">Juan Jesús Navarro
Graphene catalyzes the reversible formation of a C–C bond between two molecules</td></tr>
<tr><td>18:45-19:15</td><td colspan="2">Miriam Moreno (Artículo Destacado)
One-Pot Preparation of Mechanically Robust, Transparent, Highly Conductive, and Memristive Metal-Organic Ultrathin Film (invited)</td></tr>
</table>

Symposium S8: Trends in Magnetism. Conference Hall (Floor -1)

Chairs: Lucas Pérez, Mari Ángeles Laguna

Time	Monday, July 15th
15:00	**S. Sangiao** Spin to charge conversion at the YIG/Bi interface: characterization and ageing analysis
15:15	**B. Rivas-Murías** Tuning the magnetic response in cobalt ferrite nanoparticles using the exchange – spring magnetic approach for catalytic applications
15:30	**G. García** ALBA status and new BL programme
15:45	**V. Franco** Magnetocaloric Effect: From Energy Efficient Refrigeration to Fundamental Studies of Phase Transitions. (**Plenary)**
16:30	**COFFEE + POSTERS** S8-P1 **Julia Herrero Albillos.** 2D magnetic domain wall ratchet: the limit of submicrometric holes S8-P2 **Ana Arauzo.** Rare earth role in spin-glass RFeTi2O7 compounds S8-P3 **Jorge Marqués Marchán.** MFM-KPFM characterization of magnetic nanocomposites for bioapplications S8-P4 **Maria Angeles Laguna-Marco.** Sn-doped IrO2 thin films for spin current detection S8-P5 **Alberto Moya.** Electronic transport properties in bidimensional ferromagnet GdAu2 with atomic scale resolution S8-P6 **Pilar Jiménez-Cavero.** PLD-grown Iridium Oxide for Spin Seebeck detection by Inverse Spin Hall effect S8-P7 **Javier Pablo-Navarro.** Three-dimensional functional magnetic nanostructures grown by Focused Electron Beam Induced Deposition S8-P8 **María José Martínez-Pérez.** Multi-shaped individual nanoparticles investigated by nanoSQUID magnetometry at variable temperature S8-P9 **Miguel Ciria.** Magnetic properties and local ordering in epitaxial Fe 100-x Gax/MgO(001) films S8-P10 **Unai Urdiroz.** Spin waves phase shift through local X-rays irradiation of amorphous Fe80B20 microstripes S8-P11 **Diego Ramírez.** Static and thermal characterization of magnetic multilayers and Ru-based thin films and its application to current and temperature sensors S8-P12 **Arantzazu Mascaraque.** Domain wall structure and magnetization reversal processes in FeNi nanowires S8-P13 **Diego Ramírez.** Magnetoresistive current sensor behaviour under a total ionizing dose (TID) process S8-P14 **Fernando Bartolomé.** Magnetism of a monolayer of Cr_{10} molecular wheels deposited on Au(111)
17:15	**E. Langenberg** Controlling thermal conductivity through domain wall engineering in epitaxially-grown ferroic thin films. (**Invited)**
17:40	**E. Palmero** New routes for developing alternative permanent magnets: from composite materials synthesis to 3D-printing. (**Invited)**
18:05	**L. Hernández-López** Fe nanodots formed on a metalorganic network: growth and magnetism
18:20	**R. Sáez Puche** High pressure synthesis, and magnetic properties of $MnRMnSbO_6$ double perovskites (R=La-Gd)
18:35	**I. Castellanos-Rubio** Tunable Microdisks Loaded with Multifunctional Cargo for Efficient Magnetothermal Actuation. (**Invited**)

Symposium S9: Theoretical and Particle Physics. Room 0.8 (ground floor).

Time	Monday, July 15th	Tuesday, July 16th	Wednesday, July 17th	Thursday, July 18th
15:00	**Mariam Tórtola** Neutrino physics beyond the Standard Model en DUNE			**Galo Rafael Gonzalvo Rodríguez** Probing the Wtb structure in t-channel single top-quark production using the ATLAS detector at the LHC
15:20	**Jose María Pérez Poyatos** Neutrinos in the LHT	**Andrea García Alonso** Test beam characterization of irradiated 3D pixel sensors		**Andrea Vioque-Rodríguez** Chiral symmetry restoration and the thermal f0(500) state.
15:40	**Joan Ruiz Vidal** Novel method for the direct measurement of the tau lepton dipole moments	**David Redondo** Radiation Aging studies of the CMS DT Muon Detector		**Jorge Alda** Some Results on Lepton Flavour Universality Violation
16:00	**Ivan Sayago Galvan** Search for Higgs boson pair production in the γγbb-final state with 13 TeV pp collision data collected by ATLAS	**Héctor García Cabrera** Prototipo del calorímetro hadrónico con lectura semi-digital de CALICE		**Rafael Delgado López** Unitary predictions for dynamical vector resonances emerging at VBS-LHC
16:30	**COFFEE + POSTERS** S9-P1. **Florencia Luciana Castillo.** Dark matter production with mono-top signatures at ATLAS.			
17:30	**Alberto Prades** Prospects of a top quark mass measurement at 13 TeV with the ATLAS detector	**Javier Aparisi** In-situ calibration of Large-R jet energy and mass in 13 TeV proton-proton Collisions with the ATLAS detector		**Adrián Casado Turrión** Triggering the QCD phase transition through acceleration
17:50	**Josep Navarro González** Prospects for a search of invisible particles produced in association with single-top quarks with the ATLAS detector at the HL-LHC	**Jesús Guerrero Rojas** ATLAS Inner Detector alignment: Radial distortion studies		**José Javier Relancio** Physics in a momentum space geometry
18:10	**Víctor Rodríguez Bouza** Recent single top differential cross section measurements at CMS	**Carlos Soláns Sánchez** A Monolithic Active Pixel Sensor Pixel detector for the outer barrel of the ITK of the ATLAS experiment		**Cédric Prieels** Searches for Dark Matter combined with top quarks at CMS
18:30	**Javier Alberto Aparisi Pozo** IFIC-Valencia ATLAS Tier-2 perspective on computing over the next years	**Jaime León Holgado** A new trigger algorithm for the upgrade of the CMS Drift Tube detector at the HL-LHC		
18:50	**Florencia Luciana Castillo** Explore dark matter production with mono-top signatures at ATLAS			

Symposium S10: Astrophysics and Astroparticles. Room 0.6 (ground floor)

Time	Tuesday, July 16th	Wednesday, July 17th
15:00	**E. Sánchez García** Underground argon for DarkSide-20k	**R. Logroño García** 2D SFR studies in the nearby universe with the J-PLUS photometric survey
15:15	**S. Cebrián** Status of the TREX-DM experiment at the Canfranc Underground Laboratory	**J. M. R. Espinosa** An ionised bubble before the epoch of re-ionisation
15:30	**I. Coarasa Casas** ANAIS-112 sensitivity in the search for dark matter annual modulation	**O. Ivanytskyi** Effects of tetraneutron condensation on properties of Neutron Star matter
15:45	C**. Lagunas Gualda** Search for secluded dark matter with the ANTARES and KM3NeT neutrino telescopes	**C. López San Juan** J-PLUS : Status and updates in photometric calibration
16:00	**G. Gámez** Measurement of Cosmic Positrons with AMS-02	**M. A. Pérez Torres** An extremely energetic tidal disruption event with a resolved radio jet in a galaxy merger
16:15	**N. Castelló-Mor** Tick, silicon CCDs to search for Dark Matter within the DAMIC-M Experiment	**M. A. Satorre Aznar** Water. What else? ASW computational study and experimental comparison
16:30	**COFFEE + POSTERS** S10-P1. **J. Gómez Cazorla.** The Curvature Volume Of The Quantum Vacuum As Responsible For The Gravitatory Effect S10-P2. **D. Cintas.** Measurement of the Relative Efficiency Factor for nuclear recoils in NaI(Tl) crystals for Dark Matter detection S10-P3. **C. Millán.** Experimental carbon dioxide porosity testing Effective Medium Theories to obtain porosity from the refractive index S10-P4. **J. Amaré.** Analysis of radioactive backgrounds for the ANAIS-112 dark matter experiment	
17:30	**M. Molero** Anisotropy of Cosmic Rays Arrival Direct ions with AMS-02 on the International Space	**J. L. Ballester** Nonlinear evolution of Alfvén waves in a partially ionized plasma
17:45	**T. Matos** The Quantum Character of the Scalar Field Dark Matter	**C. Margalejo** Background model for IAXO-D0, prototype of the IAXO (International AXion Observatory) experiment
18:00	**S. Alves** Machine Learning for Pattern Recognition in Dark Matter Searches	**B. Maté** Adsorption of volatile molecules on interstellar carbonaceous dust analogs
18:15	**T. Miener** Constraining branon dark matter from observations of the Segue 1 dwarf spheroidal galaxy with the MAGIC Telescopes	**J. M. R. Espinosa** A binary nucleus in Mrk 622?
18:30	**T. Miener** Application of deep convolutional neural networks to enhance the performance of imaging atmospheric Cherenkov telescopes	

Symposium S11: Physics of the Atmosphere and the Ocean. Room 0.8 (ground floor)

Time	Wednesday, July 17th
15:00	**José M. Vaquero** Pyrheliometer measurements in Madrid (1910–1929): trends in atmospheric column transparency
15:30	**Javier Vaquero- Martínez** Water vapor and aerosol effects in short-wave surface radiation in Valladolid
15:45	**Nuria Plaza Martín** Sensitivity of water vapour in lower stratospheric monsoon anticyclones to different processes
16:00	**Javier Vaquero- Martínez** Obtaning Integrated Water Vapor Estimates from a cheap IR thermometer
16:15	**David Gallego Puyol** El concepto de monzón global: variabilidad secular del monzón
16:30	**Ricardo García- Herrera** Examining the NAO-EA relationship and the jet variability since 1685
16:45	**Carlos Ordóñez** Air stagnation in the Euro-Mediterranean region
17:00	**COFFEE + POSTERS** S11-P1. **Luis Gimeno**. The role of moisture transport for precipitation in the inter-annual and inter-daily fluctuations of the Arctic sea ice extension. S11-P2. **Nieves Bravo Paredes**. The relationship between rogation ceremonies in Extremadura and the NAO index S11-P3. **Javier Montero-Martín**. Preliminary study of the variability of sunshine duration in Badajoz during 1928-1950 S11-P4. **Iván Noguera Corral**. Frist steps in the study of flash droughts in Spain. S11-P5. **Carlos Ordóñez**. Impact of the North Atlantic jet on winter particulate matter concentrations in Europe. S11-P6. **Fernando Domínguez-Castro, Pablo Orus**. Main results of IMDROFLOOD project. S11-P7. **Inmaculada Vega**. Nueva metodología para identificar fechas de interés en la estación monzónica en el noroeste del Océano Pacífico. S11-P8. **Francisco de Paula Gómez-Delgado**. Long term variability of the northerly winds over the Eastern Mediterranean as seen from historical wind observations S11-P9. **David Gallego Puyol**. Caracterización de la corriente del Chocó mediante observaciones históricas de viento. S11-P10. **Ricardo García Herrera**. Dynamical drivers of the synoptic heatwaves in different regions of Iberia.
17:30	**Maria J. Ortiz Bevia** The Mediterranean atmospheric modes: variability and trends
17:45	**Nieves Bravo Paredes** Analysis of actinometric measurements for the period 1913-1923 in Cáceres (Spain)
18:00	**Xavier Navarro** Análisis de seguimiento de chubascos en el área urbana de Barcelona utilizando una red pluviométrica de microescala
18:15	**Manuel Fernández-González** Relation between extreme precipitation and climate change over the Miño-Sil Basin
18:30	**Juan A. Añel** Very large climate ensembles using Cloud Computing: a case study
18:45	**Susana Bayo Besteiro** Results of a systematic review. Wind and wind power forecasting in the Iberian Peninsula and the Canary Islands
19:00	**Juan A. Añel** Current status of scientific reproducibility in geophysics: from climate models to journal policies

Symposium S12: Thermodynamics and Thermal Analysis. Room 1.3 (first floor)

Café	Monday, July 15th
15:00	**C. Sánchez** Charcoal as a bacteriological adherent of the biomethanation
15:30	**J.M. Ortiz de Zárate** Definition of frame-invariant Soret coefficients for ternary mixtures
15:45	**C. Hermida** Optimization of nanofluids derived from Graphene and Fluorinated Ionic Liquids for applications of capture of fluorinated gases
16:00	**A.M. Gayol** Systems of two aqueous polymeric phases + sodium salts
16:15	**B. Reding** Thermal conductivity of Fullerene C_{60} Nano-Fluid using the Transient Hot-Wire Method
16:30	**COFFEE + POSTERS** S12-P1 **J. L. Legido.** Análisis de la estabilidad de mezclas ternarias de nutrición parenteral con medidas de viscosidad realizadas a diferentes días tras su elaboración. S12-P2 **C. González.** Thermodynamic properties of 2-hydroxy ethyl ammonium propionate (2-HEAPr) + water, methanol and ethanol at different temperatures. S12-P3 **J. J. Suñol.** Thermal and thermomagnetic analysis of magnetic shape memory Heusler alloys. S12-P4 **J. L. Legido.** Estudio de la tension superficial de sistemas ternarios dialquilcarbonato (dimetilcarbonato y dietilcarbonato) + n-decano + p-xileno a las temperaturas de 288.15, 298.15 y 308.15 K S12-P5 **G. Lorusso.** On-chip nanocalorimetry. S12-P6 **C. González.** Investigation on the Thermal Stability of Protic Ionic Liquids. S12-P7 **A. M. Mainar.** Green Solvents and Renewable Resources: A Framework to Share Research and Social Inclusion. S12-P8 **J. F. Martínez-López.** Excess isobaric heat capacity modelling of binary mixtures between some natural aromatic monoterpenes and ethanol or propan-1-ol. S12-P9 **O. Cabeza.** Diffusion of Li+ in novel electrolytes composed by dmso, Li-TFSi and/or MPPyrr-TFSi in function of temperature. S12-P10 **J. S. Urieta.** Dielectric behaviour of mixtures 1,8-cineole (eucalyptol) + short chain alcohol at 298.15 K. S12-P11 **T. P. Iglesias.** Conductividad eléctrica del nanofluido CuO (12 nm) + agua a bajas concentraciones y distintas temperaturas. S12-P12 **T. P. Iglesias.** Conductividad eléctrica del etilenglicol a diferentes temperaturas. S12-P13 **R. Burriel.** A Magnet for Caloric Applications: Design, Optimization, and Experimental Results. S12-P14 **J. P. Martínez.** Comportamiento dieléctrico de un compuesto ternario sinterizado, Resina-epoxi / $BaTiO_3$ / Cu_2O, en la banda 0-6 GHz.
17:45	**A.Y. Chuquitarqui** An experimental set-up to study the blockage problem in the flow of liquid helium (LHe) in small impedances
18:00	**J. L. Beltrán** Room temperature magnetic refrigeration: design and construction of a test prototype
18:15	**M. Castro** Calorimetric set-up to measure the Specific Absorption Rate Coefficient (SAR) of Gold nanoparticles colloidal suspensions
18:30	**Closing**
18:45	

Symposium S13: Energy and sustainability. Conference Hall (floor -1)

<table>
<tr><th>Time</th><th>Tuesday, July 16th</th><th>Wednesday, July 17th</th><th>Thursday, July 18th</th></tr>
<tr><td>15:00</td><td rowspan="2">Conferencia Invitada
Estudio teórico de materiales fotovoltaicos avanzados basados en Perovskitas.
Pablo Palacios. Universidad Politécnica de Madrid.</td><td></td><td>Nuevos materiales fotovoltaicos de alta eficiencia: La importancia de absorber fotones por debajo del gap.
Pablo Sánchez-Palencia. Universidad Politécnica de Madrid</td></tr>
<tr><td>15:20</td><td></td><td>Evaluation of Accelerated Renewable Energy Deployment Roadmaps.
Ignacio Mauleón. Universidad Rey Juan Carlos.</td></tr>
<tr><td>15:40</td><td>Tribochemical stability of pyrite films.
Esmeralda Muñoz-Cortés. Universidad Autónoma de Madrid.</td><td></td><td>El Tabaco como Cultivo Energético.
Francisco Cuadros Blázquez. Universidad de Extremadura & Metanogenia.</td></tr>
<tr><td>16:00</td><td>Towards more efficient central tower gas turbine thermosolar plants. Rosa Pilar Merchán Corral. University of Salamanca.</td><td></td><td>Distributed energy: the challenge of solar parabolic dishes. Julián González Ayala. University of Salamanca.</td></tr>
<tr><td>15:00-17:30 (Wed.)</td><td colspan="3">COFFEE + POSTERS (ONE SESSION, WEDNESDAY)
S13-P1 Wind Energy Modelling Using ERA5 Wind Reanalysis. Younes Zekeik. Abdelmalek Essaadi University.
S13-P2 Transparent and p-type conductive thin films for energy conversion devices. Cecilia Guillén. CIEMAT.
S13-P3 Study of the electronic structure of LixCoO2 near the metal-insulator transition by angle-resolved photoemission spectroscopy. E. Salagre. Univ. Autónoma de Madrid.
S13-P4 Stabilizing wind power supply: seasonal evaluation of useful spatial patterns in the variability of winds over the Iberian peninsula. Ali Al Rubaye. University of Alcalá.
S13-P5 Multiferroicos obtenidos mediante procesos sostenibles. Carmen Aragó. Universidad Autónoma de Madrid
S13-P6 Reactive Dye on Sustainable Multifiber Dyeing Applying Protic Ionic Liquids as Solvents. Joana Follador. Universidade Federal da Bahia.
S13-P7 Modelado numérico tridimensional de celdas solares de películas delgadas de Cu(In,Ga)Se2. Hernando Ariza Calderón. Universidad del Quindío, Colombia.
S13-P8 Implantación de minicentral hidroeléctrica para aprovechar el recurso energético del embalse tahuín (ecuador). Óscar Cabeza. Universidade da Coruña.
S13-P9 Evaluating the toxicity of fabrics embedded into Protic Ionic Liquids using HepG2 cytotoxicity test. Rebecca Andrade. Universidade Federal do Recôncavo da Bahia.
S13-P10 Electronic energy meter based on a magnetoresistive shunt. Diego Ramírez. University of València.
S13-P11 A simple enviornmental model for air traffic emissions. Francisco Antonio Buendía Hernández. Universidad de Alcalá.</td></tr>
<tr><td>17:30</td><td>Simulation of a Hybrid Thermoelectric-Magnetocaloric Refrigerator.
Jesús Francisco Beltrán López. Universidad de Zaragoza</td><td rowspan="3">Mesa redonda
La transición energética 2030 en España</td><td>Critical Assessment of the 2030 Power Sector Transition in Spain.
Roberto Gómez-Calvet. Universidad Europea de Valencia.</td></tr>
<tr><td>17:50</td><td>Quantification of the energy footprint of bottom-up energy transitions by using the Global Multiregional Input-Output methodology.
Estitxu Villamor. University of the Basque Country.</td><td>An study of the driving forces of CO2 emissions in the member states of the European Union (EU-28).
José Enrique García Ramos. University of Huelva.</td></tr>
<tr><td>18:10</td><td></td><td>Amperia: Virtual Power Plant for Dynamic Optimal Aggregation of Energy Storage.
Xavier Benavides. Ampere Energy.</td></tr>
</table>

Symposium S14: Physics of complex systems. Room 0.4 (ground floor)

Time	Thursday, July 18th
15:00	**Juan Carlos Losada González** Opinion Polarization during dichotomous Twitter conversations
15:30	**Carlos Gracia-Lázaro** Revisiting the Stability of a Plant-Pollinator Mutualistic Community With and Without Phenology
16:00	**Alberto Aleta** Self-exciting Dynamics of Discussion Threads in Online Boards
16:30	**COFFEE + POSTERS** S14-P1. **Oleksii Sliusarenko.** Model for Anomalous Diffusion with Finite Moments in Complex Medium.
17:30	**Diego Gella** Separation of geometrical and kinematic influences in the probability of clogging a granular silo
18:00	**Miguel Angel Ramos** Are low-temperature "anomalies" of glasses really universal?
18:30	**Megan Khoshyaran** Homology theory on Random Groups

Symposium S15: Quantum Information. Room 1.5 (first floor)

Time	Monday, July 15th
15:00	**Alejandro Gonzalez-Tudela** (Premio RSEF-BBVA) Analog quantum chemistry simulation with ultra-cold atoms
15:30	**Yue Ban** Spin entangled state transfer in quantum dot arrays: Coherent adiabatic and speed-up protocols
15:45	**Andrés Ruiz Chamorro** Fast and high-fidelity quantum logic gates with superconducting circuits
16:00	**Alvaro Alhambra** Dynamics of two-point correlation functions in quantum many-body systems
16:15	**Andrés Agustí** Entanglement through qubit motion and the dynamical Casimir effect
16:30	**COFFEE + POSTERS**
17:30	**Flash talks** S15-P1. **Álvaro Navarrete** Asymmetric decoy-state estimation for twin-field quantum key distribution S15-P2. **Marcos Rubín** Direct detection of clock transitions in molecular magnets by heat capacity measurements S15-P3. **Jorge Calvo-Ibar**. Dynamics and spectrum of a molecule coupled to a vibrational mode, study of emissions in nanocavities
17:45	**Alejandro Pozas-Kerstjens** Bounding correlations in quantum causal networks
18:00	**María C. Boscá** Sobre el teorema PBR

18:15	**Víctor Zapatero** Quantum key distribution secure against malicious providers

Symposium S16: Quantum Technologies. Room 1.5 (first floor)

Chairs: Alejandro González-Tudela, Juan José García Ripoll

Time	Tuesday, July 16th
15:00	**E. Sánchez-Burillo** Long- and short-range qubit-qubit interactions in quasi-one-dimensional photonic baths
15:18	**S. Grandi** Towards long distance entanglement between a photon and a solid-state quantum memory
15:36	**D. Lago-Rivera** Quantum Storage of Frequency-Multiplexed Heralded Single Photons
15:54	**J. M. Llorens** Towards a spin-photon interface based on InAs/GaAsSb quantum dots
16:12	**I. Giménez-Alonso** Close-up analysis of spin-clock transitions in molecular spin qubits by on-chip broad-band spectroscopy
16:30	**COFFEE** 1. S16-P1. ID: 3705, **J. Ávila Camuñas et al.** Non-Hermitian topology: a unifying framework for the Andreev versus Majorana states controversy
17:20	**A. Cabot Martorell** Quantum synchronization in dimer atomic lattices
17:38	**B. Pérez** Simulation of chiral topological phases in driven quantum dot arrays
17:56	**V. Ciriano Tejel** Reducing readout overhead in silicon quantum computing by sequential redout
18:14	**R. Gracia** Intrinsic and extrinsic effects on the transport properties of nanodevices based on topological insulator Bi2Se3
18:32	**J. Ávila Camuñas** Majorana excitations in Rashba nanowire-based transmon qubits: a new path in the quest of Majorana detection
18:50	**J. L. Preciado** Multiqubit control system based in specific FPGA IP designs
19:08	**Closing**

Symposium S17: Quantum Optics and Nonlinear Optics. Room 1.4 (first floor)

Chairs: Verónica Ahufinger, Eugenio Roldán

Time	Wednesday, July 17th
15:00	**In memoriam: Ramón Corbalán Yuste**
15:13	**A. Palacios** Theoretical methods for attosecond molecular dynamics (**invited**)
15:38	**L. Rego** Light with Self-Torque: Extreme-ultraviolet Pulses with Time-Dependent Orbital Angular Momentum
15:51	**R. Boyero-García** Efficiency optimization of coherent extreme-ultraviolet radiation through pulse shaping in high harmonic generation
16:04	**O. Zurrón-Cifuentes** Polarization control of non-perturbative high-order harmonics in gapless graphene
16:17	**E. Roldán & G .J. de Valcárcel** Optomechanical locking of a non-degenerate optical parametric oscillator
16:30	**COFFEE** S17-P1. ID: 3883, **D. Marco et al.** Parallel generation of vortex beams with a two-dimensional optimal triplicator geometric phase design. S17-P2. ID: 3804, **L. Rego et al.** Structured ultrafast Attosecond Pulses With Controllable Spin and Orbital Angular Momentum. S17-P3. ID: 3872, **L. Ares & A. Luís**. Nonclassicality as an alternative resource for quantum metrology. S17-P4. ID: 3821, **M. Carvalho et al.** Nonlinear Bessel vortex beams: Robust vortices of arbitrary topological charge in self-focusing Kerr media. S17-P5. ID: 4012, **F.J. Salgado-Remacha & S. Jarabo**. Estabilidad y evolución del espectro de una fuente de Supercontinuo. S17-P6. ID: 4072, **A. Esteban-Martín et al.** Interferometric transient detection imaging in a photorefractive crystal.
17:30	**C. Navarrete-Benlloch** Many-body bosonic models in quantum simulators subject to particle non-conserving processes (**invited**)
17:55	**García-Riquelme** Vortex trapping and steering by means of Nonlinear Bessel Beams in nonlinearly absorbing media
18:08	**C. Cojocaru** Phase locked generation in the opaque region of GaAs
18:21	**A. Crego** Nonlinear propagation of vector beams in hollow-core fibers
18:34	**G. Pelegrí** Quantum sensing using imbalanced counter-rotating Bose-Einstein condensate modes
18:47	**A. Castro** Optimal control theory for quantum electrodynamics: an initial state problem
19:00	**Closing**

Symposium S18: Plasma Physics. Room 1.4 (first floor)

Chair: Francisco L. Tabarés **Chair:** Luis Méndez

Time	Monday, July the 15th	Tuesday, July the 16th
15:00	**Agustín R. González-Elipe** Low Temperature Plasmas for the Tailored Fabrication of Nanostructured Thin Film Materials (**invited**)	**Fernando Moreno- Insertis** The cool plasma eruptions in the solar atmosphere (**invited**)
15:30	**Manuel D. Barriga Carrasco** Corroboración de modelos de frenado de iones en plasmas altamente ionizados	**Mario Merino** Synergies between space plasma propulsion and magnetic confinement plasma fusion: PROMETEO project
15:50	**Gonzalo Rodríguez Prieto** Shock wave from exploding wire time evolution after energy deposition ending	**Francisco L. Tabarés** Studies of Vapour Shielding Physics in the OLMAT Facility. Applications to the LMD EuroFusion Project
16:10	**Luis J. Fernández-Menéndez** Estudio de plasmas LIBS con resolución espacial y temporal: distribución de la emisión atómica y molecular.	**Isabel Tanarro** Radio-astronomy emission techniques and cold plasmas to study molecular species and processes of astrophysical interest
16:30	**COFFEE + POSTERS** S18-P1 **Carlos Hidalgo**. The influence of edge sheared radial electric fields on edge-SOL coupling in the TJ-II stellarator S18-P2 **Antonio Sarsa**. Simple and analytical function for the Stark profile of the H? and H? lines and its application to plasma characterization. S18-P3 **Dani Gallart**. Modelling of ICRF heating for JET T and D-T plasmas S18-P4 **José D. Sierra Murillo**. Influence of D2 (v) excitation on the OH + D2 →HOD ((vHO',vHOD',vOD'), J') + D reaction dynamics. Vibro-Rotational Energy in HOD vs. Chemical Laser. S18-P5 **Belén Maté**. Adsorption energies of CH4, CO, N2 and CO2 on plasma generated interstellar carbonaceous dust analogs S18-P6 **Agustín R. González-Elipe**. Activation of seed germination processes by plasma treatment S18-P7 **Luis Méndez**. A collisional-radiative model for lithium	
17:30	**Kieran McCarthy** Tracer-filled pellets for performing impurity transport studies in magnetically-confined plasmas of stellarators.	**Antoine Bret** Density jump as a function of magnetic field strength for parallel collisionless shocks in pair plasmas
17:50	**Eleonora Viezzer** Dynamics of the edge transport during edge localized mode cycles	**Miguel Jiménez-Redondo** Characterization of interstellar carbonaceous dust analogs produced in RF capacitively coupled discharges
18:10	**Beatriz Brañas** The IFMIF-DONES Project and the IFMIF Validation Activities.	**GENERAL MEETING OF THE "GRUPO ESPECIALIZADO DE FÍSICA DE PLASMAS"**
18:30	**Carlos Hidalgo** Estudio de las propiedades espacio-temporales de flujos zonales presentes en el borde del plasma del dispositivo de confinamiento magnético TJ-II	
18:50	**Closing**	
19:00		**Closing**

Symposium S19: Women in Physics. Room 1.6 (first floor)

Time	Tuesday, July 16th
15:00	**Tomas Brage** Work against bias and for meritocracy (**invited**)
15:18	**Encina Calvo**, Gender Perspective in Physics, a guide
15:30	**Milagros Morcillo, Antonio Sarsa, Cristina Yubero, José M. Alcaraz** Presencia de la mujer en los estudios de Física (1998-2017)
15:42	**Krisinda Plenkovich** Gender Equity in the optics+photonics workplace
15:54	**Florencia Castillo** Despertando vocaciones femeninas en física desde el IFIC
16:06	**Ana. X. López** Mecánica: femenino, singular
16:18	**Mª Cruz Gallego, José Mª Vaquero, Fernando Domínguez-Castro, Ricardo García-Herrera** Early instrumental observations in Equatorial Guinea by the Urquiola sisters
16:30	**Mario Peláez-Fernández** Sassy Science: Drag and non-heteronormative self-presentation as a means of empowerment for under-represented minorities and women towards STEM
16:40	**COFFEE + POSTERS** S19-P1 **Antonio J. Sarsa Rubio.** Mi física favorita S19-P2 **Carmen Ocal.** El teatro como herramienta para dar visibilidad a las mujeres sabias de la historia de la ciencia.
17:30	**María Villaroya** Mujeres en STEM, ¿por qué no cambia la tendencia? (**Invited**)
17:48	**Laura Morrón** Mi experiencia divulgando la vida de grandes físicas
18:00	**Marta Seror y Rocío Vilar** Science Outreach and Gender Perspective at IFCA
18:12	**Susana Bayo-Besteiro**, Mª Nieves Lorenzo, Laura Rodríguez, Marisela Des Los enigmas del tiempo y del clima.
18:24	**M Mar Sánchez-López**, Angela Sastre-Santos, Purificación Heras Mª José Alarcón Jornadas "La Ciencia tiene nombre de Mujer" de la Universidad Miguel Hernández de Elche
18:36	**Julia Herrero Albillos**, Mª José Calderón, Leni Bascones Iniciativa 11 de Febrero. Fomentar la presencia de mujeres en física a través de la acción colectiva.
18:48	**Juana Moya**, María Hernández, Milagros Arrébola, Julia Herrero Albillos Divulgar la física a través de los escaparates de la ciudad. Iniciativa 11 de febrero

Symposium S20: Nuclear Physics. Room 0.7 (ground floor)

Time	Monday, July 15th	Tuesday, July 16th	Wednesday, July 17th
15:00	**Alejandro Mazal** (**invited**)	**Juan Penas** A high repetition laser-plasma proton accelerator for radioisotope production	**Jesús Casal** Exploring continuum structures in reactions with three-body nuclei
15:15		**Adrián Sánchez Fernández** Variational approximations to exact solutions in shell model valence spaces	**Santiago Rodríguez** Correlación entre la humedad relativa y la concentración 222Rn en aire en el Laboratorio Subterráneo de Canfranc. Seis años de mediciones (2013 a 2018).
15:30	**José María Benlloch** Visión de la imagen médica para la próxima década (**invited**)	**Manuel J. Gutiérrez** The TRAPSENSOR facility: towards universal Penning Trap Mass Spectrometry with single-ion sensitivity	**Claudia González-Boquera** Core-crust transition in neutron stars with finite-range interactions: the dynamical method
15:45		**José Manuel Udías Moinelo** The role of Nuclear Physics in Neutrino Oscillations	**Victor Sanchez-Tembleque Verbo** Characterization of scintillator crystals using current SiPM arrays
16:00	**Víctor Valladolid Onecha** PET Imaging and Dose correlation from Proton Activation.	**Jorge Lerendegui-Marco** Radiative neutron capture on 242Pu: combining beams and techniques to improve the cross section accuracy from thermal to 500 keV	**Araceli Navarro Fernández** BRIKEN measurements of half-lives for Ce to Nd nuclei relevant for the formation of the r-process rare-earth peak (A~160)
16:15	**Teresa Rodríguez González** Measurement of the production cross section of the short-lived beta+ emitters of interest in range verification in proton therapy	**José Enrique García Ramos** On shape coexistence in zirconium region	**Víctor Babiano** 80Se(n,γ) cross-section measurement at n_TOF (CERN)
16:30	**COFFEE + POSTERS** S20-P1 **Alejandro Martín Sánchez.** XRF spectroscopy applied to the analysis of vestiges from the archaeological site of Medellín (Badajoz, Spain) S20-P2 **Iván Coaras.** Analysis of the 222Rn content in the nitrogen gas purging the ANAIS experiment using a HPGe detector		
17:30	**Paula Ibáñez** GHMCp – GPU-based Hybrid Monte Carlo for Proton therapy	**Jaime Benito** Observation of the beta-decay of 135In	**Reunión GEFN**
17:45	**Fernando Arias** Awake Preclinical Brain PET Imaging based on Point Sources	**Silvia Vinals Onses** Latest advances in the study of the 8B nuclear structure	
18:00	**Víctor Sánchez-Tembique** Activation of contrast agents for range verification in proton therapy	**Miguel Macías Martínez** HISPANoS, the neutron facility at CNA: latest upgrades, status and future plans	Entrega de los **premios ATI a la mejor tesis doctoral**
18:15	**A. López** Pseudoinverse reconstruction for real-time PET imaging	**Javier Díaz Ovejas** Halo effects in the low-energy scattering of 15C with heavy targets.	**Mesa redonda** Una vida en la Física Nuclear
18:30	**G. Llosa** Beam test and upgrades of MACACO II Compton telescope	**Victoria Vedia** Fast-timing investigation of the neutron rich ^{136}Te and ^{138}Te	
18:45	**Luis Barrientos** Evaluación del telescopio Compton MACACO II		

Symposium S21: Medical Physics. Room 0.7 (Monday, ground floor) and room 1.3 (Tuesday and Wednesday, first floor)

Time	Monday, July 15th	Tuesday, July 16th	Wednesday, July 17th
	Nuclear Medicine	**Nanotechnology Applications in Diagnosis**	**New Applications of Nanotechnology**
15:00	**Alejandro Mazal.** Introduction to hadrontherapy: physics, biology, qualy (**invited**)	**Laura Lechuga** Nanophotonic biosensor devices for the early diagnostics and therapy follow-up of infectious diseases (**invited**)	**Paulo Freitas.** Nanotechnology and health (**invited**)
15:30	**José María Benlloch.** Visión de la imagen médica para la próxima década (**invited**)	**Jesús Martínez De La Fuente.** Biosensor based in gold nanoparticles (**invited**)	**Gerardo Goya.** Magnetic hyperthermia (**invited**)
16:00	**Víctor Valladolid Onecha.** PET Imaging and Dose correlation from Proton Activation.	**J. Melchor/G. Rus.** Interaction between tissue and ultrasonic waves for diagnosis (**invited**)	**J. A. Fuente.** Synthesis of Fe_3O_4 nanoparticles using ultrasound irradiation
16:15	**Teresa Rodríguez González.** Measurement of the production cross section of the short-lived beta+ emitters of interest in range verification in proton therapy		
16:30	**COFFEE + POSTERS** S21-P1 **José Manuel González Hernández.** MRI magneto-stimulation thresholds for the Peripheral Nervous System S21-P2 **Rosa María Cibrián.** Analisis de la temperatura de la planta del pie en pacientes diabeticos tras un estrés mecánico y térmico S21-P3 **Jesús Manuel Fuentes García.** Sonochemical synthesis of Mn_xFe_2-xO_4@SiO_2 core-shell Nanoparticles for smart drug delivery systems S21-P4 C**ristina González.** Hen's egg chorioallantoic membrane test for irritation potential of protic ionic liquids S21-P5 **Bonifacio Tobarra.** Gestión de la dosis radiológica en un sistema de ámbito regional: experiencia y resultados de 4 años S21-P6 **Juan A. Monsoriu Serra.** Diffractive corneal inlays for presbyopia compensation. Ray tracing analysis S21-P7 **César Rodríguez.** A new approach to radiochromic film dosimetry based on non-local means S21-P8 **César Rodríguez.** Sensitometry of radiochromic films based on two polymer color phases S21-P9 **Adriana Gilarska.** Magnetic nanoparticles as inorganic components of hybrid materials for tissue regeneration S21-P10 **Elżbieta Gumieniczek-Chłopek.** Magnetically Navigated Polysaccharides-based Capsules as Smart Delivery Systems		
		Novel Imaging Techniques	
17:30	**Paula Ibáñez.** GHMCp – GPU-based Hybrid Monte Carlo for Proton therapy	**Ireneus Grulkowsky**. Optical Coherence Tomography - Technologies and Applications in Biomedical Research (**invited**)	**F. J. Jiménez.** a) Calculo Monte Carlo para verificación tratamientos de radioterapia**;** b) Verificación mediante el método de Monte Carlo del blindaje de una sala de tratamiento de radioterapia
17:45	**Fernando Arias.** Awake Preclinical Brain PET Imaging based on Point Sources		
18:00	**Víctor Sánchez-Tembique.** Activation of contrast agents for range verification in proton therapy	**M. Gómez.** Local particles concentration measurement in capillary models **C. Freijo.** Image reconstruction of Protoacustic signals	**F. de Luis.** Puesta en Marcha de Generadores de 68Ge/68Ga. Medidas de Protección Radiológicas Asociadas
18:15	**A. López.** Pseudoinverse reconstruction for real-time PET imaging		**A. D. Domínguez.** A new multichannel radiochromic film dosimetry method using Bayesian estimation techniques
18:30	**Gabriela Llosá.** Beam test and upgrades of MACACO II Compton telescope	**A. Nowicki** The normalization of flow mediated dilation by the base scaled shear rate	**M. Seimetz.** Use of CR-39 nuclear track detector for ion spectroscopy in laser-plasma experiments
18:45	**Luis Barrientos.** Evaluación del telescopio Compton MACACO II		**Francisco Javier Jiménez.** Validación de algoritmos de cálculo de dosis en tratamientos de radioterapia modulados

ABSTRACTS

1. PLENARY SESSIONS

ID: 04076, 15/07/2019 09:45 - 15/07/2019 10:25, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

The dawn of quantum networks

Ronald Hanson [1]

1) QuTech and Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands

** Ronald Hanson , r.hanson@tudelft.nl*

Entanglement – the property that particles can share a single quantum state - is arguably the most counterintuitive yet potentially most powerful element in quantum theory. The non-local features of quantum theory are highlighted by the conflict between entanglement and local causality discovered by John Bell. Decades of Bell inequality tests, culminating in a series of loophole-free tests in 2015, have confirmed the non-locality of nature [1].

Future quantum networks [2] may harness these unique features of entanglement in a range of exciting applications, such as quantum computation and simulation, secure communication, enhanced metrology for astronomy and time-keeping as well as fundamental investigations. To fulfill these promises, a strong worldwide effort is ongoing to gain precise control over the full quantum dynamics of multi-particle nodes and to wire them up using quantum-photonic channels.

Here I will introduce the field of quantum networks and discuss future plans and ongoing work with the specific target of realizing the first multi-node network wired by quantum entanglement, including first primitive network experiments [3,4] using diamond-based quantum network nodes.

References

[1] For a popular account of these experiments, see e.g. Ronald Hanson and Krister Shalm, Scientific American 319, 58-65 (2018).

[2] Quantum internet: A vision for the road ahead, S Wehner, D Elkouss, R Hanson, Science 362 (6412), eaam9288 (2018).

[3] N. Kalb et al., Science 356, 928 (2017).

[4] P.C. Humphreys et al., Nature 558, 268 (2018).

ID: 03649, 15/07/2019 10:25 - 15/07/2019 10:15, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Low Temperature Plasmas: a Unique Non-Equilibrium State for Tackling Grand Societal Challenges

Peter Bruggeman[1]

1) University of Minnesota

** Peter Bruggeman, pbruggem@umn.edu*

Low temperature plasmas (ionized gas) represent a unique state of matter composed of neutral atoms and molecules, radicals, excited states, ions and electrons. These plasmas have characteristic electron energies of a few eV and can produce a chemically rich environment at close to ambient temperatures. This unique condition enables the delivery of highly reactive plasma species to even extremely heat sensitive surfaces and enabled major advances in the microelectronics industry. Recent developments at atmospheric pressure led to several emerging applications including wound healing, cancer treatment, food decontamination, and water purification. In addition, the highly non-equilibrium state, many self-organization phenomena and the complex interactions of plasmas with matter provide ample of opportunities for ongoing and future fundamental research.

In this presentation, I will present an overview of the state of the art in the field of low temperature plasmas. We will particularly emphasize some scientific advances that enabled above-mentioned promising innovative applications emerging from the field.

ID: 04192, 15/07/2019 11:40 - 15/07/2019 12:20, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Counting the Uncountable: Entropy, granular Entropy and Information

Daan Frenkel[1]

1) University of Cambridge

** Daan Frenkel, df246@cam.ac.uk*

In an attempt to construct a Statistical Mechanics of Powders, Sir Sam Edwards introduced the concept of "granular entropy", defined as the logarithm of the number of distinct packings of N granular particles in a fixed volume V. In 1989, the proposal was rather controversial but much of the debate was sterile because the granular entropy could not even be computed for systems as small as 20 particles - hardly a good approximation of the thermodynamic limit.

In my talk I will describe how granular entropies of much larger systems can now be computed, using a novel algorithm. Interestingly, it turns out the definition of granular entropy will have to be modified to guarantee that granular entropy is extensive. Which brings us back to the Gibbs paradox and a dirty secret of colloid science.

ID: 04183, 15/07/2019 12:20 - 15/07/2019 13:00, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

JULIO PALACIOS AND THE SILVER AGE OF PHYSICS IN SPAIN

Francisco A. González Redondo[1]

1) Universidad Complutense de Madrid

** Francisco A. González Redondo, faglezr@edu.ucm.es*

The first third of the 20th century witnessed two revolutions in Physics: the Theory of Relativity and Quantum Mechanics. These revolutions in international Science coincide with what in Spain has been considered the Silver Age of our Culture; the period 1898-1936, along which three successive generations of scientists, those of ‘98, ‘14 and ’27 will approach scientific convergence with Europe. Once the foundations were laid by the generation of ’98, the process of convergence with Europe culminated with the generation of ’27, with its members mentored by the most important figures of ’14. Between these two generations is to be found the Aragonese Julio Palacios, emerging figure in Spanish Physics (after his mentor, Blas Cabrera), who will witness the end of the Silver Age as a consequence of Spanish Civil War, and the reference for all Spanish physicists at the end of the conflict.

ID: 04189, 16/07/2019 09:00 - 16/07/2019 09:40, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

The ISOLDE Facility: Present Status and Future Perspectives

María José García Borge[1]

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** María José García Borge, mj.borge@csic.es*

The On-Line Isotope Mass Separator ISOLDE at the CERN Proton-Synchrotron Booster (PSB) is a facility dedicated to the production of a large variety of radioactive ion beams for many different experiments in the fields of nuclear and atomic physics, materials science and life sciences. The facility has garnered unique expertise in radioactive beams over the fifty years since its first radioactive beams [1]; passing from being an experiment to become a real facility.

The ISOL method involves in this case the bombardment of a thick target with a high energy intense proton beam, producing high yields of exotic nuclei with half-lives down to the millisecond range. By a clever combination of target and ion source units, pure beams of over 1000 different nuclei of 74 elements are being produced and delivered to experiments where properties of the nuclei such as masses, radii, decay modes, structure and shapes are determined. In addition, since 2001 ISOLDE offers the largest variety of post-accelerated radioactive beams in the world today from 6He to 224Ra.

The HIE-ISOLDE upgrade (HIE stands for High Intensity and Energy), intends to improve the experimental capabilities at ISOLDE in the intensity, purity and energy fronts. The boost of energy of the post-accelerated beams will reach this year the 10 MeV/u for A/Q = 4.4 and higher for lower A/Q-values. The targets are ready to accommodate a roughly fourfold increase in intensity of the proton beam that will be available at CERN from 2021. An increase of energy of the proton injector to 2 GeV will have a different effect on the operation due to the different mechanisms operating in the target. Yield increases between a factor of 1 – 10 are expected. In addition, improvements in several aspects of the secondary beam properties such as purity, ionisation efficiency and optical quality are addressed. Presently the facility and the experimental equipment undergo extensive transformation to commit to the new physics challenges. Furthermore, the HIE-ISOLDE upgrade has attracted new instrumentation and extension to new fields of research such as transfer reaction studies in an ample domain of masses.

In this presentation, recent physics highlights obtained in the facility as well as the next steps in the HIE-ISOLDE upgrade are discussed.

References

[1] Focus on Exotic beams: ISOLDE Laboratory Portrait; J. Phys G. Nucl. Part. Phys. 44 (2017)

ID: 04167, 16/07/2019 09:40 - 16/07/2019 10:20, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

See atoms move in real time

Petra Rudolf[1]

1) Zernike Institute for Advanced Materials, University of Groningen

** Petra Rudolf, p.rudolf@rug.nl*

Time-resolved electron diffraction is a unique tool for providing direct and detailed information on the structural dynamics of solid surfaces, nano-sized materials, molecules and atomically thin layers, thanks to the high cross section for interaction between electron and matter. Femtosecond lasers are used to generate ultrashort light and electron pulses. Light initiates a process in the sample - a phase transition, an electronic excitation or simply a temperature jump - and by recording snapshots of the electrons diffracted from the sample in a stroboscopic fashion, one can image the photo-induced motion of thestructure. In this talk I shall try to give a taste of the immense possibilities of ultrafast electron diffraction, illustrating how this novel technique opens the door to physical understanding of many aspects of light-matter interaction such as out of equilibrium structural phase transitions, melting, controlled nanoscale mechanical phenomena, and creation of coherent phonons.

ID: 03949, 16/07/2019 11:40 - 16/07/2019 12:20, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Correlated Electrons: The Dark Energy of Quantum Materials

Laura Greene[1]

1) National MagLab and Florida State University

** Laura Greene, lhgreene@magnet.fsu.edu*

The nearly 80-year-old correlated electron problems remain largely unsolved; with one stunning success being BCS electron-phonon mediated “conventional” superconductivity. There are dozens of families of superconductors that are “unconventional” including the high-T_c cuprates, iron-based, and heavy fermion superconductors. Although these materials are disparate in many properties, some of their fundamental properties are strikingly similar, including their ubiquitous phase diagram; with intriguing correlated-electron (not-Fermi liquid) phases above the superconducting transition. These remain among the greatest unsolved problems in physics today; and a fun analogy stressing this will be presented. I will also present a MagLab overview and outline some of our recent work on heavy-fermion superconductors.

ID: 03579, 16/07/2019 12:20 - 16/07/2019 13:00, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Helium nanodroplets – from basics to applications

Lorenz Kranabetter[1] , Felix Laimer[1] , Paul Martini[1] , Lukas Tiefenthaler[1] , Simon Albertini[1] , Arne Schiller[1] , Linnea Lundberg[1] , Fabio Zappa[1] , Michael Gatchell[1] , Paul Scheier[1]

1) Institut für Ionenphysik und Angewandte Physik, Universität Innsbruck, Austria

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Pickup of atoms and molecules by helium nanodroplets (HNDs) has been demonstrated for a large variety of dopants [1]. Clusters, nanoparticles and nanowires are formed upon agglomeration of dopants inside or on the surface of the HNDs. They are quickly quenched to 0.37 K, the temperature of the surrounding superfluid He matrix. The low temperature as well as the weak interaction between the dopants and the superfluid He provide perfect conditions for matrix isolation spectroscopy. Ionization of pristine as well as doped HNDs has been investigated for more than 30 years and mostly low-mass ions have been observed. However, the models found in the literature to explain the formation and liberation of these ions are not applicable for HNDs that contain more than 10^6 He atoms. With new experiments, we discovered that HNDs can become very highly-charged. Ionizing a neutral beam of HNDs with few (1 µA) or many (1 mA) electrons, has a dramatic effect on the measured size distribution (Fig. a). Ionization of mass selected charged HNDs clearly indicates that pure ionization is the dominant process (Fig.b). Coulomb repulsion between charges of same polarity in highly-charged He droplets leads to minimum energy configurations in the form of Coulomb crystals. Dopants are polarized and attracted by the charged centers which thereby act as seeds for cluster growth. A very uniform growth rate of dopant clusters can be expected. With charge states >100, even massive HNDs can be manipulated with reasonably low electric fields. Such highly-charged doped HNDs have the potential for several exciting applications, ranging from matrix isolation spectroscopy of ions to the synthesis of novel clusters and nanoparticles.

This work was supported by the EU commission, EFRE K-Regio FAENOMENAL EFRE 2016-4, the Austrian Science Fund FWF (P26635, P31149 and W1259) and the Swedish Research Council (contract No. 2016-06625)

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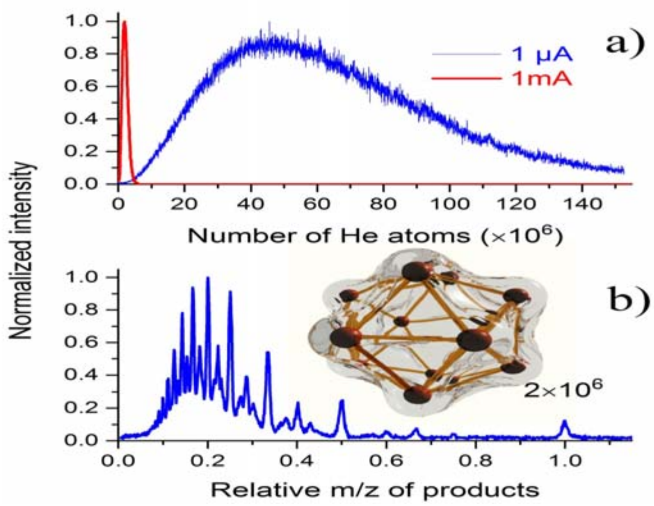

ID: 03677, 17/07/2019 09:00 - 17/07/2019 09:40, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

A novel scheme for efficient energy transfer to ions using ion-cyclotron waves: applications in terrestrial and space plasmas

Jozef Ongena[1] , Yevgen Kazakov[1]

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** Jozef Ongena, j.ongena@fz-juelich.de*

Three-ion ICRH scenarios [1] offer new exciting possibilities to deposit energy from ion-cyclotron waves to plasma ions. In a plasma consisting of two main ions, ICRF power absorption is strongly enhanced in the vicinity of theion-ion hybrid (IIH) layer because the RF electric field E_+ is rotating nearly exactly in the direction of the plasma ions. Candidate absorber ions are those for which the resonance layer is located close to the IIH layer and thus can be a third ion species with Z/A in between that of the two main ions or fast main ions, with a Doppler shift that displaces their resonance layer in between that of the two main ions. These ions may be typical H or He isotopes or impurities intrinsic or extrinsic to the plasma such as ^{9}Be, ^{22}Ne, Ar, etc. Both plasma heating and fast particle acceleration are possible with this technique. We summarize recent and past experiments with various three-ion ICRH scenarios on TFTR [2], C-Mod [1], JET [1] and AUG [3], using third ions and fast accelerated beam particles [4] as resonant absorbers and with on- and off- axis heating. We will illustrate the promising potential of three-ion ICRH scenarios for future JET D-T, ITER and DEMO operations and for testing the fast particle confinement properties of the optimized stellarator W7-X at the high densities expected in this device in the coming years.

Finally, applications of three-ion scenarios are not only limited to laboratory plasmas, but can also be applied to explain observations of energetic ions in space-plasma environments, in particular, ^{3}He-rich solar flares.

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ID: 04182, 17/07/2019 11:40 - 17/07/2019 12:20, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Gamma-ray Astrophysics

Monica L. Vazquez Acosta [1]

1) Instituto de Astrofísica de Canarias

** Monica Vazquez Acosta, monica.vazquez.acosta@cern.ch*

High energy gamma-ray astronomy probes the most extreme and violent environments in the Universe. This allows to study, among others, the role of relativistic cosmic particles and to search for dark matter. A review of physics highlights of the current gamma-ray ground-based and space-born detectors will be presented. Prospective studies for the future Cherenkov Telescope Array (CTA), the first gamma-ray observatory in both hemispheres, will also be discussed.

ID: 03751, 17/07/2019 12:20 - 17/07/2019 13:00, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Uncertainties in the reconstruction of long-term solar activity: What about the Maunder minimum?

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** José M. Vaquero, jvaquero@unex.es*

The solar activity of the past is a subject of great interest for geoscientists. On the one hand, solar activity is the main driver of the heliosphere and the magnetosphere. On the other hand, it is a natural forcing of the atmosphere and its dynamics, although the mechanisms of this forcing are complicated and non-linear. We can study the historical observations of sunspots preserved in the archives and libraries to reconstruct the solar activity of the past, obtaining an index commonly called “relative sunspot number”. In any case, there are telescopic observations only in the last four centuries (although they cover the interesting Maunder minimum (1645-1715), a period when solar activity was very low). We have to use the cosmogenic isotope (C^{14} and Be^{10}) recorded in natural archives to reconstruct solar activity over the last millennia. Today, there are methodologies based on physical models that manage to reconstruct solar activity during the Holocene.

ID: 03980, 15/07/2019 16:15 - 15/07/2019 16:30, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
Plenary session

Manipulating vortices using tilted magnetic fields.

Edwin Herrera Vasco[1]

1) Laboratorio de Bajas Temperaturas - Instituto de CIencia de Materiales Nicolás Cabrera. Universidad Autónoma de Madrid.

** Edwin Herrera Vasco, edwinherrera24@gmail.com*

Type-II superconductors allow a partial penetration of magnetic fields by introducing flux-quantized lines. These flux lines penetrate the sample as periodic arrangements, i.e., vortex lattice. The organization of the vortex lattice and the vortex core shape reveal unequivocally the anisotropies of the superconducting host material. Here, by using a scanning tunneling microscopy (STM) and a magnetic force microscopy (MFM) inside of a homemade three axis magnet coil, we study vortices in tilted magnetic fields on three layered superconductors with very different electronic properties. In β-Bi_2Pd we find that vortices under tilted magnetic fields, exit the sample perpendicular to the surface, even when the magnetic field is parallel to the surface. Thus, vortices are bent beneath the surface [1]. Tilted magnetic fields in 2H-$NbSe_2$ produce patterns of stripes due to in-plane vortices. The stripe pattern changes with the in-plane direction of the magnetic field. Our data show that vortices exit at an angle with the surface and that the sixfold gap anisotropy is present over the whole Fermi surface [2]. By tilting the magnetic field in $Bi_2Sr_2CaCu_2O_8$, we trigger Abrikosov vortex motion in between Josephson vortices, and find that Josephson vortices in different layers can be brought on top of each other [3]. Our measurements suggest that vortices can be manipulated in tilted magnetic fields much more easily than in the usual perpendicular magnetic field configuration. This can be used to design methods to entangle vortices.

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ID: 03996, 18/07/2019 09:00 - 18/07/2019 09:40, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Multifunctional Optical Materials

Hernán Míguez[1]

1) Consejo Superior de Investigaciones Científicas, Instituto de Ciencia de Materiales de Sevilla

** Hernán Míguez, h.miguez@csic.es*

Optical materials play a key role in the performance of different devices in fields as diverse as solar energy, light emission, radiation protection or detection. In this talk, different approaches based on ordered and disordered photonic structures to improve the efficiency or enhanced the functionality of different types of optoelectronic devices, such as solar cells or LEDs, solar mirrors, detectors or UV shields will be presented and discussed. The path from fundamental material design to applications will be described.

ID: 03652, 18/07/2019 09:40 - 18/07/2019 10:20, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Harnessing light as a probe of matter: Q-works new creation

Stefano Spagna[1]

1) Quantum Design Inc.

** stefano spagna, stefano.spagna@qdusa.com*

Quantum Design develops and manufactures instruments for precision measurement applications. Our success is based on our ability to identify emerging measurement opportunities, invent the requisite technology, and produce instruments uniquely suited to specific measurement applications. Physics provides a foundation for these technological advances with the technical team playing a critical role in translating fundamental physics discoveries into viable measurement capabilities. In this paper I will discuss how the "Q-works team", a selected group of Industrial Physicists at Quantum Design, has developed a new revolutionary magneto-optic platform specifically designed to meet the stringent requirements of material's characterization experiments to harness light and other forms of radiant energy as probe of matter.

ID: 04204, 18/07/2019 11:30 - 18/07/2019 12:10, Conference Hall (floor -1)

Plenary session

(Invited Plenary)

Topological Data Field Theory: structure and applications

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Science and Society are facing one of the most important challenges of their history; the challenge of dealing efficiently with the tsunami of the digital revolution.

In particular, big data impose a strenuous data processing effort, touching extreme frontiers both in computer science (new computing paradigms; interaction-based computing; ‘beyond Turing machine’) and in data analytics (new approaches to data mining; non-linear causal inference; the question of decidability and predictions).

However, the conventional approaches to complex problems in basic science (mostly the life sciences, climate and earth science) as well as in societal questions, as implemented by data science (A.I., data mining, machine learning, deep learning, graph analytics) and complexity science (network theory), pay relatively little attention to basic conceptual and universal features. In ‘Topological Data Analysis’ (TDA) the foresight is that appropriate mathematical tools, grounded on the profound notion, quite appealing for physicists, of considering a data set as a discrete point space, the \'space of data\', may provide – through this geometrical (indeed mostly topological) object – an ideal setting for the interpretation/representation of large data sets, enabling us to incorporate them in a framework that permits to individuate their hidden information patterns in a very effective way.This will endow IT with the capacity of playing much more efficiently its role in the process:

data → information →knowledge → wisdom.

TDA is a theoretical framework allowing for the efficient exploration of large amounts of data, fully usupervised. It generates an innovative data mining method, merging into a ‘non-linear topological field theory of data space’, that appears to be able to improve significantly the efficiency of machine learning techniques.

Our approach resorts indeed to the inference of information from global rather than local data space properties, as well as to the consideration of many-body rather than simply two-body data relations. It stems out of the integration of deep mathematical aspects of algebraictopological analysis of the data space, tools and ingredients for the topological field theory, with formal language theory and theoretical computer science.

TDA goes beyond the conventional complex networks based theory and the constraints of conventional data mining methods such as machine learning, replacing them with the notions of complex simplicial networks and correlation functions grounded information.

In this talk I’ll briefly review the motivations at the basis of the use of topological methods in data science, and outline the basic steps that lead to the construction of a ‘topological field theory for data sets’. I’ll also mention a few successful case studies – in particular in the domain of neuroscience – which produced increasing confidence in the power of the method, also for an interesting, unexpected feedback on conventional machine learning.

ID: 04048, 18/07/2019 12:20 - 18/07/2019 13:00, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Large Hadron Collider and its search for the building blocks of the Universe

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1) IFIC (CSIC-U.Valencia) 2) CERN

** María Moreno Llácer, mamolla@cern.ch*

The Large Hadron Collider (LHC) at CERN is the world's most powerful particle accelerator. Its very-high-energy proton collisions (at 13 TeV) are yielding new discoveries about the nature of the physical Universe. The goal is to explain the missing pieces in our understanding of the fundamental constituents of matter and their interactions.

The elementary particles, their properties and their interactions are described by the Standard Model (SM), which is the theoretical framework for the description of the strong interactions of quarks and gluons and the unified electroweak force. The SM, based on local gauge invariance, has been very successful in accounting for most of the observed phenomena at the microscopic frontier of physics, and has been verified and tested in many experiments in the last decades, including the discovery of the Higgs boson at CERN in 2012. However, several key questions remain unsolved in physics: around 95% of the content of the Universe remains unknown, and even for the content we can explain it is unclear why the Universe is dominated by matter with such a high imbalance over antimatter. New theories are being developed to explain such key questions in the understanding of our world, and they need to be validated with experimental data.

The unprecedented dataset available now thanks to the LHC provides a unique opportunity for precise measurements and greatly extends the sensitivity of the experiments to heavy new particles, potentially opening the way leading to new discoveries. Reaching the precision needed for that requires common efforts from both experimentalists and theory community, including new methods and the usage of advanced statistical techniques applying artificial intelligence methods with big-data.

In this talk, I will present a selection of the recent LHC results, and highlight what we can learn from future measurements as well as the challenges ahead.

ID: 03977, 16/07/2019 17:30 - 16/07/2019 18:00, Room 1.3 (first floor)
S21. Medical Physics (GEFM)
(Invited Symposio)

Focused ultrasound beyond phase-arrays: acoustic holographic lenses enable transcranial focusing of arbitrary fields at the central nervous system

Noé Jiménez[1] , Sergio Jiménez-Gambín[1] , José M. Benlloch[1] , Francisco Camarena[1]

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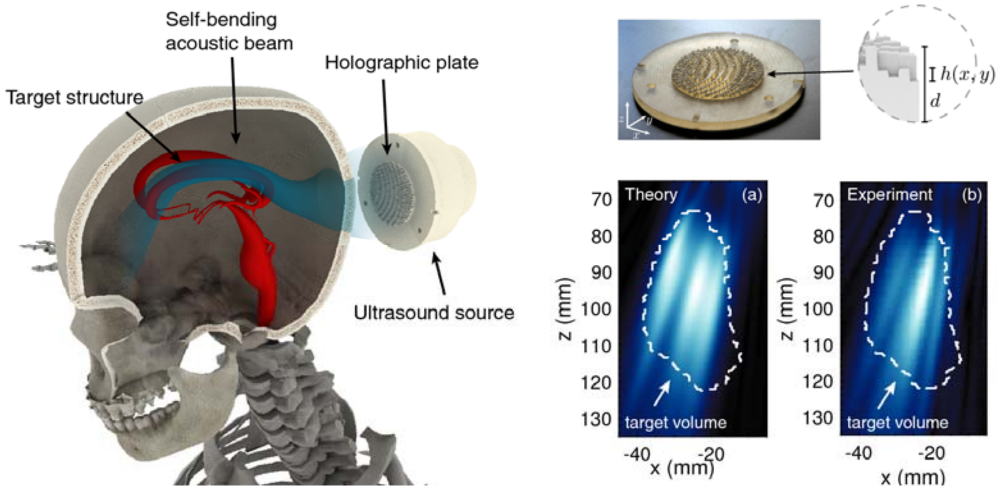
Focused ultrasound is currently used in many emerging therapeutic applications for the non-invasive treatment of neurological disorders and pathologies inside the central nervous system. The accurate focusing ultrasound beams at the central nervous system is mainly limited due to the strong phase aberrations produced by refraction and attenuation of the skull. In this talk we will present 3D-printed acoustic holographic lenses for the generation of ultrasonic fields of complex spatial distribution inside the skull. Using holographic lenses, we experimentally, numerically and theoretically produce acoustic beams whose spatial distribution match the volume of target structures of the central nervous system. This include multiple-target foci, self-bending beams and focusing over arbitrary volumes. In this way, the focus of the corresponding holographic lens overlaps with the target volume in excellent agreement between theory in free-media, experiments and simulations including a skull phantom. Using the present method, ultrasonic beams can be focused not only at a single point, but overlapping one or various target structures simultaneously, e.g., left and right hippocampi, using low-cost 3D-printed acoustic holographic lens. These results open new paths to spread emerging biomedical ultrasound applications including blood-brain barrier opening or neuromodulation.



ID: 04188, 19/07/2019 08:25 - 19/07/2019 09:05, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Results on dark matter annual modulation from ANAIS-112 experiment.

Marisa Sarsa[1]

1) Results on dark matter annual modulation from ANAIS-112 experiment.

** Marisa Sarsa, mlsarsa@unizar.es*

DAMA/LIBRA observation of an annual modulation in the detection rate remains as a puzzle in the search for dark matter. The DAMA/LIBRA signal is incompatible with the negative results from other very sensitive experiments in most of the dark matter scenarios usually considered. ANAIS-112 experiment, using 112.5 kg of NaI(Tl) as target, is taking data at the Canfranc Underground Laboratory in Spain since August 2017. ANAIS-112 aims at testing DAMA/LIBRA result using the same target and technique, which removes many of the dependences on the dark matter particle and halo models affecting the comparison among different experimental results. First results of ANAIS-112 experiment corresponding to 1.5 years are compatible with the absence of modulation and in some tension with DAMA/LIBRA results, although statistical relevance is below 2 σlevel. ANAIS-112 goal is to achieve a 3σ sensitivity to the DAMA/LIBRA result within 5 years of data taking. In the talk, ANAIS-112 experimental set-up will be presented, as well as the performance and first results of the experiment.

ID: 03919, 19/07/2019 09:05 - 19/07/2019 09:45, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Multi Illumination approaches for Biomedical Imaging: From Ultrasound to Optics

Mathias Fink[1]

1) Langevin Institute

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Noninvasive in vivo medical imaging with light or with ultrasound requires reflection-mode detection. As tissues are complex disordered media, containing random distribution of scatterers, these techniques suffer various limitations as distortion induced by aberrating layers as well as multiple scattering contributions. Multi illumination strategy is the solution to solve these problems. We will show that recording a time-gated reflection matrix can provide enough information both on the properties of aberrating layers and on the level of multiple scattering. We will show how to extract from the coherence properties of this reflection matrix enough information both to compensate the effects of aberrating layers and to overcome the contribution of multiple scattering. Various strategies to measure this refection matrix will be discussed and their applications will be presented both in ultrasonic imaging and in deep optical coherent tomography (OCT).

ID: 04165, 19/07/2019 09:45 - 19/07/2019 10:25, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

On-surface synthesis by atomic manipulation studied with atomic force microscopy

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** Leo Gross, lgr@zurich.ibm.com*

Elusive molecules can be created using atomic manipulation with a combined atomic force/scanning tunneling microscope (AFM/STM). Employing high-resolution AFM with functionalized tips provides insights into the structure, geometry, aromaticity, charge states and bond-order relations of the molecules created and into the reactions performed [1].

We created radicals, diradicals [2], non-Kekulé molecules [3] and polyynes [4] and studied their structural and electronic properties. We recently showed that the reorganization energy of a molecule on an insulator can be determined [5]. In addition, we expanded the toolbox for the synthesis of molecules by atomic manipulation, demonstrating reversible cyclisation reactions [2], skeletal rearrangements [4] and controlled reactions on insulating substrates by electron attachment/detachment [6].

On insulating substrates, we can control the charge state of molecules and resolve changes within molecular geometry, adsorption and aromaticity related to its oxidation state.

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ID: 03942, 19/07/2019 10:40 - 19/07/2019 11:20, Conference Hall (floor -1)
Plenary session
(Invited Plenary)

Gravitational Waves Astronomy

Gabriela Gonzalez[1]

1) Louisiana State University

** Gabriela Gonzalez, gonzalez@lsu.edu*

The first detection of gravitational waves in 2015 by the LIGO detectors, created by the merger of black holes more than a billion years ago, was followed by several other signals from black holes. In 2017, the merger of neutron stars was detected by LIGO and Virgo detectors and by gamma-ray telescopes, and was found by many electromagnetic observations too: a new era of gravitational wave astrophysics has started with very bright prospects for the future. We will describe the technology involved in the LIGO gravitational wave detectors, details of the latest discoveries and the exciting prospects for more detections in the next years.

2. SYMPOSIA

S1. XXIX Encuentro Ibérico de Enseñanza y Divulgación de la Física (DEDF)

El Encuentro Ibérico de Enseñanza y Divulgación de la Física es un congreso que se organiza desde el año 1991 coincidiendo con la Bienal de la Real Sociedad Española de de Física (años impares) y en Portugal con el Congreso de Física de la Sociedad Portuguesa de Física (años pares).

Hasta la anterior edición española (27º E.I. de Santiago) ha sido el Grupo Especializado de Enseñanza de la Física (GEEF) quien ha venido gestionando su realización. En la edición de 2019, el 29º Encuentro Ibérico será gestionado por la recientemente creada División de Enseñanza y Divulgación de la Física (DEDF), resultado de la fusión del GEEF y del Grupo Especializado de Comunicación y Divulgación de la Física (GEDF).

Las actividades que se llevan a cabo son una referencia no sólo para los miembros de la DEDF interesados en las cuestiones que tienen que ver con la investigación e innovación en la enseñanza de Física, sino en aquellas otras relacionadas con la divulgación y aplicaciones de la física de interés para los niveles de secundaria y universidad.

Tradicionalmente el Encuentro Ibérico ha estado siempre abierto a que cualquier miembro de la RSEF interesado en estas temáticas pueda participar en él y presentar las oportunas comunicaciones. Es también un congreso abierto a todos aquellos profesores que motivados por estas cuestiones, que por tener carácter presencial y celebrarse bianualmente en nuestro país, tiene la característica de constituirse en una actividad de referencia en la comunicación de profesores y profesionales de la Física.

El hecho de ser un congreso realizado con participación entre la RSEF y la SPF, le confiere un valor añadido que contribuye a favorecer los contactos entre profesores de Física de ambos países de los niveles de secundaria y de universidad. A lo largo de los casi treinta años de su historia esta actividad conjunta ha contribuido a favorecer un intercambio importante de opiniones y realidades en torno a la enseñanza de la Física, en el marco que determinan las dos comunidades ibéricas pertenecientes ambas a la European Physical Society.

Los profesores de Educación Secundaria que participen en el Encuentro Ibérico tendrán derecho a que el Ministerio de Educación y Formación profesional (MEFyP) les expida, a través del INTEF, el certificado de las horas correspondientes. Esta acreditación es consecuencia del Convenio que la RSEF tiene firmado con el MEFyP para las actividades de formación.

<u>Organizadores:</u>
José María Pastor Benavides, *Universidad Autónoma de Madrid*
María Fernanda Miguélez Pose, *Universidad de A Coruña*
Rogério Nogueira, *Escola Secundária, Marinha Grande*
Marília Peres, *Escola Secundária, Mafra*

<u>Comité científico:</u>
Jenaro Guisasola Aranzábal, *Universidad del Pais Vasco*
María Luisa Amieva Rodríguez, *IES Valle de Aller (Asturias)*
Manuel Fiolhais, *Universidade de Coimbra*
Carlos Portela, *Escola Secundária, Figueira da Foz*

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EDITORIAL
REVERTÉ

S1. XXIX Iberian Meeting on Physics Education and Dissemination (DEDF)

The Iberian Meeting on Physics Education and Dissemination is a congress that has been organized since 1991 in coincidence with the Biennial Meeting of the Spanish Royal Society of Physics (in Spain, odd years) and together with the Physics Congress of the Portuguese Society of Physics (in Portugal, even years).

Until the previous Spanish edition (the 27th Meeting held in Santiago de Compostela) the Specialized Group of Physics Education (GEEF) has managed its realization. For the 2019 edition, the Iberian Meeting will be managed by the recently created Division of Education and Dissemination of Physics (DEDF), which resulted from merging the GEEF and the Specialized Group of Communication and Dissemination of Physics (GEDF). The activities carried out during the Meeting are a reference for members of the DEDF interested in studying and innovating the way Physics is taught, as well as for those involved in the dissemination and applications of Physics that can be relevant to teaching at high schools and universities. Traditionally, the Iberian Meeting has been open to participation by any members of the RSEF and teachers who are interested in these questions. For these reasons, the Meeting has become a reference forum for the communication between teachers and professionals of Physics.

The participation of the RSEF and the SPF confers an added value, as it contributes to foster contacts between Physics teachers of both countries at secondary and university levels. Throughout its almost thirty years of history, this joint activity has contributed to important exchanges of opinions and realities related to the teaching of Physics within the framework of both Iberian communities, which belong to the European Physical Society. Secondary school teachers who take part of the Iberian Meeting will gain the right to get, through INTEF, a training certificate from the Spanish Ministry of Education (MEFyP). This accreditation is backed by the agreement that the RSEF has signed with the MEFyP for the realization of training activities.

Organizers:
José María Pastor Benavides, *Universidad Autónoma de Madrid*
María Fernanda Miguélez Pose, *Universidad de A Coruña*
Rogério Nogueira, *Escola Secundária, Marinha Grande*
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ID: 04202, 15/07/2019 15:00 - 15/07/2019 16:00, Room 1.8 (first floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Invited Symposio)

Potenciales catastróficos

Manuel Fiolhais[1], Rogério Nogueira[2]

1) Universidade de Coimbra
2) Escola Secundária Engº Acácio Calazans Duarte

** Manuel Fiolhais, tmanuel@uc.pt*

Resumen (castellano):

Potenciales tales como $(x) = x^3 + bx$, donde x es la variable dinámica y b es el “parâmetro de control”, son bien conocidos en la teoría de catástrofes: (x) es el potencial de la denominada “catástrofe en pliegue”. Para $b < 0$, el potencial tiene un mínimo local y un máximo local, pero, para $b > 0$, el potencial es una función monótona creciente.

Este tipo de potenciales, que muestran un comportamiento muy diferente en función del valor de uno o más de sus parámetros, juegan un importante papel en física. Se pueden encontrar ejemplos en física de la materia condensada, en la explicación de la superconductividad y, en física de partículas, en la explicación del origen de la masa de algunas partículas a través del denominado mecanismo de Higgs.

También en el aula este tipo de potencial puede sorprender y divertirse, captando así la atención del alumno a la importancia del enfoque energético a las cuestiones. Presentaremos tres ejemplos de potenciales catastróficos – en termodinâmica [1], en electromagnetismo [2] y en mecânica [3], enfocándonos no sólo en los aspectos teóricos, sino también en los enfoques computacional y experimental que pueden ser explorados en el aula.

Resumen (portugués):

Potenciais como $(x) = x^3 + bx$, onde x é a variável dinâmica e b é o “parâmetro de controle”, são bem conhecidos na teoria das catástrofes: $U(x)$ é o potencial da, assim chamada, “catástrofe fold”. Para $b < 0$, o potencial tem um mínimo local e um máximo local, mas, para $b > 0$, o potencial é uma função monótona crescente.

Esse tipo de potencial, que mostra um comportamento muito diferente dependendo do valor de um ou mais de seus parâmetros, desempenha um papel importante na física. Podemos encontrar exemplos na física da matéria condensada, na explicação da supercondutividade e, na física de partículas, na explicação da origem da massa de algumas partículas através do chamado mecanismo de Higgs.

Também na sala de aula este tipo de potenciais pode surpreender e divertir, captando assim a atenção do aluno para a importância da abordagem energética às questões. Apresentaremos três exemplos de potenciais catastróficos – em termodinâmica [1], em eletromagnetismo [2] e em mecânica [3] –, focando-nos não só nos aspetos teóricos mas também nas abordagens computacional e experimental que podem ser exploradas em sala de aula.

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ID: 04112, 15/07/2019 16:00 - 15/07/2019 16:30, Room 1.8 (first floor)

S1. XXIX Iberian Meeting on Physics Education and Dissemination

(Invited Symposio)

Experiencias de innovación de Física en enseñanza secundaria y universidad (UVEG)

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Hace unos 20 años que en la Facultad de Física de la Universidad de Valencia se desarrollan iniciativas de innovación docente, tanto en el ámbito de la enseñanza secundaria como de universidad, y sobre todo en su relación mutua. Una de ellas se desarrolla en ámbitos no formales y ligada a la formación y divulgación STEM, como la Feria-Concurso Experimenta de Física y Tecnología, iniciada en 2005 y en la que el alumnado de enseñanza secundaria junto a sus docentes (unos 450 por año) desarrolla proyectos experimentales, los expone y explica al público visitante (5000 personas) [1]. Por otro lado, desde 1999 se convocan periódicamente cursos y talleres de formación en física para el profesorado en activo e iniciativas de enseñanza y aprendizaje de la física en contextos más formales, como el Aula Experimenta: sesiones prácticas específicas para el alumnado de enseñanza secundaria que suplen la carencia, o ausencia del laboratorio en su formación. En contexto más específicamente universitario, aunque compartiendo aspectos con las iniciativas anteriores, tenemos (desde 2007) la Colección de Demostraciones de Física para el Aula, ligada a diferentes proyectos de innovación educativa. Actualmente consta de 160 demostraciones, utilizadas en sus clases (in situ) por 40 docentes en 25 asignaturas de física de más de 18 titulaciones universitarias, sobre todo de ciencias e ingenierías. Estas se utilizan también en numerosas actividades de divulgación como espectáculos científicos o talleres infantiles [2].

En esta presentación hablaremos de los aspectos más importantes y comunes de estas iniciativas, que suponen una toma de contacto con los fenómenos naturales y su integración con los aspectos teóricos. Y como contextos que permiten una mayor variedad metodológica, incentivando la interacción y diálogo con el alumnado y la transmisión de formas de pensar y razonar en física.

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ID: 03783, 15/07/2019 17:30 - 15/07/2019 17:45, Room 1.8 (first floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Oral)

STEAM for Primary Education: on the convenience, training of pre-service teachers and examples based in project-based learning

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The STEM paradigm (Science, Technology, Engineering and Mathematics) is currently on the rise as a means of achieving a more inclusive and global way of learning. It also seeks to provide a more practical and motivating sense in the teaching of Science by combining the technological part with the classical teaching of Experimental Sciences and Mathematics.

In recent years, the aim is to include the Arts (plastic, visual and musical arts) in this paradigm, thus being called the STEAM paradigm. The objective is to make knowledge even more complete and complementary, developing aspects directly related to createvity and the aesthetic and artistic sense to, achieving in this way that the Sciences and the Arts will be a motivating subjects for more students, perhaps contributing to the reduction of the existing gender gap in different academic careers.

This gap in the perception of one\'s own capacities has existed since very early ages and has been documented since the age of 6. It is therefore crucial to tackle this problem since the Primary Education. Within this purpose, the Faculty of Education of the University of Alcalá has started a specific specialty called *Mention in Science and Technology for Primary Education*, that we believe it is necessary to foster the knowledge and skills of pre-service teachers. Similar mentions exist in very few Spanish Universities and in those cases with a different approach and scope.

This contribution discusses these aspects in detail. In addition, two specific examples of STEAM projects developed by students of this specialty are presented. It includes their connection with the curriculum, objectives, planning and detail of the proposed activities. Finally, it includes data from the survey carried out on students who have finished the specialty for the first time for their evaluation.

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(Oral)

Ideas preconcebidas de Física en alumnos del Máster Universitario de Formación del Profesorado de Secundaria

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El ser humano trata de buscar explicación a los fenómenos que percibe a su alrededor y, si bien estas explicaciones pueden dar respuesta a las experiencias de la vida cotidiana, lo que viene a denominarse como la *ciencia del sentido común*, pueden en muchas ocasiones ser erróneas o poco precisas.

Las explicaciones anteriores se denominan ideas preconcebidas o preconceptos, y son errores conceptuales que tienen los estudiantes al principio del curso, lo que puede dificultar enormemente el proceso de enseñanza-aprendizaje. Además, algunas de ellas son extremadamente *robustas* (al sobrevivir a lo largo de los distintos niveles educativos) y *universales* (al estar presentes en diferentes culturas) [1].

En este trabajo se analizan las respuestas a un test sobre ideas preconcebidas de Física por parte de los alumnos matriculados en la Especialidad de Física y Química del Máster Universitario en Formación del Profesorado de Educación Secundaria Obligatoria, Bachillerato y Formación Profesional de la Universidad Politécnica de Madrid (curso 2018/2019).

La eficacia del proceso de enseñanza-aprendizaje en nuestros alumnos (y futuros docentes) se ha estudiado identificando qué errores conceptuales se han mantenido al final del curso, comparando, para ello, las respuestas de los test al comienzo y al final del mismo. Los resultados obtenidos se han comparado con los ofrecidos al realizar el mismo test alumnos de primer curso del Grado en Ingeniería Agroambiental de la ETSIAAB [2]. Se ha comprobado que algunas de estas ideas previas son comunes a ambos grupos de estudiantes, lo que demuestra su *persistencia* en todos los niveles educativos.

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ID: 03681, 15/07/2019 18:00 - 15/07/2019 18:15, Room 1.8 (first floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Oral)

Análisis comparativo del nivel de conocimiento del docente en formación y el alumnado de primaria sobre contenidos básicos de física

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Numerosas investigaciones analizan la existencia de preconcepciones en física que perduran en los estudiantes de diferentes niveles académicos aún después de la instrucción formal. Sin embargo, estas preconcepciones son especialmente relevantes cuando el colectivo que las presenta son docentes en formación, pues deben enseñar esos contenidos a su futuro alumnado. Asimismo, es necesario para la enseñanza de la física, establecer puentes entre el conocimiento científico y el conocimiento inicial de los estudiantes, siendo imprescindible que el docente posea una adecuada formación en el área. El objetivo principal ha sido analizar el nivel de conocimiento sobre contenidos básicos de física del maestro en formación frente al del alumnado de primaria.

El diseño de la investigación ha sido de tipo exploratorio, descriptivo y con análisis mixto. La muestra ha estado formada por 693 sujetos, 236 docentes en formación de nivel de Educación Primaria y 457 alumnos de Primaria. Los instrumentos de medida utilizados estaban basados en contenidos de física del currículo de primaria. Las pruebas psicométricas del instrumento utilizado mostraron su validez y fiabilidad. Los resultados revelan un bajo dominio cognitivo en ambos colectivos encontrándose diferencias estadísticamente significativas (Sig.<0,05) en las calificaciones promedio y en las puntuaciones obtenidas en función de la temática de las cuestiones formuladas. Sorprendentemente, estas diferencias son a favor del alumnado de primaria en algunos contenidos. Por otro lado, no existen diferencias estadísticamente significativas (Sig.> 0,05) en función de la variable género. Se detecta por tanto la necesidad de mejorar la formación en física de los futuros maestros para que alcancen las competencias científicas necesarias y favorezcan una formación científica de calidad a sus futuros alumnos.

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Diseño y desarrollo de un *taller inclusivo* sobre las propiedades de los fluidos

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La exclusión educativa y social del alumnado con discapacidad intelectual sigue todavía latente. Este problema es aún más evidente en el ámbito de ciencias. Para mejorar esa situación, surge el proyecto de innovación educativa *I.amAble*, con el objetivo de diseñar y realiza talleres inclusivos de física y química [1] [2] [3]. En la comunicación oral se presentará uno de los talleres científicos inclusivos que se llevó a cabo con estudiantes de 4º de E.S.O. del I.E.S. Alameda de Osuna perteneciente a la Comunidad de Madrid, junto con alumnado del colegio de educación especial Aleph Tea, especializado este último en trastornos del espectro autista (TEA).

Para el diseño del taller se eligió un tema de fluidos contemplado en el currículum de 4º de E.S.O. publicado por el B.O.E. [4] y el B.O.C.M. [5]. Aunque a nivel conceptual no es de los temas más fáciles, se eligió ya que permite realizar un taller muy manipulativo, uno de los requisitos indispensables en el diseño de talleres inclusivos bajo la metodología de *I.amAble*. Esta metodología conlleva una adaptación de la actividad teniendo en cuenta las discapacidades intelectuales del alumnado implicado, al mismo tiempo que se convierte en una jornada de sensibilización en el IES para concienciar y transmitir al alumnado la necesidad de potenciar la interacción entre las personas, independientemente de si tienen una discapacidad reconocida o no.

Para evaluar la actividad, se diseñan test para todo el alumnado. Estos se responden antes y después de la experiencia con el fin de medir el aprendizaje de las diferentes competencias. Si bien los dos test medían las mismas competencias científicas, sociales y transversales, el test destinado al alumnado con discapacidad intelectual se adaptó, tanto mediante el uso de un lenguaje de fácil lectura, como con la inclusión de pictogramas.

ID: 03799, 15/07/2019 18:30 - 15/07/2019 18:45, Room 1.8 (first floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Oral)

Thermal capacity: how should we teach?

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Thermodynamics is an area of physics where some topics remain unclear. This makes teaching difficult and leads to demotivation of students. To overcome these obstacles, the critical spirit and a reflection on the conceptual structure of thermodynamics are fundamental. In addition, the various concepts and definitions are closely related, requiring a global view of the issues addressed, and not one confined to specific cases.

It is usually assumed that learning difficulties are on the students\' side only, but it is necessary to clarify concepts without which teaching strategies become unsuccessful: you cannot teach well what is poorly understood. Some of the subtleties of thermodynamics are no more than conceptual misunderstandings.

This communication discusses critically how the concept of thermal capacity is presented in the textbooks, comparing the different definitions found. These definitions are not all equivalent to each other, so it is necessary to identify what to modify in order to obtain consistent and general definitions. The pursuit of this task requires discussion of the concepts of heat [1] and dissipative work [1, 2], the latter being systematically ignored [3]. These topics are almost always presented in the literature in a way that reinforces the confusion between the concepts of reversible and quasi-static process, with little attention being paid to the concept of dissipative work.

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ID: 04032, 15/07/2019 18:45 - 15/07/2019 19:00, Room 1.8 (first floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Oral)

La Iniciativa 11 de Febrero en la Enseñanza y Divulgación de la Física

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Uno de los objetivos de la enseñanza y divulgación de la física es su inclusividad. Lograr que cada alumno y alumna desarrolle al máximo su potencial y acceda a la ciencia en igualdad de condiciones. La baja presencia de alumnas en carreras de física y su menor autoestima en estas materias nos indica que este objetivo no se está logrando. En parte ello se debe a la falta de referentes femeninos en física.

En la charla presentaremos la iniciativa 11 de Febrero, que impulsa y facilita la realización de actividades que conmemorando el día internacional de la mujer y la niña en la ciencia, ayuden a lograr la igualdad de género y las vocaciones en las niñas en ciencia, y en particular en física. Centros educativos y personal científico están llamados a organizar y participar en estas actividades. La iniciativa, de la que ya se han celebrado tres ediciones, está ayudando a rediseñar la forma en la que se aborda la igualdad de género en las aulas y la divulgación.

ID: 03920, 16/07/2019 15:00 - 16/07/2019 16:30, Room 1.8 (first floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Invited Symposio)

Problemas de Enseñanza y Aprendizaje de la Física en Universidad y Bachillerato

Simposium apoyado por la División de Enseñanza y Divulgación de la Física, dentro de las actividades del Encuentro Ibérico

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La enseñanza de la física a nivel universitario es particularmente relevante cuando los modelos de educación universitaria para la ciencia y la tecnología se están analizando y se cuestionan en todo el mundo. La educación científico-tecnológica a nivel universitario debe apoyar a una población estudiantil diversa donde el uso del conocimiento, no solo la memorización, se está volviendo más importante. Aunque la mayoría de los científicos, matemáticos e ingenieros lograron aprender en un formato de enseñanza tradicional, son la excepción y no la regla.

En diferentes países, grupos de expertos informan sobre un enfoque de educación científica basado en el aprendizaje y la enseñanza activos. En este nuevo enfoque de la enseñanza de la física, la Investigación en Enseñanza de la Física (IEF) ha desarrollado un papel clave. Muestra que, en comparación con los cursos tradicionales que transmiten el conocimiento, los métodos de enseñanza activa pueden mejorar el aprendizaje de los conceptos y las leyes necesarios para aplicar el conocimiento en diferentes contextos. Los resultados de la IEF están cambiando la educación científica universitaria de la tradición y la intuición a propuestas basadas en teorías de aprendizaje y evaluadas por instrumentos confiables y validados.

La comunidad de investigación en IEF ha trabajado duro para presentar propuestas de enseñanza sólidas, materiales de instrucción y métodos que se han evaluado repetidamente. En este simposio presentamos ejemplos de estos cambios en la enseñanza de la física en educación superior y bachillerato.

ID: 03750, 16/07/2019 17:30 - 16/07/2019 18:00, Room 1.8 (first floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Invited Symposio)

Nuevas formas de divulgar ciencia

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Las nuevas tecnologías están cambiando nuestra manera de vivir y comunicarnos, así como nuestra manera de aprender y transmitir ideas. La divulgación científica no escapa a esta nueva revolución que además está sirviendo para impulsarla y llegar a más público. ¿Cuáles son estos nuevos canales de comunicación? ¿En qué medida están influyendo en nuestra manera de comunicar y de divulgar? Se abordarán estas y más cuestiones relacionadas con la divulgación de la física y qué cosas deberíamos mejorar para acercar la ciencia básica a toda la ciudadanía.

ID: 04104, 16/07/2019 18:00 - 16/07/2019 18:15, Room 1.8 (first floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Oral)

Aprendiendo ciencia con visión europea: Erasmus+ "Atelier for STE(A)M".

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Cinco escuelas de secundaria de España (Jaén y Burgos), Eslovenia, Portugal y Polonia hemos trabajado en un proyecto Erasmus+ durante los dos últimos años desarrollando actividades relacionadas con la enseñanza STE(A)M.

Durante este tiempo se han aplicado con los estudiantes de primaria y secundaria diversos escenarios de aprendizaje, con el objetivo de transformar los procesos educativos de estas asignaturas. Para ello se ha realizado formación del profesorado (4 docentes de cada escuela) en Portugal (octubre 2017) y Burgos (octubre 2018). A partir de ahí se han desarrollado las actividades y se concluye con la organización de un congreso de estudiantes, donde son los alumnos los que deben presentar sus conclusiones, en inglés. Estos congresos se han celebrado en Jaén (abril 2018) y Eslovenia (abril 2019). Se favorece así el desarrollo de habilidades transversales: competencias lingüísticas, culturales, habilidades sociales, de comunicación, aprender a aprender, a desenvolverse en un país extranjero, desarrollo del sentimiento de pertenencia a Europa, etc.

En el aspecto científico se han desarrollado actividades relacionadas con el agua desde numerosos puntos de vista, sobre la luz, robótica, programación en Scratch, App Inventor y Arduino, funcionamiento de redes neuronales, investigación en geología y biología, etc. Algunas de estas actividades han sido organizadas en colaboración con las Universidades de Lisboa, Burgos, Jaén, la Politechnika Bialostocka (Polonia) el National Science Institut Jozef Stefan de Ljubljana (Eslovenia).

Los coordinadores de las escuelas españolas somos miembros de la RSEF, la cual ha colaborado en el proyecto.

En esta presentación se mostrarán las experiencias realizadas, así como las conclusiones extraídas de nuestra participación en un proyecto Erasmus+ para centros escolares, analizando las ventajas que este tipo de iniciativas ofrecen para la mejora de la enseñanza y aprendizaje de las áreas STE(A)M.

ID: 03680, 16/07/2019 18:15 - 16/07/2019 18:30, Room 1.8 (first floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Oral)

¿Influye en los resultados del alumnado de primaria la inclusión de imágenes en cuestionarios de física?

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Diversos autores han confirmado la utilidad didáctica de las imágenes en el aprendizaje de conceptos de física en edades tempranas. El objetivo de la investigación ha sido analizar si la inclusión de imágenes en cuestionarios de física influye en los resultados académicos del alumnado de primaria.

El diseño de la investigación ha sido de tipo cuasi-experimental, cuantitativo, con grupos de control y experimentales. La muestra, seleccionada por muestreo no probabilístico ha estado constituida por 678 estudiantes de 4º, 5º y 6º de primaria. Estos alumnos fueron divididos en cada uno de los niveles académicos en grupos de control (n= 333) y grupos experimentales (n= 345). Como instrumento de medida se diseñó un cuestionario sobre contenidos de física del currículo planteado de dos formas diferentes, uno ilustrado con imágenes para los grupos experimentales y otro textual, sin imágenes, para los grupos de control. Los resultados obtenidos revelan un bajo dominio cognitivo del alumnado de primaria ante conceptos de física. Sin embargo, la inclusión de imágenes favoreció los resultados obtenidos por los grupos experimentales en todos los niveles educativos.

El análisis inferencial confirmó la existencia de diferencias estadísticamente significativas (Sig.<0,05) en las calificaciones promedio de los diferentes grupos, siendo favorables a los grupos experimentales. Asimismo, no se encontraron diferencias significativas en la variable conocimiento (Sig. > 0.05) en términos de la variable género. La comparación de resultados permite concluir que la imagen enriquece el aprendizaje de la física porque ayuda a retener y recordar los conceptos de física aprendidos. Por tanto, complementar los contenidos con imágenes aclarativas bien seleccionadas puede potenciar la alfabetización científica en el alumnado de primaria.

ID: 03653, 16/07/2019 18:30 - 16/07/2019 18:45, Room 1.8 (first floor)

S1. XXIX Iberian Meeting on Physics Education and Dissemination

(Oral)

Problemas de Relatividad para desarrollar la competencia científica

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Presentamos una colección de problemas sobre Relatividad, apropiados para el Bachillerato y para primeros cursos de Universidad. Inciden en temas de interés científico y/o social (experimento histórico de los muones de Rossi y Hall, posibilidad de realizar un viaje interplanetario a una velocidad elevada, movimientos de partículas en aceleradores, interacciones, etc.) y siguen un modelo de resolución coherente con las características esenciales del trabajo científico [1]. Así, incluyen la realización de un análisis cualitativo, la emisión de hipótesis fundadas sobre los factores de que puede depender la magnitud buscada, imaginando posibles casos límite de fácil interpretación física, la elaboración de posibles estrategias de resolución, una resolución literal formal, un análisis detenido de los resultados, etc.

Los problemas están a disposición del profesorado [2, 3] y se enriquecen con animaciones informáticas interactivas de elaboración propia con las que los alumnos pueden, p. e., contrastar la influencia que tiene en el resultado cambiar una u otra variable, etc. En la exposición oral desarrollaremos uno de forma concreta para mostrar la plausibilidad del modelo. Su potencial utilidad se resalta porque precisamente la Relatividad, a pesar de su importancia, es uno de los temas peor tratados en el Bachillerato [4]. Sin embargo, al utilizar esta propuesta en el aula y en cursos de formación docente, hemos constatado que alumnos y profesores la perciben como un tema fascinante, apropiándose de una forma más efectiva de los contenidos y de la metodología desarrolladas.

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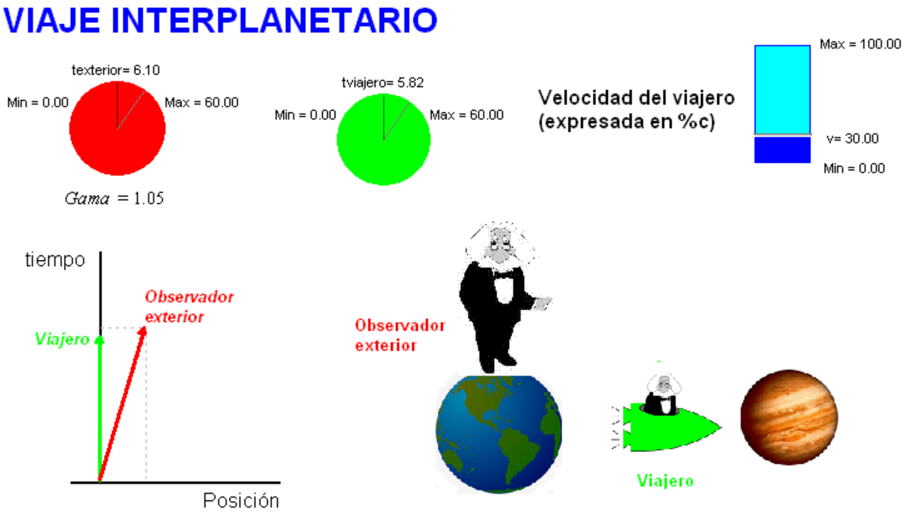
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(expresada en %c)
Max = 100.00
v= 30.00
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Observador
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ID: 03827, 16/07/2019 18:45 - 16/07/2019 19:00, Room 1.8 (first floor)
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(Oral)

CRAFTSMANSHIP: GENUINE INTERCESSOR OF THE PEDAGOGY OF PHYSICS

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Introduction
The study of Physics and craftsmanship allows students to know many physical processes, XIX century scientific instrument and tools related to physical laws and its evolution.

Methodology
A selection of handicrafts has been made from the street signage of Antequera, so it contributes to the splendor that these guilds had in our city and to value their contribution to the improvement and transmission of knowledge.
The oldest craftsman in every area has been to select in order to have first-hand all the information related to his trade. Their tools have been compared with the scientific instruments of the XIX century that is housed is IES "Pedro Espinosa" high school, where it has been possible to study the relationship with the different parts of Physics and the laws that govern its execution.
Results and Discussion
Once different handicrafts have been analyzed, it can be affirmed that the greatest proportion of tools is related to Mechanics, Heat and Electromagnetism. It also happens in the XIX century scientific instruments belonging to the school.
Conclusions
The study of the History of Craftsmanship is essential to understand the importance of its noble craftsmen, who have contributed to the advancement of physics and society as well as an integral way of life with their fellow citizens and the environment.
Acknowledgements
The author acknowledges the cooperation of all students in the Bachelor´s Degree in Physics and Chemistry in the IES "Pedro Espinosa" and the support of the artisans who contributed with their knowledge in every guild researched.
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ID: 03990, 17/07/2019 15:00 - 17/07/2019 16:00, Room 1.8 (first floor)
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(Invited Symposio)

Presentación del informe: El estado de la enseñanza de la Física en la educación secundaria

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El informe ha sido elaborado por la "Comisión sobre la Enseñanza de la Física en la Educación Secundaria", presidida por José María Pastor. Fue aprobado en la Junta de Gobierno del 4 de mayo de 2018 y puede descargarse en:
http://www.dedfisica.com/wp-content/uploads/2018/11/informe_fisica_14-11-2018.pdf.

A partir de la normativa vigente se analiza la distribución temporal que se dedica al estudio de las materias de Física y de Química en cada una de las Comunidades Autónomas (CCAA) a lo largo de la Educación Secundaria Obligatoria y el Bachillerato.Las diferencias que se presentan son de interés tanto para conocimiento y reflexión del profesorado como para la ciudadanía. Este análisis se complementa con el estudio comparado de los currículos de Física y Química a lo largo de toda la Secundaria apreciándose diferencias significativas en la implantación de la LOMCE, vigente en este momento.

Tanto la utilización de los laboratorios escolares como la formación del profesorado son aspectos importantes que se analizan en el informe, al igual que la actitud de las chicas en relación con los estudios de Física. El análisis de los datos de alumnos que eligen Ciencias en el Bachillerato al compararlos con los que eligen otras modalidades permite obtener consecuencias significativas.

Una parte importante del estudio se dedica al análisis de las Pruebas de Acceso a la Universidad (tanto PAU como EBAU) a lo largo de un periodo de cinco años. Ello permite estimar las tendencias que se dan en las distintas CCAA en torno a la elección de la Física como materia a estudiar en 2º curso de Bachillerato. Estas pruebas se analizan tanto para el total de los estudiantes como para el caso de las mujeres. Al comparar estos datos con los de Matemáticas y Química se obtienen perspectivas de gran interés para el profesorado. El informe se cierra con unas recomendaciones para mejorar la enseñanza de la Física tanto en la ESO como en el Bachillerato, dirigidas a los distintos estamentos de la comunidad educativa: administración, centros, profesorado y estudiantes.

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F = -grad V y sus descendientes: Tres siglos de física y el principio de menor acción

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Las fuerzas conservativas, que son el gradiente de una energía potencial V, aparecen en la teoría de la gravedad newtoniana, cuyos éxitos en todo el S. XVIII permitieron la inteligencia de los movimientos en el Sistema Solar: hoy estas fuerzas se mencionan y estudian en todos los cursos básicos de Física.

Pero en electromagnetismo aparecen fuerzas que literalmente no son gradientes de ningún potencial. Muy a finales del S. XIX se entendió que todas las fuerzas electromagnéticas admiten una descripción en términos de un `conjunto de potenciales\', más complicado que un simple potencial V: aparece así el `primer descendiente\' que en ciertas circunstancias especiales se reduce a la relación básica.

La teoría de Einstein de la gravedad, ya en el S. XX, da otra vuelta de tuerca en esa relación, que nos lleva a lo que podríamos considerar el `segundo descendiente\': con matices, las fuerzas gravitatorias e inerciales pueden expresarse en términos del conjunto completo de \'potenciales de la interacción gravitatoria\'; en ciertas circunstancias este `segundo descendiente\' se reduce aproximadamente a los anteriores.

Y como también ocurre probablemente a lo largo de varias generaciones de personas, los caracteres nuevos que van apareciendo, los `potenciales\', adquieren un rol que va dejando en muy segundo plano a las fuerzas, que inicialmente habían sido las protagonistas principales.

Ese cambio enlaza con el otro hilo conductor de ésta charla: el principio de acción estacionaria. En la formulación de ese principio son los `potenciales\' y no las fuerzas quienes aparecen. Este cambio de énfasis es el que, ya entrado el S.XX permite enlazar con la mecánica cuántica, en la que los potenciales tienen un papel fundamental.

Las restantes interacciones básicas, débiles y fuertes, estudiadas en la segunda mitad del S. XX, de las que aquí no se hablará, encajan por completo en este esquema conceptual.

ID: 04128, 17/07/2019 17:30 - 17/07/2019 17:45, Room 1.8 (first floor)
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(Oral)

Evaluación de diez años de experiencia con Aprendizaje Basado en Problemas en Física

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La presente tiene por finalidad mostrar las implicancias didácticas del aprendizaje basado en problemas (ABP), en el proceso de enseñar y aprender (E-A) en Física I a estudiantes de Ingeniería Civil de la Universidad del Bío Bio. La propuesta tiene como punto de partida la selección de entornos de aprendizaje integradores y contextualizados, a partir, de los cuales, se implementa una propuesta de renovación metodológica bajo tres tipos diferentes de ABP. Alrededor de este problema generatriz, se articula una secuencia de problemas más acotados. La solución de estos problemas en el aula a largo del semestre permite avanzar en la solución del problema original [1]. Aquí se consideran actividades de aprendizaje (A.A) que aseguran la transferencia de contenidos en situaciones nuevas. La finalidad del trabajo es implementar una renovación metodológica bajo ABP, que mejore el rendimiento académico, la tasa de aprobación y retención en la asignatura de Física. Esta renovación metodológica se fundamenta en dos ejes teóricos que aportan significado, el aprendizaje significativo de Ausubel, y la interacción Social Vigotsky.

El trabajo recoge los resultados académicos obtenidos en los últimos 10 años de un curso, física I (mecánica), para estudiantes de Ingeniería Civil de la Universidad del Bío Bío, que son enfrentado a una renovación metodológica bajo ABP cuyos resultados, se comparan bajo un diseño longitudinal con los resultados obtenidos en la misma asignatura en años anteriores, algunos se dictan con lecciones magistrales. Aquí, el ABP se usa con la finalidad de nivelar los conocimientos previos y establecer sus implicancias didácticas en la construcción del conocimiento y desarrollo de competencias.

En esta innovación se pretende, a través de un contexto, plantear un problema integrador, para enseñar y aprender todos los contenidos del curso, (columna vertebral de la asignatura) donde es necesario haber adquirido los conceptos básicos de la asignatura, lo que se logra al resolver una serie de problemas más acotados. Estos contenidos son: parámetros de cinemática, tipos de movimiento, cantidad de movimiento lineal, impulso, fuerza, trabajo, energía, principios de conservación, dinámica de cuerpo rígido, etc.

Este enfoque se plantea para su aplicación en la enseñanza universitaria. La propia dinámica interna de esta estrategia fomenta el aprendizaje autorregulado. Así, durante el análisis inicial del problema, el alumno debe crear una representación mental relativa a la situación que se describe en el enunciado. Es muy posible que esta primera representación inicial sea incompleta y que tenga lagunas importantes. Asimismo, descubrirá posibles alternativas y enfoques válidos que, en principio, pueden resultar apropiados para avanzar en la solución del problema. El que investiga debe aprender contenidos relevantes.
Con este método se ha logrado nivelar los conocimientos previos, competencias básicas y genéricas de los estudiantes de nuevo ingreso a las carreras de ingeniería civil de la Universidad, y así mejorar el rendimiento académico, la tasa de aprobación y retención de la asignatura sin aumentar las horas de clase, agregando cursos de introducción o talleres paralelo. La regulación del aprendizaje bajo ABP se realiza de forma continua con resultados alentadores, alcanzado cambios en la tasa de retención, rendimiento académico, que son estadísticamente significativos.

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ID: 03768, 17/07/2019 17:45 - 17/07/2019 18:00, Room 1.8 (first floor)
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(Oral)

Análisis de las competencias adquiridas y del perfil de los estudiantes en Grados de Física y de Óptica y Optometría. Conclusiones y análisis final

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En este trabajo se presenta un estudio realizado durante los últimos cuatro cursos académicos en el que se evaluó la percepción subjetiva de los alumnos del Grado en Física y de Óptica y Optometría respecto a su grado de adquisición de competencias e intereses en cuanto a perfiles de salida.

El objetivo principal del proyecto es conocer la opinión de los alumnos respecto a sus vocaciones, sus perfiles de entrada y salida, su bagaje previo, y su impresión sobre el grado de asimilación de las competencias específicas de cada grado. Se analizan las diferencias entre los alumnos nuevos, aquéllos que finalizan este año (cursos 1º y 4º), y la evolución de una promoción durante los cuatro años del grado. El estudio se basa en la realización de una encuesta por parte de los alumnos, de forma anónima, y en un estudio estadístico de los resultados.

Los resultados en el Grado en Física han mostrado varios hechos significativos; se ha ido detectando un progresivo aumento en la nota de corte y las preferencias laborales de los estudiantes se han mantenido estables, siendo la docencia universitaria y la investigación, tanto en centros públicos como privados, las opciones preferidas por los estudiantes de física. En cuanto a la apreciación subjetiva de las competencias, se ha observado un incremento en las valoraciones de los estudiantes de primer curso. Este hecho es atribuido al incremento de la nota de acceso mencionado.

Los resultados en el Grado de Óptica y Optometría han mostrado que aproximadamente el 50% de los alumnos escogieron dichos estudios como primera opción y que el perfil de ingreso es aproximadamente de un 60% de estudiantes que han cursado el bachillerato sanitario-biomédico, siendo la salida laboral preferida dicho ámbito sanitario-biomédico. En cuanto a la valoración de las competencias, los resultados han sido positivos con una nota media superior a 7.

Los resultados aquí expuestos son de gran interés para la comunidad docente en grados de física.

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(Oral)

Integración curricular (bloque i) de electricidad y magnetismo, cálculo multivariable y ecuaciones diferenciales en un ambiente de aprendizaje basado en retos.

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En este trabajo se muestra la experiencia de incorporar la técnica de aprendizaje basado en retos en el contexto del nuevo modelo educativo en las carreras de ingeniería que se imparten en el ITESM el cual, se enfoca en el aprendizaje basado de retos ABR y en el desarrollo de competencias. Bajo este esquema se implementó el bloque i, este bloque se conformó por módulos de aprendizaje y un reto que se desarrolló durante un semestre. En el bloque, el reto es una situación real y es el eje de los módulos de aprendizaje, esta metodología es vivencial y motivante para los estudiantes, además incorpora herramientas tecnológicas, técnicas didácticas y además permite que el alumno desarrolle competencias de análisis desde las perspectivas de matemáticas y física que suelen ser complementarias.

Se muestra la metodología de integración de tres materias, electricidad y magnetismo, cálculo multivariable y ecuaciones diferenciales en un bloque con un reto que consistió en la construcción de un aerogenerador con una potencia de 1 KW en equipos de 4 alumnos. Los estudiantes eligieron el diseño de su aerogenerador, entre las opciones de eje vertical, horizontal e hibrido. Posteriormente los estudiantes usaron herramientas de dibujo computarizado para diseñar su propuesta. Durante la última etapa se construyó la propuesta utilizando procesos de manufactura, impresión 3D y cortadora láser. Al final del semestre cada equipo presentó su prototipo funcional con un reporte técnico donde se integraron las competencias disciplinares de los tres cursos.

En este ambiente los estudiantes adquieren responsabilidad de su propio aprendizaje y aplican conocimientos adquiridos en los módulos de aprendizaje en un prototipo funcional guiados por un profesor que actúa como facilitador, conectando las diversas disciplinas y desarrollando sus competencias disciplinares y transversales.

ID: 03912, 17/07/2019 18:15 - 17/07/2019 18:30, Room 1.8 (first floor)
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(Oral)

Your smartphone: a Physics lab in your hands

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Smartphone usage has expanded dramatically worldwide in recent years and their use goes considerably beyond the original purpose of *talking on the phone*. Indeed, it is everyday more frequent to use smartphones as clocks, cameras, agendas, music players or gps. More remarkable is the habit, especially among young people, of bringing their smartphones every time *and everywhere*. From a physicist\'s point of view, it is impressive that smartphones usually incorporate several sensors, including accelerometer, angular velocity sensor, magnetometer, proximity or pressure sensor. Although these sensors are not supplied with educational intentions in mind, they can be employed in a wide range of physical experiments, especially in high school or undergraduate laboratories. Moreover, experiments with smartphones can be easily performed in non-traditional places as playgrounds, gyms, travel facilities, among many others. Here, I will briefly review some of the capabilities of the smartphones and next discuss some physics experiments using them. All the possibilities that smartphone exhibit, foster students interest in exploring, measuring and meeting the physical world around them. We expect, as mobile phones changed our way of life, they will also change our way of teaching and learning.

Additional information including references to our work can be found at http://smarterphysics.blogspot.com.

ID: 03983, 17/07/2019 18:30 - 17/07/2019 18:45, Room 1.8 (first floor)
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(Oral)

Análisis de la dinámica de un yoyó utilizando el giroscopio de un smartphone

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El uso de juguetes para enseñar física es un enfoque interesante para promover el interés de los estudiantes [1]. Tradicionalmente, han sido ampliamente utilizados como herramientas en demostraciones. Sin embargo, con frecuencia es difícil extraer resultados cuantitativos en experimentos de física con juguetes. Una posible estrategia para abordar esta dificultad es el uso de sensores de teléfonos inteligentes.

En este trabajo se analiza la dinámica de un yoyó utilizando el giroscopio (también conocido como sensor de velocidad angular) de un smartphone. Como el yoyó es un juguete ubicuo, simple y tradicional, esta sencilla propuesta podría animar a los estudiantes a experimentar con objetos cotidianos y tecnologías modernas. Además, el yoyó involucra varios conceptos básicos de mecánica. Por otro lado, el giroscopio es un sensor muy adecuado para experimentar en situaciones que involucran dinámicas de rotación [2].

Tras construir un yoyó al que se le puede adherir un smartphone (tal y como se muestra en la imagen), hemos podido registrar la velocidad angular del sistema. Por medio de ajustes lineales, también hemos obtenido las correspondientes aceleraciones angulares. Hemos analizado el movimiento completo del yoyó. Las aceleraciones en ventanas temporales diferentes son muy similares en módulo y también coherentes con los resultados obtenidos con el video-análisis del movimiento.

Una propuesta interesante para el aula es presentar el problema a los estudiantes, permitirles discutir y predecir la evolución de las variables angulares, y finalmente caracterizar el movimiento del yoyó con el smartphone. Este tipo de propuesta con elementos familiares para los estudiantes podría contribuir a demostrar que la Física está en todas partes y a incentivar el pensamiento crítico.

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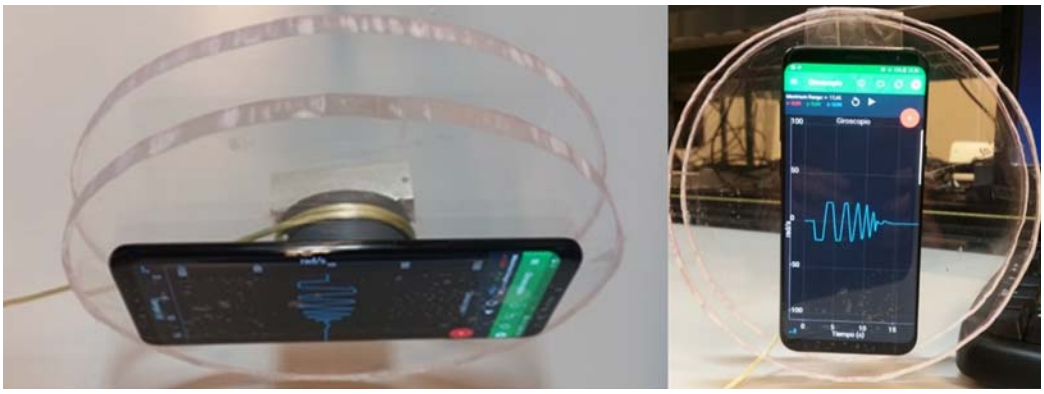

ID: 03738, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Poster)

The Influence of Physical Propierties in Flexography.

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3) UNIVERSIDAD DE BURGOS

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Introduction

In the field of graphic arts, Flexography [1] has developed significantly at the end of the 20th century. Its increased use in industry is due to the fact that this type of printing allows high quality final printing products that are used in different areas, from packaging in the food industry, to labeling in the textile industry.

Physical properties

To make a Flexographic print it is necessary to take into account several physical properties, such as: pressure applied and temperature. In the case of ink: viscosity, density, pH, temperature, surface tension, fluidity, must be considered amongst other factors; depending on the type of ink used and the purpose for which the equipment or specific material is used.

It is very important to take into account all the parameters mentioned above if a quality impression is to be obtained. It is also very important to make the right choice of the type of ink to be used as these can be water based, solvent based or ultraviolet. The decisión depending on the print run and the final application of the final printed product.

Acknowledgments

We thank for the financial support provided by the project ED431C 2016-034 by ‘‘Xunta de Galicia’’ of Spain. This project is co-financed with FEDER funds.

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ID: 03791, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
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(Poster)

Actividades de Gamificación en el Aula: Fislets

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El absentismo es uno de los principales males que aqueja a la enseñanza universitaria actual. La mentalidad del alumno recién ingresado se ha adaptado a la psicología de redes, haciendo suya ideas como el me gusta o no me gusta. Centrados en la disciplina que impartimos, la Física, es difícil que materias básicas de una enseñanza de grado susciten el suficiente interés en el alumno para que motiven su aprendizaje de por sí. En este sentido resulta fundamental añadir a las clases elementos motivadores basados en elementos de juego1 que atraigan al alumno. El alumno actual aplica la ley del mínimo esfuerzo, cuenta con todos los materiales de estudio haciendo un solo clic, y la asistencia a clase no deja de ser un trabajo añadido. Hagamos pues que esa asistencia sea divertida utilizando recursos con los que el alumno pueda entretenerse.

El profesor debe resolver problemas en clase para que el alumno tenga modelos que le permitan resolver con acierto problemas similares. La idea reside en que si después de resolver alguno de esos problemas, el alumno pueda interaccionar con ellos y visualizar los efectos que produce en el sistema el cambio de ciertas variables, su aprendizaje se verá reforzado. Los fislets o applets de java permiten crear simulaciones al profesor, pero que pueden ser vistas como un juego por el alumno si se introducen una serie de variables que este puede manejar y que producen cambios significativos en el sistema. Estas simulaciones son fácilmente diseñadas por una herramienta de programación de libre distribución (Ejjs2) y pueden ser fácilmente subidas a un Moodle (al cual se ha añadido el “plug-in” adecuado), que evite conflictos de seguridad en los navegadores de internet, para poder ser utilizadas por el alumno desde su terminal móvil.

Referencias

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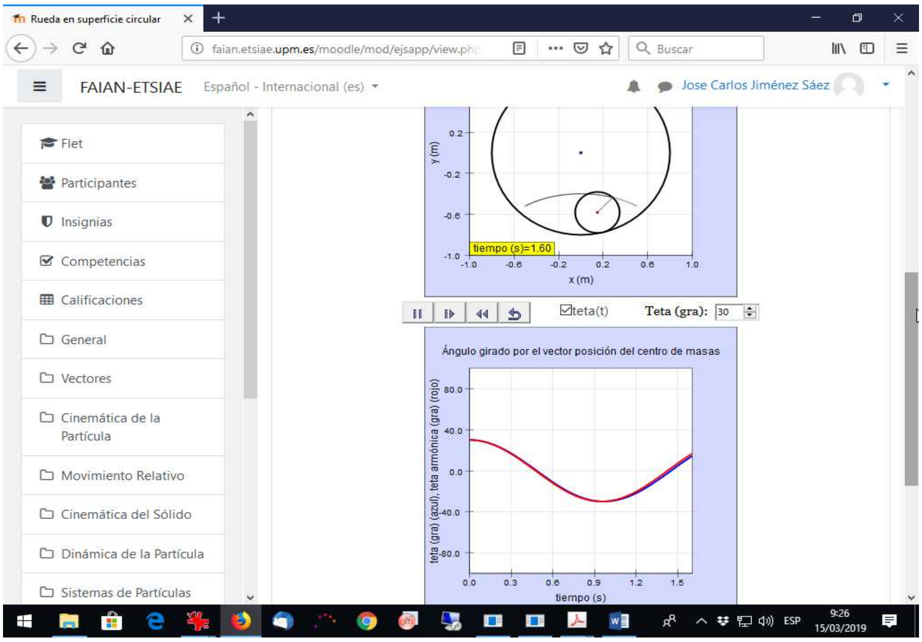
Rueda en superficie circular
faian.etsiae.upm.es/moodle/mod/ejsapp/view.php
Buscar
FAIAN-ETSIAE
Español - Internacional (es)
Jose Carlos Jiménez Sáez
Flet
Participantes
Insignias
Competencias
Calificaciones
General
Vectores
Cinemática de la Partícula
Movimiento Relativo
Cinemática del Sólido
Dinámica de la Partícula
Sistemas de Partículas
y (m)
x (m)
tiempo (s)=1.60
teta(t)
Teta (gra): 30
Ángulo girado por el vector posición del centro de masas
teta (gra) (azul), teta armónica (gra) (rojo)
tiempo (s)
ESP
9:26
15/03/2019

ID: 03849, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Poster)

Innovative Education Networking for Optics and Photonics Active Learning

Pascuala García-Martínez[1] , Isaac Fernández[1] , Ignacio Moreno[2] , María del Mar Sánchez-López[3] , David Mas[4] , Julián Espinosa[4] , Carlos Ferreira-Gauchía[5] , Adolfo Esteban-Martín[1] , Eugenio Roldán[1] , Fernando Silva[1]

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Nowadays, students demand resources such as innovative tools for complementing the understanding of their studies. Optics and Photonics are subjects where simple observation phenomena can be used as demonstrations for active learning. Here we present the trajectory of a Spanish Innovative Education Network for teaching Optics. Our network involves academic staff from four different Spanish universities linked together around Optics and Photonics. For the last five years we have been receiving fundings to carry out different teaching activities such as: 1) Developing theoretical-practical didactic materials and increasing their accessibility to portable environments; 2) Video-Tutorials of laboratory and exercises of different subjects around Optics and Photonics; 3) Experiences in the classroom, in which the students perform at the classroom simple experimental demonstrations using the Photonics Explorer teaching kit financed by the European Union and distributed in our country by Spanish Society of Optics (SEDOPTICA); 4) Celebrating International Day of Light (IDL), where we organize a photograph competition for undergraduate students based on illustrating physical phenomena of optics and photonics, that makes students being much more involved in learning by discovering optical phenomena into their domestic and everyday environments as well as develop their creativity. We acknowledge to Vicerectorat de Polítiques i Qualitat Educativa of Universitat de València, project UV-SFPIE_GER18-846540.

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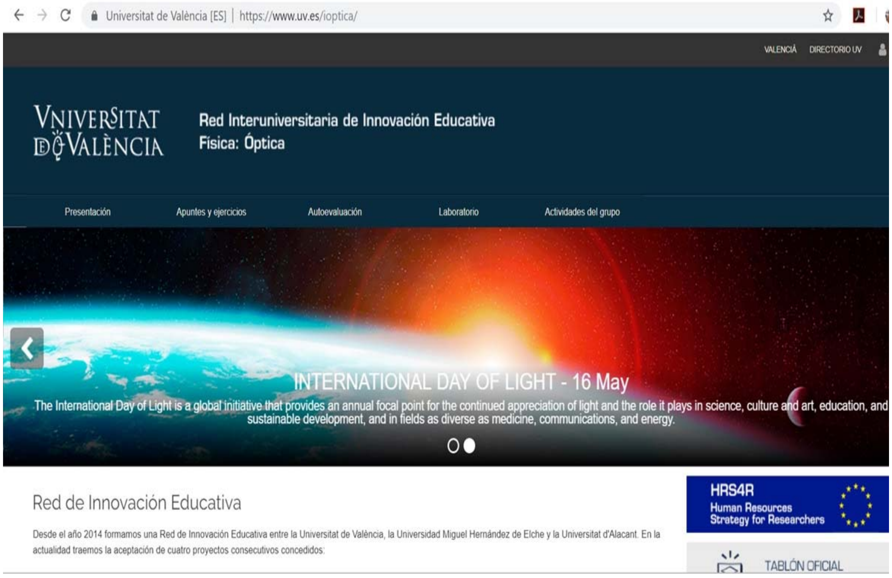
Universitat de València [ES] | https://www.uv.es/ioptica/
VALENCIÀ DIRECTORIO UV
VNIVERSITAT DE VALÈNCIA
Red Interuniversitaria de Innovación Educativa
Física: Óptica
Presentación
Apuntes y ejercicios
Autoevaluación
Laboratorio
Actividades del grupo
INTERNATIONAL DAY OF LIGHT - 16 May
The International Day of Light is a global initiative that provides an annual focal point for the continued appreciation of light and the role it plays in science, culture and art, education, and sustainable development, and in fields as diverse as medicine, communications, and energy.
Red de Innovación Educativa
Desde el año 2014 formamos una Red de Innovación Educativa entre la Universitat de València, la Universidad Miguel Hernández de Elche y la Universitat d'Alacant. En la actualidad traemos la aceptación de cuatro proyectos consecutivos concedidos.
HRS4R
Human Resources Strategy for Researchers
TABLÓN OFICIAL

ID: 03901, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Poster)

Integración de los Laboratorios docentes LABFIS en las Redes Sociales

ANTONIO DAVID GARCÍA GIL[1] , ELENA NAVARRETE ASTORGA[1] , DANIEL SOLÍS CORTES[1] , JUAN JOSÉ ALONSO PEREDA[1]

1) UNIVERSIDAD DE MÁLAGA

** ANTONIO DAVID GARCIA GIL, adgargil@uma.es*

Introducción

En el Departamento de Física Aplicada I de la UMA hemos integrado nuestro laboratorio docente LABFIS para alumnos de primer año en las redes sociales. Nuestra intención ha sido establecer una comunicación más cercana con los estudiantes utilizando la red Twitter como plataforma que facilite las tareas de los alumnos en el laboratorio, así como difundir conocimientos relacionados con la Física.

Resultados más relevantes

Encontramos que el uso de redes sociales como Twitter facilita la tarea de los alumnos en sus visitas a nuestros laboratorios docentes, y les resulta más atractiva. Ello nos permite además añadir contenidos divulgativos relacionados con la Física. En particular publicamos fotos y videos que permiten a los alumnos un primer contacto con las prácticas a realizar. Estos contenidos se unen pequeñas guías audiovisuales y noticias de actualidad relacionadas con la Física. También se publican regularmente avisos relacionados con la marcha de las asignaturas, cambios horarios, fechas de entrega de trabajos, etc.

Conclusiones

Con la integración de LABFIS en las redes sociales hemos logrado establecer una comunicación directa, en línea con los alumnos, y establecido una herramienta metodológica que facilita la tarea de los alumnos en los laboratorios docentes de prácticas. A todos los materiales publicados en Twitter se puede acceder en abierto desde cualquier teléfono inteligente, Tableta u ordenador con conexión a internet

ID: 04101, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Poster)

Experiencias con mentores en Física propedéutica

Marianna Soler[1] , Jesús Planella[1] , M.L. Escoda[1] , J.J. Suñol[1]

1) University of Girona

** J.J. Suñol, joanjosep.sunyol@udg.edu*

Uno de los problemas detectados en los estudiantes de primer año de estudios universitarios en grados de ingeniería es la disparidad en la capacitación previa en materias como matemáticas o física. Una de las formas de apoyar a estos estudiantes es la generación de cursos propedéuticos. En este poster presentamos los resultados de una experiencia relacionada con la materia de Física (primer año académico) de estudios de ingeniería en la Universidad de Girona. En concreto en una formación complementaria de carácter básico para estudiantes con escasos conocimientos de Física (Fisica 0).

Uno de los aspectos importantes es que, como apoyo a las sesiones en el aula, hay uno o dos mentores. Los mentores son estudiantes expertos de cursos superiores que actúan en el aula cuando los estudiantes tienen alguna duda al tratar de resolver (generalmente en grupo) uno de los casos prácticos planteados por el profesor.

Los estudiantes que actúan como mentores han sido capacitados en sesiones anteriores con el apoyo del tutor. Su actividad es reconocida académicamente a través de una beca o de créditos ECTS.

En cuanto a los estudiantes que reciben la formación, la mayoría tiene un conocimiento muy básico de las matemáticas y la física. La experiencia previa es que muchos abandonaron sus estudios o necesitaron entre 2 y 3 años más para completar sus estudios más que el promedio.

El análisis de sus resultados académicos se está llevando a cabo durante estos últimos años y se verifica que la tasa de deserción ha disminuido significativamente y que el porcentaje de estudiantes que terminan aprobando la materia ese mismo año académico es aproximadamente un 20% más alto.

El programa de mentores también se ha utilizado para otros menesteres como la generación y adaptación de materiales de enseñanza (incluido el aprendizaje virtual), siempre bajo la supervisión de un equipo de profesores. El estudio confirma que es recomendable que los académicos y los estudiantes generen equipos para trabajar conjuntamente y proporcionar mecanismos efectivos de apoyo a los estudiantes.

ID: 04126, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Poster)

Eficacia de las preguntas en desarrollo de habilidades cognitivo lingüísticas, estrategias y tipo de aprendizaje en Física.

Iván Sánchez [1]

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** Ivan Sánchez Soto, isanchez@ubiobio.cl*

El presente analiza la eficacia del aprendizaje basado en preguntas en física, en las habilidades cognitivos lingüísticas, describir, explicar, justificar y argumentar, como también en las estrategias de procesamiento de la información y el tipo de aprendizaje adquirido por estudiantes de ingeniería, aquí se muestra la forma de implementar el aprendizaje basado en preguntas en clases de física como indicador de aprendizaje significativo. Donde se considera diferentes tipos de preguntas como son: fácticas, comprensión y creativas que a su vez se subdividen en cinco categorías: interpretación, aplicación, análisis, síntesis y evaluación, abarcando todos los niveles de conocimiento. El punto de partida es la presentación de una situación problema contextualizada, que sirve de hilo conductor de la unidad programática a desarrollar a través de una secuencia de preguntas, que van desde la exploración del conocimiento previo a la transferencia de contenidos en situaciones nuevas. Estas se organizan en una guía de preguntas para enseñar y aprender los contenidos en cuestión y su vez desarrollar las habilidades cognitivo lingüísticas, con la finalidad de cambiar la dinámica cerrada de transmisión acabada de conocimiento, por unas más activas y participativas. Los resultados de su aplicación sistemática en los último 5 años, muestran evidencia de su impacto en algunas de las categorías de las variables en estudio, y los estudiantes en general se muestran motivados y opinan favorablemente sobre esta propuesta de trabajo.

El presente trabajo tiene por finalidad. a) Lograr cambiar la dinámica cerrada de preguntar, aprendiendo a formular mejores preguntas: estimulantes, reflexivas o hipotéticas, que promuevan el desarrollo de las habilidades cognitivo lingüísticas en un curso de Física General I (mecánica), b) Establecer un modelo para el diseño y construcción de guías para la adquisición de aprendizaje significativo y su evaluación en situaciones nuevas. d) Establecer el impacto de la propuesta de enseñar y aprender a través de preguntas en las estrategias y tipo de aprendizaje.

El diseño y elaboración de guías con preguntas considera un contexto para cada unidad programática a partir del cual se formulan los diversos tipos de preguntas para abordar los contenidos del curso de Física. El uso de estas guías promueve el desarrollo de habilidades cognitivos lingüísticas y lleva al estudiante a planificar, organizar, jerarquizar y transferir su conocimiento a situaciones nuevas distintas a las trabajadas en el aula tradicionalmente, promoviendo un aprendizaje profundo y elaborativo [1].

Para [1] “el profesor que no utiliza habitualmente las preguntas difícilmente puede ser un profesor eficaz.” Por ello, entre las “funciones más específicamente didácticas del profesor se encuentra la formulación de preguntas y la estimulación de las capacidades interrogadoras de los alumnos”.
Las guías contextualizadas diseñadas y elaboradas para abordar los contenidos de Física se aplican a estudiantes de Ingeniería Civil, de la Universidad de Bío-Bío, a partir de 2014 de forma sistemática para verificar la adquisición del aprendizaje significativo y del 2017 para desarrollar habilidades cognitivo lingüísticas. Los resultados muestran que las preguntas son un buen método para desarrollar las estrategias de aprendizaje, aprendizaje profundo y elaborativo y algunas de las habilidades cognitivas lingüísticas.

Referencias

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ID: 04121, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S1. XXIX Iberian Meeting on Physics Education and Dissemination
(Poster)

¿De qué depende la temperatura en el interior de un edificio? Propuesta indagativa sobre arquitectura bioclimática

Iñigo Rodríguez-Arteche[1], Belén Fernández-Sánchez[2], Mª Mercedes Martínez-Aznar[2], Paloma Varela-Nieto[2]

1) Universidad Rey Juan Carlos 2) Universidad Complutense de Madrid

** Iñigo Rodríguez-Arteche, inigo.rodriguez@urjc.es*

Se presenta una experiencia formativa sobre arquitectura bioclimática en el Grado en Pedagogía, alineada con movimientos como CTSA (Ciencia, Tecnología, Sociedad y Ambiente) y con metodologías como la indagación. La idea es que los futuros profesionales conozcan de primera mano los beneficios y retos de estos enfoques, a través del problema "¿De qué depende la temperatura en el interior de un edificio?" y de los kits didácticos del proyecto PSE-ARFRISOL. Así, el trabajo plantea dos objetivos: 1) identificar los niveles de logro de los futuros pedagogos en la resolución del problema; 2) analizar su visión sobre la aplicabilidad de la indagación en los niveles escolares.

La propuesta se desarrolla en cuatro sesiones de 2 horas con un grupo-clase de 30 estudiantes. Primero se motiva la conveniencia de recurrir a la indagación y se distribuye al alumnado en 6 grupos, para comenzar a planificar la resolución y reflexionar sobre los conceptos implicados (temperatura, calor, resistividad térmica, consumo, etc.). Después, los formadores facilitan los kits didácticos, que incluyen sensores y edificios construibles con diferentes materiales, ventanas, tejados, etc. Así, los estudiantes concretan su análisis inicial según sus intereses y registran los datos oportunos con programas informáticos. Finalmente, disponen de varias semanas para elaborar informes grupales.

Los logros se infieren del análisis del contenido de estas producciones. Los resultados son positivos en las diferentes competencias analizadas, mejores en la emisión de hipótesis y en la recogida de datos, y algo más negativos en el análisis teórico inicial y en la identificación de las variables. Por otra parte, las reflexiones individuales extraídas de un cuestionario en línea dan cuenta de una visión positiva sobre la indagación. Se destaca su promoción de la creatividad y del trabajo cooperativo, y su utilidad para comprender situaciones de la vida cotidiana.

S2. Didáctica e Historia de la Física (GEDH)

Este simposio será un foro de intercambio de conocimientos y discusión en el que se pretenderá contribuir a la formación de la cultura científica, ayudar al profesorado a motivar a los alumnos hacia el aprendizaje de la Física y otras ciencias experimentales, así como apoyar su labor en los diferentes niveles educativos en los que fomentar las denominadas “competencias STEM (Science, Technology, Engineering and Mathematics)”. El principal objetivo de este simposio será facilitar la información, contrastar opiniones y compartir experiencias sobre diversos aspectos de la didáctica y la historia de la física desde una perspectiva lo más amplia posible. Por ello se incluirán los aspectos metodológicos de la docencia (aprendizaje activo, aprendizaje basado en problemas/proyectos, adquisición y evaluación de competencias, uso de las TIC, etc.), los epistemológicos (¿qué conceptos deberían enseñarse?), los contenidos de otro tipo y, por supuesto, las novedades en la investigación en la historia de las ciencias en general y de la física en particular. De forma relevante, dado que 2019 ha sido declarado por la ONU como Año Internacional de la Tabla de los Elementos Químicos, se hará énfasis en la potencialidad de dicha tabla, tan emblemática para la ciencia, en la enseñanza de las distintas etapas educativas y en la historia de la física y la química. En concreto, se pondrán en valor las importantes contibuciones para la explicación de la tabla periódica del físico inglés Moseley y del científico zaragozano Miguel A. Catalán Sañudo.

Organizadores:
Gabriel Pinto Cañón, *Universidad Politécnica de Madrid*
Luis Moreno Martínez, *Universitat de València*

Patrocinado por:

Grupo Especializado de Didáctica e Historia de la Física y la Química
Real Sociedad Española de Física R.S.E.F.
RSEQ Real Sociedad Española de Química

Ver programa del simposio

S2. Didactics and History of Physics (GEDH)

This symposium will be a forum for exchange of knowledge and discussion intended to contribute to the formation of a scientific culture, help teachers in motivating students to learn Physics and other experimental sciences, and support their work at the different educational levels to promote the so-called "STEM competencies (Science, Technology, Engineering and Mathematics)". The main objective of this symposium will be to provide information, contrast opinions and share experiences on various aspects of didactics and of the History of Physics, from a wide perspective. This will include the methodological aspects of teaching (active learning, problem-based learning / projects, acquisition and assessment of skills, use of ICT, etc), epistemological aspects (what concepts should be taught?), and, of course, the most recent advances in the research of the History of Science in general and of Physics in particular. Given that 2019 has been declared by the UN as the International Year of the Table of Chemical Elements, emphasis will be placed on the potential of such a table, which is so emblematic for Science, in the teaching at different stages of education and in the History of Physics and Chemistry. In particular, the important contribution to the understanding of the periodic table made by the English physicist Moseley and by the Zaragoza scientist Miguel A. Catalán-Sañudo will be put in value.

Organizers:
Gabriel Pinto Cañón, *Universidad Politécnica de Madrid*
Luis Moreno Martínez, *Universitat de València*

Sponsored by:

ID: 03683, 18/07/2019 15:00 - 18/07/2019 15:15, Room 1.8 (first floor)
S2. Didactics and History of Physics
(Oral)

TRES EXPERIMENTOS DE FÍSICA LOW COST. Experimentos con canicas
Analogía con canicas del experimento de Millikan
Un juego análogo al equilibrio en cinética química
Todos los caminos conducen a Roma

José Antonio Martínez Pons[1]

1) Grupo de Didáctica e Historia (RSEF+Q)

** José Antonio Martinez Pons, jamartinez46@gmail.com*

TRES EXPERIMENTOS DE FÍSICA LOW COST.

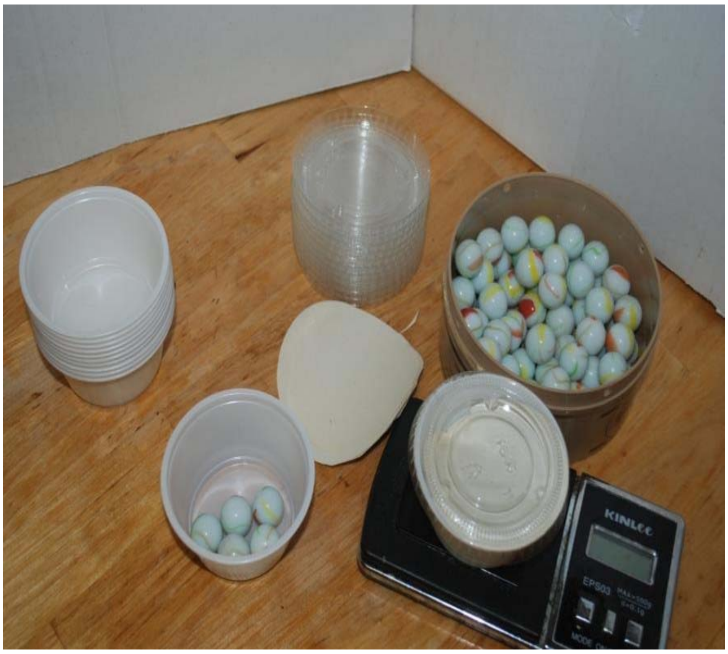
Parece que hacer física experimental requiere grandes y caros laboratorios, y equipamiento complejo. Es cierto si hablamos de física profesional, pero con un poco de ingenio es posible hacer física didáctica con elementos sencillos que permitan una mejor comprensión por parte del alumnado de la física mediante la observación crítica y curiosa del mundo.

Se proponen tres sencillos trabajos con un lote de canicas como elemento común.

a) Analogía con el experimento clásico de Millikan. En este experimento las canicas representarán cargas elementales y unos vasitos opacos siendo su masa aproximadamente cuantizada análoga a la carga elemental, exactamente cuantizada. La carga de las gotas de aceite será análoga a la masa de las canicas contenidas. Por pesada se determinará cuántas canicas contiene cada vaso y la masa de una canica.

b) Lev Landau considera la cinética química parte de la física, de ahí la inclusión de este experimento En las reacciones reversibles el equilibrio químico se alcanza cuando las velocidades de reacción en sentido progresivo y regresivo se igualan. Por analogía a la reacción jugaran dos personas, cada canica representará una unidad de producto o reactivo y a cada jugador se le asigna una fracción que representa su contante de velocidad. Entregado un lote de canicas a cada uno, van intercambiando la fracción de las que posee cada uno hasta llegar a que se intercambian siempre las mismas Se ha llegado al equilibrio.

c) En este experimento se medirá la constante elástica de un resorte o una goma elástica utilizando la ley de Hooke y midiendo el periodo del resorte oscilando con diferentes números de canicas suspendidas. Se comparan los resultados estimando el intervalo de incertidumbre en cada método.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ID: 04003, 18/07/2019 15:30 - 18/07/2019 15:45, Room 1.8 (first floor)
S2. Didactics and History of Physics
(Oral)

Año Internacional de la Tabla Periódica (2019): Una oportunidad para abordar contextos de didáctica e historia de la física y la química

Gabriel Pinto Cañón[1] , Manuela Martín Sánchez[2] , M. Araceli Calvo Pascual[3] , Almudena de la Fuente[4]

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** Gabriel Pinto, gabriel.pinto@upm.es*

La Asamblea General de la ONU proclamó 2019 como *Año Internacional de la Tabla Periódica de los Elementos Químicos* (IYPT 2019, por sus siglas en inglés), con ocasión del 150 aniversario de la propuesta al respecto de Dimitri Mendeléiev, que coincide, además, con el centenario de la creación de la IUPAC (*International Union of Pure and Applied Chemistry*) y otras conmemoraciones relacionadas. La celebración se incluye entre las iniciativas emprendidas para potenciar las relaciones entre ciencia, tecnología y desarrollo.

Aparte de otras acciones, como la divulgación entre el público en general de este icono universal, dicha efeméride puede ser (y, de hecho, está siendo) de utilidad para el profesorado de física y química de las distintas etapas educativas, para profundizar y abordar contextos de ambas ciencias. Para ello, es importante conocer cómo se tratan el tema de la tabla periódica (TP) y aspectos relacionados en el currículo actual español, así como algunos de los recursos que facilitan su aprendizaje.

La TP no solo es un instrumento fundamental para el estudio de la química, sino que su evolución es un paradigma de la historia de la ciencia como resultado de una obra colectiva. Los descubrimientos de la física, desde finales del siglo XIX al desarrollo de la mecánica cuántica, la han ido afinando y han subsanado "anomalías" de los primeros ordenamientos de los elementos químicos.

En este trabajo, que se recoge ampliado en el primer número de este año de la *Revista Española de Física*, sugerimos algunas ideas para conocimiento general sobre la TP y, de forma especial, para docentes de todas las etapas educativas. Para ello, se exponen: el tratamiento de la TP así como el concepto y descripción de los elementos químicos según el currículo educativo español actual; una breve introducción al desarrollo histórico de la TP; y recursos seleccionados para promover su aprendizaje, incluyendo el tratamiento de algunas contribuciones de científicos españoles sobre el tema.


PERIÓDICO

ID: 04131, 18/07/2019 15:45 - 18/07/2019 16:00, Room 1.8 (first floor)
S2. Didactics and History of Physics
(Oral)

Introducción a la Computación Cuántica en el Grado de Física: Un caso práctico.

Joaquín Fernandez Rossier[1] , Carlos Untiedt[1]

1) Universidad de Alicante

** Carlos Untiedt, untiedt@ua.es*

La irrupción de las tecnologías cuánticas a primera linea de la investigación actual ha hecho que nos replanteemos el programa de Mecánica Cuántica del grado de Física en la Universidad de Alicante.

Para ello hemos introducido en el temario el estudio de fundamentos de información cuántica, tales como: qubits, operaciones cuánticas de uno y dos qubits, estados cuánticos en sistemas compuestos; temas normalmente omitidos en el curriculo convencional de introducción a la Mecanica Cuántica. Con este tranfondo teórico, hemos propuesto una práctica de 3 horas en la que los alumnos han utilizado los ordenadores cuánticos de la plataforma de "The quantum experience" de IBM. En esta práctica los alumnos implementaron el algoritmo de Deutsch.

Valoramos muy positivamente nuestra experiencia que ha tenido una gran aceptación en el alumnado.

ID: 03278, 18/07/2019 16:00 - 18/07/2019 16:15, Room 1.8 (first floor)
S2. Didactics and History of Physics
(Oral)

Física en las aulas (1915-1939): Observar, construir y medir para adquirir el hábito científico

Luis Moreno Martínez[1]

1) Instituto Interuniversitario López Piñero, Universitat de València

** Luis Moreno Martínez, luis.moreno-martinez@uv.es*

El primer tercio del siglo XX constituyó un periodo de profundos cambios en la enseñanza en España, también en el ámbito de las ciencias. El discurso didáctico renovador que circuló por Europa y Norteamérica desde finales del siglo XIX arraigó en diversas instituciones españolas, lo que permitió a diversos docentes tener contacto con las ideas y prácticas promovidas por la Escuela Nueva. Un colectivo de gran interés para conocer la forma en que dicho discurso didáctico fue adoptado y transformado en las aulas del primer tercio del siglo XX lo constituyó el profesorado de Escuela Normal: los maestros de los futuros maestros.

Tal es el caso del profesor Modesto Bargalló (1894-1981) quien, antes de su exilio en México en 1939 con motivo de la guerra civil, publicó en España numerosos folletos para maestros, manuales escolares y publicaciones pedagógicas. Es por ello que el análisis de su obra se revela como una ventana privilegiada a la enseñanza de las ciencias y su renovación en las primeras décadas del pasado siglo. Desde el marco de las investigaciones históricas más recientes y partiendo del análisis de su producción impresa en España, la presente comunicación aborda los cambios en la enseñanza de las ciencias físicas en el periodo 1915-1939. Se pretende así contribuir a la reflexión sobre cuestiones de interés actual en la enseñanza de la física desde una perspectiva histórica, tales como el aprendizaje de la física a partir de prácticas experimentales en niveles preuniversitarios o el diseño de estrategias docentes para la enseñanza de los conceptos físicos fundamentales partiendo del entorno del estudiante.

ID: 03991, 18/07/2019 16:15 - 18/07/2019 16:30, Room 1.8 (first floor)
S2. Didactics and History of Physics
(Oral)

Mercator and his 1569 spherical chart. How did he designed?

Alfredo Surroca Carrascosa[1]

1) Real Sociedad Geográfica

** Alfredo Surroca Carrascosa, alfredo_surroca@yahoo.es*

Mercator, a distinguished cosmographer from the Renaissance period, pioneered a great cartographic transformation of outstanding importance and productivity that revolutionised the represetation of maps in general, and nautical charts in particular. Within his broad collection of works, his most important contribution is in the form of a unique and conclusive map published in 1569 in which the latitudes are represented as parallel lines but instead of being equidistant, as was the case up to then, these were distances growing in relation to latitude.

However, Mercator either did not know how or did not want to explain in a convincing manner te steps he took to capture this singular modification on the map.

In this study, we suggest the route taken by the Flemish cartographer to produce his spherical map and we investigate the reasons why he silenced it.

ID: 03705, 18/07/2019 17:15 - 18/07/2019 17:30, Room 1.8 (first floor)
S2. Didactics and History of Physics
(Oral)

Miguel A. Catalán Sañudo: La dramática historia de un científico español nacido en Zaragoza, hace ciento veinticinco años.

Gabriel Barceló[1]

1) Dinamica Fundación

** Gabriel Barceló, gabarce@iies.es*

En el 125 aniversario de Miguel Catalán Sañudo, nacido en Zaragoza el 9 de octubre de 1894, deseamos recordar su obra científica, y su perfil personal, especialmente como investigador y pedagogo.

Recordaremos sus descubrimientos en fisica atómica, su propuesta de una Tabla Periódica de los elementos, como resultado de sus investigaciones, y su modelo estructural para el átomo, a partir de sus estudios espectrográficos.

ID: , 18/07/2019 17:15 - 18/07/2019 17:30, Room 1.8 (first floor)
S2. Didactics and History of Physics
(Oral-Round Table)

El papel de la mujer en la física y la Edad de Plata de la física en España a través de la figura de Miguel A. Catalán Sañudo.

Gabriel Barceló[1]

1) Dinamica Fundación

** Gabriel Barceló, gabarce@iies.es*

En el 125 aniversario de Miguel Catalán Sañudo, nacido en Zaragoza el 9 de octubre de 1894, deseamos recordar su obra científica, y su perfil personal, especialmente como investigador y pedagogo.

Recordaremos sus descubrimientos en fisica atómica, su propuesta de una Tabla Periódica de los elementos, como resultado de sus investigaciones, y su modelo estructural para el átomo, a partir de sus estudios espectrográficos.

ID: 04058, 18/07/2019 17:00 - 18/07/2019 17:07, Room 1.8 (first floor)
S2. Didactics and History of Physics
(Poster- Flash Talk)

Una introducción práctica a los sistemas ópticos reales: Diseño y construcción de telescopios y microscopios en laboratorios de grado y máster

Antonio Marzoa[1] , Santiago Vallmitjana[1]

1) Departament de Física Aplicada, Universitat de Barcelona

** Antonio Marzoa Domínguez, tonymarzoa4@gmail.com*

La Óptica es una de las materias troncales de los estudios de Física que tiene más transversalidad y relación con las aplicaciones técnicas diarias. Dentro del temario correspondiente a la Óptica Geométrica los alumnos estudian los principios operativos básicos de instrumentos ópticos tales como el telescopio. No obstante, esta introducción no deja de ser un acercamiento teórico, puesto que los estudiantes no experimentan las limitaciones reales de estos instrumentos. Desde hace tiempo, en la mayoría de facultades de Física se vienen introduciendo experiencias prácticas basadas en el diseño y montaje de telescopios sencillos. En el caso del Grado en Física de la Universitat de Barcelona, los estudiantes realizan una sesión práctica basada en el diseño y construcción de dos telescopios astronómicos y de un microscopio compuesto. No obstante, no acaban de profundizar en los problemas técnicos reales que limitan la calidad de imagen y resolución: la difracción y las aberraciones.

Por ello, se introdujo una sesión práctica complementaria en la que los estudiantes deben diseñar, mediante el software JavaOptics®, un telescopio, que luego construyen sobre un banco óptico, primero con objetivo simple y luego con doblete acromático. De esta manera pueden apreciar las variaciones en la calidad de imagen y cuantitativamente estimar las diferencias entre la resolución teórica y experimental. Del mismo modo, los estudiantes construyen un microscopio compuesto con dos lentes simples y luego comparan su trabajo con un modelo antiguo. Finalmente utilizan un microscopio invertido moderno para observar las mismas muestras, comparando distintos objetivos. En esta comunicación se presenta una descripción de ambas sesiones prácticas, mostrando como realizarlas e impartirlas en los laboratorios de docencia.

ID: 04059, 18/07/2019 17:07 - 18/07/2019 17:14, Room 1.8 (first floor)
S2. Didactics and History of Physics
(Poster- Flash Talk)

El patrimonio de instrumentos científicos de la facultad de Física de la Universitat de Barcelona

Santiago Vallmitjana[1] , Antonio Marzoa[1] , Pol Molina[1]

1) Departament de Física Aplicada, Universitat de Barcelona

** Antonio Marzoa Domínguez, tonymarzoa4@gmail.com*

Los instrumentos científicos constituyen la herramienta fundamental de las ciencias experimentales y, por ello, establecen una fuente muy importante para el estudio del conocimiento humano. A lo largo del siglo XIX, en España, a la par que, en el resto de Europa, se populariza el uso de aparatos e instrumentos científicos en las aulas de las facultades e institutos, gracias al empuje producido por el auge de la Física experimental. Promoviendo así unas clases más interactivas en las que se mostraba el fenómeno dentro del aula o en los llamados gabinetes de Física. En España, parte de esta difusión se debe a la reforma educativa impulsado por la aparición del Plan Pidal (1845) y la Ley Moyano (1857), que presentan una modernización de todos los programas de estudio superior y, concretamente, listan los instrumentos científicos idóneos para la enseñanza.

Concretamente, la Facultad de Física de la Universitat de Barcelona cuenta con una importante colección de instrumental acumulado durante más de ciento cincuenta años de vida académica y de investigación. Desde hace algunos años se ha ido trabajando en la labor de recuperación de todo este material, llevando a tener más de cuatrocientos elementos clasificados en la actualidad. La propia colección ha sido objeto de diversos estudios, tanto correlacionando libros de texto y otro material gráfico con los instrumentos, como analizando y testeando los propios instrumentos en el laboratorio.

En esta comunicación presentamos la situación actual del proyecto, así como su evolución hasta la fecha y la proyección de futuro. Esta comunicación también pretende poner de manifiesto la importancia y relevancia del patrimonio cultural científico, así como de su preservación y conservación.

S3. Materiales Superconductores (DFMC-GEFES)

La superconductividad es una propiedad de algunos materiales que por debajo de una temperatura crítica no presentan resistencia a la corriente eléctrica. Es un área de investigación muy activa que continúa planteando nuevos retos, los más recientes la superconductividad en hidruros a presiones extremas y temperaturas récord y en bicapas de grafeno rotadas. A nivel fundamental se dedica mucho esfuerzo a entender los mecanismos responsables de la superconductividad en los superconductores de alta temperatura y otros no convencionales, comprender las propiedades en la nanoescala o descubrir nuevos superconductores. La superconductividad puede utilizarse en un gran número de aplicaciones (medicina, altas energías, fusión, energía, sensores, computadores cuánticos), muchas aún en desarrollo. Hasta la fecha, las aplicaciones de superconductividad que se hallan en el mercado han utilizado los materiales de baja temperatura. Sin embargo, en los últimos años la tecnología ha alcanzado un alto grado de madurez con avances en el desarrollo de cintas e hilos superconductores de alta temperatura que ya han permitido desarrollar muchos prototipos a escala real en el sector de la energía.

El simposio abordará los avances y retos de la investigación en materiales superconductores en sus diferentes aspectos: síntesis, caracterización y propiedades, teoría y fundamentos microscópicos, hetero-estructuras híbridas, optimización de materiales y desarrollo de aplicaciones. Además de conocer las últimas novedades en el campo, el simposio pretende favorecer la cohesión entre los grupos españoles que investigan en superconductividad.

El simposio contará con una charla invitada, presentaciones orales seleccionadas a partir de los resúmenes recibidos y sesión de posters. Por la mañana Laura Greene, científica jefe del National MagLab en Tallahassee impartirá una charla plenaria sobre materiales superconductores.
La jornada también incluirá actividades de divulgación sobre superconductividad.

Organizadores:
Leni Bascones, *ICMM-CSIC*
Teresa Puig, *ICMAB-CSIC*

Patrocinado por:

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Real Sociedad Española de Física
R.S.E.F.

S3. Superconducting Materials (DFMC-GEFES)

Superconductivity is a property of some materials that do not show electrical resistance below a critical temperature. It is a very active research area that continues to pose new challenges, the most recent being superconductivity in hydrides at extreme pressures and with record temperatures and superconductivity in rotated graphene bilayers. At the fundamental level, much effort is devoted to understanding the mechanisms responsible for superconductivity in high temperature and other nonconventional superconductors, understanding superconductivity at the nanoscale or discovering new superconductors. Superconductivity can be used in a large number of applications (medicine, high energy Physics, fusion, energy generation and storage, sensors, quantum computers,...), many still in development. To date, superconductivity applications that have reached the market use low Tc materials. However, in recent years the technology has reached a high degree of maturity, with advances in the development of superconducting high temperature ribbons and wires that have already allowed the development of many prototypes for the energy sector on a real scale. The symposium will address the latest advances and challenges of the research on superconducting materials in its different aspects: synthesis, characterization and properties, theory and microscopic foundations, hybrid hetero-structures, material optimization and application development. In addition to presenting the latest developments of this field, the symposium aims to promote collaborations among the Spanish groups that investigate on superconductivity.

The symposium will include an invited talk, oral presentations selected from the abstracts received and poster sessions. In the morning, Laura Greene, chief scientist of the National MagLab in Tallahassee, will give a plenary talk on superconducting materials. The day will also include outreach activities on superconductivity.

Organizers:
Leni Bascones, *ICMM-CSIC*
Teresa Puig, *ICMAB-CSIC*

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ID: 03753, 15/07/2019 15:00 - 15/07/2019 15:30, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Invited Symposio)

Near Room Temperature Superconductivity in Hydrides

Ion Errea[1]

1) University of the Basque Country (UPV/EHU)

** Ion Errea, ion.errea@ehu.eus*

The field of high-pressure superconducting hydrides has exploded in the last years due to the discovery of record critical temperatures: 203 K at 155 GPa in H3S [1] and 260 K at 190 GPa in, probably, LaH10 [2]. These values beat the cuprates and open very realistic prospects of finding room temperature superconducting hydrides in the near future, at least at high pressure.

In this lecture, I will underline that the progress in this filed has been possible thanks to first-principles calculations, which in this case can perform accurate predictions since the coupling mechanism is the well-known electron-phonon interaction. Ab initio crystal structure prediction methods have predicted many new compounds that can be formed at high pressure, for which superconducting critical temperatures have been calculated. These calculations have placed experimentalists on the right track.

The calculation of thermodynamic and superconducting properties of these compounds however requires often going beyond the state of the art, as the large quantum fluctuations associated to hydrogen atoms often cause the collapse of the standard harmonic approximation applied to calculate the phonon frequencies [3]. This quantum effects may have a huge impact on the calculated superconducting critical temperatures and the thermodynamic properties of these compounds, and has required the development of new ab initio methods [4].

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ID: 03882, 15/07/2019 15:30 - 15/07/2019 15:45, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Tunable interfacial superconductivity in multiferroic tunnel junctions

Fernando Gallego[1], Mariona Cabero[2], David Sánchez-Manzano[2], Javier Tornos[2], Fabián Andrés Cuéllar[2], Alberto Rivera-Calzada[2], Zouhair Sefrioui[2], Federico Mompeán[1], Mar García-Hernández[1], Carlos León[2], Jacobo Santamaría[2]

1) Instituto de Ciencia de Materiales de Madrid, Consejo Superior de Investigaciones Científicas, Cantoblanco, 28049 Madrid, Spain 2) GFMC, Departamento de Física de Materiales, Universidad Complutense, 28040, Madrid

** Fernando Gallego, fernando.gallego.toledo@gmail.com*

Emergent electronic states at Interfaces between correlated 3-d transition metal oxides (TMOs) are focusing a lot of interest because of the possibility they offer of new physical phenomena resulting from their complex proximity interactions. The wide variety of electronic groundstates can be brought to directly interact at atomically sharp interfaces in epitaxial heterostructures. This opens the way to novel responses and functionalities resulting from the interplay between different electronic states.

In this work, we have studied multiferroic tunnel junctions (MFTJ) made of ferromagnetic $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) bottom electrode, a ferroelectric (FE) $BaTiO_3$ barrier and $La_{0.84}Sr_{0.16}CuO_{3-\delta}$ (LSCO) top electrode. LSCO is related to the lanthanum copper oxide family [1] which can hold a large number of oxygen vacancies (OV) and nucleate a variety of magnetic states [2]. This family has been considered a potential source of superconducting materials, although the superconductivity has not been observed [3]. FE polarization switching in MFTJ may be accompanied by the switching of OV, which can have large effects on the interface density of states [4]. We have found that the removal of OV from the cuprate interface has a strong hole doping effect of the material beyond the limits allowed by chemical doping. We have observed the emergence of a new gap in the tunneling differential conductance curves which scales with temperature as a superconducting gap, strongly suggesting the nucleation of a superconducting phase at the interface. Switching the ferroelectric polarization of the barrier with an external electric field enables turning the superconducting gap on and off suggesting the possibility of the field effect control of the interface superconductivity.

References

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ID: 03826, 15/07/2019 15:45 - 15/07/2019 16:00, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Transport properties of superconductors with spin-dependent fields

F. Sebastian Bergeret[1]

1) Centro de Física de Materiales (cSIC-UPV), Donostia-San Sebastian, Spain

** Sebastian Bergeret, fs.bergeret@csic.es*

The past decades have witnessed an extraordinary progress in understanding the interplay between superconductivity and spin-dependent fields in hybrid devices. Starting in 2001 with the first realisation of ferromagnetic Josephson pi-junctions and the almost simultaneous prediction of triplet correlations in ferromagnetic films, superconductivity and ferromagnetism are no longer considered as competing phenomena but rather as sources of emergent states and new effects when combined. Moreover, the density of the triplet condensate behaves in several aspects as the electronic spin-density, and interesting analogies with spintronic concepts, as spin-currents and spin-charge conversion, can be drawn.

In this talk, I will present different aspects of the spin-dependent transport in superconducting hybrid structures, analysing its similarities and differences with respect to electronic transport in the normal state. Special emphasis will be on superconductor/ferromagnetic –insulator (S/FI) systems, where the interplay between superconductivity and magnetism leads to striking transport phenomena.

Different applications of S/FI structures, including highly sensitive detectors, thermometers, and cryogenic memory elements, are discussed in this talk.

ID: 03808, 15/07/2019 18:00 - 15/07/2019 18:15, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Development of Transition Edge Sensors (TES) for soft X-ray detection

Carlos Pobes[1], Lourdes Fàbrega[2], Agustín Camón[1], Pavel Strichovanec[1], Nieves Casañ-Pastor[2], Javier Moral-Vico[2], Rosa María Jáudenes[1]

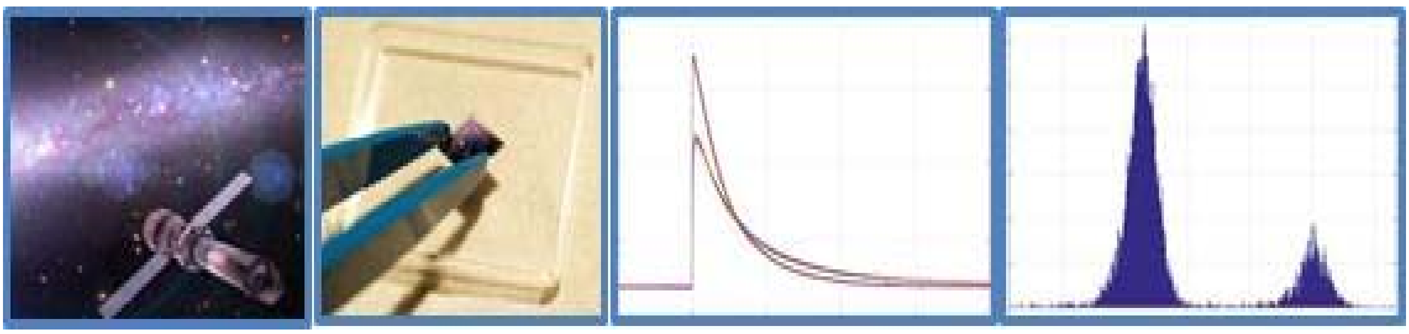
1) Instituto de ciencia de Materiales de Aragón 2) Institut de Ciència de Materials de Barcelona

** Carlos Pobes, cpobes@unizar.es*

Transition Edge Sensors (TESs) are very sensitive thermometers which operate at mK temperatures and, coupled to a suitable absorber, are used in a wide range of experiments as radiation detectors or even particle detectors in applications from astrophysics to material science. With a suitable tuning of the coupling to a thermal bath, they can operate as microcalorimeters (single photon spectroscopy) or as bolometers (radiation integration).

Within the context of ATHENA, the next ESA's X-ray telescope to be launched by 2031 to address the hot and energetic Universe, our group is developing microcalorimeters with TESs based on Mo/Au proximity bilayers coupled to Gold/Bismuth absorbers tuned to soft X-rays in the 1-10keV band.

In a proximity bilayer, a normal metal is deposited on a superconductor reducing in this way the Tc of the superconductor. With a suitable combination of thicknesses, the Tc of the bilayer can be tuned to the desired value, which for X-ray detection is around 100mK. This is achieved in our Mo/Au TESs with 45nm of Mo and 265 of Au. We have optimized the fabrication process for single pixels on 4" wafers. The full characterization of the devices is performed with a dilution refrigerator operated at mK temperatures by measuring IV curves, complex impedance and noise under DC polarization. In addition, we have incorporated a Fe55 X-ray source in our set-up obtaining calibration X-ray spectra for the first time in Spain with this type of sensors obtaining unprecedented energy resolution. Finally, we are also investigating the transition mechanism in TESs with studies of the R(T,I,B) surface, which may allow to identify and control sources of the so called excess noise and improve their performance.



ID: 03931, 15/07/2019 18:15 - 15/07/2019 18:30, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Practical nanoSQUID sensors

María José Martínez-Pérez[1] , Diego Gella[3] , Tobias Schwarz[3] , Benedikt Müller[3] , Slav Morosh[4] , Oliver Kieller[4] , Javier Sesé[2] , Reinhold Kleiner[2] , Dieter Koelle[2]

1) Instituto de Ciencia de Materiales de Aragón (ICMA, CSIC-Universidad de Zaragoza) and Fundación ARAID, E-50004 Zaragoza, Spain
2) Instituto de Ciencia de Materiales de Aragón (ICMA, CSIC-Universidad de Zaragoza) and Laboratorio de Microscopías Avanzadas (LMA), Universidad de Zaragoza, Spain
3) Physikalisches Institut – Experimentalphysik II and Center for Collective Quantum Phenomena in LISA+, Universität Tübingen, Germany
4)Fachbereich 2.4 "Quantenelektronik", Physikalisch-Technische Bundesanstalt, Braunschweig (Germany)

** María José Martínez-Pérez, pemar@unizar.es*

We present the realization of ultra-sensitive YBCO and Nb nanoSQUIDs which can be operated in strong magnetic fields [1,2]. YBCO SQUIDs are based on submicron grain boundary junctions and have been patterned by focused ion beam milling, whereas Nb SQUIDs consist of SNS sandwich-type junctions based on Nb/HfTi/Nb technology patterned by e-beam lithography. A Nb-based three-axis vector magnetometer consisting of three mutually perpendicular SQUIDs loops is also presented (see Figure). The latter allows measuring the three orthogonal components of the magnetic vector. White flux noise down to ~50 $n\Phi_0/Hz^{1/2}$ has been achieved, yielding spin sensitivities of down to a few $\mu_B/Hz^{1/2}$. Moreover, we demonstrate that magnetic fields up to the tesla range can be applied. As an example, we present the successful deposition of different individual magnetic nanoparticles close to the YBCO nanoSQUID loop enabling the detection of their magnetization reversal [3]. Depending on the nanoparticle's shape, the latter is mediated by, e.g., nucleation/propagation of domain walls or nucleation/annihilation of magnetic vortices. Our measurements demonstrate the enormous convenience of using nanoSQUID sensors for the magnetic characterization of nanoscopic magnets.

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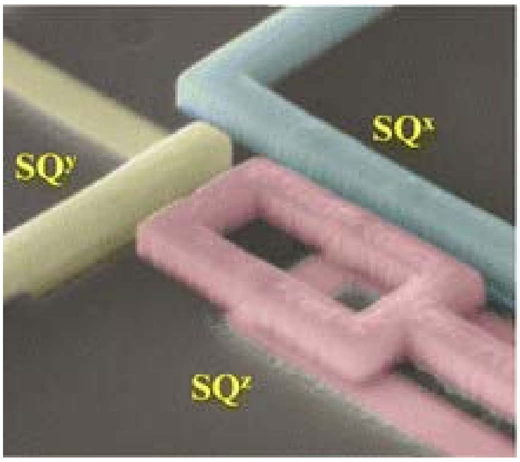
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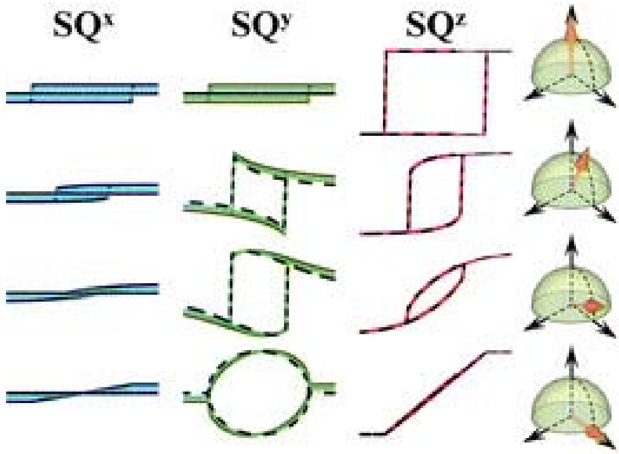
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ID: 04086, 15/07/2019 18:30 - 15/07/2019 18:45, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Development of Superconducting Lumped Element Resonators for molecular spin quantum processors

Marina Calero de Ory[1], Ignacio Gimeno[2], María Teresa Magaz[3], Enrique Burzirí[1], Daniel Granados[1], Fernando Luis [2], Alicia Gómez[3]

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Molecular nanomagnets strongly coupled to superconducting coplanar waveguide resonators have been proposed as an implementation for large-scale quantum computation. The crucial advantage of this proposal is the use of molecules as qubits, which brings the opportunity of a scalable architecture [1].

In this work, we propose to couple the molecular nanomagnets to Lump-Element superconducting Resonators (LERs). Each LER consists of a series inductance-capacitance circuit coupled in parallel to a single transmission line [2]. Contrary to coplanar wave resonators, LERs allow large freedom on the geometry design, which enables to control key parameters such as the quality factor and the induced magnetic field. These parameters are essential to tailor the interaction between qubits and photons, and therefore, determine the coupling and coherence between the spins and photons. In addition, LERs are intrinsically multiplexable on-chip, which allows the simultaneous readout of several qubits at different frequencies [3].

In order to optimize the coupling between Niobium LERs and single molecules magnets, different designs are studied. Simulations and low-temperature characterization are used to tailor the resonators properties such as resonance frequency, quality factor and induced magnetic field. In addition, the influence of temperature, incident microwave power and magnetic field on these parameters is presented.

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ID: 03960, 15/07/2019 17:45 - 15/07/2019 18:00, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Coated Conductor technology for the beam screen of high energy circular colliders

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The future circular hadron-hadron collider (FCC-hh) is a CERN study for a next generation large proton – proton collider aiming for a 100 TeV center-of-mass collision energy in a 100 km circumference ring. Superconducting magnets operating at 16 T cooled at 1.9 K will steer the beam which will emit 28 W/m/beam of synchrotron radiation. A beam screen held at around 50 K shall absorb the radiation and shield the magnets, thus allowing for a better overall cryogenic efficiency and power consumption. State-of-the-Art technology at CERN relies on a stainless-steel beam screen optimized for operation at 4.2 K coated with an 80-micrometer low-surface resistance Cu layer. The Cu layer is added in order to minimize beam coupling impedance. A high impedance would create large electric fields in the beam screen due to the image currents generated by the accelerated protons. In turn, the electric fields will have catastrophic impact on the proton beam stability. However, copper operating at 50 K may not provide low enough beam coupling impedance in the FCC-hh. The alternative of having the 100 km beam screen operating at 4.2 K is economically and energetically not viable.

Within this consortium, we have identified the possibility of using REBa2Cu3O7-x coated conductors, operating above 40 K as potential candidates to substitute Cu in the FCC beam screen chamber. This consortium is committed to develop knowledge of accelerators with thin films and material development and characterization under the extreme conditions found in high energy particle accelerators.

We present the consortium goals and the identified challenges for using coated conductors' technology in the extreme environment of the FCC. We will also present the very promising results already obtained on commercially available REBa2Cu3O7-x coated conductors from different manufacturers, showing the potential for these materials to substitute copper as the beam screen coating in circular colliders.

ID: 03913, 16/07/2019 18:00 - 16/07/2019 18:15, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Effect of UV picosecond pulse laser irradiation of Nb surfaces on their magnetic flux pinning

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Ultra-short laser pulse sources have become a robust alternative for high-speed manufacture of periodic nanostructures on metallic surfaces. The irradiation with linearly polarized ultra-short pulsed lasers may induce surface morphologies (ripples, grooves, spikes…) with periodic distances closer or smaller than the laser wavelength, featuring new functionalities.

The interaction of ordered and random artificial nanostructures, most commonly obtained by lithography techniques, and magnetic flux lines on superconducting thin films have been widely studied as an effective way to fine-tune their properties. Particularly, those on Nb, a pure element with highest critical temperature T_c and upper critical magnetic field B_{c2}(T), are relevant for superconducting radiofrequency cavities.

In this contribution, the effects of pulsed laser induced surface morphologies on the magnetic flux pinning of Nb have been explored. A 300 ps Rofin UV (355 nm) pulsed laser source with pulse frequencies 200-800 kHz and maximum average power of 3 W has been used. The availability of a laser beam scanning configuration, with a flat field focussing lens and galvanometric mirrors, gives nearly-circular laser beams with 34 mm diameter at the focus and scanning velocities up to 10 m/s. The additional scan line overlap control yields uniform nanostructured surfaces.

Different samples have been analysed, including 1 mm-thick Nb thin films deposited on sapphire substrates and commercial Nb foils of different thickness, ranging from several microns to 1 mm. They have been irradiated on one and two sides, in air and in Ar atmosphere. Scanning electron microspcopy (SEM), as well as magnetic measurements (magnetization and ac susceptibility) at different temperatures, in perpendicular applied fields up to B_{c2}(T), have been used for sample characterization. The effect of laser treatments on the surface microstructure, the magnetic flux pinning, T_c and $B_{c2}(T)$ are analysed.

ID: 03851, 15/07/2019 18:45 - 15/07/2019 19:00, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Ultrafast transient liquid assisted growth of high current density superconducting films

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To date, a broad commercial market of applications based on High Temperature Superconductivity (HTS) is kept from emerging due to the high manufacturing costs of superconducting tapes, also known as Coated Conductors (CCs). Performance-wise, commercial tapes reach remarkable current carrying capacity of 400 A at 77 K in 1 cm width, however, the fabrication throughput and cost-effectiveness is limited by small growth rates of the superconducting layer in the order of ~1-5 nm/s. To address this challenge, we are developing a novel growth approach, entitled Transient Liquid Assisted Growth (TLAG), that aims to overcome throughput and cost constraints of current state-of-the-art growth techniques for $YBa_2Cu_3O_7$ (YBCO) tape production. TLAG combines the technological feasibility and upgradability of Chemical Solution Deposition (a low-cost deposition technique) with ultrahigh growth rates of liquid-mediated approaches.

In this presentation, relevance and prospects of growing YBCO films with TLAG will be outlined. In particular, we present results from numerous measurement techniques that helped develop a comprehensive understanding on growth mechanisms, thin film properties and superconducting performance:

Fast *in-situ* X-Ray imaging (100 ms/frame) under synchrotron radiation allowed us to explore complex nucleation kinetics and demonstrate ultrahigh growth rates up to 100 nm/s. Low-temperature transport measurements in combination with transmission electron microscopy results present films of high crystalline quality that have enhanced vortex pinning capabilities due to their enriched nano scale defect landscape (compared to conventional approaches). Critical current densities up of 2-6 MA/cm^2 at 77K are already realized. TLAG is furthermore shown to be compatible with secondary phase addition to enhance vortex pinning performance at high magnetic fields. We conclude with main opportunities arising from the novel growth approach and where we go from here.

ID: 03732, 16/07/2019 15:30 - 16/07/2019 15:45, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Crystal Structure and Hole Doping Relations in Overdoped $Mo_{0.3}Cu_{0.7}Sr_2RECu_2O_y$ (RE= Pr, Nd, Gd, Tm and Yb) Supeconducting Materials.

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Among the factors controlling the critical temperature (Tc) in the high temperature superconducting cuprates (HTSC), the hole-doping level is one of the most crucial ones. In fact, a universal optimal hole doping level p_{opt} ~ 0.16 per copper plane has been conventionally accepted, corresponding to the maximum Tc at the superconducting dome [1]. While the complex charge-spin-lattice interplay in the underdoped regime (i.e. at p<popt) has attracted most of the efforts, the overdoped regime (p>popt) remains less explored and perceived as simpler, Fermi-liquid behaved. However, recent results are highlighting the potential of this region in the understanding of the condensation mechanism [2].

In searching for overdoped systems, the so-called M-1212 phases resulting from partial or total substitution of copper in the Charge Reservoir Layer by other transition metal are suitable candidates, as they allow the total oxygen content to be widely modified with respect to the YSCO parent compound. In particular, the Mo-1212 system has shown to be of special interest, with an unusually high Tc of 84 K, corresponding to a heavily overdoped $Mo_{0.3}Cu_{0.7}Sr_2YCu_2O_{7.54}$ composition [3].

To shed light on this uncommon superconducting compound, we have simultaneously varied both the oxidation degree and the RE size, looking at the effect of the crystal structure on Tc. We specially focus on the connection between the atomic arrangement within the unit cell and the hole distribution. To that end, we have performed a joint structural-electronic characterization by means of NPD, HRTEM and EELS spectroscopy of ozone [4] and high-pressure oxidized phases with general formula: $Mo_{0.3}Cu_{0.7}Sr_2RECu_2O_y$ (RE= Pr, Nd, Gd, Tm and Yb). The corresponding results will be presented and discussed.

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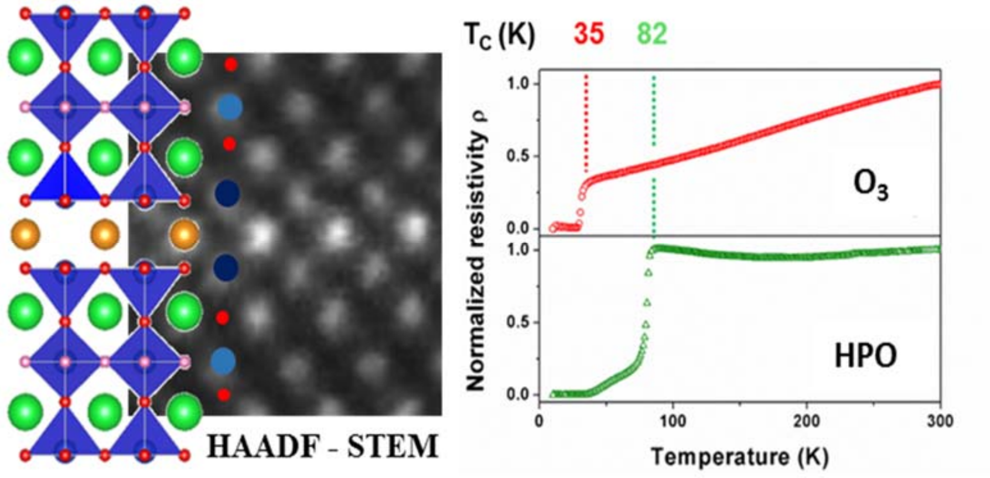
HAADF - STEM
T_C (K)
35
82
Normalized resistivity ρ
O_3
HPO
Temperature (K)
0.0
0.5
1.0
0
100
200
300

ID: 03811, 15/07/2019 17:05 - 15/07/2019 17:10, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster)

Spin-orbital interplay in the mechanism of superconductivity of iron superconductors

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What is the mechanism of superconductivity in unconventional superconductors is one of the most exciting question in physics nowadays. In many of these unconventional superconductors there is a phase diagram where a magnetic order is found either coexistent or nearby the superconducting phase. As a consequence, spin fluctuations have arising as a strong candidate for the pairing of Cooper pairs [1]

Iron superconductors are an example of this unconventional superconductivity. They are high Tc superconductors and multiorbital systems. They present a strong interplay between the spin and the orbital degrees of freedom. An example is the nematic phase which origin has been one of the most controversial topics in this field.

Our group has proposed a low-energy effective model for iron-based superconductors characterized by the presence of orbital-selective spin fluctuations (OSSF) [2,3]. The model has been used to explain puzzle experiments in the nematic and in the superconducting phase [2,3,4,5,6]. In this work we study the possibility of OSSF as mechanism of superconductivity in iron superconductors. We calculate the pairing vertex mediated by the OSSF for the FeSe and the 122 families in the tetragonal and nematic phases. We compute the spin-fluctuation susceptibility via the random-phase approximation (RPA) and compare the results with standard multiorbital RPA for iron superconductors and with neutron scattering experiments [7]. Finally, we compute the gap equation for the FeSe and the 122 families within this OSSF scenario.

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ID: 03987, 16/07/2019 16:00 - 16/07/2019 16:15, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Exploring correlations in twisted bilayer graphene

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Correlated states at different fillings have been observed upon doping a graphene bilayer with a small twist angle, creating a lot of excitement in the scientific community. The stacking misorientation produces a moiré pattern with a superlattice modulation corresponding to thousands of atoms per unit cell. When the rotation angle is close to the so-called magic angle, the low energy electronic bands of the moiré become almost flat. This flatness implies that electronic correlations become prominent. The insulating states, believed to be due to this electronic correlations, arise when the system is doped with an integer number of electrons or holes per moiré unit cell. The superconducting states are intercalated between the insulating ones and show nematic features. More recently, scanning tunneling microscopy (STM) experiments have uncovered a new correlated state in which the flat band splits. Many different theoretical proposals have been put forward to explain these correlated states and the origin of superconductivity.

Understanding the nature of these ordered phases requires the use of different techniques. To date most of the experimental data is coming from transport experiments and a few STM experiments. Optical conductivity is one of the techniques which can be used to analyze these systems. I will discuss the features in the optical conductivity spectrum which can help identify the nature of the correlated states.

ID: 04108, 16/07/2019 16:15 - 16/07/2019 16:30, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Angular dependence of magnetoresistance up to 22T in topological materials

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Recently, several compounds have been discovered to show an extremely large magnetoresistance that does not saturate at very high magnetic fields. This is at odds of what we know about the resistance under magnetic fields and is often found in semi-metals that have features in the band structure likely holding excitations that are topologically non-trivial, such as Dirac or Weyl fermions.

Here, we report extremely large, non-saturating magnetoresistance measurements up to 22T on hexagonal semimetallic $PtBi_2$. We carefully study the magnetoresistance as a function of the angle between the magnetic field and the crystalline axis. There is no saturation for all angles and we observe a change from a positively curved to a negatively curved magnetoresistance as a function of the angle. At the angle where the behavior changes, the magnetoresistance is exactly linear with magnetic field. We find Shubnikov-de Haas oscillations for all angles and use these to characterize the Fermi surface of this compound. Our data connect features of the topology of the electronic properties with the linear magnetoresistance and are a further step forward to understand this phenomenon.

Finally, we will also discuss on some recent angular-dependent magnetoresistance data on the topological insulator Ru_2Sn_3 and the topological superconductor Au_2Pb.

ID: 03852, 16/07/2019 16:00 - 16/07/2019 16:15, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Vortex dynamics on superconducting and non-superconducting periodic arrays

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Superconducting vortices are robust topological defects which allow studying a lot of distinct topics and scenarios. Vortex lattice on the move is a powerful tool to probe superconducting materials. Vortex lattice dynamics on non-superconducting (e.g. metallic, semiconducting, magnetic) periodic arrays of defects has led to very interesting physics and a flood of papers, the field seems to be almost exhausted. Conversely, the reversed situation, when the array of defects is made of superconducting materials, has called the attention of a few experimental researchers [1-3]. We have tackled this topic studying vortex dynamics of hybrids samples made of arrays of superconducting Nb triangles embedded in superconducting V films. In these hybrid samples, the superconducting critical temperature of the array is higher than the one of the plain film. We will show and explore the main findings of vortex dynamics on this peculiar system. In brief: i) strong anomalies in the well-known commensurability effects between the vortex lattice and the array unit cell, ii) decrease of the glass transition temperature and iii) unexpected behavior of the matching effects when changing the direction of the applied magnetic field.

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ID: 03728, 16/07/2019 16:15 - 16/07/2019 16:30, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Vortex transport in superconducting W-C nanostructures

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The quantized nature of superconducting vortices in Type II superconductors makes them appealing candidates for the transfer of information in the form of discrete packets. We report the fabrication and investigation of superconducting nanowires (NWs) in which nonlocal resistances, generated solely by vortex motion, are detected in areas depleted of current. By perpendicularly injecting a driving current at one end of NW, a Lorentz force is exerted on the present vortices, which push neighboring ones along the long axis of the NW. Vortices passing through the opposite end, free of current, generate measurable nonlocal voltages (Fig. A, D). [1]

The nanowires have been fabricated by means of Focused Ion Beam Induced Deposition, using a focused ion beam to decompose an organometallic gaseous precursor previously adsorbed onto the substrate surface. We have used $W(CO)_6$ as a precursor in combination with two different charged particles: Ga^+ ions, which are known to yield superconducting W-C [2] and are whose properties have been thoroughly studied by the group [3-5] (Fig. C); and He^+ ions, for which the group has shown that superconducting nanostructures are also obtained [6-7], and whose reduced beam size and scattering allow for patterning resolution down to a few nanometers. [8] Numerical simulations based on the Ginzburg-Landau theory support the experiment interpretation (Fig. B).

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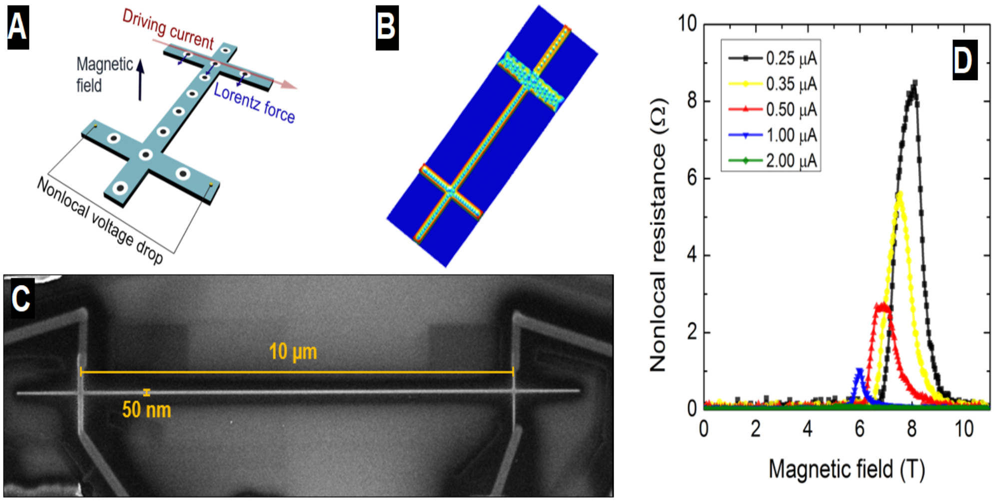

ID: 03773, 16/07/2019 17:30 - 16/07/2019 17:45, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

A combined microscopy and first-principles approach for understanding the defect landscape of $YBa_2Cu_3O_{7-x}$ at the single-atom level

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The presence of defects in materials can be taken for granted but it is experimentally challenging to resolve their structure at the atomic scale, which becomes crucial for understanding tueir role on the functional properties of the material. A paradigmatic case is the $YBa_2Cu_3O_{7-x}$ (YBCO) superconductor, in which two closely realted factors – structure and stoichiometry – control superconductivity. We have combined scanning transmission electron microscopy (STEM) and density functional theory (DFT) calculations to study the structural changes stemming from defects and their effect on the YBCO electronic and magnetic structure. The commonest defect in YBCO is the $Y_2Ba_4Cu_8O_{18}$ (Y124) intergrowth, which comprises two Cu-O_x chains between Ba-O planes. We will show that an unforeseen complex point-defect formed by Cu and O vacancies within the Y124 intergrowth leads to the formation of ferromagnetic clusters embedded within the superconductor. X-ray magnetic circular dichroism (XMCD) spectroscopy results provides evidence of the theoretically predicted Cu magnetic moments and the presence of a dilute network of magnetic defects below T_c [1]. In addition, we will show that the localized strain surrounding Y124 intergrowths strongly affects the venue of oxygen vacancies. As predicted by the theory, a strain-driven reordering of oxygen vacancies takes place towards the bridging apical sites (in the BaO plane). The demonstration of apical V_O in optimally doped YBCO and the derived structural changes in the superconducting planes have significant implications on some of the eminent theories that have been proposed to explain the unconventional superconductivity of cuprates [2–5].

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ID: 03771, 16/07/2019 17:45 - 16/07/2019 18:00, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Oral)

Direct-write method to fabricate 3D superconducting nanotubes

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Nowadays superconductors are commonly used in applications such as energy generators and storage due to their unique capability of transferring electricity without energy losses. Their miniaturization can optimize their functionality and the possibility of studying novel physical phenomena that can arise at the nanoscale [1]. Moreover, three-dimensional (3D) superconductors are expected to promote a change in the development of a new generation of electronic devices. Nevertheless, their fabrication is still challenging and a matter of debate.

In this contribution, we introduce a template-free nano-lithography method to fabricate in a single-step nano-elements on-demand with arbitrary shape and in the three dimensions, opening fascinating novel routes in the fields of material science and nanotechnology. This specific technique called focused ion beam induced deposition (FIBID) is based on a chemical vapour deposition process assisted by a charged particle beam focused to a few nanometers.

Particularly, by using a He^+ ion beam focused to 0.3 nm together with tungsten hexacarbonyl molecules, type-II 3D superconducting crystalline WC nanotubes with controllable inner and outer diameters have been fabricated [2, 3]. By studying their magnetotransport properties, we have found that nanotubes exhibit 1.5 times higher superconducting critical temperatures (6.4 K) as well as 1.5 times higher upper critical magnetic fields (≈14 T) when compared to nanowires grown by the analogous technique Ga^+ FIBID. Transmission electron microscopy studies revealed that nanotubes are composed of grains of large size fitting with face-centered cubic WC_{1-x} phase.

The fabrication of such nanomaterials with excellent properties makes this technique at the cutting edge of nanofabrication methods based on focused beams of charged particles.

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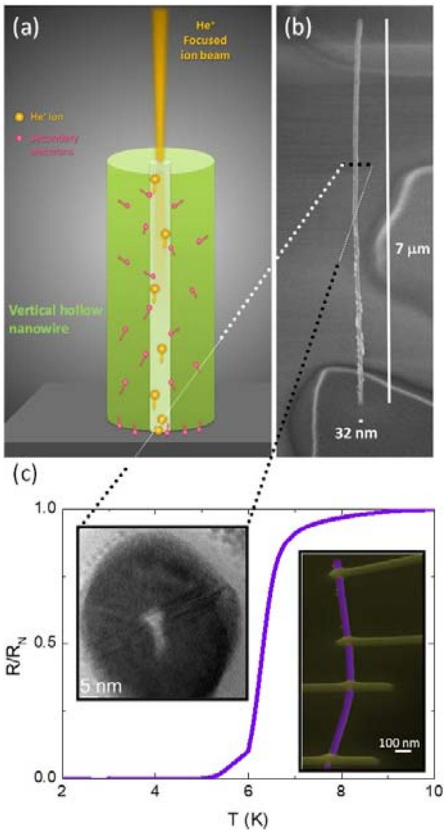

(a)
He+
Focused
ion beam
He+ ion
Secondary electrons
Vertical hollow
nanowire
(b)
7 μm
32 nm
(c)
1.0
0.5
0.0
R/R_N
5 nm
100 nm
2
4
6
8
10
T (K)

ID: 04070, 15/07/2019 16:00 - 15/07/2019 16:05, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster)

Superconducting vortices moving on a periodic pinning potential created by magnetic multilayer nanostructures:

Commensurability vs Little Parks effects

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Superconductivity and magnetism are two long range order cooperative effects which compete against each other. Recently, this antagonist behavior has been turned around, since, in some cases, magnetic nanostructures enhance superconducting properties, the so-called domain wall superconductivity (1) is a good example. In this work, we focus on hybrid superconducting/magnetic samples. The hybrid system studied here consists on a nanometric dot array made of Co/Pd multilayers embedded in a Nb superconducting thin film. The superconducting vortex dynamics is affected by the magnetic landscape provided by the perpendicular magnetization of the Co/Pd multilayers (2). Two mechanisms prevent the flow of superconducting vortices when a current is applied to the superconductor: i) core pinning which is due to local depression of the superconductivity by random defects and ii) magnetic pinning that is due to supercurrents which expel the magnetic stray fields. In our case, the multilayered nanomagnets are arranged in such a way they compose a periodic potential well landscape. Magnetoresistance measurements show oscillations in the resistance when the applied magnetic field is changed. Two possible origins can explain this effect, depending on the temperature and the length scales. On one hand, the hybrid sample can behave as a superconducting network and in this case, the stray field does not play any role and the origin of oscillations is the well-known Little-Parks effect (3). The second possible origin is commensurability effects between the vortex lattice and the nanomagnets array. In this case, magnetic pinning is the origin of the magnetoresistance behavior, since magnetic pinning is maximized at matching conditions. In this work we studied the competition and interplay between these two very different effects; that is Little-Parks and matching effects.

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ID: 03801, 15/07/2019 16:05 - 15/07/2019 16:10, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster)

Conditions for the existence of a topological protected phase in full shell proximitized nanowires.

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One of the most promising routes to achieve a topologically non-trivial superconducting phase in one dimension is based on inducing an effective spinless p-wave pairing in a semiconducting nanowire. The discovery that experimentally available ingredients could be combined to engineer such regime [1] was a major breakthrough, which lead to a huge experimental activity in the last decade [2]. The standard prescription consists on a semiconducting nanowire with spin-orbit coupling (SOC), proximitized by an s-wave superconductor, and under the influence of a Zeeman field applied longitudinally.

Although, great progress towards the detection of topological non-trivial states in these platforms has been achieved, one important problem still persists: the need of intense magnetic (Zeeman) fields is at odds with robust superconductivity.

To address this, a new platform predicted to host a topological non-trivial phase was recently proposed [3]. It is based on a semiconducting nanowire with a radial SOC, fully surrounded by a s-wave superconducting shell, and pierced in the longitudinal direction by a moderate (sub-Tesla) magnetic flux. In such system, a topological transition is triggered by the field-induced winding of the superconducting order parameter.

In light of the recent experimental zero bias signatures observed in full shell nanowires [4] we perform a realistic study of such systems using a combination of numerical and analytical methods. We find that the nature of the semiconducting and superconducting contact plays a crucial role in the conditions for the existence of this topological non-trivial phase. The results obtained are in good agreement with those found in the experiment and clarify some questions about the nature of the subgap features reported

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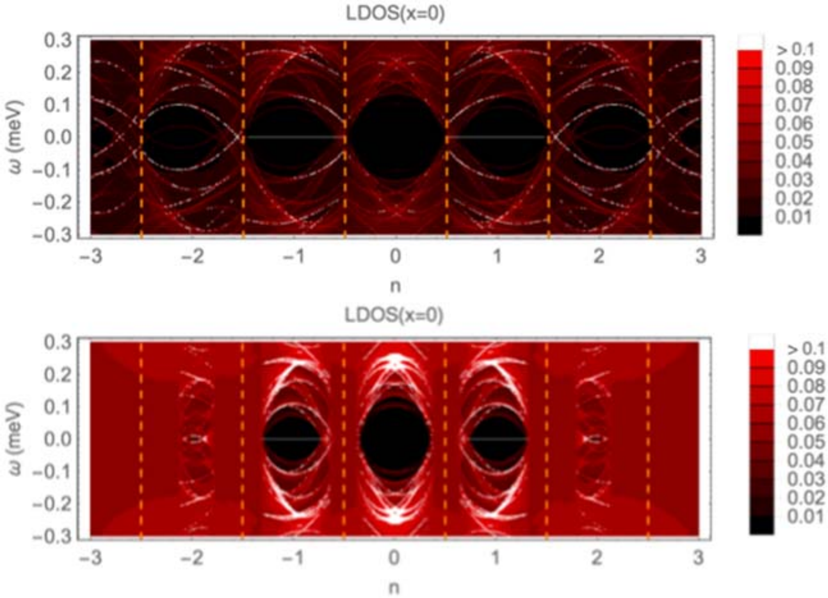

LDOS(x=0)
ω (meV)
n
> 0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
LDOS(x=0)
ω (meV)
n

ID: 04098, 15/07/2019 16:10 - 15/07/2019 16:15, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster)

Magnetoresistance of the superconductor $LaRu_2P_2$

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We present a study of the magnetoresistance at high magnetic fields of the pnictide superconducting material $LaRu_2P_2$. We have grown single crystals using the solution growth method. This system is similar to iron-based materials, but it superconducts in a stoichiometric phase, which allows to study samples of much higher purity. We have obtained high quality single crystals, with a Tc of 4.16 K and a residual resistivity of 8.6 μΩcm, corresponding to a mean free path of 15 nm. We report measurements of the upper critical field, from which we obtain a value for the coherence length of about 27 nm. Furthermore, we measured the sample to high magnetic fields (22 T) and found signatures of quantum oscillations with low frequency in agreement with band structure calculations.

ID: 03879, 15/07/2019 16:15 - 15/07/2019 16:20, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster)

High temperature long range proximity effect in $YBa_2Cu_3O_7$ / $La_{0.7}Sr_{0.3}MnO_3$ planar structures

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Ferromagnetism and superconductivity are antagonistic phenomena due to the pair breaking effect of the exchange field of the ferromagnet on singlet Cooper pairs. Recent theoretical works have raised the possibility of a long-range proximity effect in ferromagnet / superconductor (F/S) structures driven by triplet correlations [1,2]. Pioneer experiments in multilayers combining transition metal ferromagnets and low temperature superconductors have shown indications of Josephson supercurrents surviving long distances into the ferromagnet [3,4,5]. In this work we show evidence of F/S proximity effect at 50 K in planar S/F/S microstructures based on microwires of half-metallic $La_{0.7}Sr_{0.3}MnO_3$ with superconducting $YBa_2Cu_3O_7$ contacts separated distances of the order of 1μm. By measuring the resistance as a function of temperature across the F wire we observe a superconductor transition occurring at a temperature smaller than that of YBCO which is unambiguously ascribed to the LSMO. Magnetotransport and critical current measurements support the transition of LSMO to a new superconductor-ferromagnet state with a hysteretic Fraunhofer pattern. The coexistence of magnetic hysteresis and typical Josephson junction features suggests the possibility of spintronic devices combining quantum coherence and memory. Furthermore, our results on structures combining correlated oxide manganites and cuprates enable completely new quantum device concepts for future oxide electronics operating at high temperatures.

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ID: 03813, 15/07/2019 16:20 - 15/07/2019 16:25, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster)

PROCEDURE FOR INDUCE AND MEASURE HIGH CURRENTS IN HTC SUPERCONDUCTORS RINGS

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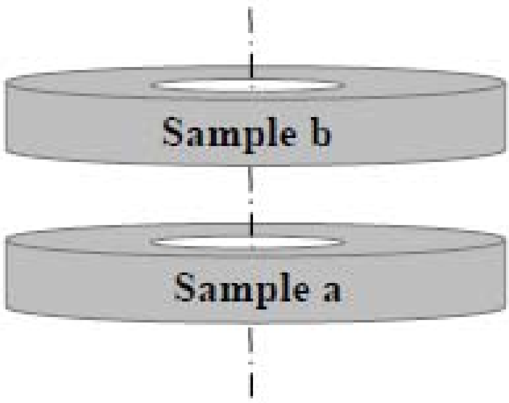
Through the use of an iron core magnetized to saturation (~2T), gets the critical current in $Y_1Ba_2Cu_3O_{7-\delta}$rings. The zero resistance of superconducting materials causes the magnetic flux through them must remains constant (Faraday-Lenz law). Therefore, if we confront a ring with current to another (with or without current), schematically shown in figure, a chain induction is produced as the distance between rings is reduced, that causes the variation of currents intensities (increase if the interaction is repulsive and decrease if the interaction is attractive). In the particular case of repulsion interaction, the increase of current happens regardless of whether in any of the rings the initial current is equal to the critical. The currents are determined by a numerical calculation (based in the filament method) of the mutual inductance between the rings.

On the other hand, we have developed a device that allow to measure a magnetic field along a line which encloses a rectangular section of the ring. The current that flow through this can be calculated using the Ampère law, knowing the magnetic field circulation. Getting consistent results for the determined by the two described methods. The remarkable of our procedure is that the constancy of the magnetic flux through the rings allows the induction of currents greater than the critical current in absence of external field.



ID: 03878, 15/07/2019 16:25 - 15/07/2019 16:30, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster)

Tuning the electronic structure of High Temperature Superconducting films by field induced oxygen diffusion

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High temperature superconductivity (HTS) is expected to be a very relevant technology in the future of diverse research fields like power technology, energy harvesting, electronic devices or medicine. A unique feature of HTS materials is that their physical properties strongly depend on the carrier concentration. In particular, a non-volatile reversible resistance modulation can be achieved in strongly correlated cuprates, a widely studied family of HTS, by means of an electric field. This modulation is based on the Resistive Switching effect (RS) induced by means of a tunable metal-insulator transition (MIT). The mechanism responsible of this phenomenon is not clear yet but oxygen vacancies, which change carrier density of CuO2 planes, play a key role.

Here we present studies on bipolar RS effect in YBa2Cu3O7 superconducting thin films by analysing R(V) curves, measured in micrometric patterned tracks using metal electrodes, at different conditions. Temperature-dependent transport and in-situ micro-Raman spectroscopy measurements have been performed in order to study the local oxygen diffusion along the tracks. Experimental data may be accurately described with a simulation model of the oxygen diffusion that considers electrochemical oxygen doping. We demonstrate that volume phase transitions modulated with different gates can be induced in superconducting transistor-like devices.

ID: 03860, 15/07/2019 16:30 - 15/07/2019 16:35, Room 0.4 (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster- Flash Talk)

Controllable Switching of the Superconductivity of a Tungsten STM Tip on Epitaxial Graphene

Cosme González[3] , Pablo Casado[1] , Andrew Norris[1] , Juan Jesus Navarro[1] , Manuela Garnica[1] , Maria Azebron[1] , Daniel Granados[1] , Fabian Calleja[1] , Jose Gabriel Rodrigo[2] , Amadeo López Vazquez de Parga[3] , Rodolfo Miranda[3]

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3) Instituto Madrileño de Estudios Avanzados en Nanociencia (IMDEA Nanociencia), Cantoblanco 28049, Madrid, Spain & Departamento de Física de la Materia Condensada and IFIMAC, Universidad Autónoma de Madrid, Cantoblanco 28049, Madrid, Spain

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Epitaxial Graphene on metals has become a playground for a wide range of 2D systems displaying competing interactions that may lead to long range magnetic order, Kondo resonances or superconductivity [1], with STM as a favorite tool to probe their LDOS at the atomic level.

We report a controlled method to produce in-situ superconducting (SC) nano tip at the apex of a conventional W STM tip. Starting from Ar+ sputtered pristine tungsten tips, we reproducibly build a SC structure at the tip apex by means of voltage pulses on several graphene-covered surfaces like gr/Ir(111) or gr/Pb/Ir(111). The superconducting tip is robust, stable, achieves atomic resolution (see figure 1(a)) and show a great consistency in the value of the energy gap . We have characterized the resulting SC gap as a function of temperature and magnetic field (see figure (b)), obtaining a transition temperature close to 3.2 K and a critical field well above 3T in all cases. The superconductivity can be easily reversed by controlled voltage pulsing or indentation on a clean metal surface. he present result should be taken into account when studying zero-bias features like Kondo or superconductivity by means of STM, especially when using tungsten tips on carbon-based surfaces or 2D systems.

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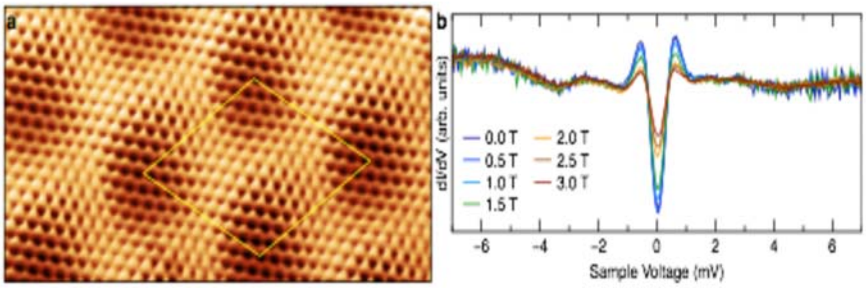

Figure 1: (a) Atomic resolution STM topographic image recorded on gr/Ir(111) with a SC tip prepared following the method described in the main text. Moire pattern is highlighted in yellow. Stabilization parameters V=2V, I=2nA. (b) Differential conductance (dI/dV) spectra obtained stabilizing the tip at V=10mV and I=2.5nA (R=4Mohms) for increasing values of applied external field. All measurements done at 1.19K.

ID: 04110, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster- Flash Talk)

Quasiparticle interference and vortex lattice imaging in pure and Ni-doped $CaKFe_4As_4$

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Quasiparticle interference and vortex imaging have both been shown to be powerful tools to investigate pnictide superconductors. Here I will review new results in the recently discovered family of 1144 materials, particularly in pure and Ni-doped $CaKFe_4As_4$. The 1144 $CaKFe_4As_4$ compound shows the highest Tc among stoichiometric pnictide superconductors (35 K). We show that this material is two-gap, sign-changing superconductor [1,2] and is located at optimal doping. Quasiparticle interference shows the opening of a superconducting gap in the hole bands around the zone center. Ni doping reduces Tc and induces a magnetic transition where a unique hedgehog magnetic order has been proposed [3]. I will show the changes in the superconducting gap, band structure and vortex lattice induced by Ni doping.

Work supported by ERC Starting Grant and Spanish MINECO.

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ID: 03981, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster- Flash Talk)

Observation of a gel of quantum vortices in a superconductor

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** Hermann Suderow, hermann.suderow@uam.es*

A gel is a disordered solid that can be formed by freezing a system with spatially varying density,for example a mixture of liquid and gas. The result is a porous solid where particles are mainly organized in a scaffold and the density is spatially inhomogeneous. In presence of material disorder, quantized vortices in type II superconductors can freeze into an amorphous solid, particularly at low magnetic fields where vortices are nearly noninteracting. Here we present high-resolution imaging of the vortex lattice displaying dense vortex clusters separated by sparse or entirely vortex-free regions in beta-Bi2Pd superconductor containing one-dimensional structural defects. In contrast to the amorphous state, we find that the vortex distribution follows a multifractal behavior and the variance of intervortex distances diverges upon decreasing the magnetic field. These properties, characteristic of gels, establish the presence of a novel vortex matter phase, distinctly different from the well-studied disordered and glassy phases observed in high-temperature and conventional superconductors. The vortex gel is expected to be generic to type-II superconductors containing strained extended defects, which could be engineered for isolating and manipulating clusters of quantum vortex states.

ID: 03916, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster- Flash Talk)

Nano-engineered YBCO Superconducting tapes for Fusion Applications

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Superconducting magnetic systems are the ultimate enabling technology for fusion device, based on magnetic confinement concept. The most advanced fusion reactors exploit superconducting magnets based on low temperature superconductors that may be cooled at liquid helium temperature. However, in perspective of sustainable commercial fusion reactors, the possibility to use high temperature superconductors (with operation temperatures > 4.2 K) offer clear technological advances with higher efficiency in cooling and reduction in the reactor complexity. High temperature $YBa_2Cu_3O_{7-d}$ (YBCO) coated conductors offer a realistic vision for high field (B > 13–20 T), low temperature (T < 50 K) conditions of fusion devices. In general pinning performance of YBCO films have been optimized for applications in liquid nitrogen temperature (65-77 K) at intermediate fields (0-5 T) and up to date, relatively poorly knowledge exists on their performance at low temperatures.

In this contribution we will present the pinning performance of several nanostructured YBCO thin films, with nanosized oxide secondary phases, where processing conditions have been tuned to control the defect landscape. The synergetic combination of natural and engineered defects in these systems will be evaluated by means of in situ angular transport measurements in order to establish a correlation between pinning centers and performance at low temperature and high field conditions.

ID: 04081, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)

S3. Superconducting Materials (DFMC-GEFES)

(Poster- Flash Talk)

Exploring new materials for superconducting Kinetic Inductance Detectors

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Future space missions to study the cosmic microwave background will require cameras with a large number of detectors, very good sensitivity and polarization selectivity. Kinetic Inductance Detectors (KIDs) [1] are the ideal candidates for these applications, as they exhibit very good sensitivity and they are intrinsically multiplexable which allows to couple thousands of pixels to a single transmission line [2]. In fact, KIDs based on Aluminum (Al) have already demonstrated very good optical performance on Earth-based telescopes such as on the NIKA2 Instrument [3]. However, the superconducting gap limits the detection band and the performance of Al- KIDs to the millimeter range (100 - 850 GHz). Therefore, further developments are still required to fulfil the requirements of future missions.

In this work, we present two different approaches to push the limits of state-of-the-art KIDs. First, we present our results on the developments of KIDs based on Al/Ti bilayers and AlMn alloys which allow us to lower the superconducting transition temperature, and hence, to lower limit of the absorption band. Second, we introduce the development of hybrid KIDs based on two-dimensional materials.

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ID: 03952, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster- Flash Talk)

Field-induced Gap-like Structure in the Heavy-fermion Superconductor $CeCoIn_5$

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The pairing symmetry of the heavy-fermion superconductor $CeCoIn_5$ is known to be $\mathbf{d_{x^2-y^2}}$. Our planer tunneling spectroscopy data as a function of temperature down to 20 mK show sharp coherence peaks with an estimated gap of 0.65 meV on the (100) and (001) faces; and a distinct zero-bias peak on the (110) face, as expected for a superconductor of this symmetry. As a function of increasing magnetic field, as superconductivity is destroyed, the features evolve into an intriguing gap-like structure that increases linearly up to 18T. Possible origins of this field-dependent evolution will be discussed, including one with that invokes an exotic pairing mechanism.

This work was supported by NSF/DMR-1704712 (FSU), NSF/DMR-1157490 (FSU) NSF/DMR-1644779 and the State of Florida (NHMFL), DOE, Office of BES, and Division of MSE (LANL), and NSF/DMR-1810310 (UCSD)

ID: 04203, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S3. Superconducting Materials (DFMC-GEFES)
(Poster- Flash Talk)

Fabrication of Mo/Au-based Transition Edge Sensor

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Transition Edge Sensors (TESs) are devices which exploit the sharp transition of superconducting materials to use them as extremely sensitive detectors. Within the framework of the ESA mission ATHENA -an X-ray telescope to be launched in 2032- our group is developing X-ray detectors with Mo/Au TESs coupled to bismuth absorbers, aimed at detecting soft X-rays (1-10keV band).

The TES sensor is a superconductor-normal metal bilayer with critical temperature typically between 50 and 400 mK. The bilayer takes the advantage of the proximity effect between both materials to control the critical temperature and thus the operation temperature of the device. Sensor contacts and wires are constituted by a superconductor material with a higher critical temperature than that of the bilayer, in order to avoid any heat load to the detector.

In this contribution we describe the fabrication of TESs. This is very crucial and demanding, since there is a strong dependence of the Mo critical temperature on impurities and stress, and also because the critical temperature of proximity bilayers depends on the interface quality and individual layers' thickness. Thus, sharp superconducting transitions require outstanding control of all the steps of the fabrication.

The Mo/Au bilayers are deposited at room temperature on Si wafers covered by low stress Si_3N_4 in a so called trilayer design. First, Mo and a thin Au layer are sputtered in a UHV chamber. Afterwards, Au is deposited ex-situ by electron-beam up to the desired thickness. The sensors are fabricated through several optical lithography steps. Nb/Mo wires are used. We have found that different etching techniques (wet, ion milling, RIE) produce different Mo/Au edge profiles, which have significant impact on the superconducting transition width. We have achieved a fabrication procedure with excellent yield and homogeneity, producing transition widths of less than 2 mK for TEsS with critical temperatures of 100 mK. With this process we have fabricated square and rectangular devices from 240x240 mm2 down to 10x10 mm2, over 4'' wafers.

S4. Fotónica Aplicada (DFMC-GEFES)

La fotónica es la disciplina que estudia, tanto a nivel fundamental como a nivel de aplicaciones tecnológicas, la generación, el control, la detección y el aprovechamiento de los fotones. Esta disciplina tiene una multitud de aplicaciones ya integradas en nuestro día a día que no podrían lograrse usando otras tecnologías: operaciones de oftalmología utilizando láseres, internet tal y como la conocemos hoy en día, pantallas e imagen de alta resolución, entre otras. Sin embargo, lejos de agotarse, el potencial de la fotónica aplicada es todavía enorme. La fotónica ha sido identificada tanto por la Comisión Europea, como por Estados Unido y China como una Key Enable Technology (KET), es decir, es una de las disciplinas que jugará un papel clave en el desarrollo tecnológico del siglo XXI. Este simposio se plantea como un foro para dar a conocer los últimos avances en distintos ámbitos de la ***Fotónica Aplicada*** (láseres ultra rápidos, biosensores fotónicos, fotónica cuántica integrada, plasmónica, etc.) en el que tengan lugar discusiones entre expertos que contribuyan al avance en esta disciplina y a abrir la puerta a posibles colaboraciones.

Organizadores:
Elena Pinilla, *NTC-Universidad Politécnica de Valencia*
Maribel Gómez, *NTC-Universidad Politécnica de Valencia*

Patrocinado por:

GEFES División de Física de la Materia Condensada
R.S.E.F. Real Sociedad Española de Física

S4. Applied Photonics (DFMC-GEFES)

Photonics is the physical science that studies the generation, control, detection and manipulation of light from fundamental level to applications. Currently, applications of photonics are ubiquitous and include areas of our everyday life, that couldn't been achieved using other type of technologies, such as lasers for eye surgery, the internet as we know it today, high resolution images and screen, among others. However, far from being over, potential applications in photonics are huge. Photonics has been identified by the European Union, as well as by USA and China, as a Key Enable Technology (KET). In other words, it is supposed to be a key field for the development of science and technology over this century. This symposium intends to serve as a forum for the ***Applied Photonics*** community to discuss about the latest developments in Nanophotonics and their applications. Experts in different topics such as ultrafast lasers, bio-photonics, quantum integrated photonics or plasmonics will have the opportunity to meet, share new ideas and open the door for new collaborations.

Organizers:
Elena Pinilla, *NTC-Universidad Politécnica de Valencia*
Maribel Gómez, *NTC-Universidad Politécnica de Valencia*

Sponsored by:

GEFES División de Física de la Materia Condensada

Real Sociedad Española de Física R.S.E.F.

ID: 04133, 17/07/2019 15:00 - 17/07/2019 15:30, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Invited Symposio)

Nanooptics in 2D materials

Pablo Alonso González[1]

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** Pablo Alonso González, pabloalonso@uniovi.es*

The advent of two-dimensional (2D) materials and their extraordinary optical properties has allowed the visualization of nanolight in the form of low-loss and electrically tunable (active) plasmon polaritons in graphene or high optical quality phonon polaritons in h-BN or MoO_3, which introduces a very encouraging arena for scientifically ground-breaking discoveries in nano-optics. In this talk I will show the first proof-of-concept devices that are laying experimentally the foundations of a 2D nano-optics field.

ID: 04042, 17/07/2019 15:30 - 17/07/2019 15:50, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Oral)

Tuning of the optical properties of single photon sources by elastic strain engineering

Javier Martín-Sánchez , Xueyong Yuan[2] , Davide Tedeschi[3] , Javier Taboada-Gutiérrez[1] , Pablo Alonso-González[1] , Rinaldo Trotta[3] , Armando Rastelli[2]

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2) Institute of Semiconductors and Solid State Physics, Johannes Kepler University, Altengerger str. 69, 4040, Linz, Austria
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** Javier Martín-Sánchez, javiermartin@uniovi.es*

The development of novel photonic technologies for quantum information processing and quantum computing relies on our ability to tailor the optical properties of single photons emitted by quantum dot-like sources of non-classical light. One the most prominent experimental approaches to date is based on the use of a novel class of piezoelectric actuators which allow one to introduce controlled in-plane strain fields under any working conditions [1,2].

In this talk, we will present the capabilities of this kind of devices to introduce fully control in-plane strain fields in semiconductor nanomembranes. The possibility of manipulating the optical properties of single photons to produce energy-tunable sources of entangled photons in polarization from III-V semiconductor quantum dots will be presented [3,4]. Finally, preliminary results on the tailoring of the optical properties of semiconductor two-dimensional materials will be discussed [2].

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ID: 03966, 17/07/2019 15:50 - 17/07/2019 16:10, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Oral)

Fabrication of MoS_2 p-n Homo-junctions via Direct Nanopatterning

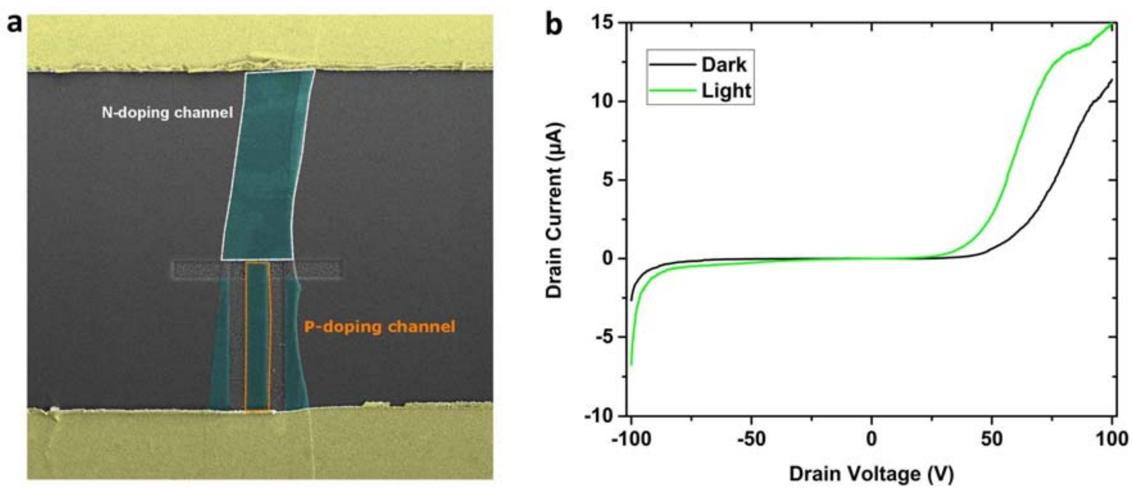
Fernando Jiménez[1] , Victor Marzoa[1] , Jorge Trasobares[1] , Rodolfo Miranda[2] , Daniel Granados[1]

1) IMDEA Nanociencia, Cantoblanco, 28049, Madrid, Spain
2) Departamento de Física de la Materia Condensada and IFIMAC, Universidad Autónoma de Madrid, Cantoblanco, 28049, Madrid, Spain

** Fernando Jiménez, fernando.jimenez@imdea.org*

Transition Metal Dichalcogenides (TMDCs) have attracted great interest due to their outstanding optoelectronic properties. Recent studies have shown the capability of fabricating P-N junctions using different approaches like chemical doping or material stacking. The burden of these methods appears when involving fabrication steps like resist deposition, aligning/lithography procedures, chemical manipulation and wet/dry etching processes that increase the cost and can alter the device\'s properties. In our group, we developed a direct fabrication method, Pulsed Focused Electron Beam Induced Etching (PFEBIE), which allows the scissoring of TMDCs regions on the devices once their fabrication steps have been completed, saving additional fabrication phases. This method enables the possibility to fine-tune the device\'s optoelectronic properties. When the etching is done a p-doping mechanism occurs. Taking the advantage of this doping phenomenon, we can fabricate a lateral P-N homo-junction from an intrinsically N field effect transistor.

Field effect devices were fabricated from mechanically exfoliated MoS_2 flakes via optical beam lithography followed by a metal evaporation and a lift-off process to define the gate-contact structures. MoS_2 devices show a transistor behavior. The devices were characterized employing Raman and Photoluminescence mapping spectroscopy, AFM/SEM microscopy and transport measurements at low temperatures. Afterwards, PFEBIE was utilized to fabricate a lateral P-N homo-junction that was characterized with the same methods as before. Electric measurements after PFEBIE show a N-P diode behavior with excellent white light photoresponse.



ID: 03892, 17/07/2019 16:10 - 17/07/2019 16:30, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Oral)

Quenching of the exciton recombination in strained few-layered monochalcogenides

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We predict that long-lived excitons with large binding energies can also exist in a single or few layers of monochalcogenides such as GaSe. Our theoretical study shows that localized excitons are unable to recombine despite of electrons and holes co-existing in the same layer. Before taking on interactions, the localization of both type of carriers is achieved by introducing a local isotropic strain in a GaSe monolayer. In order to model such perturbation, an envelope function approximation is used starting from an effective k·p Hamiltonian. The momentum matrix element and Gamma-point energies required to build such hamiltonian are obtained from density functional theory calculations, as well as the band edge variations around the strain perturbation. The local band gap variation is in the end the responsible of confining both electrons and holes. Once the single-particles states are calculated, we construct electron-hole pairs and account for their correlations using the Bethe-Salpeter equation, from which the exciton binding energy is obtained. From the many-body results, the decay rate for the ground state exciton can be calculated, showing a huge recombination time for the exciton. The interplay between the localized strain and the caldera-type valence band (characteristic of few-layered monochalcogenides) creates localized electron and hole states with very different quantum numbers, which hinders the recombination even for singlet excitons.

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ID: 03716, 17/07/2019 17:10 - 17/07/2019 17:40, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Invited Symposio)

Optical design of metal-halide perovskite-based materials and devices

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ABX_3 perovskites represent a novel field of research in third generation PV, with efficiencies competing with those leading the solar race in the last decades. This irruption in the scientific scenario is a direct consequence of the unique properties of this material, which are still interrelated pieces of a big puzzle to be assembled in order to understand its working principles [1].

In this talk, we will give an overview of the optical properties of this family of perovskites and perovskite-based solar cells. In order to understand light propagation in these materials, it is key to attain their optical constants (n,k). In this regard, we will introduce how different preparation methods lead to different values of such constants, affecting light-matter interaction effects. The in-depth characterization, understanding and modelling of the optics of perovskites have allowed our group proposing optimized photovoltaic device architectures when ABX_3 perovskites are integrated as photoactive layers. We have developed optical designs to understand the behaviour of above-20% efficiency cells, and also to propose for the first time a perovskite-perovskite tandem cell that harvests up to 1150 nm of the solar radiation spectrum [2,3]. Moreover, we will present our results on the theoretical and experimental realization of efficient devices showing bright structural colours on demand by integrating a novel specifically designed one-dimensional photonic crystal as a scaffold [4]. Finally, we will discuss our recent advances on the development of spatially confined perovskite nanocrystals whose optical properties are strongly modified [5].

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ID: 04118, 17/07/2019 17:40 - 17/07/2019 18:00, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Oral)

Tamm Plasmons for Controlled Emission of Nanophosphors

Elena Cabello-Olmo[1] , Dongling Geng[1] , Gabriel Lozano[1] , Hernán Míguez[1]

1) Institute of Materials Science of Seville, Spanish National Research Council

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Herein we demonstrate that the luminescent properties of thin layers based on rare-earth nanocrystals (nanophosphors) can be modified using resonant structures that sustain photonic-plasmonic modes. Phosphor materials are widely used for many applications related to the generation of light due to their chemical and thermal stability. However, such robust emission is difficult to modify using alternative synthetic methods without a loss of the overall efficiency.

In this piece of work, we develop a careful design and fabrication of a metal-dielectric architecture where Eu^{3+}-based nanophosphors layers are combined with dielectric periodic multilayers and metal films. These hybrid structures exhibit Tamm plasmons, which yield large electromagnetic fields in the spatial region close to the metal layer where Eu^{3+} cations are distributed. In particular, the periodic multilayer is made of alternated large-area UV-transparent ZrO_2 and SiO_2 layers deposited using wet deposition methods. Then, a layer of $GdVO_4$:Eu^{3+} nanophosphors is dip-coated atop the multilayer. Finally, the stack is coated with a noble metal film, *i.e.*, silver and gold. Steady-state photoluminescence measurements reveal an 8-fold enhancement when the luminescence is measured in a direction close to the normal to the surface. In addition, time resolved measurements are performed and the analysis shows a reduction in the average lifetime when the Eu^{3+} cations are coupled to the optical modes supported by the hybrid system. Thus, our results demonstrate that a judicious design of their optical environment allows an accurate modification of the emission properties of rare-earth nanophosphors [1,2].

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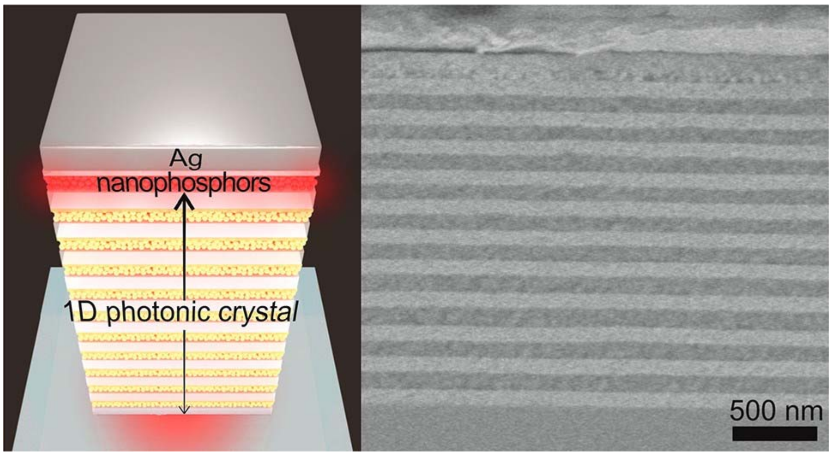

Towards Large Coupling Rate in Optomechanical Crystal Cavities with a Full Phononic Bandgap

Laura Mercadé[1] , Leopoldo L. Martín[1] , Amadeu Griol [1] , Alejandro Martínez[1]

1) Nanophotonics Technology Center, Universitat Politècnica de València

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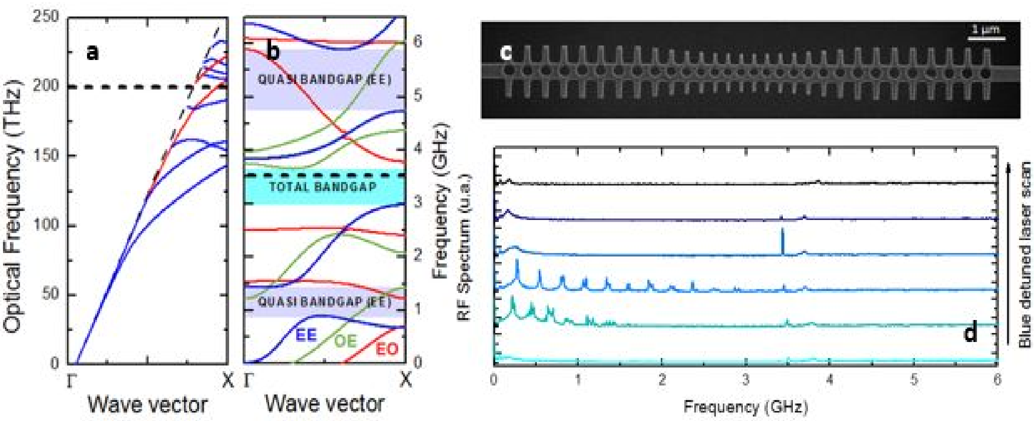
One-dimensional optomechanical (OM) crystals are quasi-periodic structures built on high-index released semiconductor slabs in which propagation and coupling of optical and mechanical waves can be obtained. However, most of the OM crystal cavities designs with high quality factors (Q) and high OM coupling factors (g0) do not have a complete phononic bandgap. This implies that the mechanical resonances lie into a quasi-bandgap, which enables phonon leakage and mechanical losses. In order to avoid this, some authors [1] placed a 2D phononic crystal displaying a full phononic bandgap at the surroundings to reduce the acoustic radiation, although still mechanical waves can propagate out of the defect region reducing the Q factor. In [2], an OM crystal cavity with a full phononic bandgap around 4 GHz was demonstrated but the OM coupling in that region was too weak. Here, we combined those previous cavity designs to get GHz-scale mechanical modes within a phononic bandgap but with a large OM coupling rate (g_0 >1MHz) [3].

The resulting cavity in Fig. 1c has been designed through the analysis of the photonic and phononic band diagrams (Fig, 1a-b). For the case of the phononic bands we have introduce directly an acoustic shield in the mirror region, so the phononic shield is integrated in the beam and the mechanical mode gets completely bounded to the wavelength-size cavity region. We have obtained the first experimental measurements of this silicon new OM crystal cavity design with simultaneously localized mechanical and optical modes. Optical quality factors of the order of 10^4 have been found which enable transduction of mechanical modes in the MHz and GHz range, as can be seen in Fig. 1d.



ID: 03969, 17/07/2019 18:20 - 17/07/2019 18:40, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Oral)

Flexible optically disordered materials for LED coatings

José María Miranda-Muñoz[1] , Dongling Geng[1] , Mauricio E. Calvo[1] , Gabriel Lozano[1] , Hernán Míguez[1]

1) Multifunctional Optical Materials Group, Institute of Materials Science of Sevilla, Consejo Superior de Investigaciones Científicas – Universidad de Sevilla (CSIC-US), Américo Vespucio 49, 41092, Sevilla, Spain

** José María Miranda-Muñoz, jm.miranda@csic.es*

LED devices present the advantages of low consumption and compact size, while offering tuning of the properties of the emitted light. Nevertheless, some issues still have to be overcome in order to reach the full potential of the technology. Among them, one of the most important and debated ones is related to the low out-coupling efficiency, *i.e.* the ratio between the light that can be extracted from the device surface and that actually emitted by phosphors, LEDs typically present.

In this work, we developed a procedure based on solution-processing methods for the fabrication of flexible and transparent films[1] to create an adaptable coating that integrates nano-sized phosphors displaying intense emission under UV irradiation and susceptible to be implemented as conversion layers into LEDs.[2] We demonstrated that the inclusion of optical disorder by randomly distributing nanocrystalline TiO_2 spheres in a controlled manner boosts the luminescence extracted from the films, as a consequence of a more efficient out-coupling of the generated light.

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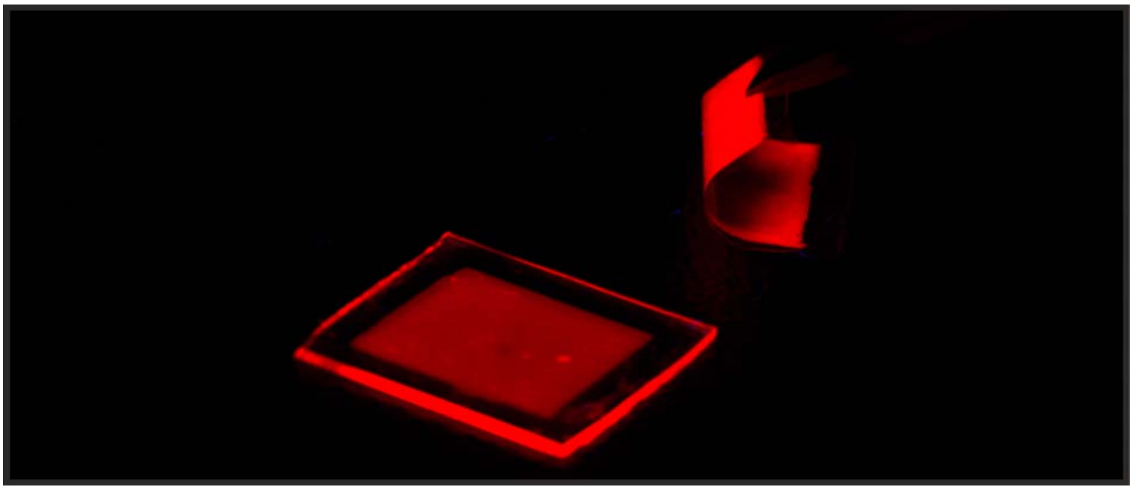

ID: 04092, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Poster)

Optical characterization of few-layer MoS_2 mechanical resonators

Victor Marzoa[1] , Fernando J. Urbanos[1] , Cristina García-Pérez[1] , Jorge Trasobares[1] , Amjad Al Taleb[1] , Rodolfo Miranda[1] , Alicia Gomez[1] , Daniel Granados[1]

1) IMDEA Nanoscience

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Nanoelectronics is certain to improve the way we gather, store, and process information. The ability to reach down to the nanoscale allows us to develop more efficient, faster and less energy consuming technology than we have ever had. However, such technology requires new tools for sensing and signal processing. Two-dimensional (2-D) materials, such as graphene or transition metal dichalcogenides (TMDs), are an excellent candidate for ultrasensitive detectors due to their intrinsic small dimensions, low weight, chemical stability, and high electrical conductivity [1]. Graphene mechanical resonators have shown to reach resonant frequencies in the gigahertz range, proving to play a major role in the future of nanoelectromechanical systems (NEMS) [2,3]. However, the lack of band-gap of graphene may restrict its usefulness in certain applications requiring a semiconducting material. Molybdenum disulfide (MoS_2), a semiconductor analog to graphene, has a direct band gap of approximately 1.8 eV when in its monolayer thickness. This allows the fabrication of nano-electro-optical resonators out of this material [4,5,6].

This work aims to demonstrate the modulation of the optical emission of 2D membranes based on exfoliated few-layer MoS2 mechanical resonators, suspended on top of micrometer-size circular acousto-optical cavities on SiO_x/Si substrates. The objective is to excite acoustically standing vibrational wave modes following the experimental set-up of a driven oscillator. In this way, it would be possible to deform the lattice of the monolayer sufficiently as to modify the energy of the band-gap, and thus of the optical emission. The different vibrational eigen-modes will then have different emission energy. The same scheme could lead to the generation of artificial quantum dots on the suspended membranes, with quantum confinement properties of high technological interest.

Here, we report our preliminary results on the optical characterization. Both micro-Raman and micro-PL studies of the resonators have been performed. Atomic Force Microscopy characterization will also be presented. We have found a 4-fold increase in the intensity of the micro-PL at room temperature and atmosfereic conditions. The intensity increase haeppnes at the the borders of the mechanical resonators, siggesting that it might be lined to strain induced thorugh mechanical deformation.

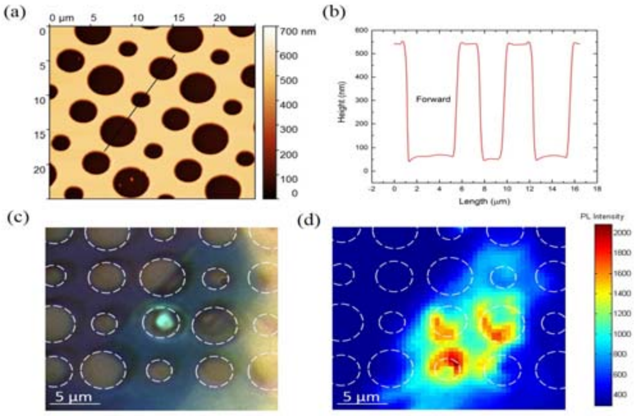

Figure: (a), (b) AFM image of the circular micro-holes, 2, 3 and 4 µm in diameter, and 500 nm in depth; (c) Optical image of an exfoliated few-layer MoS_2 flake transferred onto the micro-holes; (d) PL map of the same flake at 667 nm.

ID: 04050, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Poster)

Wave-couplers for see-through applications on photopolymers

Sergi Gallego[1], Cristian Neipp[1] , Sergio Bleda[1] , Fernández Roberto[1] , Márquez Andrés[1] , Morales-Vidal Marta[1] , Pascual Inmaculada[1] , Beléndez Augusto[1]

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Nowadays, wearable eyeglasses and waveguides [1] are one of the most promising applications in photonics for the holographic recording materials. Holographic techniques structures together with the optimized recording materials permit the fabrication of the high resolution structures.

In the applications of see-through glasses, the light signal can be generated on the back of the human head and guided along the temples of the glass to the frontal lenses and redirected to the eye. Therefore, we need two wave-couplers, W-C, one to trap the light inside the temples, and second in the lenses one to redirect the guide light into the eye.

The holography gives us a possibility when we store the holographic optical element, HOE, with a determinate wavelength and we use the display with a longer one. Our proposal is fabricating this wave-couplers for normal light incidence using photopolymers, as recording material, because we can self-fabricate them and modify their composition and optical properties. We fabricate the HOE using a 532 nm laser to guide the 632 nm light. Furthermore, in this work we present the results obtained with different family of photopolymers [2].

This work was supported by the “Ministerio de Ciencia, Innovación y Universidades” (Spain) under projects FIS2017-82919-R (MINECO/AE/FEDER, UE) and FIS2015-66570-P (MINECO/FEDER). R.F. and M.M-V. acknowledge the financial support by the "Generalitat Valenciana” (Spain) under grants APOSTD/2018/084 and CDEIGENT/2018/024, respectively.

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ID: 03740, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Poster)

Propiedades láser de monocristales Yb:Ca$_3$(NbGa¤)$_5$O$_{12}$ con desorden estructural

Jorge Omar Álvarez Pérez[1] , Jose María Cano Torres[1] , María Dolores Serrano Hernández[1] , Concepción Cascales Sedano[1] , Carlos Zaldo Luezas[1]

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Mediante el método Czochralski se han crecido monocristales de granates Ca$_3$(NbGa¤)$_5$O$_{12}$ (en adelante CNGG, grupo espacial cúbico *Ia-3d*, representa vacantes catiónicas) dopados con Yb y modificados con Li^+ o Na^+. En estos monocristales los iones Nb^{5+} y Ga^{3+} comparten las posiciones octaédricas y tetraédricas del granate lo que origina gran desorden estructural y como consecuencia las bandas de absorción óptica y luminiscencia del Yb^{3+} se encuentran ensanchadas inhomogeneamente. Esto ha sido utilizado en osciladores *mode-locking* para la demostración de pulsos laser de 55 fs [1].

Se ha determinado que el Li^+ ocupa exclusivamente la posición tetraédrica eliminando las vacantes catiónicas de esa posición [2,3]. El uso de precursores con pureza 99.99% (o mayor) y la modificación con Li permiten obtener cristales con una coloración muy débil, ver Figura 1a. Sin embargo, la coloración parece tener poca influencia en el rendimiento láser, Figura 1b. Por el contrario, la pureza del Yb_2O_3 y la concentración de Yb son determinantes para un buen rendimiento láser de los cristales, Figura 1c.

El objetivo de esta comunicación es discutir la influencia de los métodos de preparación, modificadores del cristal y dopaje con Yb en la optimización de la eficiencia láser de los monocristales Yb:CNGG a través de la comprensión de su estructura cristalina y de sus propiedades espectroscópicas.

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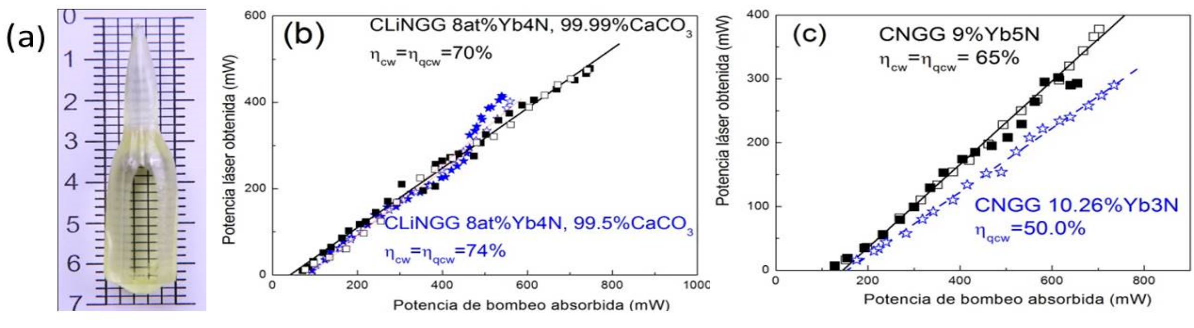

Figura 1. (a) Monocristal de 8at%Yb:CLiNGG obtenido con precursores ultrapuros (≥99.99%). (b) Comparación del rendimiento láser cw (η) del cristal anterior con uno de la misma composición pero crecido con 99.5%$CaCO_3$ y que presenta una coloración tres veces mayor. (c) Rendimiento laser (η) de cristales crecido con Yb_2O_3 de diversa pureza.

ID: 04090, 17/07/2019 18:40 - 17/07/2019 18:45, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Poster-Flash Talk)

Optical interference effects on the Casimir-Lifshitz force between plane-parallel systems with multilayer nanostructures

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The Casimir-Lifshitz force ($F_{C\text{-}L}$) is a dominating force in micro- and nano- electromechanical systems (MEMS and NEMS) [1], thus the control of the intensity, but also of the sign, of $F_{C\text{-}L}$ is critical for their performance. Multilayer structures, in particular one dimensional photonic crystals, have been proposed as a means to tune such forces [2]. However, the potential effect of the localization of enhanced field inside the structure due to optical interference, which should modify the absorption of the whole structure, has so far been disregarded. In this work, we study $F_{C\text{-}L}$ in dielectric multilayer nanostructures and evaluate the effect of optical interference phenomena. Our hypothesis, based on the fluctuation-dissipation theorem, relates the modification of the total optical absorption in the system (resulting from the modification of the electric field distribution and hence absorption profile within the multilayer systems) to the observed variations of $F_{C\text{-}L}$. As a model, we choose dielectric multilayers made of interleaved silica (SiO_2) and polystyrene (PS) layers, which interact through glycerol with a planar silicon substrate in front. Our previous results demonstrated that single slabs made out of SiO_2 or PS display repulsive and attractive $F_{C\text{-}L}$ forces, respectively, in the same materials configuration. In particular, we find that in multilayer systems in which the material volume of the constituent materials is kept constant, for a fixed separation distance of 20 nm, the intensity and the sign of $F_{C\text{-}L}$ can be tuned by changing the number of layers and their thickness. Based on the correlations observed, we hypothesize that the results are due to different optical absorption occurring in each configuration. The results here presented pave the way to design plane-parallel systems with fixed separation distances in MEMS and NEMS displaying desired $F_{C\text{-}L}$.

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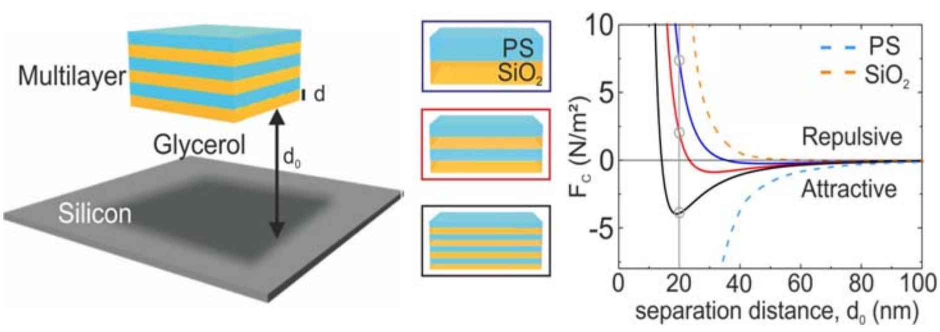

ID: 04120, 17/07/2019 18:55 - 17/07/2019 19:00, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Poster-Flash Talk)

VEGA laser facility: current system capabilities and near future improvements

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VEGA is a Ti:Saphhire laser facility located in Salamanca that offers ultrashort and ultraintense laser pulses to technological, industrial and scientific community.

The facility, installed in the Centro de Láseres Pulsados [1], provides three common front-end outputs with following main characteristics:

	VEGA 1	VEGA 2	VEGA 3
Pulse energy	600 mJ	6 J	30 J
Pulse duration	<30 fs	<30 fs	<30 fs
Pulse peak power	20 TW	200 TW	1 PW
Central wavelength	800 nm	800 nm	800 nm
Repetition rate	10 Hz	10 Hz	1 Hz

The Center has recently started operation phase and the first users' access period on VEGA 2 was developed all over 2018.

In this work we present a detailed description of the Chirped Pulse Amplification laser chain together with key parameters for efficient and reproducible performance in these kind of PW class systems [2].

We also show system's operational results obtained during user's competitive access experimental campaign [3] and discuss future laser beamlines improvement including laser outputs reorganization, synchronization and combination with external laser sources.

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ID: 04026, 17/07/2019 18:50 - 17/07/2019 18:55, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Poster-Flash Talk)

Highly efficient generation of arbitrary vector beams

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Spatial structure of a light beam is an important and interesting degree of freedom to be explored. Vector beams have states of polarization that are spatially inhomogeneous, having different at every point in the light's beam transverse [1]. In addition, spatial light modulators (SLM) are widely used as diffractive optical elements (DOEs) in optical systems to facilitate flexible control of light beams. We have designed a simple experimental optical setup based on two liquid-crystal on silicon (LCOS) SLM useful to manipulate the spatial full field information (amplitude-phase-polarization) of a light beam. Each SLM displays a different phase-only mask, each one encoding a different pattern onto a different and orthogonal polarization component of the input beam. These phase-only masks are designed using a recently proposed random technique to encode complex amplitude values. By addressing properly designed such phase-only holograms we demonstrate the generation of arbitrarily polarized vector modes. Hermite-Gaussian (HG) and Laguerre-Gaussian (LG) scalar beams are also generated. In addition, we obtained controllable superpositions of different Orbital Angular Momentum (OAM) modes. OAM modes are having special interest for optical communication as quantum, classical and hybrid states, so considerable attention are placed on the optical setups to generate such modes.

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Acknowledgements

This work has been financed by Generalitat Valenciana, Conselleria d'Educació, Investigació, Cultura i Esport (PROMETEO-2017-154) and by Ministerio de Economía, Industria y Competitividad of Spain and European Union (MIMECO/FEDER funds, "Una manera de hacer Europa", grant FIS2015-66328-C3-3-R).

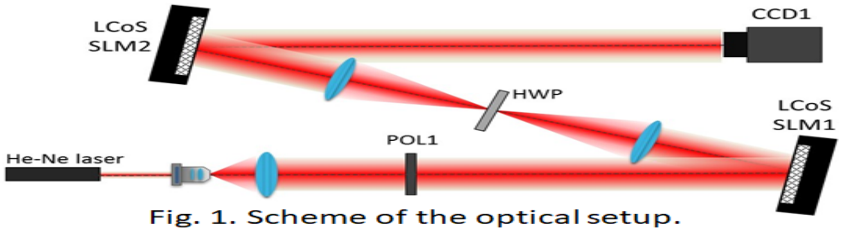

Fig. 1. Scheme of the optical setup.

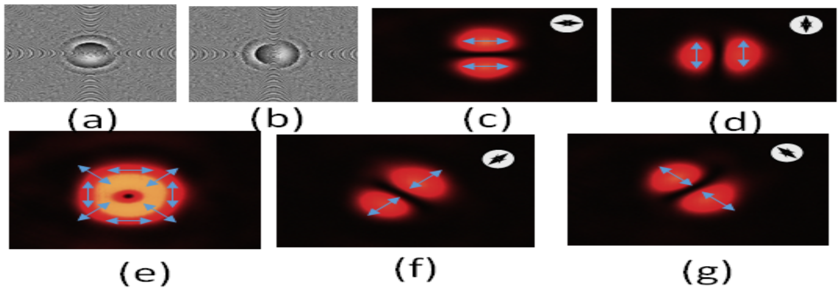

Fig. 2. (a)-(b) Detail on LCOS1 and LCOS2 to generate HG_{10} (c) and HG_{01} (d). (e-g) Different superpositions of beams

ID: 03772, 17/07/2019 18:45 - 17/07/2019 18:50, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Poster-Flash Talk)

Indium tin oxide for a new generation of photonic devices

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Indium tin oxide (ITO) is a well-known transparent conducting oxide (TCO) which stands out by having both high optical transparency and electrical conductivity [1]. Because of these unique properties and compatibility with CMOS process, ITO have risen as a promising material to integrate on the silicon photonics platform for developing a new generation of photonic devices [2,3].

In this work, we investigate the use of ITO for new scopes such as thermo-optic and non-volatile applications. Most relevant findings for thermo-optic effect show state-of-the art results by achieving experimental power consumptions lower to 10 mW to achieve a π-phase shift (Fig. a-b). On the other hand, by utilizing the ITO as a floating-gate in a flash-like memory structure and exploiting its epsilon-near-zero (ENZ) state it would be possible to achieve ultra-compact photonic memories (Fig. c-e). Therefore, our results show that ITO could be used to enhance new disruptive photonic applications based on silicon thermo-optic effect such as quantum processors [4]. Furthermore, the utilization of ITO for non-volatile switching tackles the lack of memory in silicon and provides a pathway for ultra-low power consumption electro-optic devices.

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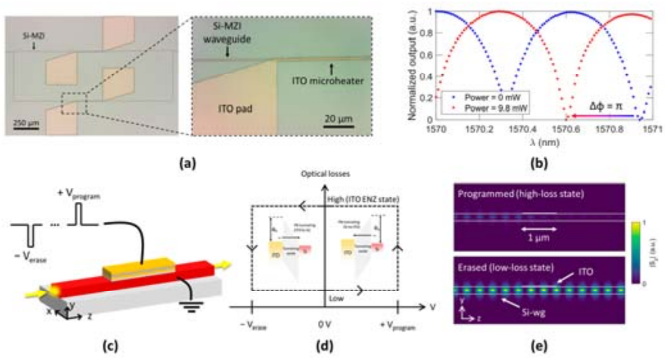

Figure. (a) Fabricated silicon Mach-Zehnder interferometer (MZI) with ITO microheaters. **(b)** Thermo-optic response of the MZI. **(c)** Concept-art of the photonic memory. **(d)** Schematic representation of the electro-optic response of the memory. The ITO switches between states of high (ENZ) and low optical losses by injecting carriers based on the Fowler-Nordheim (FN) tunneling. **(e)** Light propagation through the waveguide with the memory on different states.

ID: 03972, 17/07/2019 19:00 - 17/07/2019 19:05, Room 0.4 (ground floor)
S4. Applied Photonics (DFMC-GEFES)
(Poster-Flash Talk)

Dipole resonances of sub-wavelength dielectric spheres in the optical range: approximate conditions for moderate- and high-refractive-index materials

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Let us suppose that a uniform, non-magnetic and non-absorbing dielectric sphere with radius *R* is surrounded by an also non-magnetic and non-absorbing dielectric medium. By means of the Mie theory, the scattering efficiency for light propagating through the surrounding medium with wavelength λ can be expressed as an explicit function of R, λ and *m*, where *m* is the relative refractive index of the sphere with respect to that of the medium. Such scattering response is strongly resonant within the optical region for the case of dielectric nanoparticles, which can in fact be considered as a sort of dielectric nanoantennas, given their ability to redirect freely propagating light into localized energy, and vice versa [1]. When in the sub-wavelength regime, dielectric nanoparticles can also be used as building blocks for optical meta-materials that enable one to tailor the effective response to electromagnetic waves [2].

In order to fully develop all these promising applications, the dependence of a given resonance at a specific material on *R,* λ and *m* might be straightforwardly obtained without the actual evaluation of Mie scattering coefficients. In this work [3], we discuss the way in which resonant (*R*, λ, *m*) triplets can be approximately determined for the case of dipole resonances. Starting from some previous results for high-refractive-index spheres [4], we manage to obtain explicit expressions that also hold for materials with $m < 3$ within the optical range, such as Cu_2O or TiO_2.

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S5. Fronteras en la Física Molecular (GEFAM)

La física molecular es un campo maduro donde tanto los experimentos como las simulaciones teóricas se han vuelto muy sofisticadas, precisas y fiables. Este conocimiento está siendo aplicado y está contribuyendo cada vez más a otros campos como la nanociencia, la materia cuántica, la astrofísica molecular, etc. El simposio aspira a reunir a investigadores interesados en varios tópicos “en la frontera” en donde sea valiosa una perspectiva a nivel molecular: agregados moleculares, procesos moleculares en condensados cuánticos, transporte molecular en materiales nanoporosos, interacciones no covalentes en materia blanda, y muchos otros que se puedan beneficiar de esta “perspectiva molecular”, bien desde un punto de vista experimental como teórico.

Organizadores:
José Campos Martínez, *IFF-CSIC*
Tomás González Lezana, *IFF-CSIC*
Massimiliano Bartolomei, *IFF-CSIC*
Marta Isabel Hernández Hernández, *IFF-CSIC*

Patrocinado por:

Real Sociedad Española de Física
R.S.E.F.

GE Física Atómica y Molecular

S5. Frontiers in Molecular Physics (GEFAM)

Molecular physics is a mature field where both experiments and theoretical simulations have become quite sophisticated, precise and reliable. This know-how is being increasingly applied and contributing to neighboring fields such as nanoscience, quantum matter, molecular astrophysics, etc. This symposium aims to bring together researchers interested in various frontier topics where insights from a molecular level perspective are worthwhile: molecular clusters, molecular processes within quantum condensates, molecular transport in nanoporous materials, non-covalent interactions in soft matter, and many more that will benefit from a "molecular view" both from the experiment and the theory.

Organizers:

José Campos Martínez, *IFF-CSIC*
Tomás González Lezana, *IFF-CSIC*
Massimiliano Bartolomei, *IFF-CSIC*
Marta Isabel Hernández Hernández, *IFF-CSIC*

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ID: 03767, 15/07/2019 14:50 - 15/07/2019 15:10, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

MOLECULAR AGGREGATION IN COLD ENVIRONMENTS: THE TYRANY OF –OH AND THE DEMOCRATIC –NH_2

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All molecules aggregate, under appropriate conditions. However, the mechanistic of the aggregation process strongly varies depending on the chemical nature of the molecules: while some chemical species tend to form ordered structures, others produce more chaotic clusters. A thin and not completely well understood line separates these behaviors. Here we present some examples of very similar molecules with very different aggregation preferences. The results were obtained using a combination of laser spectroscopy in jets and DFT calculations and highlight the difficulty of modeling non-covalent interactions [1,2].

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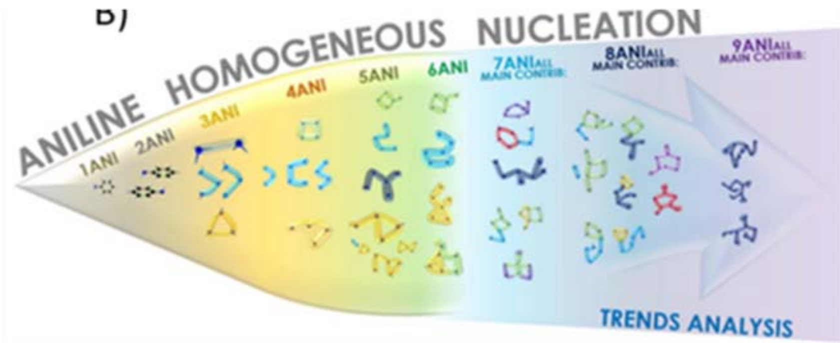

ID: 03823, 15/07/2019 15:10 - 15/07/2019 15:30, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Dynamics of doped helium nanodroplets

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We report theoretical investigations on the dynamics of doped He nanodroplets in real-time. He nanodroplets are intriguing, quantum fluid objects of finite size. Doping them with atoms or molecules makes them a particularly interesting model to study the fate of an excited system in or on them. The doping process itself is still not fully understood, in particular in the presence of quantum vortices. Helium density functional theory (He-DFT) approach and its time-dependent version (He-TDDFT) are the best compromise between accuracy and feasibility to study the stability and real time dynamics of doped helium droplets with a size comparable to experiments.[1] Comparing with highly detailed recent experiments such as those combining pump-probe spectroscopy with velocity map imaging allows to shed light on the importance of energy transfers between the excited atomic or molecular system and this unusual quantum solvent.
In this presentation, the recent work conducted in collaboration between the Barcelona and the Toulouse teams on ^{4}He nanodroplets will be reviewed. The following processes will be presented, depending on time:

- doping [2], possibly with quantum vortices [3],
- real time dynamics of photo-excited alkalis on the droplet surface [4],
- electronic relaxation induced by the helium environment [5, 6].

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ID: 03870, 15/07/2019 15:30 - 15/07/2019 15:50, Room 0.5 (ground floor)

S5. Frontiers in Molecular Physics (GEFAM)

(Invited Symposio)

Dissociation of acids in tiny water droplets

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The dissociation of acids is one of the most fundamental chemical processes. It has been well studied in bulk, but in situations where the amount of water is very limited, studies are scarce. In particular, the question regarding the minimum number of water molecules required to dissociate an acid molecule in a microsolvated environment still remains open.

There is solid evidence that dissociated HCl can be stabilized using a minimum number of only four water molecules [1]. However, this number has been questioned both on experimental and theoretical sides [2,3]. A recent experimental work [4], in which the dipole moment of $HCl(H_2O)_n$ clusters is measured as a function of the number of water molecules, tried to offer a definitive answer to this question. A sudden rise in the dipole moment for n=6 was understood as the onset of the acid dissociation. However, ab initio path integral (AIPI) calculations performed in our group proved the interpretation of this experiment wrong [5].

Our AIPI calculations confirm that 4 is indeed the smallest number of waters to produce the dissociated acid at low temperature in agreement with previous studies [1]. In addition, we find that as temperature increases, the HCl gets back to its molecular form, therefore more water molecules are needed in order to trigger the dissociation.

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ID: 03979, 15/07/2019 15:50 - 15/07/2019 16:10, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Quantum Monte Carlo simulations in Graphical Processing Units

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Quantum Monte Carlo (QMC) methods have become a powerful tool in Atomic and Molecular Physics because provide reliable description of the ground and some excited states of quantum many body systems starting from the interaction between their constituents. Systems of interests such as many electron atoms or molecules [1,2] or quantum clusters [3] are currently studied by using QMC. These methods, however are computationally expensive. In the last years, the rapid development of graphics processing units (GPU) including double precision arithmetic and enhanced memory performance, has allowed their use for scientific applications [4,5]. QMC is, in principle a good candidate for using in GPU because of its high degree of data parallelism. However, difficulties related memory handling have hindered its use [6,7,8]. In this work, we present an alternative algorithm to circumvent part of these problems and study the performance of QMC simulations on GPU for helium droplets as compared to CPU based simulations.

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ID: 03717, 15/07/2019 17:10 - 15/07/2019 17:30, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Probing intermolecular forces in weakly bound aggregates by supersonic jet microwave spectroscopy

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Non-covalent interactions (NCIs) play an important role in multiple physical, chemical and biological problems, since they control molecular interaction, aggregation and self-recognition. We approach the study of NCIs by generation of neutral molecular clusters in supersonic jet expansions, followed by spectroscopic probing via molecular rotational spectroscopy, with either chirped-pulsed or single-tone microwave excitation. In this communication three case studies will be considered, including the dimers of (cyclohexanol)$_2$, (cyclohexylamine)$_2$ and 2- and 3-(thiopheneethanol)$_2$. The experimental rotational constants and conformational landscapes will be compared with density-functional theory calculations at the B3LYP level with empirical inclusion of (D3) dispersion terms. The results will illustrate the benefits of rotational spectroscopy to characterize the potential energy surface and structural and energetic properties of weakly-bound molecular clusters, simultaneously behaving as accurate benchmark for the quantum chemical calculations [1,2].

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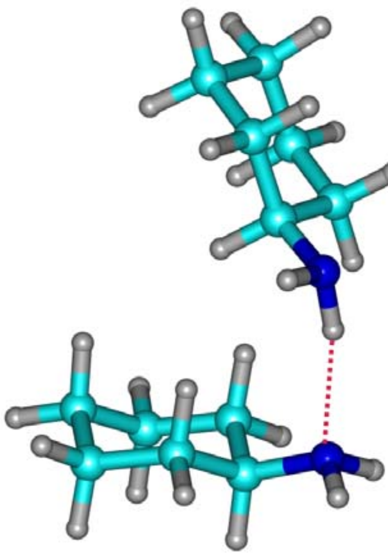

ID: 03796, 15/07/2019 17:30 - 15/07/2019 17:50, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Functional group-based corrections for the calculation of noncovalent interactions by semiempirical quantum mechanical methods

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Simulations of large molecular systems may be carried out by using either molecular mechanical force fields or semiempirical (SE) quantum mechanical methods. The most popular SE methods are those based on the neglect of diatomic differential overlap (NDDO) approximation; examples are the AM1, PM*x* and PMO*x* Hamiltonians. The dramatic approximations involved in these methods lead to significant errors in the calculation of intermolecular interactions [1,2]. Over the last years, there have been significant efforts directed at improving the performance of these methods, either by strengthening the quantum mechanical Hamiltonian or by including analytical corrections for dispersion and hydrogen bonding (e.g., see [3-7]). However, we have found that, for some geometrical configurations of certain systems, these improved methods predict very inaccurate interaction energies. The main origin of these errors comes from the limited number of relative orientations of interacting molecules considered in the parametrization processes. We are developing analytical corrections using a pairwise approach in which the parameters depend on the nature of the interacting functional groups. Our preliminary results show significant improvements over previous approaches.

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S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Molecular diffraction under fast grazing incidence: A suitable tool for surfaces analysis?

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Since pioneering experiments of diffraction of atoms and molecules from surfaces under fast (0.2-25 keV) grazing (1º-2.5º) incidence condition [1,2], GIFAD and GIFMD, a great deal of effort has been devoted to develop this promising surface analytical tool [3]. Most of the effort has been focused atomic projectiles. However, the use molecular projectile opens very interesting perspectives. For example, H_2 can be degenerated more easily than H, and is lighter than He, thus reducing the relative importance of surface-phonon inelastic processes. Furthermore, the internal degrees of freedom (DOFs) of H_2 allow for a more in-dept exploration of the surface characteristics.

The lack of studies focusing on molecular projectiles is partly due to the fact that an accurate theoretical description of GIFMD is quite challenging, and such description is key to extract as much as possible meaningful information from experimental measurements. Few years ago, we already showed that GIFMD could be used to determine molecular sticking probabilities at thermal energies [4]. More recently, we have showed that as a result of the anisotropy of the projectile, initial rotational excitation leads to an increase in intensity of high-order diffraction peaks at incidence direction that satisfy precise symmetry constraints, which provides a more details information on the surface characteristics than that obtained from low-order GIFAD peaks [5], and that scattering in predominantly rotationally elastic [6]. Our latest results reveal that an accurate theoretical description of GIFMD is basic to know the characteristic of the experimental molecular beam. During the conference, we will discuss theoretical studies.

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ID: 03689, 15/07/2019 18:10 - 15/07/2019 18:30, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Models for CO_2 adsorption and separation by carbon-based membranes

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Graphynes are porous derivatives of graphene that can be considered as ideal 2D nanofilters. Here, we investigate by theoretical methods graphtriyne multilayers, proposing them as membranes featuring pores of subnanometer size suitable for CO_2/N_2 separation and CO_2uptake. The potential energy surfaces, representing the intermolecular interactions within the CO_2/N_2gaseous mixtures and between the graphtriyne layers and the molecules, have been formulated in an internally consistent way, by adopting potential models far more accurate than the traditional Lennard-Jones functions, routinely used to predict static and dynamical properties of matter. The new force fields so obtained and tested on accurate ab initio calculations have been used to perform extensive molecular dynamics simulations of membrane selectivity and adsorption. The accuracy of the potentials granted a quantitative description of the interactions and realistic results for the dynamics under a wide range of conditions of applied interest, indicating a single-layer permeation ratio $CO_2/N_2$of 4.25 (meaning that permeations of $CO_2$are typically 4.25 times those of N_2). At low pressure, graphtriyne bilayer membranes exhibit good performances as a molecular sieving candidate for postcombustion CO_2separation because of a high permeance and a relatively good selectivity. On the other hand, graphtriyne trilayer membranes present a relatively high interlayer adsorption selectivity and a high CO_2uptake. Such properties make these graphyne nanostructures versatile materials competitive with other carbon- based adsorbing membranes suitable to cope with post-combustion CO_2 emissions. Moreover, guidelines for the extension of the proposed methodology to carbon nanostructures and other gaseous mixtures of relevance for atmosphere and combustion are also provided.

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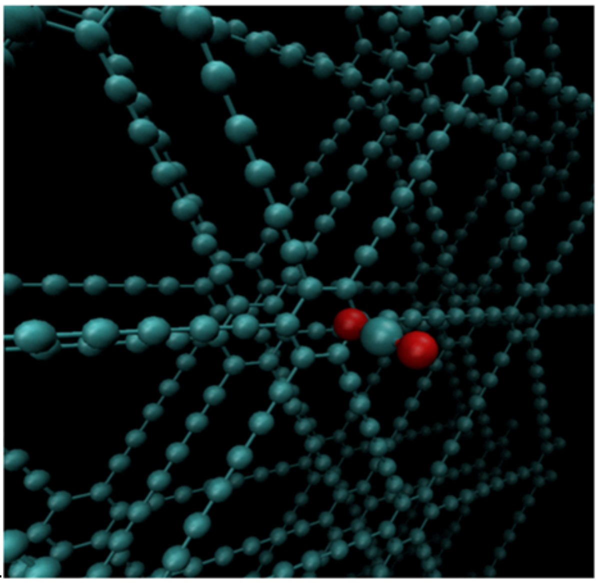

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S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Bimetallic clusters: mixing at the nanoscale

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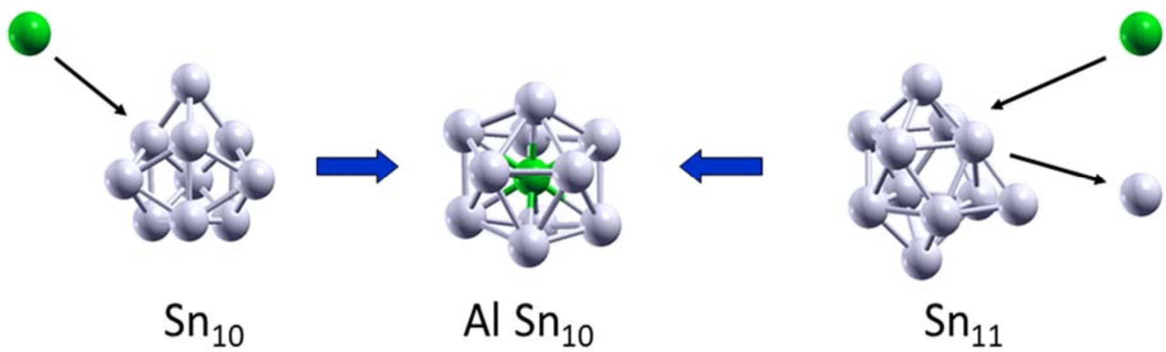
Immiscible metals in the bulk solid phase can mix at the nanoscale, and a typical example is the Al-Sn system. We have investigated the reasons for the enhanced miscibility by performing Density Functional calculation for small Al_mSn_n clusters. The cohesive energies show that the clusters are energetically stable with respect to the separated atoms. This justifies the observation that those clusters can form by condensation in gas phase experiments. An adequate miscibility criterion consists in studying the substitution reactions in which an Al atom replaces a Sn atom of the Al_mSn_n cluster or a Sn atom replaces an Al atom. Substitution reactions enriching the clusters in Sn and depleting the clusters in Al are favorable. However, $AlSn_{10}$ is an exception to this general trend. It readily forms by replacing a Sn atom by an Al atom in Sn_{11}, or by adding an Al atom to Sn_{10}. The exceptionally stability of $AlSn_{10}$, whose structure is that of a Sn_{10} cage enclosing the Al atom, justifies its high population in the mass spectra. The two paths leading to the formation of $AlSn_{10}$ unravel a physical effect important to understand the enhanced alloying at the nanoscale. This is the structural flexibility of the clusters. In our particular case it means that the geometric structures of Sn_{11} and Sn_{10} easily reorganize to form $AlSn_{10}$ accommodating the Al atom inside a Sn cage.



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S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Broad Band Molecular Rotational Spectroscopy for Laboratory Astrophysics

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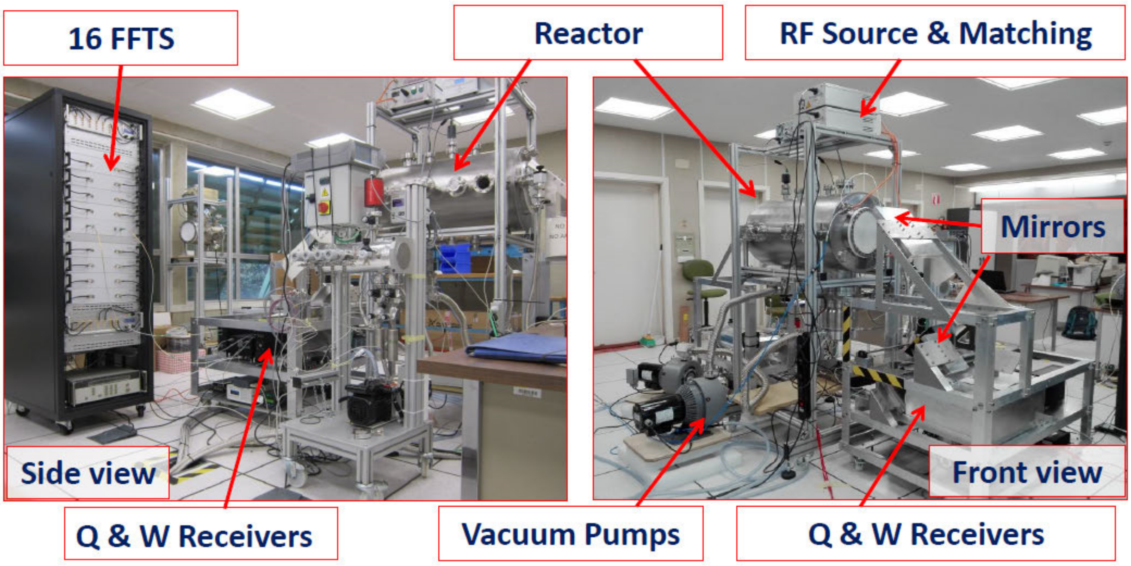
We present in this contribution the GACELA experimental setup of the ERC synery NANOCOSMOS. GACELA (Gas Cell for Laboratory Astrophysics) consists of a reactor coupled to a broad band high spectral resolution detection system similar to those used in radio telescopes to detect extremely weak signal proceeding from interstellar and circumstellar clouds.



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S5. Frontiers in Molecular Physics (GEFAM)

(Invited Symposio)

Simulating the structural diversity and infrared response of carbon clusters across the planar to fullerene transition

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Carbon clusters show a significant ability to hybridize in sp, sp^2 or sp^3 chemical bonds, reflecting at finite size the wide allotropy of bulk carbon matter. In the recent years the interest in pure and hydrogenated carbon clusters has been driven by the recent detection of C_{60} fullerene in the interstellar medium (ISM) due to their peculiar infrared emission bands [1]. These fullerene bands accompany the so-called aromatic infrared bands, which trace polycyclic aromatic aliphatic mixed hydrocarbons [2]. In order to obtain a better understanding of the formation mechanism of cosmic fullerenes and to identify other possible forms of carbon clusters in the ISM, it is essential to characterize the possible structural diversity of carbon clusters and map these structures onto their spectroscopic signature.

In this presentation, we will describe the use of atomistic simulations to explore the structural diversity and the IR spectroscopy of carbon clusters in the size range where they undergo the flake-to-fullerene transition. Although the degree of chemical ordering is obviously expected to vary with increasing excitation energy, the extent of chemical and conformational variety remains undocumented so far, and this study represents the first attempt to construct a library of carbon cluster structures in an unbiased way, not focusing on the lowest-energy structures only.

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ID: 03757, 16/07/2019 15:30 - 16/07/2019 15:50, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Spectroscopy of relevant non-rigid molecules of astrophysical interest: ethylene glycol and dimethyl-ether.

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I present my own methodology for the study of non-rigid molecules. As examples, the last works on ethylen glycol (EGLY)[1] and dimethyl-ether (DME) [2] are shown. EGLY was astrophysically identified in 2002 [3]. DME was found in 1974 [4] and latter on, it was observed its firts torsional state [5].

Many medium-sized organic molecules present non-rigidity. Large amplitude motions (LAM), intertransform the different conformers. In EGLI, they can stabilize by the formation of intramolecular hydrogen bonds which determine the symmetry and play important roles on the low vibrational energy levels. A variational procedure of reduced dimensionality based on CCSD(T)-F12 calculations is applied to understand the FIR spectrum [1]. The anisotropy of the surface in the gauche region converts the assignment and classification of the torsional levels into a tricky puzzler.

DME is an asymmetric top molecule with two internal rotors undergoing large amplitude motions. One of the torsional bands is forbidden in the infrared spectra, that preventing the experimental determination of some of the interaction parameters. The FIR spectrum was first observed and assigned by Groner and Durig in 1977 [6]. In 1995 [7-8], we erformed ab initio calculations concerning the torsional structure and the research was reconsidered in 2015 [9] using highly correlated ab initio calculations. New Raman measurements at different temperatures [2] allowed us to reassign relevant torsional bands.

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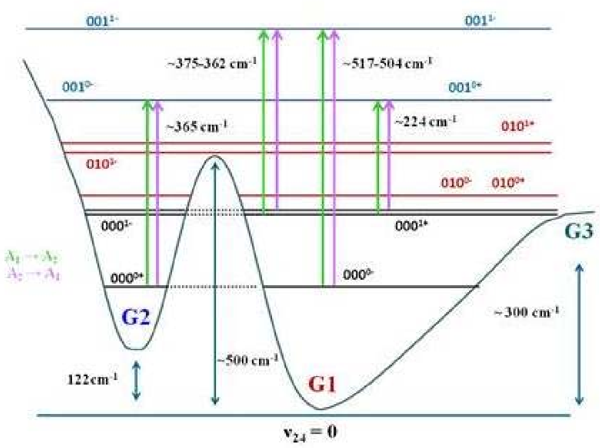
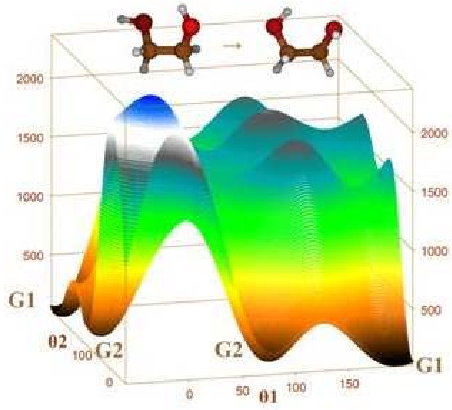


~375-362 cm-1
~517-504 cm-1
~365 cm-1
~224 cm-1
G3
G2
G1
122cm-1
~500 cm-1
~300 cm-1
v24 = 0



G1
θ2
G2
G2
θ1
G1

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S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Quantum Dynamics of H_2 in SWCNTs: Eigenstates, Diffusion, and Surface Coupling

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The rise of new materials presenting cavities and other structures with a characteristic dimension on the order of the nanometer has taken to the discovery of new physical phenomena. These *quantum confinement* effects play a major role on the electronic properties of the materials, and also on the behaviour of the molecules adsorbed therein [1]. The level fine control achievable nowadays during the synthesis of nanostructured materials allows for the design of new devices to tune the properties of the adsorbates -altering their electronic structure, their dynamics, and thus even their reactivity- in order to find new applications such as storage devices for light gases [2], molecular flasks [3], or quantum sieves [4,5,6].

Here we present an overview of our work on the accurate quantum dynamics simulation of H_2 embedded in a (8, 0) Single Walled Carbon Nanotube. Results will cover confinement effects on the eigenstate spectrum of the molecule, its diffusion along the carbon nanotube and our latest progress on the coupling between the molecular motion and the nanostructer phonons. These observations may be helpful in the design of new quantum sieves.

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S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Structural transformations of supported Pd clusters induced by hydrogen adsorption

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The properties of metal clusters depend on cluster size and shape. A lot of effort has been devoted to determining the structures of clusters as a function of cluster size. Supported clusters and nanoparticles are used as novel catalysts. Besides of the strong size-dependence, different isomeric structures of the clusters may lead to a completely different activity and selectivity of the catalyst.

Our interest focusses on the adsorption and dissociation reaction of hydrogen on supported metal nanoparticles [1,2] which is a process of broad technological application in fields such as catalysis, hydrogenation reactions, hydrogen fuel cells, hydrogen storage, etc. How the dissociation of H_2 affects the structure of the cluster is a question of practical interest for the stability of the catalytic process. Therefore, we have performed ab initio dynamical simulations based on the density functional formalism for molecular hydrogen impinging on a Pd_6 cluster anchored to a vacancy defect in graphene. A substantial fraction of the hydrogen molecules rebound after colliding with the Pd cluster but still a significant number of H_2 molecules adsorbs on the cluster. A number of those adsorbed molecules later on dissociate on the cluster, leading to two chemisorbed H atoms. Interestingly, dissociation of H_2 triggers a transition from the original octahedral structure of the anchored Pd_6 to an incomplete pentagonal bipyramid structure. No such structural change was previously observed for Pd_6 adsorbed on pristine graphene.

Although this new result comes for a specific reaction the observation of a structural change, which means that the cluster structure is not immune to the reaction taking place on its surface, may be relevant for many catalytic processes occurring on the surface of small metal particles.

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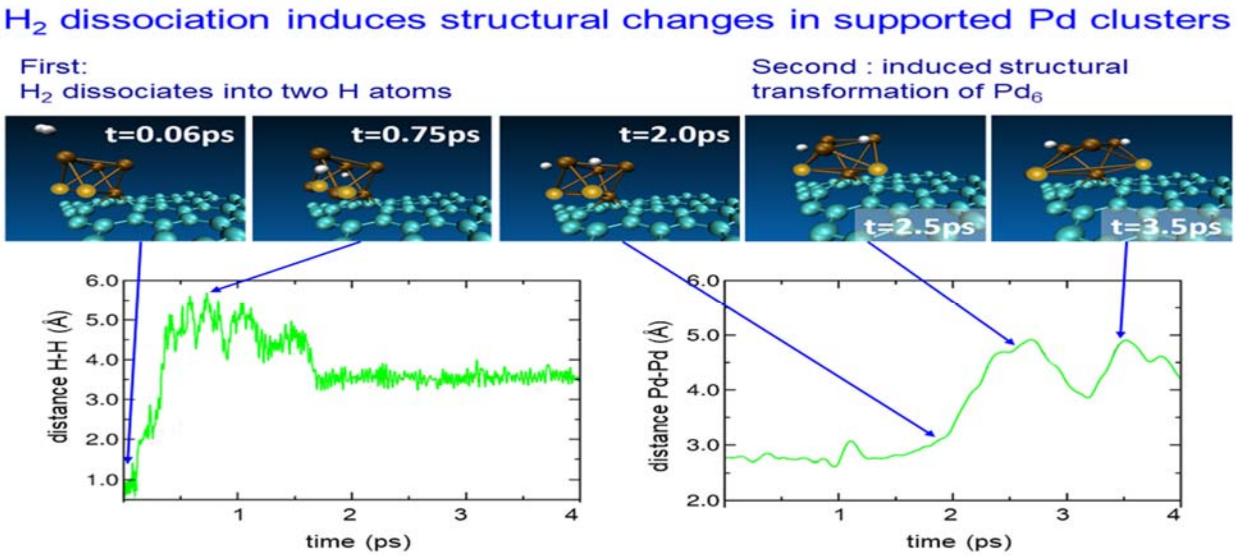

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S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

THE STEREODYNAMICS OF ELEMENTARY PROCESSES CONTROLLED BY ANISOTROPIC INTERMOLECULAR FORCES

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Present work focus on a proper investigation of the role of electric and magnetic field gradients, arising from anisotropic intermolecular forces, which can induce molecular polarization, i. e. alignment and/or molecular orientation as a consequence of molecular collisions. Knowledge of these phenomena, still not fully understood, is of general relevance for the control of the stereodynamics of elementary chemical-physical processes, under a variety of conditions both in gas phase and at surface. In particular, the mode-specificity in reaction dynamics of open-shell atoms, free radicals, molecules, atomic and molecular ions, under hyper-thermal, thermal and sub-thermal conditions is determinant for catalysis, plasmas, photodynamics, interstellar and low-temperature chemistry. On the ground of the experimental findings achieved in our laboratory, we distinguish:

Molecular alignment by weak van der Waals forces. It arises as combined effect of several elastic/inelastic collisions occurring along preferential directions in environments where anisotropic velocity distributions are operative;
Molecular orientation controlled by anisotropic intermolecular forces of intermediate strength- Occurring even in single collision events, if molecules are in low lying rotational states;
Molecular orientation induced by anisotropic intermolecular forces of high strength- Dominant in each collision event under an ample variety of conditions.

Experimental findings [1-4] will be presented and open questions will be discussed.

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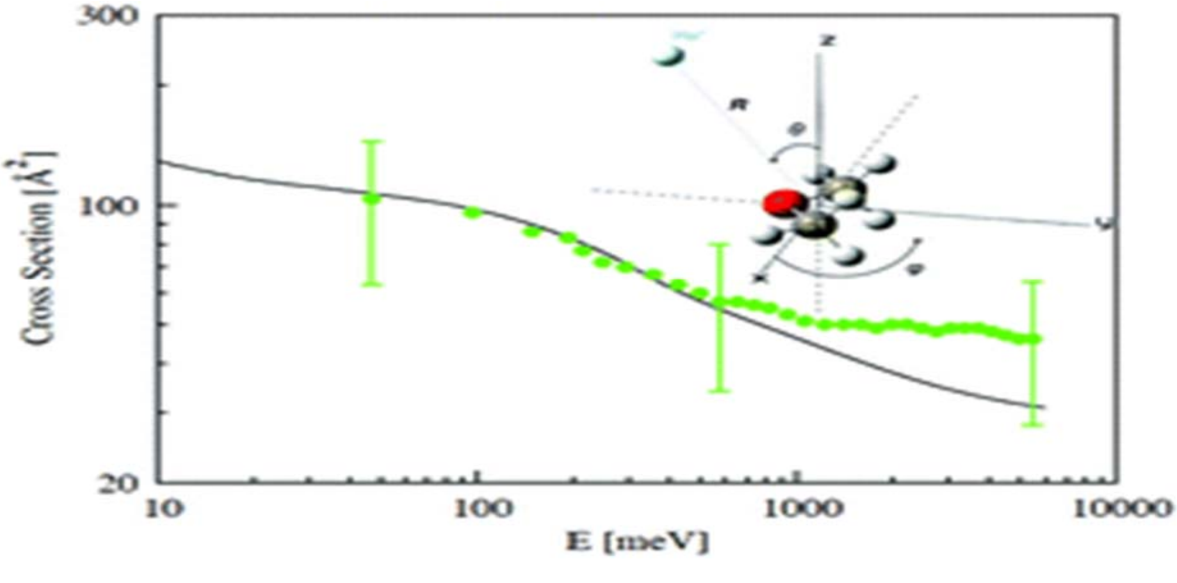

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S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

On the role of long-range interactions in the dynamics of OH + H_2 collisions

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Recently, we carried out an investigation on the dynamics of OH+H_2 collisions [1] through a mixed quantum-classical method [2], where vibrations are treated according to quantum mechanics and rotations and translation are treated classically. The study showed that the dynamics of the OH+H_2 reaction depends on the vibrational excitation of the H_2 bond, whereas it is much less affected by the vibrational excitation of OH. The simultaneous calculation of vibrational energy exchange probabilities on the other hand suggests that the non-reactive dynamics is mainly non-adiabatic. However, to get reliable results in this respect, the potential energy surface (PES) has to take into account long range effects, which are essential to accurately evaluate the exchange of vibrational quanta.

To this end, the PES [3] first employed in the study was modified by adding a long-range tail according to an Improved Lennard Jones model [4]. The results show that not only vibration to vibration energy exchange probabilities are dramatically sensitive to long range effects, but also reactive probabilities and rate coefficients are influenced by the correct description of the whole potential energy surface. From a physical standpoint, it is possible to understand that certain specific relative configurations of the colliding partners are more effective for reactive and/or inelastic scattering processes, so that comparison between the two PES's for those geometries allows to rationalize their behavior to predict reactive and inelastic scattering events.

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ID: 03650, 16/07/2019 17:50 - 16/07/2019 18:10, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Disorder hyperuniform states: new properties from well known materials

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Disordered hyperuniform states were characterized more than a decade ago by Torquato and Stillinger [2], as peculiar states of matter that display local disorder (in common with fluids and glasses) and long range order (in common with crystals). These states are characterized by the suppression of long range density (or concentration) fluctuations, which implies vanishing structure factors for small wavenumbers. They have been shown to be at the source of the acute visual systems of birds, and also in the presence of unusual wide optical gaps in amorphous semiconductors. In this presentation, we will address the nature of disordered hyperuniformity in mixtures and single component systems, in two dimensional systems in Euclidean and non-euclidean geometries, and illustrate the connection between hyperuniformity and the accurate numerical representation of images.

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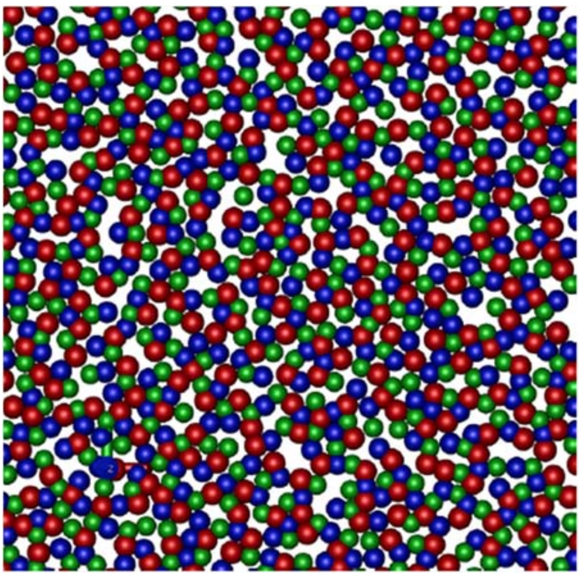

ID: 03735, 16/07/2019 18:10 - 16/07/2019 18:30, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Simulating adamantane clusters: atomistic versus coarse-grained models.

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Putative structures for the global minima of adamantane clusters, $(C_{10}H_{16})_N$, are presented. Based on a rigid model for individual molecules with atom-atom pairwise interactions that include Lennard-Jones and Coulomb contributions, low-energy structures were obtained up to N=40 using the basin-hopping method [1]. The results indicate that adamantane clusters initially grow accordingly with an icosahedral packing scheme, followed above N=14 by a structural transition toward face-centered cubic structures. The special stabilities obtained at N=13, 19, and 38 are consistent with these two structural families and agree with recent mass spectrometry measurements on cationic adamantane clusters [2]. Coarse-graining the intermolecular potential by averaging over all posible orientations only partially confirm the all-atom results, the magic numbers of 13 and 38 being preserved. However, the details near the structural transition are not captured well, because despite their high symmetry the adamantane molecules are still rather anisotropic [3].

Acknowledgments

J.H.-R. acknowledges financial support from Ministerio de Economía y Competitividad and the Fondo Europeo de Desarrollo Regional (FEDER, UE) under Grant No. FIS2016-79596-P.

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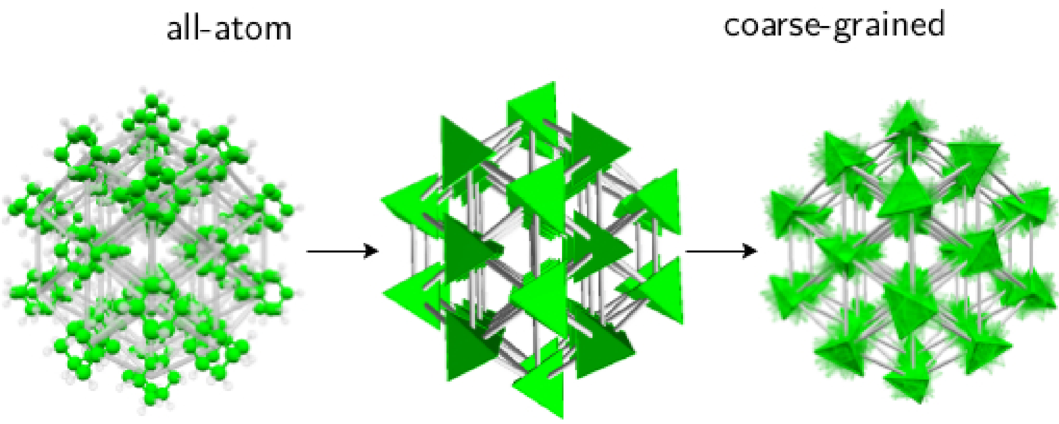

ID: 03720, 16/07/2019 18:30 - 16/07/2019 18:50, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Invited Symposio)

Microsolvation of ions by using state-of-the-art methods based on artificial intelligence

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Solvation is a ubiquitous physical process, which is relevant to understand many phenomena across several disciplines. A detailed way to look at such process is based on the microsolvation approach, where the solvent entities (atoms or molecules) are added stepwise to the solute.

Major challenges to set up the theoretical study of microsolvation are: (i) the accurate description of the interaction potential, which requires the use of state-of-the-art methods to perform electronic-structure calculations that are, then, employed in a least-squares fit to an adequate analytical potential function; (ii) by using such a potential function and effective global-optimization methods, one may be able to discover low-energy structures of the clusters; (iii) the re-optimization of these low-energy geometries by employing a higher level of theory, i.e., with either ab initio or density functional theory (DFT) calculations, may lead to more realistic structures. In particular, the latter becomes extremely time consuming due to the great number of minima that grow up rapidly with the size of the cluster.

I will present the recent advances carried out in our group to deal with the aforementioned three stages needed to study microsolvation of alkali-metal ions with either atoms or molecules [1-3]. Specifically, I will discuss the ability of the analytic potential energy surface to represent accurately low-energy minimum structures that are discovered with our evolutionary algorithms [2, 3]. The recently proposed [4] machine-learning methodology employed to select the most promising structures to be re-optimized at a higher level of theory will be also described and discussed.

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ID: 03934, 15/07/2019 16:25 - 15/07/2019 16:30, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Poster- Flash Talk)

A linear polar molecule in a two-color laser field: a symmetry analysis

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An experimental technique to induce molecular orientation is based on the use of non-resonant two-color laser fields [1], which couples pendular states with different parity due to the interaction with the molecular hyperpolarizability. In this work, we investigate the rotational dynamics of a linear polar molecule in a non-resonant two-color cw laser field. We consider non-resonant two-color laser fields having parallel polarizations in the regime where the time-average approximation does not hold [2]. To do so, we decrease the frequencies of the laser fields until the time-average over the rapid oscillations of the laser field becomes non-negligible. Note that we still assume that the laser field does not drive any electronic, vibrational or rotational transitions in the molecule, which is described within the rigid-rotor approximation. Thus, the field-dressed rigid-rotor Hamiltonian includes the interaction of the two-color electric field with the permanent electric dipole moment, the polarizability, and the hyperpolarizability of the molecule.

In the regime beyond the time-average approximation, we explore the symmetries of the two-color electric field given by the biharmonic function [3] and analyze their impact on the field-dressed rotational dynamics. This study is done for different initial conditions as well as by averaging the influence of the initial condition on the final results. We investigate the rotational dynamics of a rigid-rotor molecule in detail as the parameters of the two-color electric field, i.e., the frequencies of the two electric field components, their relative phase, and their relative strength, are varied. We show that the alignment and orientation are symmetric and antisymmetric, respectively, as a function of the relative phase of the two components of the electric field. We also provide the field parameters needed to reach the largest orientation.

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ID: 04040, 15/07/2019 16:30 - 15/07/2019 16:35, Room 0.5 (ground floor)
S5. Frontiers in Molecular Physics (GEFAM)
(Poster- Flash Talk)

Quantum trap for atomic states: a case study

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A great interest in the study of confined systems has been motivated by the development of experimental techniques for the encapsulation of atoms and molecules [1-4]. In this communication we address the problem of the fate of a Hydrogen atom when it is liberated from a confining environment, which is described by a square-well potential [5]. The analytic continuation method and the sudden approximation are used in the work [6-8].
Ionisation probabilities of the atom when confinement is removed are obtained for different starting states. They are analysed as a function of the confinement size for fixed height and width of the well. For the well considered, a high ionisation probability is observed for two orbitals, while for the rest of states it presents lower maxima. Such behaviour can be explained by the attractive nature of the well, causing a state to be trapped in the well for sizes larger than 5.0 a.u.

Figure: Ionisation probability of the *2s* to *6s* states as a function of the confinement size, r_0.

Acknowledgements

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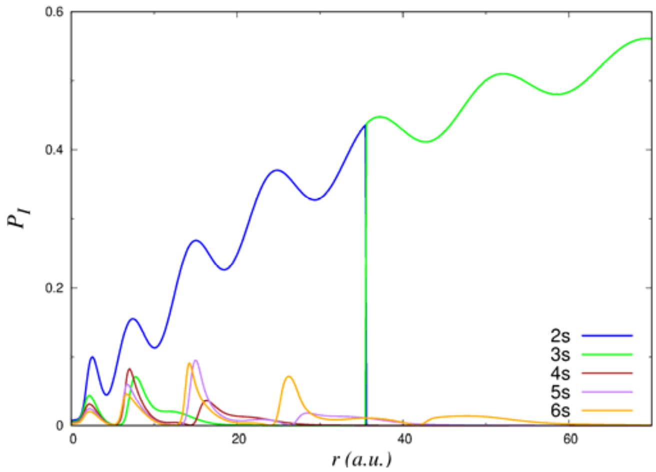

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S5. Frontiers in Molecular Physics (GEFAM)
(Poster)

Molecular dynamics simulation of the interaction between isoleucine enantiomers and β-cyclodextrin with different solvents

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A molecular dynamics simulation was carried out to study the capacity of isoleucine enantiomers to form inclusion complexes with β-cyclodextrin (β-CD), and to be discriminated by this chiral compound, *in vacuo* and with different solvents. The interaction energy is modelled by the force field proposed by *Weiner et al*. for the molecular simulation of nucleic acids and proteins. Solvents were characterized not only by the value of dielectric constant ε in the Coulombic interaction energy, but also by the neutral and zwitterion configurations of isoleucine (Ile) [1]. The molecular dynamics simulation of the interaction between Ile and β-CD shows that the enantiomers usually enter the cavity, move around inside during a certain period of time forming a stable complex and then exit from the CD. The factors that mainly influence inclusion complex formation are the solvent and the initial conditions of Ile in the trajectories. Isoleucine can form inclusion complexes with β-CD *in vacuo* and with different solvents. The binding free energy *F* for each enantiomer decreases when ε increases, the complex formed by Ile with β-CD *in vacuo* being the most stable. The solvent polarity influences the binding free energy *F*, since with the same value of ε the complexes formed by zwitterions are more stable than the neutral configurations of the amino acid. The first eluted enantiomer *in vacuo* and with different solvents is L-Ile [2], independently of the solvent polarity. Two probable configurations are deduced from the molecular dynamics simulation, in which the guest is always inside the cavity and with the carboxylic end of the amino acid oriented towards either rim of β-CD.

Acknowledgements

We are grateful to the Ministerio de Economía y Competitividad (FIS2016-79596-P, AEI/FEDER, UE) for their generous financial support.

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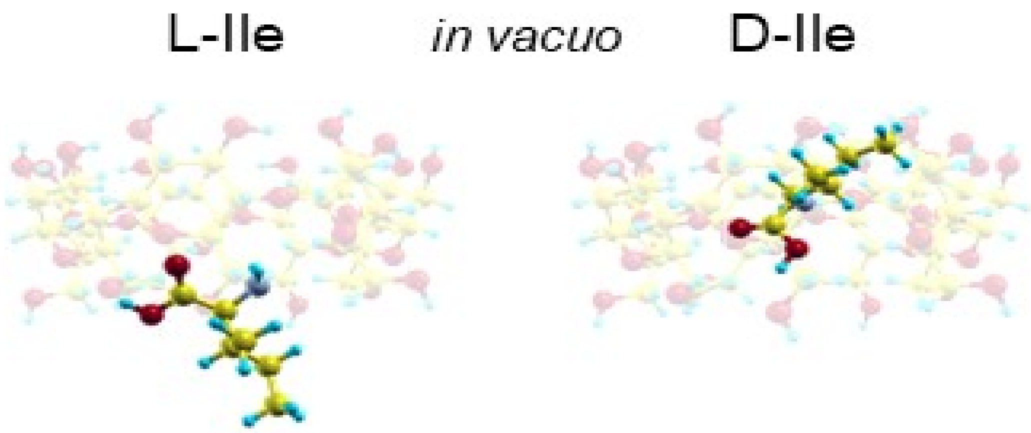

Combined theoretical and experimental studies of atom-diatom reactions

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We have recently investigated the dynamics of atom-diatom reactive collisions by means of a statistical quantum mechanical model [1,2] and mean potential phase space theory [3,4]. Theoretical results have been compared with previous and recent experimental work in order to analyze the possible complex-forming nature of the reaction pathways.

In particular we present cross sections and rate constants for $C(^1D) + H_2$ [5] and $O(^1D) + D_2$ [6] with isotopic variants where hydrogen and deuterium atoms can be interchanged.

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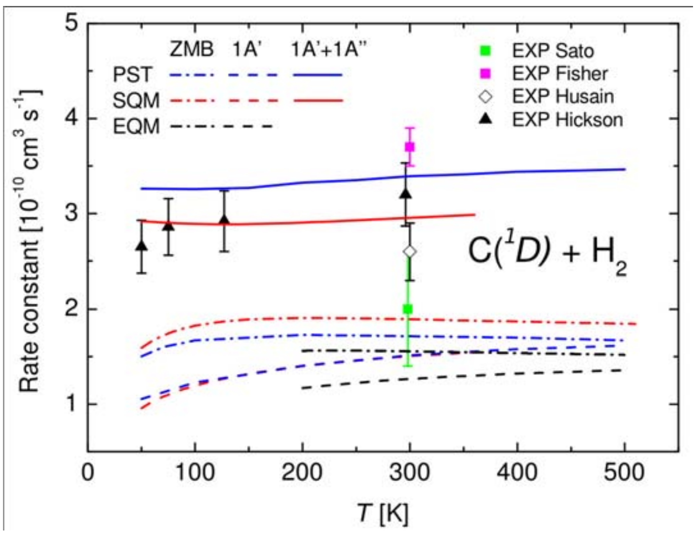

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S5. Frontiers in Molecular Physics (GEFAM)
(Poster)

A multi-proton cooperative mechanism for graphene permeation of protons

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It has been recently found that pristine graphene and some other 2D materials can be permeated by protons and deuterium at room temperature [1,2], following a low barrier (~ 0.8 eV) activated process. Most of the theoretical attempts have found so far, that permeation of the H^+ (D^+) involves large energy barriers (around 3.5 eV) and therefore they are too high to explain experiments [3]. In previous models it was assumed an isolated proton permeating the 2D membrane. In this work however, we consider protonated graphene at high local coverage and explore the role played by nearby chemisorbed protons in the process. By using density functional theory calculations (DFT) applied to large molecular prototypes for graphene we have found [4] that when various protons are absorbed on carbons belonging to the same hexagonal ring, permeation barrier can be lowered down to 1.0 eV, thus making feasible the permeation of protons through pristine graphene. The proposed insertion mechanism necessarily need to count with the nearby protons and it could be of relevance not only to help in the understanding of the experimental results, but also in many other scenarios of basic and technological interest.

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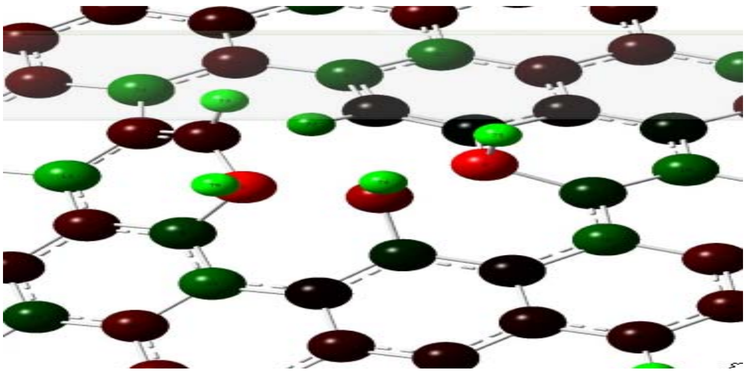

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S5. Frontiers in Molecular Physics (GEFAM)
(Poster)

Cisplatin physisorbed on graphene oxide prototypes: a computational study

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The physical adsorption of the cisplatin anticancer drug (CP) [1] on graphene oxide (GO) and reduced graphene oxide (rGO) is investigated at the DFT level of theory by using suitable molecular prototypes [2] representing the most probable adsorbing regions of GO and rGO platelets. The obtained results show that CP is preferentially adsorbed in correspondence of the epoxy and hydroxy groups (see Figure 1), by exploiting an effective hydrogen bonding between the -NH3 ends of the drug and the oxygen substituents on the (r)GO basal plane, as revealed by an energy decomposition analysis. Moreover, it is found that the reactivity of the physically adsorbed CP is practically unaltered being the free energy variation related to the first hydration reaction almost matching that of its free (unadsorbed drug) counterpart [3]. The reported results indicate that overall the CP physical adsorption on GO and rGO carriers is feasible being an exergonic process also in an aqueous medium. The CP adsorption could facilitate its solubility and transport in water solutions, exploiting the high hydrophilicity of the peripheral carboxylic acid groups located on the edge of the GO and rGO platelets. Moreover, it is also suggested the the CP loading on (r)GO platelets and its release could depend on the pH of the aqueous medium.

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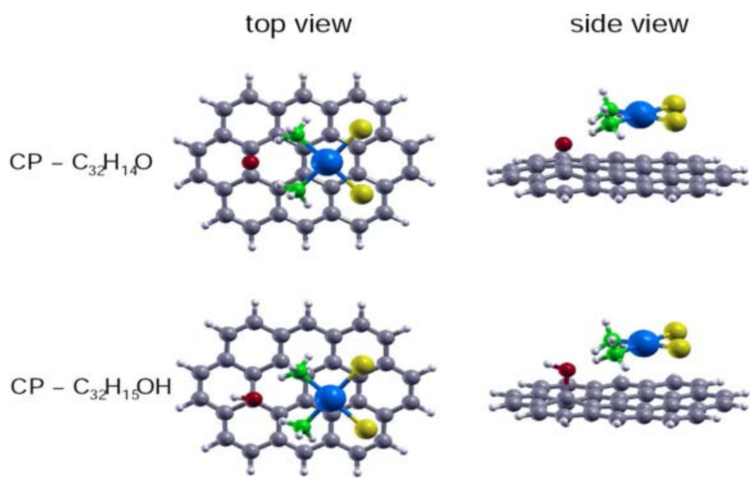

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S5. Frontiers in Molecular Physics (GEFAM)
(Poster)

Experimental and theoretical investigation of Cs^+ ions solvated in He_N clusters

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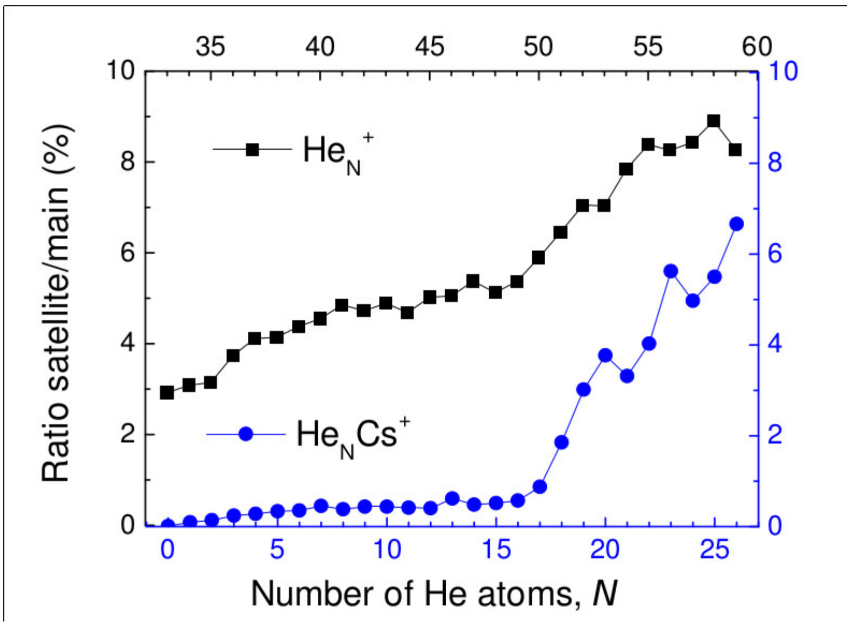
Solvation of Cs^+ ions inside helium droplets have been investigated both experimentally and theoretically. On the one hand, mass spectra of doped helium clusters ionized with a crossed electron beam, He_NCs^+ have been recorded for sizes up to $N = 60$. The analysis of the ratio between the observed peaks for each size N reveals evidences of the closure of the first solvation shell when 17 He atoms surround the alkali ion. On the other hand, we have obtained energies and geometrical structures of the title clusters by means of basin-hopping, diffusion Monte Carlo (DMC) and path integral Monte Carlo (PIMC) methods. The analytical He-Cs^+ interaction potential employed in our calculations is represented by the improved Lennard-Jones expression optimised on high level ab initio energies. The weakness of the existing interaction between helium and Cs^+ in comparison with some other alkali ions such as Li^+ is found to play a crucial role. Our theoretical findings confirm that the first solvation layer is completed at $N = 17$ and both evaporation and second difference energies obtained with the PIMC calculation seem to reproduce a feature observed at $N = 12$ for the experimental ion abundance. The analysis of the DMC probability distributions reveals the important contribution from the icosahedral structure to the overall configuration for $He_{12}Cs^+$.



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S5. Frontiers in Molecular Physics (GEFAM)
(Poster)

Solvation of Cs^+ in hydrogen/deuterium: a joint experimental-computational study

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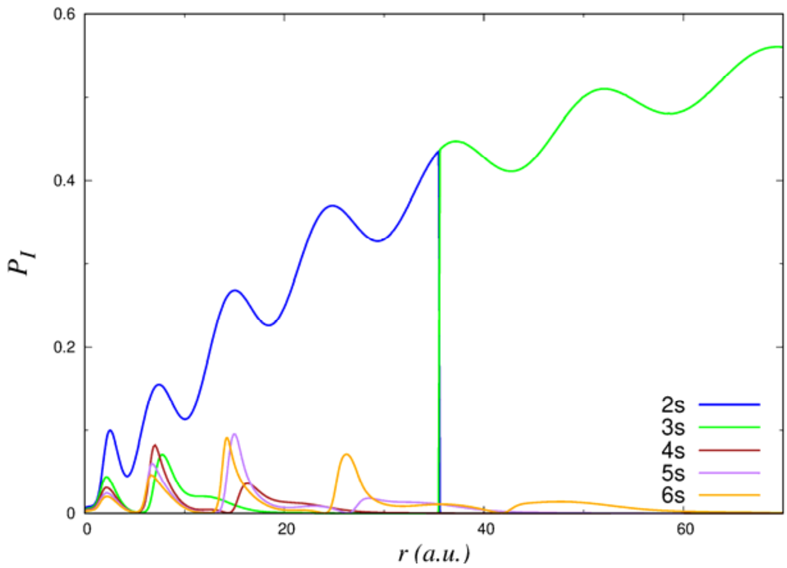
Interactions between molecular hydrogen and cations of metallic atoms are dominated by charge-quadrupole as well as induction forces, hence they are relatively strong despite being non-covalent. Due to these characteristics, one can ask whether hydrogen molecules would form dense, solid-like, solvation shells around the ion. In this work, the interactions between Cs^+ and H_2/D_2 are investigated both experimentally and computationally. On the one hand, helium nanodroplets doped with cesium and hydrogen or deuterium are ionized by electron impact and the $(H_2/D_2)_nCs^+$ (up to n=30) clusters formed are identified by mass spectrometry. On the other hand, a new and accurate potential energy surface is reported and cluster energies and structures are computed by means of classical and quantum-mechanical Monte Carlo calculations. Dependence of the computed evaporation energies with the cluster size, n, is remarkably similar to the behavior of the measured ion abundances. Clusters $(H_2)_{12}Cs^+$ and $(D_2)_{12}Cs^+$ stand out for their stability and quasi-rigid icosahedral structures. However, the first solvation shell involves thirteen or fourteen molecules for hydrogenated or deuterated clusters, respectively. It is found that these solvation layers exhibit the typical characteristics of the well-known Atkins snowballs. The role played by three-body induction interactions as well as the rotational degrees of freedom of the molecules is analyzed and it is found that, despite they are important at a quantitative level (10-15%), they become negligible once the first shell is completed.



S6. Nanociencia y Materiales Moleculares (NANOMATMOL)

La idea motriz del simposio es ofrecer a la comunidad española de física una visión lo más completa posible del estado de este campo multidisciplinar así como servir de foro de discusión a los diversos grupos activos en nuestro país. El simposio recogerá los últimos avances en el estudio experimental y teórico de fenómenos físicos en materiales moleculares, tales como transporte electrónico, magnetismo y superconductividad, fotónica, etc, así como su integración en dispositivos y potenciales aplicaciones en electrónica y espintrónica molecular, computación cuántica y refrigeración magnética, entre otras. El programa del simposio, previsto para la tarde del miércoles 17 de julio, constará de tres charlas invitadas (25+5 minutos) y unas 8 charlas de 15+5 minutos, distribuidas en dos sesiones.

Organizadores:
Angela Sastre, *Universidad de Elche*
Fernando Luis, *ICMA-CSIC*

Patrocinado por:

GRUPO ESPECIALIZADO NANOCIENCIA Y MATERIALES MOLECULARES

RSEQ Real Sociedad Española de Química

S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)

The symposium aims to offer a complete vision of the state-of-the-art of this multidisciplinary field and serve as a discussion forum for the various groups that are active in our country. It will help to discuss the latest advances in the experimental and theoretical study of physical phenomena in molecular materials, such as electronic transport, magnetism and superconductivity, photonics, etc, as well as their integration in devices and potential applications in electronics and molecular spintronics, quantum computing and magnetic refrigeration, among others. The program of the symposium, scheduled for the afternoon of Wednesday July 17th, will consist of three invited talks (25 + 5 minutes) and about 8 talks of 15 + 5 minutes, divided into two sessions.

Organizers:
Angela Sastre, *Universidad de Elche*
Fernando Luis, *ICMA-CSIC*

Patrocinado por:

ID: 03737, 17/07/2019 15:00 - 17/07/2019 15:20, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Invited Symposio)

Molecules of Lanthanide Ions as Multiqubit Quantum Gates

Guillem Aromí[1] , David Aguilà[1] , Leoní A. Barrios[1] , Verónica Velasco[1] , Olivier Roubeau[2] , Fernando Luis[2]

1) Universitat de Barcelona 2) Universidad de Zaragoza - CSIC

** Guillem Aromi, aromi@ub.edu*

The use of molecular electronic spins for the realization of qubits and qugates in quantum computing is one of the most recent and a very promising proposals in the area of quantum technologies. In this context, artificial magnetic molecules stand out not only because they are highly reproducible and can be mass manufactured by chemical methods. They are also versatile and engineerable and can be made for example to host several spins, thus embody several qubits.[1] Lanthanides are good candidates to embody the qubits in these systems, as they exhibit good coherent properties and offer a diversity of electronic features. We have designed a ligand-based strategy to synthesize di- or trinuclear lanthanide complexes exhibiting distinct coordination sites within one molecule type. This provides a means of preparing pure heterometallic complexes that can be of the [LnLn'] or the [LnLn'Ln] type, where the nature of the Ln and the Ln' metals can be decided almost at will. The performance of the [LnLn'] systems as CNOT as SWAP quantum gates (Figure 1) will be presented.[2,3] A proposal for using the [LnLn'Ln] molecules to implement a Controlled-phase gate will be discussed.

References

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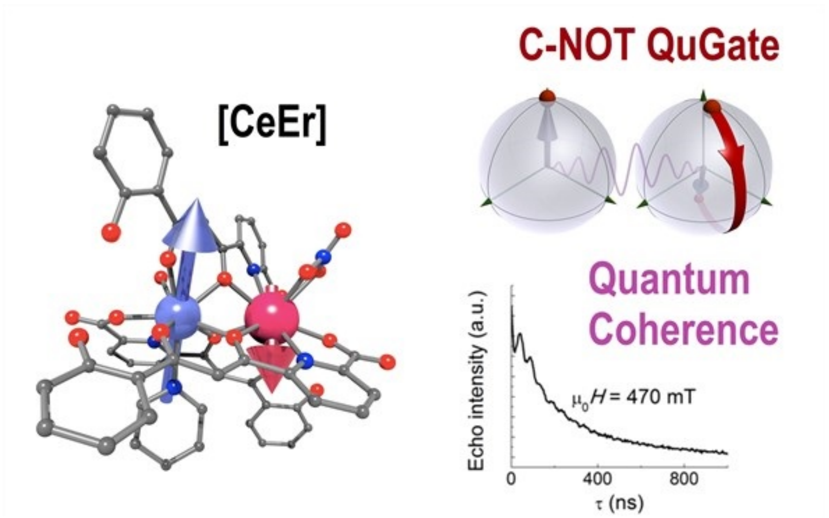

ID: 04146, 17/07/2019 15:20 - 17/07/2019 15:33, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Oral)

Spin dynamics of Dy_2 molecules deposited onto micro-SQUID sensors

Diego Gella[1] , Verónica Velasco[2] , Mari Carmen Pallarés[3] , Ana Repollés[1] , Mark David Jenkins[1] , David Aguilà[2] , Olivier Roubeau[1] , Anabel Lostao[4] , Leoni Barrios[2] , Javier Sesé[3] , Dietmar Drung[5] , Thomas Schurig[5] , Guillem Aromí[2] , Fernando Luis[1]

1) Instituto de Ciencia de Materiales de Aragón, CSIC-Universidad de Zaragoza, Spain
2) Departament de Química Inorgànica, Universitat de Barcelona, Spain
3) Laboratorio de Microscopías Avanzadas, Instituto de Nanociencia de Aragón, Universidad de Zaragoza, Spain
4) Fundación ARAID, Campus Río Ebro, Zaragoza, Spain 5) Physikalisch-Technische Bundesanstalt, Berlin, Germany

** Fernando Luis, fluis@unizar.es*

The application of single molecule magnets to quantum technologies necessarily involves a rational integration of these molecules into solid state devices, such as superconducting resonators [1,2]. An intriguing question is then how the interaction with the substrate affects the relevant magnetic properties. Here, we report results of ac susceptibility measurements performed, down to very low temperatures (T > 13 mK), on thin layers of a Dy_2 asymmetric molecular clusters that is a promising candidate to the realize of 2-qubit quantum gates [3,4]. The molecules are integrated into a μ-SQUID susceptometer by means of Dip Pen Nanolithography, which enables nanopatterning on the most sensitive areas of the sensor without any previous functionalization, while controlling the number of molecular units in the array [5]. Frequency-dependent susceptibility data measured on 4 and 20 molecular layers thick films are compared with similar results obtained for bulk polycrystalline samples. The analysis of these experiments provides direct information on the single-ion magnetic anisotropies and the intra-molecular coupling between the two lanthanide spins, which are crucial ingredients for the realization of a CNOT gate. The results show that the molecular Dy_2 units largely remain intact at the surface, in sharp contrast with a similar study performed on Mn_{12} clusters that revealed dramatic changes in the spin dynamics [6]. Low-nuclearity lanthanide magnetic clusters are robust against distortions caused by the molecule-substrate interactions and thus might provide suitable building blocks for the development of a scalable quantum architecture.

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[1] M. D. Jenkins et al, Dalton Transactions **45**, 16682-16693 (2016).
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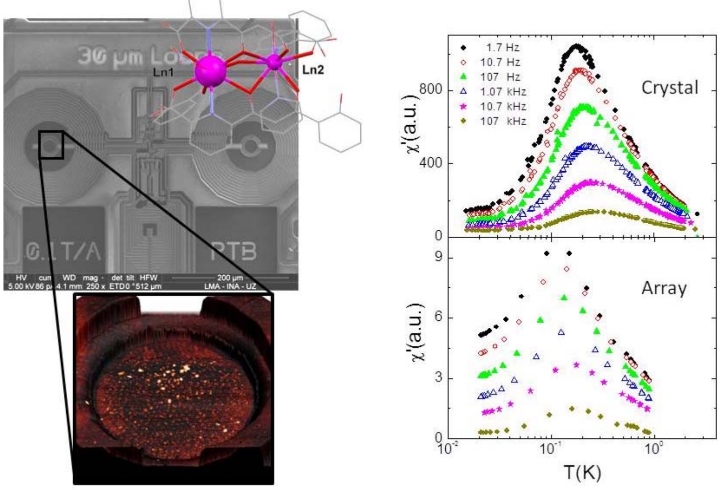

ID: 03765, 17/07/2019 15:33 - 17/07/2019 15:46, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Oral)

Slow relaxation of polymeric $\{Tb_2Ba(\alpha\text{-fur})_8\}_n$ down to mK temperatures

Ana Arauzo[1] , Elena Bartolomé[2] , Javier Luzón[3] , Silvia Melnic[4] , Sergiu Shova[5] , Denis Prodius[4] , Juan Bartolomé[1] , Andreas Amann Amann[6] , Manivannan Nallaiyan[6] , Stephano Spagna[6]

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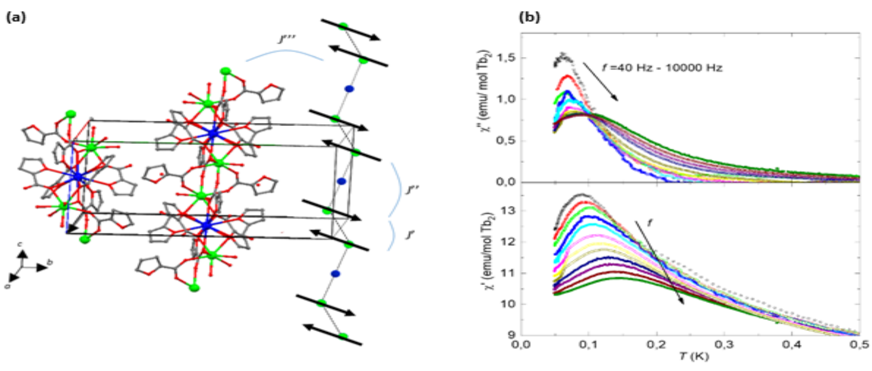
5) “Petru Poni” Institute of Macromolecular Chemistry, Alea Gr. Ghica Voda 41A, 700487 Iasi, Romania
6) Quantum Design Inc.,San Diego,CA92121, USA

** Arauzo Ana aarauzo@unizar.es*

Lanthanide-based Molecular Magnets have received an increasing level of attention due to their interesting properties and foreseeable application in information storage, quantum-computing etc. The slow-relaxation dynamics of such low-dimensional magnets relies upon the formation of an energy barrier (U_{eff}) between two stable energy states. In single-ion magnets, U_{eff} depends basically on the molecule’s anisotropy, given by the type of lanthanide used and its coordination environment. One-dimensional (1D) Ln-based complexes represent ideal model systems to investigate how relaxation behavior depends on the relative strength between single-ion’s anisotropy *vs.* Ln-Ln interactions. The furoate ligand a-fur=C_4H_3OCOO has demonstrated to be efficient in consolidating stable 1D chains containing lanthanides.

In this work, we report the synthesis and magneto-structural characterization of $\{[Tb_2Ba(\alpha\text{-fur})_8(H_2O)_4]\cdot 2H_2O\}_n$, with non-Kramers Tb ion (Fig. a). *Ab initio* calculations predict that the single-ion magnetic ground state is highly anisotropic (g_z*=17.8) and consists of a quasi-doublet with D_{Tb}/K_B=3.22 K gap, well separated from the next excited state, while the gap for the Tb_2 dimer is D_{2Tb}/K_B=2.58 K. Static magnetization and heat capacity measurements show that, magnetically, the system can be modeled as dimers of non-Kramers Tb ions, coupled by an AF intradimer interaction J'^*/k_B =-1.6 K. Dipolar interactions couple the Tb ions in the dimer with their first neighbour ions along the chain, with J''^*/k_B =-0.15 K, and with the surrounding ions out of the chain (J'''^*/k_B =-0.03 K). Ac susceptibility measurements in H=0 performed down to 50 mK temperatures (Fig. b) have enabled us to observe slow relaxation of the magnetization, with an Orbach-like activation energy of U/k_B=1.1 K. It is assigned to sluggish response of the 3D spin system due to a short-range ordering, possibly enhanced by the presence of disorder caused by defects in the polymeric chains. We discuss the relaxational phenomenology of this complex in comparison with that of the previously reported complexes of the furoate family: isostructural $\{[Dy_2Ba(\alpha\text{-fur})_8(H_2O)_4]\cdot 2H_2O\}_n$ and monomeric $\{Ln(a\text{-fur})_3(H_2O)_3\}_n$ (Ln=Dy, and Tb).



2D nanosheets of metalloporphyrin spin qubits for integration into hybrid quantum computing devices

Olivier Roubeau[1] , Ainhoa Urtizberea[2] , Eva Natividad[1] , Pablo J. Alonso[1] , Laura Pérez[3] , Beatriz Doñagueda[1] , Miguel Ángel Andrés[3] , Ignacio Gascón[3] , Michel Goldmann[4]

1) Instituto de Ciencia de Materiales de Aragón (ICMA), CSIC and Universidad de Zaragoza
2) Centro Universitario de la Defensa, Zaragoza
3) Instituto de Nanociencia de Aragón (INA), Universidad de Zaragoza
4) Institut des Nanosciences de Paris, Sorbonne Universités

** Olivier Roubeau, roubeau@unizar.es*

Molecular spin qubits can reach sufficiently long quantum coherence times to envision their use as hardware in quantum processors [1]. This will however require their implementation in hybrid solid-state devices for which the controlled localization and homogeneous orientation of the molecular qubits will be necessary [2]. An alternative to isolated molecules that could ensure these key aspects is 2D frameworks in which the qubit would act as node. In this work [3], we demonstrate that isolated [M(H_4TCPP)] metalloporphyrin molecules (M = Cu^{II}, V^{IV}O, H_6TCPP = 5,10,15,20-tetra(4-carboxy-phenyl) porphyrin) are potential spin qubits, that maintain similar quantum coherence as node in 2D [{MTCPP}$Zn_2(H_2O)_2$] metal-organic frameworks. Mono- and multi-layer deposits of nanodomains of a similar 2D framework are then successfully formed following a modular method based on Langmuir-Schaefer conditions. The orientation of the {MTCPP} qubit nodes in these nanosheets is homogeneous parallel to the substrate. These nanosheets are also formed with a control over the qubit concentration, i.e. by dilution with the un-metallated porphyrin. Eventually, 2D nanosheets can be formed in-situ directly on the surface of the superconducting lines of devices, through a simple protocol devised to reproduce the Langmuir-Schaefer conditions locally. Altogether our results show that 2D spin qubit frameworks are ideal components to develop a hybrid quantum computing architecture.

References

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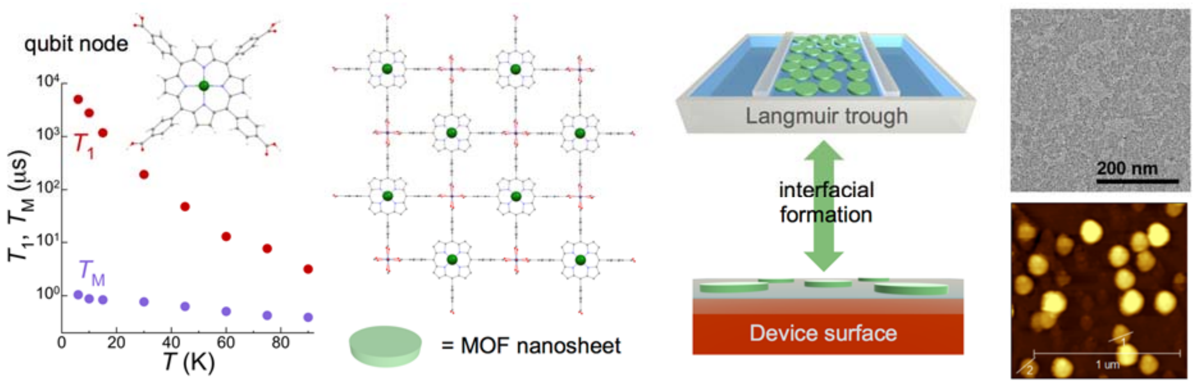
[3] for results with M = Cu^{II}, see A. Urtizberea, E. Natividad, P. J. Alonso, M. A. Andrés, I. Gascón, M. Goldmann, O. Roubeau, *Adv. Funct. Mater.* **2018**, 28, 1801695



ID: 03828, 17/07/2019 15:59 - 17/07/2019 16:12, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Oral)

Spin dynamics in spin bath models

Álvaro Gómez León[1]

1) Consejo Superior de Investigaciones Cientificas

** Álvaro Gómez León, a.gomez.leon@csic.es*

Environments can be broadly categorized in two universality classes: i) Those composed of delocalized modes, such as phonons, photons, magnons among others, and ii) those made of localized modes, such as nuclear and paramagnetic spins, defects, etc. Their behavior can be radically different, and their effect dominate in opposite regimes (typically, localized modes will dominate the low T behavior, while delocalized ones will control the high).

In this talk, I will describe their main characteristics and differences, and explain how one can easily study the dynamics using multiple-scales analysis. For this I will use a canonical model for an environment made of localized modes (the central spin model). I will show that this approach allows to capture the instanton-like dynamics and the suppression of coherent oscillations due to entanglement between the central spin and the bath, in a non-perturbative way.

ID: 03859, 17/07/2019 16:12 - 17/07/2019 16:32, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Invited Symposio)

Tailoring the absorption and emission properties of nanomaterials through their photonic environment

Alberto Jiménez-Solano[1] , Juan F. Galisteo-López[2] , Hernán Míguez[2]

1) Max Planck Institute for Solid State Research 2) Instituto de Ciencia de Materiales de Sevilla

** Alberto Jiménez-Solano, a.jimenez-solano@fkf.mpg.de*

Optical design represents an essential tool to tailor the optical properties of nanomaterials. In this talk, we will discuss the use of dielectric multilayers to demonstrate that the optical properties of nanostructures can be tailored by design. Following techniques based on solution processing, we have developed porous dielectric multilayers made of different metal oxide nanoparticles in which a nanometric control over the structural parameters, and thus over their optical response, is attained over large areas. These multilayers are ideal hosts to integrate nanomaterials ranging from metal-nanoparticles, which sustain localized surface plasmons, to dye-doped polystyrene nanoparticles, which fluoresce in the visible part of the spectrum. We have proven that the absorption and emission properties of such nanomaterials can be deterministically controlled through a precise design of their photonic environment. To illustrate this, we will show that tuning the lattice constant of TiO_2/SiO_2 multilayers allows achieving a 3-fold enhancement of light absorption in gold nanoparticles[1] along with 10-fold enhancement of the emission intensity of dye-doped polystyrene nanoparticles. These results are relevant for a wide range of fields of research such as sensing[2,3] and light emission,[4,5] in which precise control over the absorption and emission properties are sought.

References

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ID: 04199, 17/07/2019 17:15 - 17/07/2019 17:35, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Invited Symposio)

Smart molecular/2D heterostructures

Eugenio Coronado[1]

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** Eugenio Coronado, eugenio.coronado@uv.es*

Graphene and other 2D materials are a hot focus of interest in physics, chemistry and materials science. These materials are almost exclusively based on inorganic lattices and cover a wide range of electronic and magnetic properties: from insulators to superconductors, from diamagnetic to ferromagnetic (FM) and from metallic to non-metallic compositions. Except for the chemical functionalization of the surface of the 2D material, molecules have been scarcely considered in this field. In this talk I propose to create hybrid heterostructures by interfacing a layer of a molecular material with a 2D material. The aim is that of tuning the properties of the “all surface” 2D material via an active control of the hybrid interface [1]. To reach this goal the molecular system of choice will be based on spin-crossover complexes able to switch between the two spin states upon the application of an external stimulus (temperature, light or pressure). This concept will provide an entire new class of stimuli-responsive molecular/2D heterostructures, which may be at the origin of a novel generation of hybrid materials and devices of direct application in highly topical fields like electronics, spintronics and molecular sensing.

References

[1] J. Dugay et al. Nano Lett. 17, 186 (2017).

ID: 03323, 17/07/2019 17:35 - 17/07/2019 17:48, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Oral)

2D magnets (like CrI_3 or Fe3GeTe2)[1] have been recently discovered but are unstable in air conditions. We present a pre-synthetic strategy for the isolation of crystalline, robust and magnetic functionalized monolayers of coordination polymers.[1]

[1] Nature 546, 270,2017.
[2] Nat. Chem. 10, 1001, 2018.

Samuel Mañas-Valero[1] , Javier López-Cabrelles[1] , Guillermo Mínguez[1] , Eugenio Coronado[1]

1) University of Valencia, Molecular Science Institute, Catedrático José Beltrán nº2, 46980, Paterna, Valencia, Spain.

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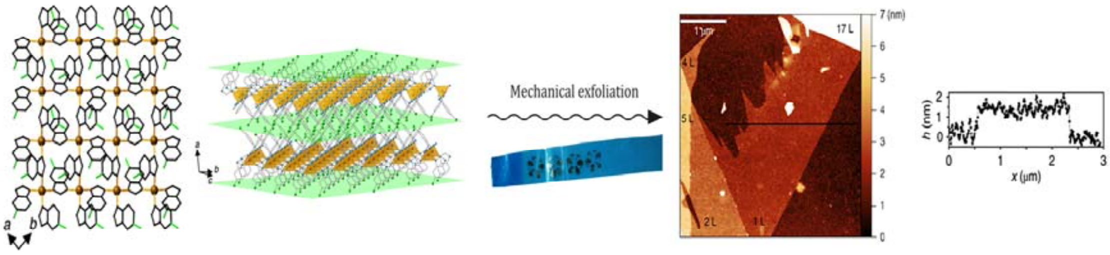

X-ray structure of the layered coordination polymer $[Fe(bimX_2)]$ showing the X = Cl atoms located at the surface of the layers as green planes. Iron centres are shown in orange (polyhedral representation), nitrogen atoms in blue, carbon atoms in black and chlorine atoms in green. Hydrogen atoms are omitted for clarity.

AFM image and height profile of a flake of $[Fe(bimX_2)]$, X = Cl. Different numbers of exfoliated layers (L) are indicated.

ID: 03997, 17/07/2019 17:48 - 17/07/2019 18:01, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Oral)

Bridging spin Qbits to superconducting circuits through carbon nanotubes

Enrique Burzurí[1] , Alicia Gómez[2] , Marina C. de Ory[1] , Ignacio Gimeno[3] , Daniel Granados[1] , Arturo Méndiz[1] , Fernando Luis[3]

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** Enrique Burzuri, enrique.burzuri@imdea.org*

Molecular spins have been proposed as Qbits due to their chemical tunability, scalability and reproducibility. The control of these spin Qbits can be done in quantum circuits, like coplanar superconducting resonators, where the spins are coupled to the photon generated in a central transmission line [1].

The strong spin-photon coupling, necessary to achieve a coherent control of the qubit, is however limited to large assembles of spins. Strategies to increase the coupling and thereof reach the single molecular spin, have tried to reduce the width of the transmission line to constrictions where the molecules are deposited [1,2].

We propose to downscale further and reach the single-spin sensitivity limit by directly replacing the superconducting constriction with a carbon nanotube of around 1-2 nm width. The controlled positioning in the nanometer-scale is achieved by dielectrophoresis [3]. We will show preliminary characterization. The carbon nanotubes offer the additional advantage of a direct functionalization with magnetic molecular species. We will show the different chemical strategies followed.

References

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[3] B. Nieto-Ortega et al., Angew. Chem. Int. Ed. **56**, 12240-12244 (2017)

ID: 04134, 17/07/2019 18:01 - 17/07/2019 18:14, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Oral)

In-situ Graphene Oxide Thermal Behaviour via TEM/EELS: Water Desorption, Reduction and Graphitisation

Mario Pelaez-Fernandez[1] , Ana Benito[2] , Wolfgang Maser[2] , Raul Arenal[1] , Raul Arenal[3]

1) Instituto de Nanociencia de Aragón - Universidad de Zaragoza
2) Instituto de Carbonquímica, Zaragoza
3) Fundación ARAID

** Mario Pelaez-Fernandez, mariopf@unizar.es*

Through the last decade, graphene oxide (GO) has been a material of great importance within the realm of Chemically modified graphene (CDG) [1] for its many potential applications [ref], yet both the chemical structure of Graphene oxide and its plausible conversion into graphene, as well as the diverse processes taking place in this reduction, are still not completely clear despite the amount of studies concerning this issue[2].

Electron energy loss spectroscopy, coupled with a sample holder capable of heating samples up to 1200°C, is a unique technique for the analysis of the reduction of GO. Using this technique, four main properties essential to this analysis can be measured at any given temperature and under ultra high vacuum: the oxidation rate [3], its thickness [4], its mass density [5] and its sp^2-sp^3 bond ratio [6].

This study presents an analysis of GO and all the aforementioned properties in two different studies: one up to 300C to better understand the physisorbed and chemisorbed water desorption, and a second one up to 1200C focused on the reduction of GO by desorption of various oxygen

functional groups; as well as the graphitisation of GO.

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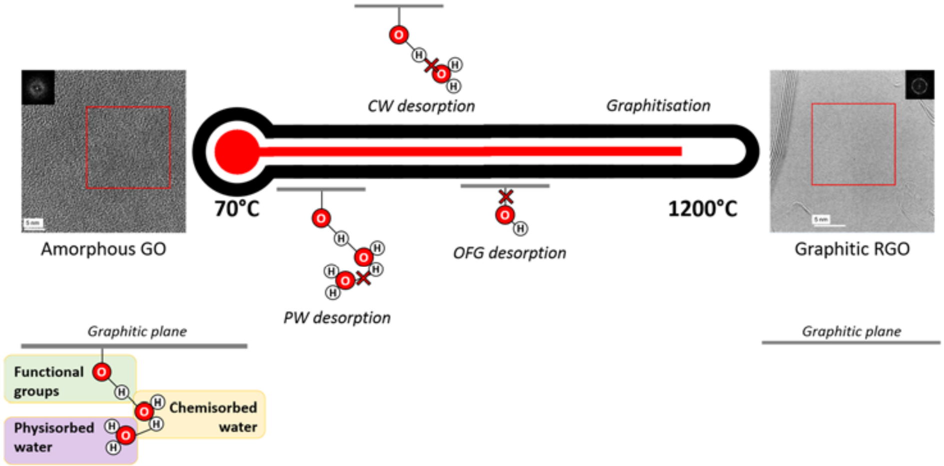


Figure 1: General Scheme of the study taking place, going from amorphous GO consisting of a graphitic plane with functional groups, as well as physisorbed and chemisorbed water; to crystalline RGO without any of the above.

ID: 04053, 17/07/2019 18:14 - 17/07/2019 18:27, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Oral)

Molecular magnetocooling

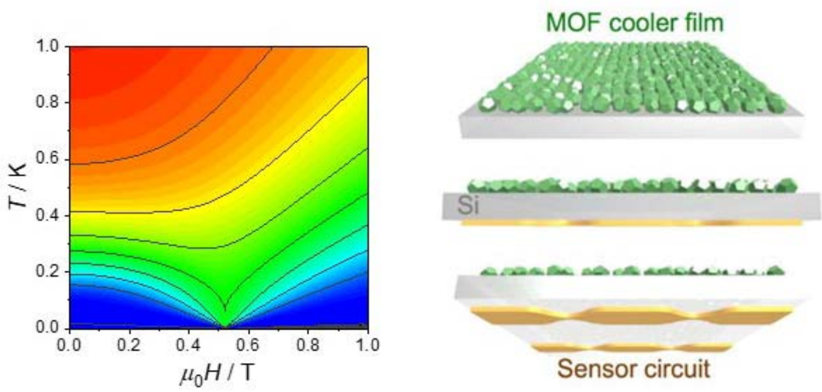
Marco Evangelisti[1] , Giulia Lorusso[1] , Elias Palacios[1] , Olivier Roubeau[1] , Eva Natividad[1]

1) ICMA, CSIC - Universidad de Zaragoza

** Marco Evangelisti, evange@unizar.es*

An important activity in cryogenics deals with the development of on-chip microrefrigerators that, in a not-too-distant future, will be used as cooling platforms for experiments requiring temperatures close to absolute zero, e.g., for gamma and X-ray detection in astronomy, materials science, quantum computing or safety instrumentation. Magnetic refrigeration based on the use of molecule-based magnetic materials is among the technologies that compete in such a race. The high chemical modularity of the molecules permits changing their quantum properties and outer functionalization at will. Besides, molecule-based materials are often soluble in organic solvents, allowing the transfer of their functionality to, e.g., the host microchips, when they are processed as thin-films or droplets.

The magnetocaloric properties of candidate molecule-based materials can be evaluated with “direct” techniques, which typically involve measurements of the sample temperature in varying magnetic fields. By so doing, one also explores the magnetic phase diagram of the material under study, which is determined by the underlying magnetic interactions. Recently, we have developed a method for measuring directly the magnetocaloric effect under quasi-adiabatic controlled conditions. Our procedures also permit to determine elegantly the intrinsic thermal conductivity of the sample, which is a characteristic of paramount importance for cooling applications. In this poster, we address this topic and present selected examples of Gd-based molecular nanoclusters and metal-organic frameworks in the form of pellets and thin-films.



ID: 03986, 17/07/2019 18:27 - 17/07/2019 18:40, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Oral)

Towards the Synthesis of Advanced Molecules for the Generation of Energy

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Photovoltaic (PV) solar cells attract much interest in science, and different semiconducting materials have been used to generate chemical energy from sun light. Photo- and electro-active organic materials are promising due to the possibility of processing from solution, affording lighter, cheaper and flexible all-organic PV devices. Recently, inorganic-organic based perovskite solar cells (PSCs) have attracted incredible attention due to its unprecedented rise in the PCE value, from 3.8% to 22% in a short span of time.

Phthalocyanines (Pcs) are outstanding dye candidates in for dye sensitized solar cells (DSSCs) due to their high extinction coefficient in the visible and near-infrared spectral region and to their high thermal and chemical stabilities. Pcs incorporated in DSSCs have achieved PCEs as high as 6.4 % [1]. An elegant strategy to improve the light-harvesting ability of the Pcs is the extension of the aromatic structure by generation aromatic-fused analogues of Pc having a red-shifted absorption. The same strategy will be also tested in PSCs as electron donor systems. On the other hand, perylenediimides (PDIs) are quite promising n-semiconducting materials as non-fullerene acceptors. Efficiencies higher than 8 % have been achieved in organic solar cells [2].

In this talk, the recent advances on Pcs and PDIs as electro-active systems for PV applications is presented in a systematic way through the variety of organic compounds synthesized in our research group [3].

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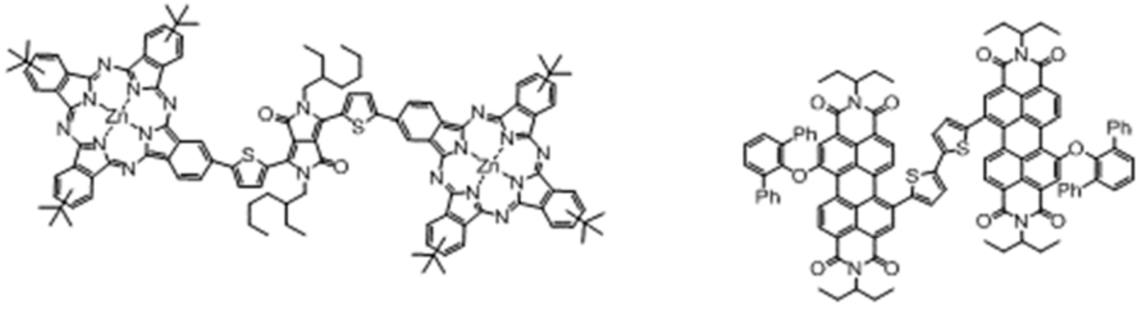

ZnPc-DPP-ZnPc **PDI-T-T-PDI**

Figure 1. Phthalocyanine-Diketopyrrolopyrrol-Phthalocyanine (ZnPc-DPP-ZnPc) and Perylenediimide-Tiophene-Tiophene-Perylenediimide (PDI-T-T-PDI)

ID: 03868, 17/07/2019 18:40 - 17/07/2019 19:00, Room 0.5 (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Invited Symposio)

Electron and Heat Transport in Molecular Junctions

Nicolas Agrait[1]

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Molecular junctions, i.e. single molecules connected to metal electrodes, offer the exciting possibility of exploring electron and heat transport at the nanometer scale at which quantum mechanical effects dominate the behavior of the system giving rise to new physical phenomena. Electronic conduction of molecular junctions has been studied intensively using scanning probe techniques, mainly scanning tunneling microscopy (STM), and mechanically-controlled break-junctions. More recently, the measurement of the thermoelectric properties arising from the coupling between thermal transport and charge transport, and even of the thermal conductance has become a reality.

The electrical transport through a molecular junction is related to the transmission probability for an electron across the junction, which depends on the electronic structure of the molecule and its coupling to the electrons. In particular, the low-bias conductance of the junction is proportional to the transmission at the Fermi level. In contrast, the thermopower or Seebeck coefficient depends on the variation of the transmission for carriers above and below the Fermi level, and consequently the measurement of the thermopower provides valuable additional information about the junction.

In this talk, I will present results on the conductance and thermopower of fullerene junctions [1,2] and of various organic molecule series [3], emphasizing the tuning of the transport properties by the control of quantum interference, chemical doping and mechanical deformation. I will also discuss the approaches to the measurement of the thermal conductance of single molecules.

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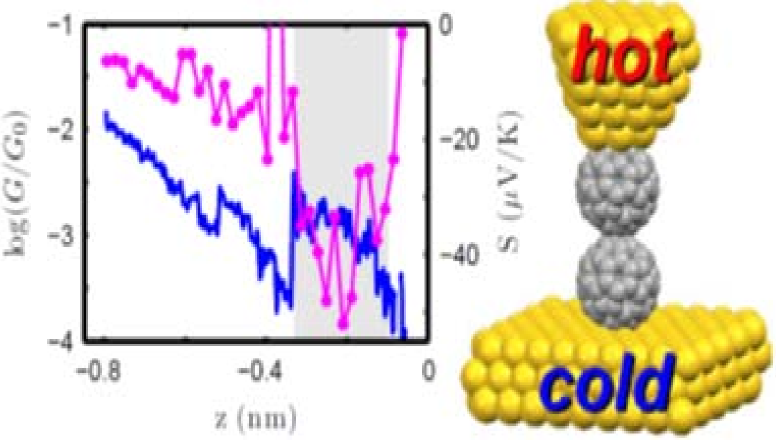

ID: 03894, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Poster)

Doping effects on physical-chemical properties of several ionic liquids and their mixtures with water and salts

David Ausín Neira[1] , Luis Miguel Varela Cabo[2] , Óscar Cabeza Gras[1] , Luisa Mª Segade Zas[1] , Elisa González Romero[3]

1) Mixtures Group, Dpt. Physics and Earth Sciences, University of A Coruña, Spain
2) NaFoMat Group, Dpt. Particle Physics, University of Santiago de Compostela, Spain
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** DAVID AUSÍN NEIRA, david.ausin.neira@gmail.com*

Ionic liquids (ILs) have been proposed as electrolytes for electrochemical devices thanks to the characteristics that lots of them show [1]. Within this field, our groups have devoted themselves on the study of the physical properties of ionic liquid mixtures both with solvents and salts in order to search for the matches that could be able to fit better in these applications [2]. Recently, a new parameter, electrochemical potential window, was added to our research, using for that, the voltammetric techniques Linear Sweep Voltammetry (LSV) and Cycle Voltammetry (CV).

In this communication, we present the results obtained for our most optimal aqueous mixture of 1-ethyl-3-methyl imidazolium octylsulfate (EMIm-OS), with and without magnesium sulfate ($MgSO_4$), as well as those for the mixtures of two nitrate ionic liquids (ethylammonium nitrate, EAN, and propylammonium nitrate, PAN) doped with several nitrate salts. Although some of the ionic liquids in their pure state have already been measured by other researchers like the ethylammonium nitrate [3], we focused our work in the changes that happen when water and other ions are added. Following this aim, all the samples were characterized by Ionic Chromatography (IC) to see the anion composition in the mixtures that could affect to the electrochemical potential windows.

Acknowledgements.

This work has been financially supported by the Spanish MINECO grants (MAT2014-57943-C3-(1, 3)-P) and, in collaboration with the ERDF, (CTM 2014-52471-R and CTM 2017-87326-R) as well as by REGALIs (ED431D 2017/06) and the Segundo Gil Dávila Foudation.

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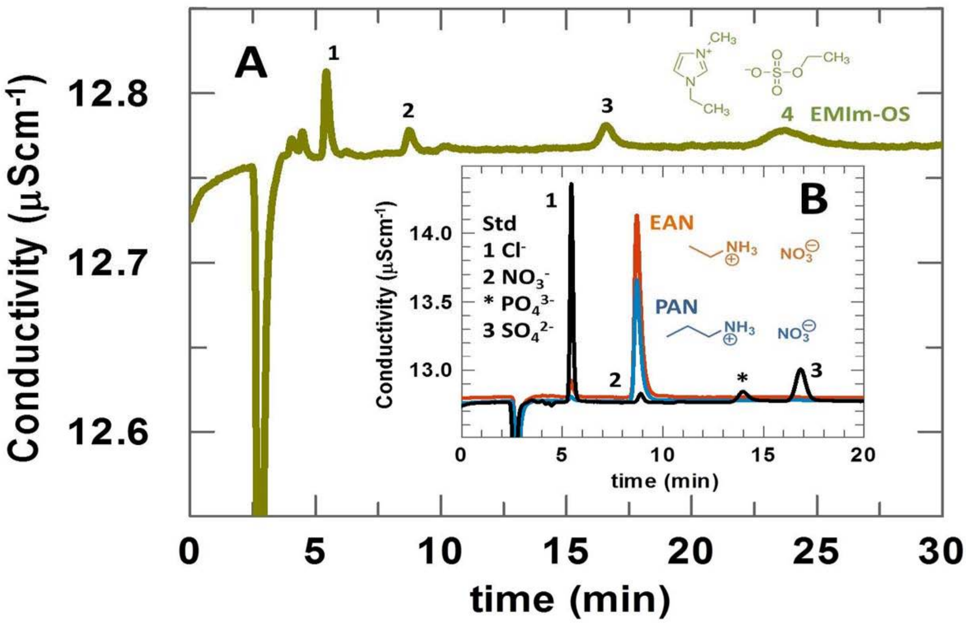

Figure 1. IC chromatograms of no doped ILs: A- EMImOS and B- EAN, PAN and Standard Solution of Anions (1- Cl^- 2.02 ppm; 2- NO_3^- 0.25 ppm; *- PO_4^{3-} 2.01 ppm and 3- SO_4^{2-} 2.06 ppm)

ID: 04013, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S6. Molecular Materials and Molecular Nanoscience (NANOMATMOL)
(Poster)

Antiferromagnetic chains of Fe_3 magnetic clusters in {Fe_3YO_2} butterfly molecules

Javier Rubín[1], Laura Badía , Fernando Luis[1] , Valeriu Mereacre[2] , Denis Prodius[2] , Ana Arauzo[3] , Fernando Bartolomé[1] , Juan Bartolome[1]

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Single molecule magnet (SMM) behaviour can be observed in molecules with clusters formed by transition metals M and rare earths. While M provides most of the cluster magnetization, Ln metals generate an enhanced magnetic anisotropy via the intracluster M-Ln interactions. The possible interactions between the transition metals. can be explored using yttrium as a non-magnetic substitution for Ln in isostructural compounds. The "butterfly" molecule $Fe_3Y(\mu_3\text{-}O)_2(CCl_3COO)_8(H_2O)(THF)_3$ ({Fe_3YO_2}) includes 3 close Fe^{3+} ions which build an Fe_3 cluster with a strong intracluster antiferromagnetic exchange J = -50 K and a total spin S=5/2 [1]. We present heat capacity and DC susceptibility measurements below 2 K, which show the cluster anisotropy and inter-cluster interactions. No phase transition to a long-range magnetically ordered phase is observed down to 20 mK. The intercluster interaction is analysed in the framework of the one-dimensional Blume-Capel model with an antiferromagnetic chain exchange constant J \' = -40 mK, and a uniaxial anisotropy with parameter D = -0.56 K. The chains are formed by Fe_3 clusters along the shortest intercluster distances in {Fe_3YO_2} and the anisotropy axes lie on the Fe_3 cluster's plane (fig. 1). *AC* susceptibility measurements reveal magnetic relaxation below 5 K with quantum tunnelling of the magnetization below 0.2 K, and a thermally activated process for higher temperature (fig. 2).

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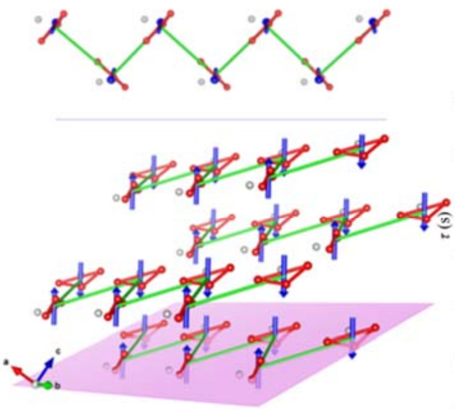

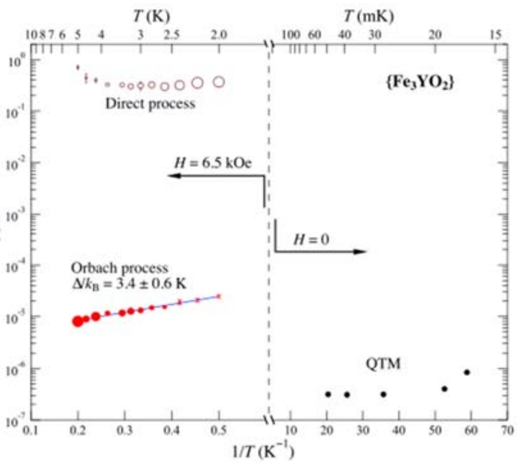

S7. Materiales Moleculares en Superficies (DMFC-GEFES)

Los materiales moleculares posibilitan la obtención de una alta variedad de propiedades físicas diseñadas mediante control químico. Su alto potencial para generar láminas funcionalesha propiciado que el campo de materiales moleculares en superficies esté presente en temas de gran actualidad: reacciones en superficies, nanoestructuración, electrónica molecular, astroquímica, espintrónica, etc. Este simposio brinda la oportunidad de compartir los últimos avances científicos sobre materiales moleculares en superficie, desde moléculas individuales a sistemas bidimensionales. El simposio aborda diversos aspectos fundamentales relacionados con la síntesis en superficie de sistemas moleculares, organización supramolecular y nuevas propiedades.

Organizadores:
Esther Barrena, *ICMAB-CSIC*
Rubén Pérez, *Universidad Autónoma de Madrid*
Nacho Pascual, *CIC-nanoGUNE*

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GEFES División de Física de la Materia Condensada

R.S.E.F. Real Sociedad Española de Física

S7. Molecular Materials on Surfaces (DMFC-GEFES)

Molecular materials offer a large range of physical properties via chemical design. In addition, surfaces actively interact with molecules, paving the way for the emergence of new structures at multiples scales and with novel functionalities. Thus, molecular science on surfaces crosses over “chemistry” and “physics" and covers a wide range of very active research fields: on-surface synthesis, astrochemistry, nanopatterning, spintronics, molecular electronics, etc. This symposium provides the opportunity to share the last scientific achievements on molecular materials on surfaces, from individual molecules to two-dimensional systems, covering fundamental aspects on on-surface synthesis, supramolecular organization and novel properties.

Organizers:
Esther Barrena, ICMAB-CSIC
Rubén Pérez, Universidad Autónoma de Madrid
Nacho Pascual, CIC-nanoGUNE

Sponsored by:

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GEFES División de Física de la Materia Condensada

Real Sociedad Española de Física R.S.E.F.

ID: 03830, 18/07/2019 15:00 - 18/07/2019 15:30, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Invited Symposio)

Bottom-up fabrication of atomically precise molecular nanostructures through on-surface synthesis

Sabine Maier[1]

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On-surface synthesis has attracted significant attention in recent years due to its potential to fabricate novel low-dimensional nanomaterials with atomic precision. In order to understand and control the synthesis of high-quality low-dimensional nanostructures, many efforts have been made to steer the reaction pathway by the design of smart precursors and by applying templating effects from the substrate. One of the challenges is the fabrication of long-range ordered two-dimensional covalently-linked networks via on-surface reactions. In contrast to molecular self-assemblies that are constructed by non-covalent bonds, the irreversible nature of the covalent bonds limits the structural control, which results in small domains and defects.

In my presentation, I will focus on recent high-resolution scanning probe microscopy experiments in combination with density-functional theory about the bottom-up fabrication and electronic properties of atomically precise one- and two-dimensional molecular nanostructures on metals.[1-4] Thereby, the effect of the flexibility, the symmetry, and chirality of the precursor molecules on the structure formation of covalently-linked molecular structures will be discussed. In particular, I will outline how well-ordered nanoporous 1D and 2D covalent molecular structures, can be fabricated by use of debromination coupling reactions. We demonstrate how organometallic structures can act as a structural template for covalent structures and can also show delocalized electronic states in surface-supported organometallic networks. Finally, I will conclude with a comparison of the structure formation of molecular structures on bulk insulators and metal surfaces.

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ID: 03992, 18/07/2019 15:30 - 18/07/2019 15:45, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Oral)

Non-covalent molecular interactions studied by atomic force microscopy: hydrogen and halogen bonds

Jaime Carracedo-Cosme[1] , Carlos Romero-Muñiz[1] , Pablo Pou[1] , Rubén Pérez[1]

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** Carlos Romero Muñiz, crm1988@hotmail.com*

Non-contact atomic force microscopy (NC-AFM) with functionalized metal tips has revolutionized the field of molecular imaging [1,2]. This is due to its capability of imaging the internal structure of molecules, resolving intermolecular features or even the determination of bond orders in aromatic compounds [1]. Moreover, this technique has opened the door to following or even inducing on-surface chemical reactions [2]. However, the use of theoretical models has become essential to achieve a proper understanding of the experimental results, often difficult to rationalize.

For instance, there is still a long-term debate about the actual ability of the AFM to disclose H-bonds [3] and other intermolecular interactions such as halogen bonding [4]. In this work, we contribute to this discussion using a recently developed approach to simulate high quality NC-AFM images [5]. Basically, this model describes both the electrostatic and short-range interactions in terms of two physical observables: the total charge densities of the sample, and the functionalized tip, which are obtained from independent ab initio calculations. In particular, we will study two relevant molecular systems on Cu(111): trimesic acid (TMA) assemblies governed by the formation of H-bonds and the adsorption of different aryl halides containing bromine and iodine, which lead to the formation of different halogen bonds.

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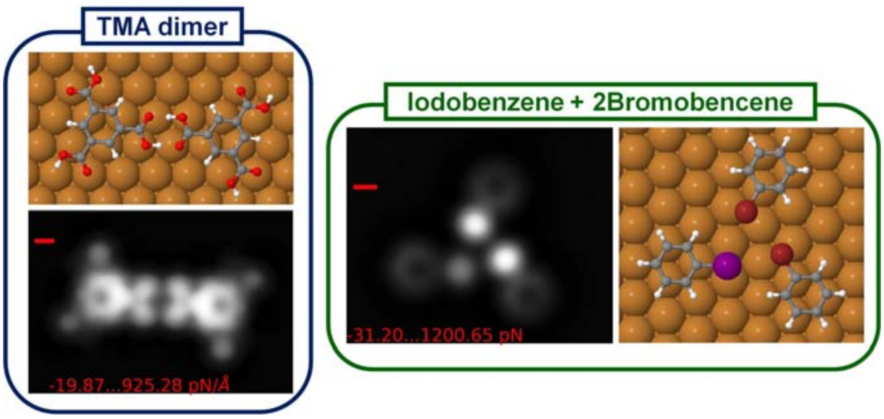

ID: 04087, 18/07/2019 15:45 - 18/07/2019 16:00, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Oral)

Metalorganic network spectroscopy: dependence on coordination atoms

Leyre Hernández-López , Ignacio Piquero-Zulaica[2] , Fernando Bartolomé[1] , David Serrate[1] , Marten Piantek[3] , Jorge Lobo-Checa[1]

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The achievement of single atom arrays is key to new fundamental properties that lead to exciting physical properties, like for instance single-atom magnets [1]. However, the resulting position of these atoms has a strong dependence on the supporting substrate and the system temperature. Liquid helium temperatures are required to freeze the atoms, which are often found random sites. A way to generate precise arrays of single atoms stable up to room temperature is the growth of self-assembled metalorganic coordination networks (MOCN) using organic molecules as spacers [2]. Here, by means of STM/STS we probe the electronic properties of different single coordinating atoms embedded in an array di-cyano anthracene (DCA) molecules [3,4] formed upon the three (111) noble metal surfaces. We have achieved these spontaneously formed MOCN using Fe, Co or Cu (see Fig). We observe distinct spectroscopic fingerprints in the LDOS that leads to shifts of the molecular LUMO levels and relevant surface state pore confinements. We will discuss the effect that the different chemical species and the substrate have on the overall electronic properties of the system.

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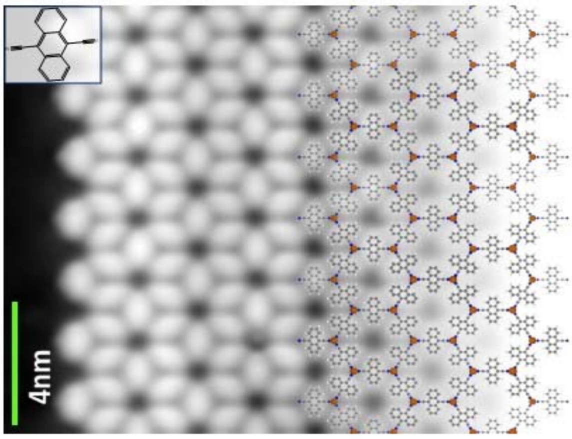

STM image with a schematic model superimposed of the network. DCA molecule is shown on the top left part.

The role of molecule-surface interactions on the chemical stability of fluorinated fullerenes on coinage metals at room temperature

R. Palacios-Rivera[1] , D. C. Malaspina[1] , J. Faraudo[1] , O. Solomeshch[2] , N. Tessler[2] , E. Barrena[1] , C. Ocal[1]

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Similarly to the well-established use of dopants in traditional semiconductor electronics, organic semiconductors doping by small molecules is an excellent strategy for improving the electrical properties of devices. In this context, the fluorinated fullerene $C_{60}F_{48}$ has a particular interest as a p-type dopant due to its large electron affinity (EI ≈ 5.4 eV) and high thermal stability [1]. A point of key importance is to ensure the chemical stability of the organic compound on the surface. In this work, we investigate the role of the molecule-surface interactions on the chemical stability of fluorinated fullerene $C_{60}F_{48}$ on coinage metals at room temperature (RT). We report a comparative study of the structural and electronic properties of $C_{60}F_{48}$ on Au(111), Cu(111) and Ni(111) by scanning tunneling microscopy (STM), X-ray and ultraviolet photoelectron spectroscopies (XPS and UPS). We demonstrate that despite the assumed stability of $C_{60}F_{48}$, its chemical integrity at room temperature depends on the particular molecule-metal interaction. Whereas on Au(111) the molecule preserves its molecular structure, on Cu(111) and Ni(111), $C_{60}F_{48}$ loses the fluorine atoms and transforms into C_{60}. The STM images show close-packed 2D molecular islands with the lattice unit cell and submolecular details expected for C_{60} as well as evidences of surface etching of the surrounding substrate (Figure 1). The mechanisms of the surface-induced catalytic defluorination of $C_{60}F_{48}$ molecules are addressed by molecular dynamics simulations using reactive force fields.

Figure 1. *STM images of a submonolayer of $C_{60}F_{48}$ on Cu (111) at room temperature.*

References

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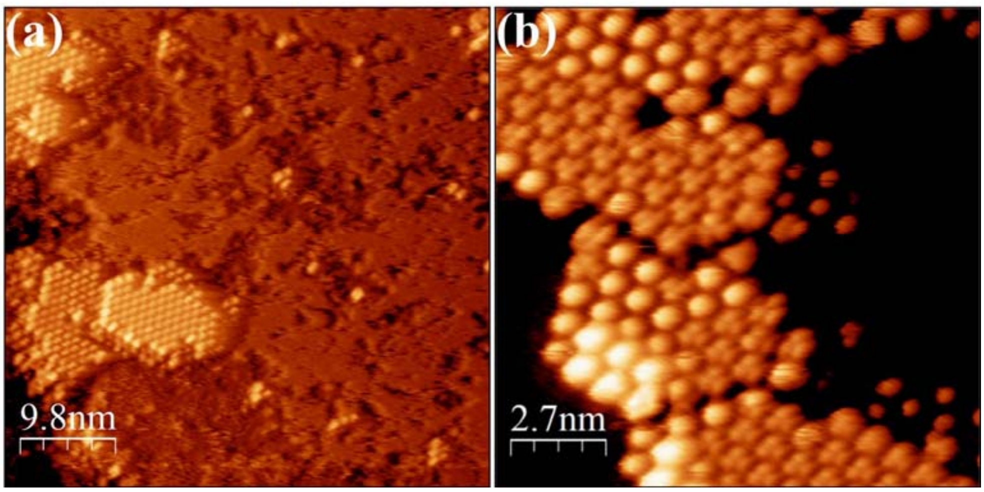

ID: 04107, 18/07/2019 16:15 - 18/07/2019 16:30, Room 0.5 (ground floor)

S7. Molecular Materials on Surfaces (DMFC-GEFES)

(Oral)

Organic optical switches covalently linked to magnetic ions

Amelia Dominguez-Celorrio, Sabela Quiroga[2] , Diego Peña[2] , Veronique Langlais[3] , Jorge Lobo-Checa[4] , David Serrate[4]

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2) Centro Singular de Investigación en Química Química Biolóxica e Materiais Moleculares (CIQUS) and Departamento de Química Orgánica, Universidad de Santiago de Compostela, Santiago de Compostela, Spain
3) Centre d'Elaboration de Materiaux et d'Etudes Structurales - Centre National de la Recherche Scientifique, Toulouse, France
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** Amelia Dominguez-Celorrio, amelia@unizar.es*

On surface synthesis is a bottom-up fabrication approach to create 2D nanostructures with atomic precision, by performing the reactions directly on the surface. This ‘dry’ chemistry allows the synthesis of products that are difficult (if not impossible) to purify by traditional in solution techniques [1].

We demonstrate the synthesis of Manganese Phtalocyanine derivatives (MnPCs) by cyclotetramerization of smaller precursors directly deposited on a metallic substrate [2]. The organic precursor used is a dicyanodiarylethene (DCDAE-2H) that is co-evaporated with Mn atoms onto a clean Ag(111) crystal under ultra-high vacuum (UHV) environment. This precursor is known to coexist in two isomeric forms: open- and closed-ring isomers. A reversible switch between both isomers takes place in solution by irradiation with light of certain wavelength. In this way, an optical response of the magnetic ground state of the Mn ion covalently linked to the ligand is expected.

After co-evaporation at room temperature, a coordinated phase is obtained and after a mild annealing up to 150ºC the cyclotetramerization [2] of the precursor molecules around the Mn ion takes place, obtaining the Mn-Phtalocyanine. Scanning tunnelling microscopy techniques are used to characterize the electronic structure of the molecules before and after inducing reversible and independent switching of the four external ligands.

References

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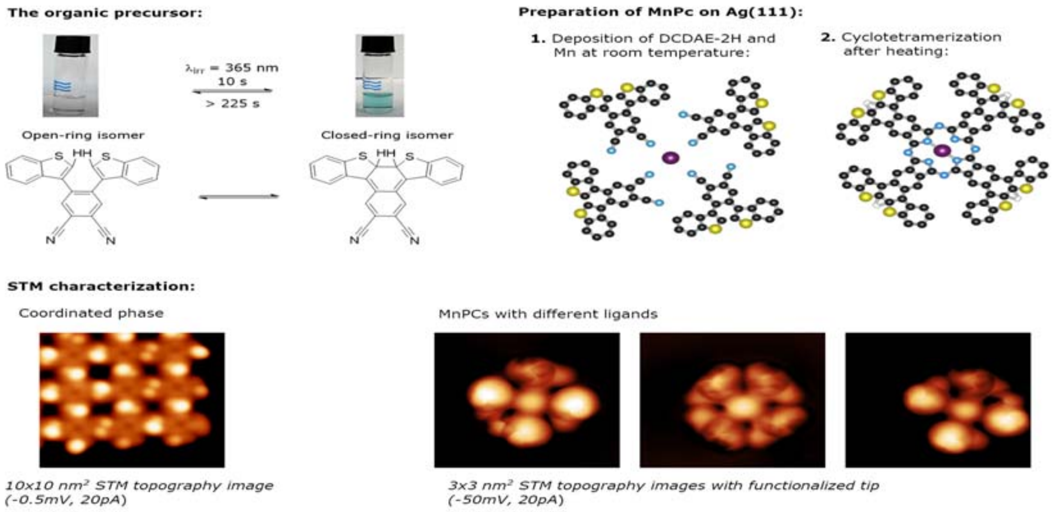
The organic precursor:
λirr = 365 nm
10 s
> 225 s
Open-ring isomer
Closed-ring isomer
Preparation of MnPc on Ag(111):
1. Deposition of DCDAE-2H and Mn at room temperature:
2. Cyclotetramerization after heating:
STM characterization:
Coordinated phase
MnPCs with different ligands
10x10 nm² STM topography image (-0.5mV, 20pA)
3x3 nm² STM topography images with functionalized tip (-50mV, 20pA)

ID: 03900, 18/07/2019 17:15 - 18/07/2019 17:45, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Invited Symposio)

Magnetism in on-surface synthesized hydrocarbon structures

Dimas G. de Oteyza[1]

1) Donostia International Physics Center

** Dimas G. de Oteyza, d_g_oteyza@ehu.es*

Even materials purely made up of non-magnetic atoms can display magnetic properties. One example of such interesting materials are aromatic hydrocarbon structures. Following Lieb´s theorem, if the number of atoms in each carbon sublattice is different, the molecular structure will hold a net spin. However, even in the absence of net spin, polyradicals can be generated on graphitic structures subject to particular edge topologies. In addition to the edge topologies, also the structure´s size determines the presence or absence of such radical states, whose corresponding spin, if present, is furthermore predicted to display a specific relative alignment. These interesting predictions are hard to verify because of the difficulty in the synthesis of appropriate nanographytic structures with atomic precision. In this respect, on-surface synthesis has appeared as an extremely promising approach. Making use of it, we have synthesized a variety of nanosized graphene structures with well-determined shapes and sizes, from acenes to graphene nanoribbons with different edge morphologies, widths and lengths. Most importantly, for each of these structures we assess, by means of scanning tunneling microscopy and spectroscopy combined with theoretical calculations, their electronic properties and potentially present magnetic moments.

Spin Signals in Electronic Transport through Functionalized Graphene Nanoribbons

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Bottom-up synthesised, atomically precise nanoribbons (GNRs) produces model graphene structures with tuned electrical properties for single molecule devices. Spin bearing graphene structures are particularly interesting, as for their potential applications in spintronics. However, it is challenging to test experimentally the desired properties of the unperturbed systems. In most scanning tunnelling spectroscopy (STS) experiments the GNRs are absorbed on a metallic substrate. This leads to hybridization of the electronic structure of the GNRs with the substrate's one.

We use the STM tip for contacting one termination of spin functionalized GNRs and then cleaving them partially from the surface. Thus, the GNRs bridge the tip-sample junction in a typical two-terminal transport configuration. The hybridization between GNR and substrate is lowered during the cleaving process. We investigate the influence of changing hybridization on two model systems bearing spin ½ [1] and spin 1 [2], namely boron doped GNRs and iron porphyrine-GNR hybrid molecules. The spin ½ gets fully quenched by the hybridization, while the spin 1 is renormalized if C4-symmetry of the environment is broken. In both cases the spin is restored and detected in STS experiments for adequate cleaving of the GNRs.

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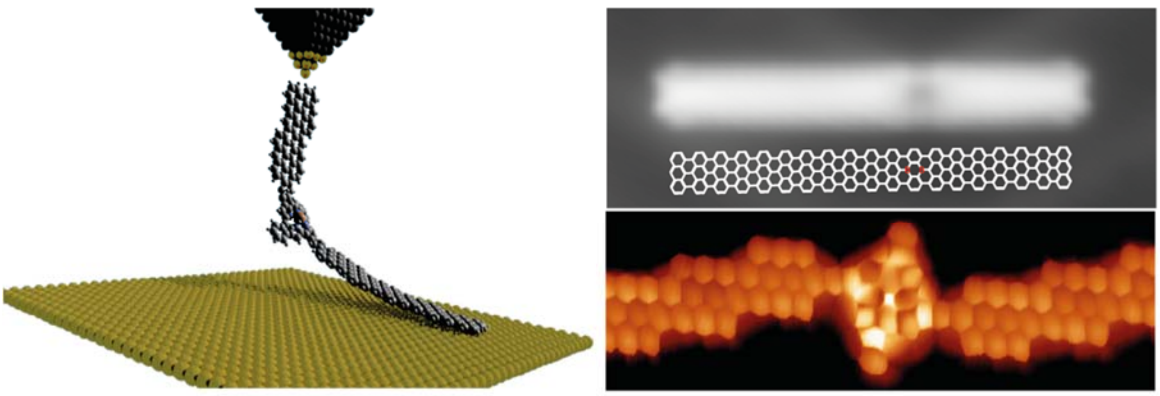

ID: 03835, 18/07/2019 18:00 - 18/07/2019 18:15, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Oral)

On-Surface synthesis role and the case of p-aminophenol

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One of the potential challenges in material science is the synthesis of novel materials with new properties. On-surface chemistry is a promising and versatile route at atomic scale to address the goal of achieving chemical reactions, which are impossible or more difficult by other routes. Interestingly, for the same molecular precursor, this approach results in the synthesis of different nanostructures depending on the catalyst surface used in the process [1].

In this work, we have used on-surface chemistry to synthetize different low dimensional nanostructures by using different surfaces, Cu(110), Pt(111) or Cu(111). Starting from the same molecular precursor, p-aminophenol (p-Ap) deposited on each surface, different reactions are promoted by a thermal annealing process. As determined by a multi-technique investigation (nc-AFM/STM, XPS, NEXAFS and LEED) the reaction mechanisms occurring at the surface are different for each metal, resulting in different final outcomes, polyaniline oligomers for the Pt(111) substrate, an electron acceptor quinoazines (QAz) for the Cu(110) substrate and a 2D porous material for Cu(111) substrate

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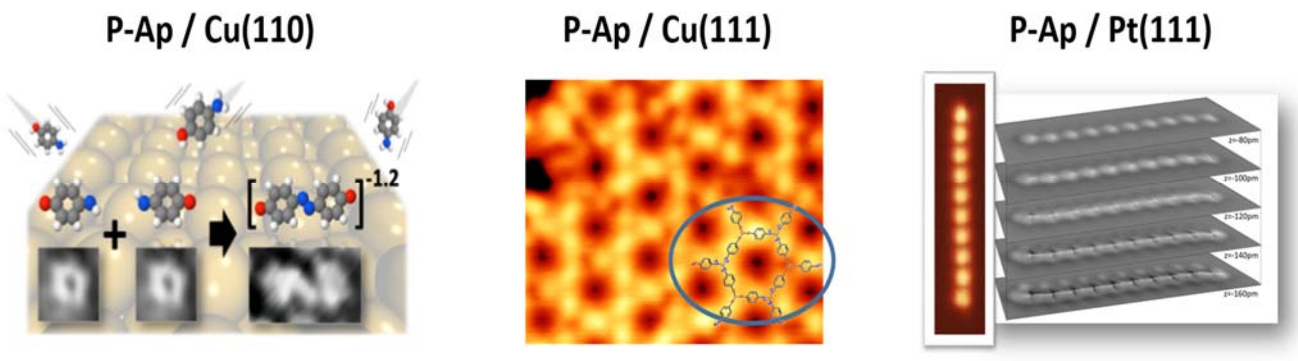

ID: 04075, 18/07/2019 18:15 - 18/07/2019 18:30, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Oral)

Bottom-up synthesis of nitrogen-doped graphene nanoribbons

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Selective functionalization of edge atoms in nanostructured graphene can be used to maintain the sp2 bonding configuration of the backbone while changing the edge properties. In this respect, the bottom-up synthesis of graphene nanoribbons with intrinsic doping offers an ideal solution by providing an atomic control of the number of dopants along the nanoribbon, plus a control on their width and edge morphology, while the sp2 honeycomb structure is not altered. However, there has been little literature about intrinsic doping in bottom-up synthesized GNRs due to the very interactive intermediates and the instability of the functional groups.

Here, we present a comprehensive study of the synthesis of 7-13 armchair GNRs doped with nitrogen atoms by the N=13 nanoribbon edges. The heteroatom substitution at the edges provides more accessibility to the nitrogen lone pairs, suitable for the interaction with target molecules.

The growth of the nitrogen-doped GNRs has been performed via surface-assisted Ullmann coupling on Au(111). The reaction pathway has been tracked with STM complemented with XPS and the electronic properties of each intermediate has been studied locally with STS. We have observed that doped graphene nanoribbons have an energy band gap of 1eV, a requirement for its implementation in semiconductor devices, and that a localized state appears at energies below the valence band, making it selective for target molecules. We prove a nitrogen preservation of an 80%, a relevant quantity as compared to the literature.

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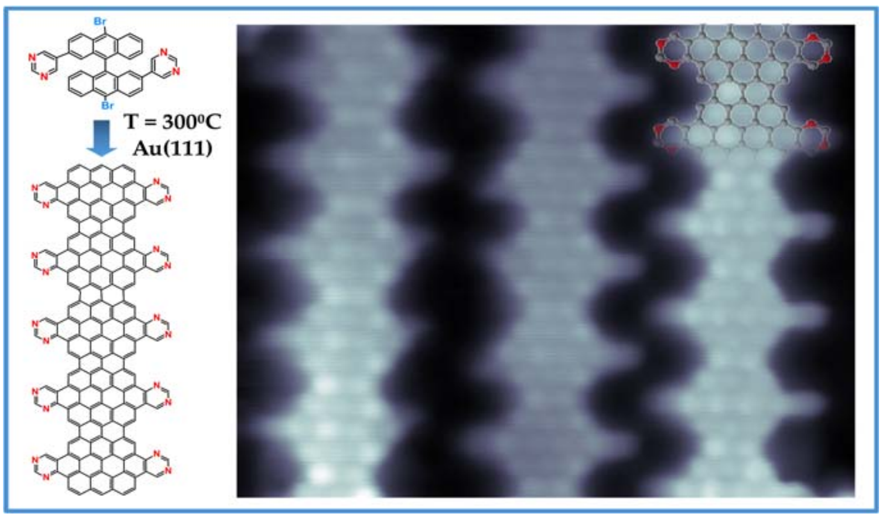

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S7. Molecular Materials on Surfaces (DMFC-GEFES)

(Oral)

Graphene catalyzes the reversible formation of a C–C bond between two molecules

Juan Jesús Navarro[1] , Michele Pisarra[1] , Belen Nieto-Ortega[2] , Julia Villalva[2] , Cosme G. Ayani[1] , Cristina Díaz[3] , Fabian Calleja[2] , Rodolfo Miranda[1] , Fernado Martín[1] , Emilio M. Pérez[2] , Amadeo L. Vázquez de Parga[1]

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In this work, we show that, against the classic view of carbon as a catalyst poison, nanostructured graphene monolayer epitaxially grown on Ru(0001) promotes a chemical reaction that would hardly take place under noncatalyzed conditions. The graphene layer promotes the reversible formation of a C–C bond between $-CH_2CN$ and TCNQ through three effects. First, it allows for an efficient charge transfer between the ruthenium substrate and the reactants, thus favoring changes in carbon hybridization; second, it holds the $-CH_2CN$ reactants in place [1] and allows the reduced TCNQ to diffuse freely on the surface; and last, it avoids the reaction between the TCNQ and the Ru(0001) surface. The product of the reaction is a contorted TCNQ-CH_2CN conjugate, which, when adsorbed on gr/Ru, does not present a magnetic moment. The reaction is fully reversible by injection of electrons from the STM tip at voltages >+1.7 eV, upon which both reagents are recovered [2]. One can think of TCNQ as a chemical "mop" with which the $-CH_2CN$ addends can be removed from the graphene surface, a cleaning operation that is otherwise impossible without decomposition of the graphene layer, even at temperatures as high as 600 K. The TCNQ/TCNQ-CH2CN pair can be viewed as a reversible magnetic switch controlled by a chemical reaction.

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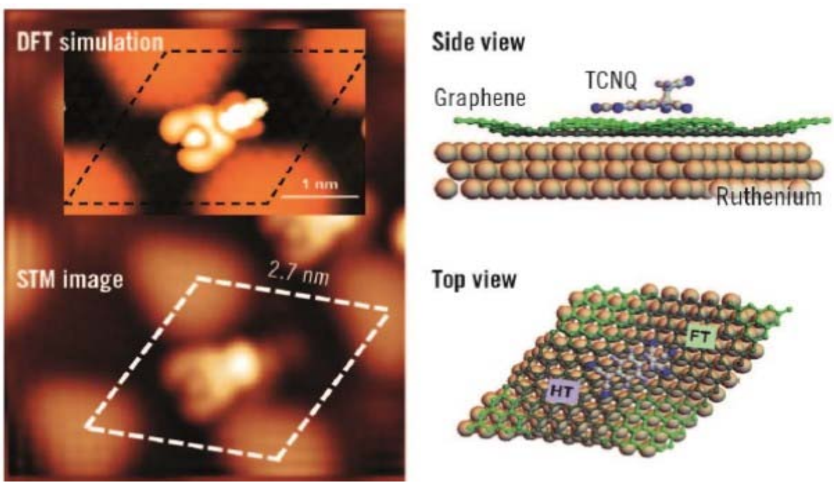
Figure 1: Left panel: STM image (6nm×8nm) of two TCNQ-CH2CN molecules and one TCNQ on gr/Ru for negative bias voltage (V_b=−1.7V, I_t=5pA). The inset shows the simulated STM image of a TCNQ-CH_2CN on gr/Ru for negative bias (V_b=−1.7V, I_t=5pA). Upper and lower left panel show top and lateral view of the adsorption configuration on the gr/Ru(0001). The molecule is adsorbed on the bridge position with the cyanomethylene end pointing toward the FCC-top areas (FT) of the moiré pattern. The cyanomethylene group is located on top of the TCNQ and points toward the vacuum



XXXVII Reunión Bienal de la Real Sociedad Española de Física
Zaragoza, 15-19 de julio de 2019
Real Sociedad Española de Física
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ID: 03793, 18/07/2019 18:45 - 18/07/2019 19:15, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Invited Symposio)

One-Pot Preparation of Mechanically Robust, Transparent, Highly Conductive, and Memristive Metal-Organic Ultrathin Film

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The future of 2D flexible electronics relies on the preparation of conducting ultrathin films of materials with mechanical robustness and flexibility in a simple but controlled manner. In this respect, metal-organic compounds present advantages over inorganic laminar crystals owing to their structural, chemical, and functional diversity [1]. While most metal-organic compounds are usually prepared in bulk, recent work has shown that some of them are processable down to low dimensional forms [2]. Here we report the one-pot preparation, carried out at the water-air interface, of ultrathin (down to 4 nm) films of the metal-organic compound $[Cu_2I_2(TAA)]_n$ (TAA= thioacetamide) [3]. The films are shown to be homogeneous over mm^2 areas, smooth, highly transparent, mechanically robust (with a Young's modulus of 11 GPa), and good electrical conductors (up to 50 S/cm) with memristive behaviour at low frequencies. This combination of properties, as well as the industrial availability of the two building blocks required for the preparation, demonstrates their wide range potential in future flexible and transparent electronics [4].

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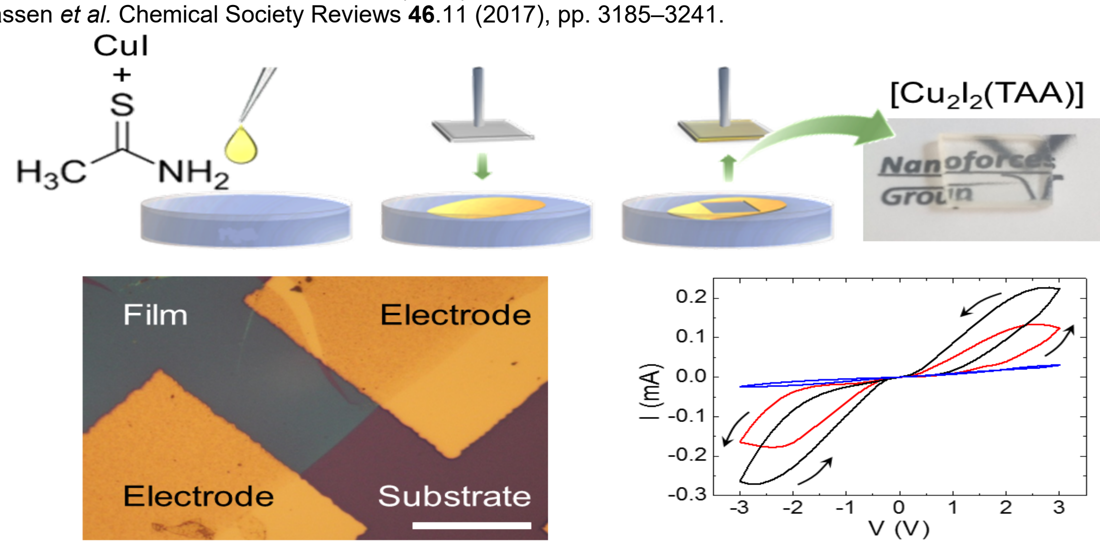

ID: 04116, 18/07/2019 16:30 - 18/07/2019 16:35, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Poster)

2D Phases and Fe Magnetic Moment upon Oxidation of Fe-Phtalocyanine mono- and multilayers on Ag (110)

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Molecular overlayers on ordered substrates have a broad field of application in catalysis, sensing, molecular electronics, etc. Recent studies of FePc on Ag(110) have shown that sub-monolayer phases are catalitically active [1]: in oxygen-dosed phases, O2 intercalates between the molecules and the surface, substantially changing the Fe magnetic moment. Reversible switching of this moment in low-density FePc phases upon an oxygenation - annealing cycle has been demonstrated [2].

A continuous FePc monolayer on Ag(110) displays several phases, with different FePc density as a function of the molecular coverage. At low coverage, two degenerate but structurally distinct low-density superstructures simultaneously appear after a ~ 450 K annealing, namely a c(10×4)- and a p(10×4)-phase. At higher coverages, a denser oblique phase O(1±4,4-+3) is stablished after annealing. At even higher coverage, denser phases do form, namely a “quasi-square” phase (R3) and a square phase (SQ) [3].

The different FePc phases have been oxygen-dosed (10-100 L). Remarkably, in oxygen-dosed phases O2 dissociates and intercalates between the molecules and the surface substantially changing the Fe magnetic moment. X-ray absorption combined with STM images allow us to determine the effectivity of the oxygenation procedure, as a function of the 2D structural phase, and to correlate it with the average magnetic moment as measured by XMCD at the Fe L2,3–edges.

Sum rule analysis yield the spin and orbital magnetic moments for each sample. It is concluded that all characterised phases display planar anisotropy, and the values of m_{eff} are about one order of magnitude larger than m_L in clear contrast to the FePc molecule in bulk or in multilayer, wich shows a larger orbital moment. Our work shows how oxidation and therefore magnetic moment switching depends on the steric facility for the molecules to form the Ag(110)-Oxygen-FePc ensemble, which is geometrically hampered in high density phases.

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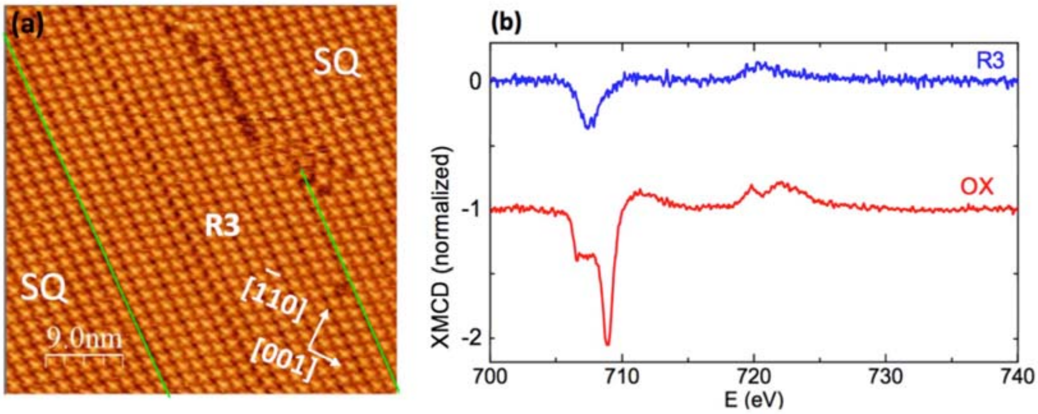

Fig. 1: a) STM of an FePc monolayer on Ag(110) showing co-existence of “quasi-squared” (R3) and square (SQ) phases. b) XMCD spectra of the pristine R3 and oxidized OX samples at the Fe $L_{2,3}$-edges (T = 1.6 K, normal incidence)

ID: 03989, 18/07/2019 16:35 - 18/07/2019 16:40, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Poster)

Organic Quantum dot arrays: Tunable energy and mass renormalization by homothetic porous networks

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Organic nanoporous networks grown on (111) noble metal surfaces, also referred to as quantum dot arrays since they can confine surface state electrons [1-4], are highly successful model systems to study scattering phenomena. On such surfaces, the 2D molecular scaffolds, commonly exhibit an upward energy shift of the Shockley state and the formation of shallow bands, which results from the repulsive scattering at the molecular walls and partial quantum confinement within each nanodot [1-4].

In this work, we present experimental evidence of a tunable downward energy shift through scalable metal-organic nanoporous networks [1,5] grown on Au(111). The electronic structure is determined by two state-of-the-art, highly complementary techniques (STM and ARPES), and supported by first principles and model calculation. Notably, the *counterintuitive* downshift is gradual with decreasing pore size and increasing adatom density, something that cannot be explained through standard quantum confinement in the molecular cavity. Therefore we assign the origin of this effect to metal-organic overlayer-substrate interactions in the form of adatom-surface state hybridizations. This local coupling keeps the Shockley state nature, but renormalizes it, thereby changing its fundamental energy and effective mass. The absence to date of the experimental band structure resulting from single adatom metal-coordinated nanoporous networks has precluded the observation of the significant surface state renormalization we have observed.

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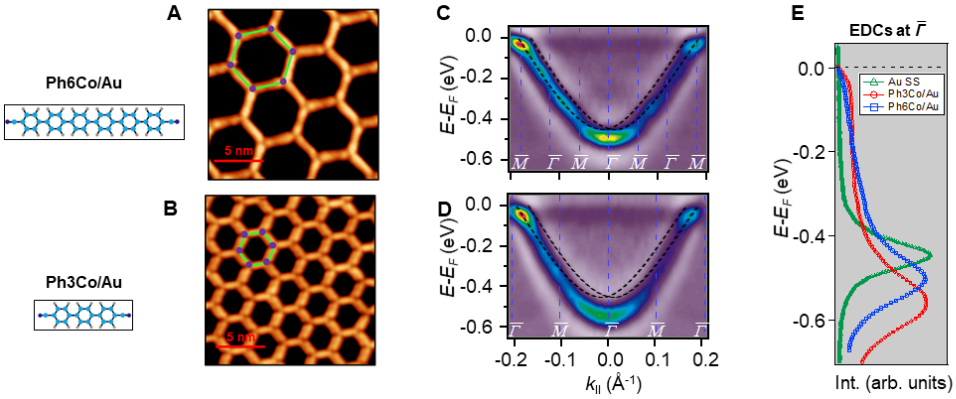

Figure 1: STM topographies of the single domain Co-coordinated hexagonal QD arrays using (A, C) dicarbonitrile-sexypheny (Ph6) and (B,D) dicarbonitrile-terphenyl (Ph3). (C, D) Second derivative of the spectral density obtained by ARPES at 150 K for the two nanoporous networks compared to the pristine Au(111) Shockley state (black dotted lines). (E) Energy distribution curves at normal emission for pristine Au(111) (green), Ph6Co (blue) and Ph3Co (red). A gradual downshift of the fundamental energy as the pore size is reduced is found concommitant with gap openings at the superstructure symmetry points

ID: 03914, 18/07/2019 16:40 - 18/07/2019 16:45, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Poster)

Molecular Beam Epitaxy Growth of 2H- and 1T\'- $MoTe_2$ Islands on Graphene/Ir(111)

Pablo Casado Aguilar[1] , Amadeo López Vázquez de Parga[1] , Rodolfo Miranda Soriano[1] , Manuela Garnica Alonso[2]

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Transition Metal Dichalcogenides (TMDs) are layered materials with a MX_2 composition, where M denotes a transition metal (such as Mo, W, Pt, Pd…) and X a chalcogen element (S, Se or Te). They crystallize in different phases, such as the direct semiconducting hexagonal phase (2H) [1] or the semimetallic distorted octahedral phase (1T′) predicted to exhibit quantum spin Hall (QSH) effect [2]. These interesting properties together with the possibility to reduce their dimensionality to a single unit cell layer [3] are some of the reasons why they have become a very fascinating field of research nowadays.

Here, we report the growth of 2D-islands of $MoTe_2$ on graphene grown on the (111) face of an Iridium single crystal by molecular beam epitaxy. Their structural characteristics as well as their electronic properties are studied by means of scanning tunneling microscopy/spectroscopy (STM/STS), finding both 2H- and 1T\'-phases (Fig. 1), and revealing their different electronic nature. In addition, it is also interesting to note that they remain decoupled from the substrate due to the weak interaction with graphene.

Fig. 1: STM images presenting a) a gr/Ir(111) surface covered with both 2H- and 1T\'- $MoTe_2$ islands, b) a 1T\'-island of $MoTe_2$ showing the characteristic striped pattern and c) a 2H-island with the representative domain walls of this phase.

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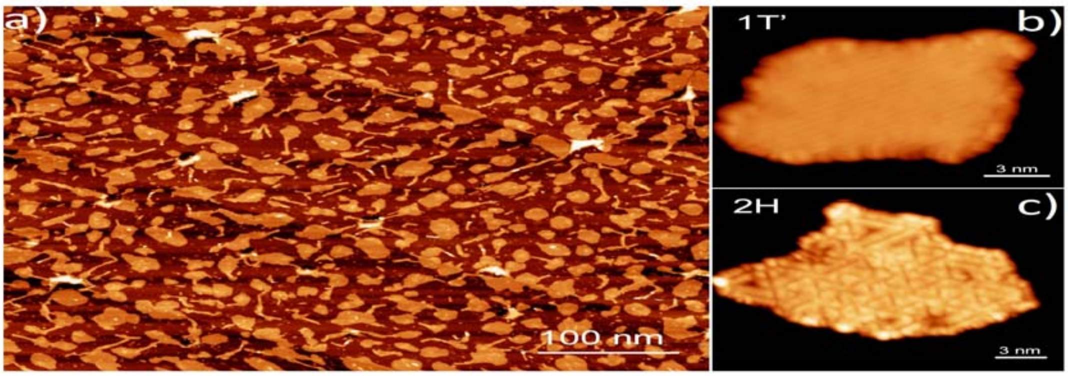

ID: 03908, 18/07/2019 16:45 - 18/07/2019 16:50, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Poster)

Investigation of enantiosensitive adsorption of chiral organic molecules on magnetic substrates by electron spectroscopies

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Recent studies using diverse surface science techniques have revealed inequivalent behaviour when chiral organic molecules of different handedness, called enantiomers, are adsorbed onto spin-polarized substrates. [1,2] Such enantiosensitive features manifest as asymmetries in the valence band spectra of the chemisorbed layers [2] and can be taken advantage of to separate and purify the enantiomers contained in a racemic mixture [3].

In this work a systematic characterization has been undertaken of the electronic structure of homochiral Diphenylethylenediamine (DPEDA) molecules adsorbed on epitaxial Co films on Cu(100). The DPEDA molecules (see Figure) possess two chiral centres situated at the two C atoms of the ethylene backbone; two enantiomers of this molecule are designated (1R,2R)-(+) and (1S,2S)-(–)-DPEDA. Electron spectroscopy (XPS, UPS) measurements have been employed to investigate both the substrate\'s and molecular electronic states, the charge transfer between the molecules and the ferromagnetic Co(100) substrate and to detect possible enantioselective effects in molecule-surface bonding. Some significant differences associated to the molecule\'s helicity have been detected, suggesting a stronger interaction between the (S,S) enantiomer and the magnetic Co substrate than for its (R,R) counterpart. This behaviour might be related to the spin filtering capabilities of the chiral molecular layers, [4] and it can have long-ranging implications for applications such as molecular spintronics or chiral resolution of racemic compounds. This research can have far-reaching implications in several technologically important areas such as heterogeneous asymmetric catalysis or the development of carbon-based spintronic materials.

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ID: 04132, 18/07/2019 16:50 - 18/07/2019 16:55, Room 0.5 (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Poster)

Quantum saturation of capacitance in metals

Bernat Olivera[1], Joaquín Fernandez Rossier[1], Carlos Untiedt[1]

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There are two contributions to the electronic capacitance in between two electrodes. First, there is the classical capacitive effect as an electric field is being developed in between these. Another contribution, which has often been neglected for metals, is related to the Pauli exclusion principle for the difficulty to accumulate charges on the electrode surface, the so-called quantum capacitance [T. Christen and M. Büttiker. Phys. Rev. Letters 77 (1996), 1]. Here we report the use of a Scanning Tunneling Microscope at low temperatures to study the variations of the capacitance as we approach two metallic electrodes made of Pt or Au. Three regimes are clearly visible in this process: A classical increase of capacitance which at short distances turn to saturation to the quantum capacitance limit, and finally, a leak of capacitance due to quantum tunneling.

ID: 04227, Mon-Thur 16:30 - Mon-Thur 16:30 , Hall (ground floor)
S7. Molecular Materials on Surfaces (DMFC-GEFES)
(Poster)

Chemical instability of semiconductor graphene nanoribbons

Alejandro Berdonces-Layunta[1,2] , James Lawrence[1,2] , Mohammed Sabri G. Mohammed[1,2] , Luciano Colazzo[1,2] , Diego Peña[3] , Shayan Edalatmanesh[4] , Pavel Jelínek[5] , Dimas G. de Oteyza[1,2,6]

1) Donostia International Physics Center (DIPC), 20018 Donostia-San Sebastian, Spain.
2) Materials Physics Center, Centro de Físicade Materiales(CSIC/UPV-EHU), 20018 Donostia-San Sebastian, Spain.
3) Centro de Investigación en Química Biolóxica e Materiais Moleculares (CIQUS), Santiago de Compostela, Spain.
4) Centre of Advanced Technologies and Materials. Palacký University, 78371 Olomouc, Czech Republic.
5) Institute of Physics, Czech Academy of Sciences, 162 00 Prague, Czech Republic. 6) Ikerbasque, Basque Foundation for Science, 48013 Bilbao, Spain

** Alejandro Berdonces-Layunta, alejandro_berdonces001@ehu.eus*

The stability of graphene nanoribbons may be a constraint for their applicability in different fields such as nanoelectronics or spintronics. Their reactivity in atmospheric conditions has already been studied for some varieties of GNR. However, these results cannot be generalized to any type of GNR, as their properties diverge substantially depending on their width and edges.

In this study, STM has been employed to study the oxidation of 3, 1 zigzag-graphene nanoribbons[1] (3,1-GNR) on an Au (111) substrate when exposed to atmospheric conditions. 3,1-GNR are degraded in the presence of oxygen, resulting in planar molecular structures with completely different electronic properties[2]

When exposed to the air, high-resolution constant height STM images show how the ribbon morphology changes, and small islands of aggregates form next to them. Further studies of ribbons exposed to pure oxygen pressures of 3 · 10-5 mbar, at room temperature, for two hours, show changes in their molecular structure.

There are variations in the spectroscopy of these ribbons that can be related directly with the areas that show changes after the exposition, what suggests a change in their electronic properties. Different structures have been proposed for these defective areas, supported by theoretical calculations, which explain the differences in the hexagonal structure compared with the pristine GNR.

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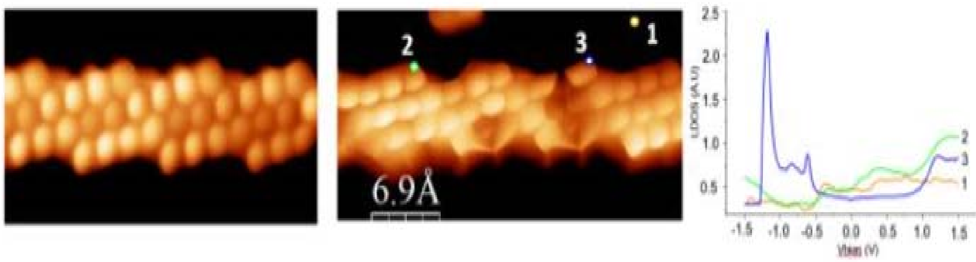

Figure 1 – High resolution, constant current image of a pristine GNR (a), and oxidized one (b). After being expose to pressures of 3 · 10-5 mbar of pure oxygen for 2 hours, the electronic structure of the oxidized ribbons (3) seems to be irreversibly affected compared to the pristine parts (3).

S8. Retos del Magnetismo (CEMAG)

El magnetismo de materiales es un área de investigación muy activa, en la intersección de diversas áreas incluyendo la Física, la Química, la Nanotecnología o la Ciencia de Materiales, tanto en el ámbito de la ciencia más básica hasta la aplicada.

Por segunda edición consecutiva, el Club Español de Magnetismo aprovecha la invitación de los organizadores de la Reunión Bienal de la Real Sociedad Española de Física para organizar, dentro del marco de la misma, un simposio sobre magnetismo. Los lazos que unen a la RSEF con el Club Español de Magnetismo son muy fuertes, no sólo por las temáticas de interés comunes sino también por el alto número de miembros del Club que lo son a su vez de la Real Sociedad.

El Club Español de Magnetismo agradece esta invitación, intentando organizar un Simposio atractivo para todos los miembros de la RSEF que participen en la Reunión Bienal, trabajen o no en el ámbito del magnetismo.

Organizadores:
Irene Lucas, *Universidad de Zaragoza*
Fernando Bartolomé, *ICMA (CSIC - Universidad de Zaragoza)*

Patrocinado por:

S8. Trends in Magnetism (CEMAG)

Magnetism of materials is a very active research area, at the intersection of different scientific subjects including Physics, Chemistry, Nanotechnology and Materials Science, ranging from the most basic to the applied science.

Zaragoza 2019 will be the second consecutive time for which the Spanish Club of Magnetism accepts the invitation of the Local Committee of the Biennial Meeting of the Royal Spanish Physical Society to organize a symposium on magnetism. The links joining the RSEF with the Spanish Club of Magnetism are very strong, not only because of the common interests, but because the high number of our Club members that are also members of the Society.

The Spanish Club of Magnetism appreciates this invitation, trying to organize an attractive Symposium for all the members of the RSEF that participate in the Biennial Meeting, whether or not they work in the field of magnetism.

Organizers:
Irene Lucas, *Universidad de Zaragoza*
Fernando Bartolomé, *ICMA (CSIC - Universidad de Zaragoza)*

Sponsored by:

ID: 03905, 15/07/2019 15:00 - 15/07/2019 15:15, Conference Hall (Floor -1)
S8. Trends in Magnetism
(Oral)

Spin to charge conversion at the YIG/Bi interface: characterization and ageing analysis

Soraya Sangiao[1] , José Ignacio Morales[2] , Irene Lucas[1] , Pilar Jiménez-Cavero[1] , Luis Morellón[1] , José María De Teresa[1]

1) Departamento de Física de la Materia Condensada and Instituto de Nanociencia de Aragón, Universidad de Zaragoza, 50009 Zaragoza, Spain. Laboratorio de Microscopías Avanzadas (LMA), Instituto de Nanociencia de Aragón (INA), Universidad de Zaragoza, 50018 Zaragoza
2) Departamento de Física de la Materia Condensada and Instituto de Nanociencia de Aragón, Universidad de Zaragoza, 50009 Zaragoza, Spain

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Spintronics relies on the generation and manipulation of spin-polarized electrical currents and its conversion into conventional electrical currents. The standard mechanism to produce such conversion is the Inverse Spin Hall Effect (ISHE) [1]. ISHE converts a pure spin current into a transverse charge current by spin-orbit coupling in a non-magnetic material [2].

In this work, the pure spin current is generated via spin pumping by inducing magnetization precession in an yttrium iron garnet (YIG) layer. The spin current is converted at the interface YIG/Bi to a dc voltage by ISHE. A broadband rf line and electronics providing frequencies up to 20 GHz have been used for performing ferromagnetic resonance (FMR) and ISHE measurements on YIG/Bi stacks with different bismuth thicknesses at different excitation frequencies up to 20 GHz. In order to get more insight on the spin to charge conversion at the YIG/Bi interface we study not only the frequency dependence of the ISHE voltage but also the dependence of the ISHE on Bi film thickness which enables us to extract all the relevant parameters characterizing this spin to charge conversion, i.e. spin-mixing conductivity of the YIG/Bi interface and spin Hall angle and spin diffusion length in bismuth.

Furthermore, we have also systematically investigated the evolution of the ISHE voltage with ageing of the YIG/Bi samples, which is of immediate relevance when considering a practical implementation of spintronics.

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ID: 04006, 15/07/2019 15:15 - 15/07/2019 15:30, Conference Hall (Floor -1)
S8. Trends in Magnetism
(Oral)

Tuning the magnetic response in cobalt ferrite nanoparticles using the exchange – spring magnetic approach for catalytic applications

Beatriz Rivas-Murias[1], Juan M. Asensio[2] , Bruno Chaudret[2] , Verónica Salgueiriño[1]

1) Departamento de Física Aplicada, Universidade de Vigo, 36310 Vigo (Spain)
2) Laboratoire de Physique et Chimie des Nano-Objets, CNRS, INSA, UPS, 31077 Toulouse (France)

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Magnetic nanoparticles (NPs) are exciting systems for applications in biomedicine, permanent magnets, etc., because they present several advantages related to the finite size effects in comparison to bulk materials. In addition, magnetic NPs can be applied as heating agents in magnetically-induced heterogeneous catalysis, such as CO_2 hydrogenation to CH_4 [1]. More complex systems with emerging properties like bimagnetic nanostructures (core-shell architecture) present also new potential applications due to the presence of the exchange interactions between both phases. In this context, arrangements such as FM/FiM conventional hard/soft and inverted soft/hard core shell have attracted much attention in several fields [2]. In these systems, the exchange-spring magnetic approach [3] results relevant to produce high-energy permanent magnets and to tune the magnetic properties (i.e., saturation magnetization and coercive fields).

This work is focused on hard/soft FiM/FiM systems of $Co_{0.6}Fe_{2.4}O_4$ cuboctahedron-shape nanoparticles of ~ 95 nm of diameter as core and Fe_3O_4 as shell synthesized by thermo-decomposition method and using oleic and stearic acid as stabilizers. The influence of the thickness (from 2 to 8 nm) of the magnetite shell on the magnetic behavior and on their viability as heating agents in the magnetically-induced CO_2 hydrogenation in continuous flow catalyzed by Ni NPs has been studied.

References
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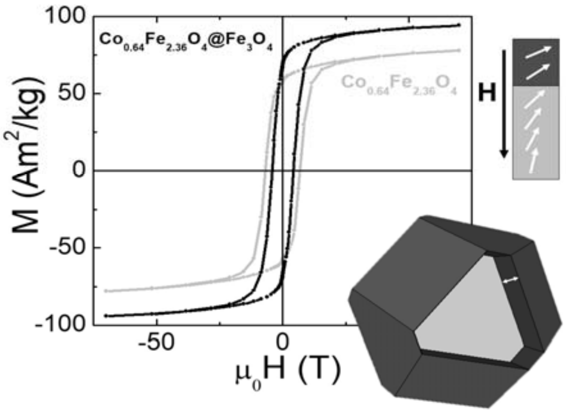

ID: 03853, 15/07/2019 15:30 - 15/07/2019 15:45, Conference Hall (Floor -1)
S8. Trends in Magnetism
(Oral)

ALBA status and new BL programme

Gaston Garcia[1]

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** Gaston Garcia, ggarcia@cells.es*

This work aims at presenting the current status of the ALBA synchrotron light source project [1]. After 7 years of successful operation, starting in 2012, it is a good moment to look back and summarize how the ALBA project was conceived, designed, implemented and thereon operated. Currently (since 2016) ALBA operates 8 beamlines for a wide international user community, while working intensively in parallel on the construction of 4 new ones [2]. The operating beamlines provide multidisciplinary tools for experiments in many different areas, with Bioscience, Nanomagnetism, Catalysis/environment and Energy materials as some of the key applications [3]. The new beamlines in construction will complement the present capabilities of ALBA in the techniques of angle-resolved photoemission, absorption, diffraction, microbeam macromolecular crystallography and imaging, with the plan to have them gradually hosting users during the period 2020-23. In 2023 ALBA shall have 12 beamlines in operation.

References

[1] www.albasynchrotron.es

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ID: 04029, 15/07/2019 15:45 - 15/07/2019 16:00, Conference Hall (Floor -1)
S8. Trends in Magnetism
(Plenary)

Magnetocaloric effect: from energy efficient refrigeration to fundamental studies of phase transitions

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** Victorino Franco, vfranco@us.es*

The magnetocaloric effect, that is, the reversible temperature change experienced by a magnetic material upon the application or removal of a magnetic field, has become a topic of increasing research interest due to its potential applications in refrigeration at ambient temperature that is energy efficient and environmentally friendly [1]. From a technological point of view, the improvement of magnetic refrigeration systems can have a notable impact on society: a large fraction of the electricity consumed in residential and commercial markets is used for temperature and climate control. From the point of view of magnetic materials, research on this topic mainly focuses on the discovery of new materials with lower cost and enhanced performance. In addition, the characterization of the magnetocaloric effect can be used for more fundamental studies of the characteristics of phase transitions.

After an overview of the phenomenon and a classification of the most relevant families of alloys and compounds, I will present a new method to quantitatively determine the order of thermomagnetic phase transitions using the field dependence of the magnetic entropy change [2]. For second-order phase transition materials, I will show that critical exponents can be determined using the magnetocaloric effect even in cases where the usual methods are not applicable [3]. In the case of first-order phase transitions, more details about their hysteretic response can be obtained using T-FORC [4].

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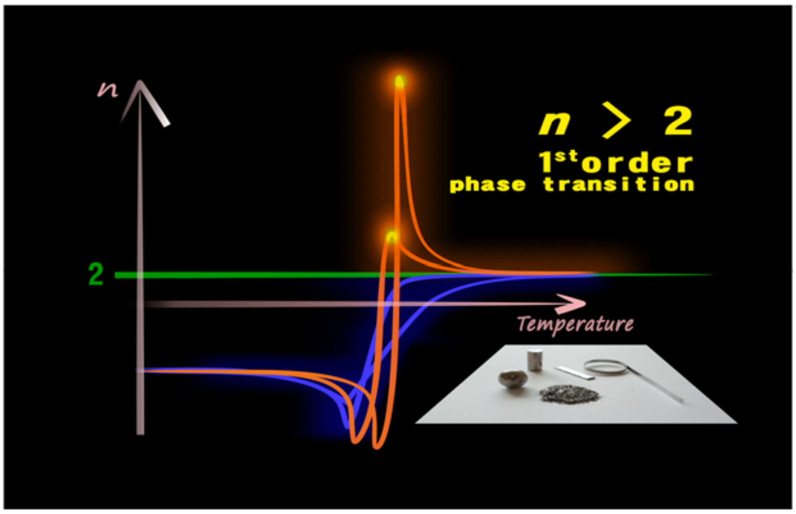

ID: 03985, 15/07/2019 17:15 - 15/07/2019 17:40, Conference Hall (Floor -1)

S8. Trends in Magnetism

(Invited Symposio)

Controlling thermal conductivity through domain wall engineering in epitaxially-grown ferroic thin films

Eric Langenberg[1]

1) CiQUS-U. Santiago de Compostela 2) Cornell University

** Eric Langenberg, eric.langenberg.perez@gmail.com*

Achieving an efficient modulation of the phonon transmission across a solid-state device is an unavoidable step in the path to achieve logic operations using "phonon currents", in the emergent field of phononics. In this regard, ferroic materials with intrinsic interfaces –domain walls– that *i*) can act as effective phonon scatterers and *ii*) can extensively be engineered are excellent candidates to be harnessed as heat modulators. Here, we show that thermal conductivity of single crystal $PbTiO_3$ thin films can be modulated by 61% at room temperature, through an accurate control over the type and density of ferroelectric DWs achieved by epitaxial strain engineering. The structural mismatch and polarization gradient between different types of domains results in a structural but reconfigurable inhomogeneity which entails several unit cells around the DWs. This results in a very low thermal conductance of the DWs, comparable to grain boundaries. The results presented in this work demonstrate the suitability of ferroelectrics as efficient heat flow regulators in phononic circuits, as well as in advanced applications in thermal energy management.

ID: 04033, 15/07/2019 17:40 - 15/07/2019 18:05, Conference Hall (Floor -1)
S8. Trends in Magnetism
(Invited Symposio)

New routes for developing alternative permanent magnets: from composite materials synthesis to 3D-printing

Ester M. Palmero[1] , Daniel Casaleiz[1] , Javier Rial[1] , Javier de Vicente[1] , Alberto Bollero[1]

1) Division of Permanent Magnets and Applications, IMDEA Nanoscience, 28049 Madrid, Spain

** Ester M. Palmero, ester.palmero@imdea.org*

Advanced additive manufacturing for developing multi-material devices is attracting much interest due to the possibility of fabricating high-performance elements with complex shapes and tuned properties [1]. For permanent magnet (PM) applications, the fabrication of magnets with no geometrical constrictions and no deterioration of their magnetic properties is a relevant point and a present challenge, [2] together with finding alternatives to the controversial rare earth (RE)-based magnets. MnAl alloy is a suitable candidate to plug partially the gap between ferrites and NdFeB magnets provided successful development of its PM properties, in addition to its high availability and diminished environmental impact [3].

Composites (magnetic particles/polymer) were synthesized and extruded into homogeneous, flexible and continuous filaments and strips. Gas-atomized τ-phase MnAlC, ferrite and hybrid (ferrite/NdFeB) materials were used for studying different alternative PM materials. The influence of particle size, fine-to-coarse particle ratio, polymer and fabrication parameters on the properties of the final products was analyzed, showing they are crucial factors to be considered and optimized for obtaining flexible and continuous filaments with a high filling factor (>80%) and length over 10 m.[4,5] Magnetic measurements revealed no deterioration of the properties of the starting particles after processing, proving that alternative PMs materials can be efficiently synthesized and processed for developing a new generation of magnets by 3D-printing.

Authors acknowledge Höganäs AB (Sweden) for providing gas-atomized MnAlC powders and IMA S.L. (Spain) for providing ferrite, NdFeB and hybrid pellets.

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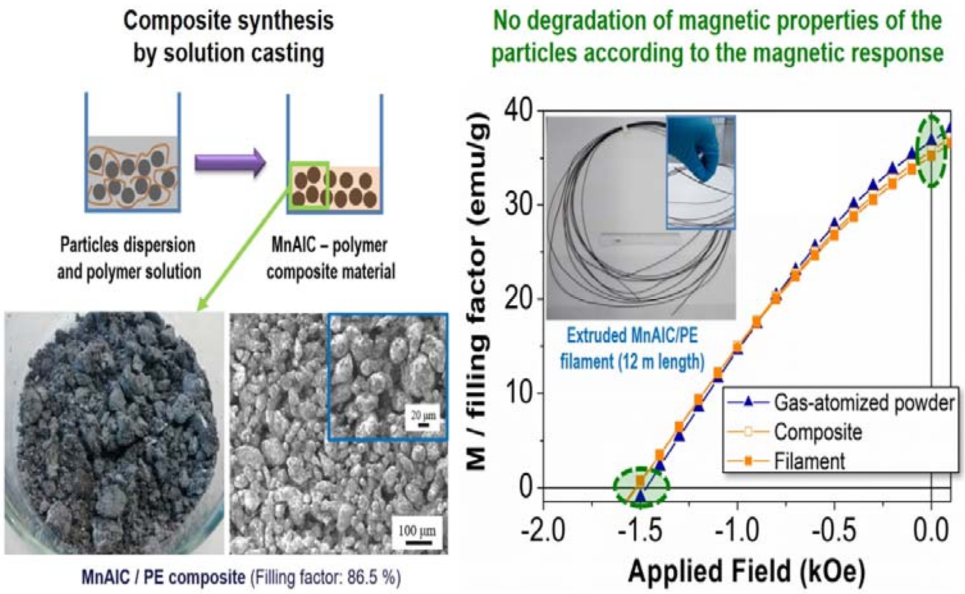
Composite synthesis
by solution casting
Particles dispersion
and polymer solution
MnAlC – polymer
composite material
20 µm
100 µm
MnAlC / PE composite (Filling factor: 86.5 %)
No degradation of magnetic properties of the
particles according to the magnetic response
M / filling factor (emu/g)
Applied Field (kOe)
Extruded MnAlC/PE
filament (12 m length)
Gas-atomized powder
Composite
Filament

ID: 04084, 15/07/2019 18:05 - 15/07/2019 18:20, Conference Hall (Floor -1)
S8. Trends in Magnetism
(Oral)

Fe nanodots formed on a metalorganic network: growth and magnetism

Leyre Hernández-López[1] , Jorge Lobo-Checa[1] , Ignacio Piquero-Zulaica[2] , Marten Piantek[3] , David Serrate[1] , Fernando Bartolomé[1]

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** Leyre Hernández-López, leyrehl@unizar.es*

Nanostructured Fe clusters whose atoms have a low average coordination number are expected to present enhanced orbital magnetic moment and anisotropy [1]. Metal-organic interactions exhibit custom reversibility in bond formation that may result in large and extended self-assembled structures. Under ultra-high vacuum conditions, we use a Cu(111) monocrystal as substrate and generate an extended metalorganic network that fully covers its surface, which is stable at room temperature [2,3]. When Fe is evaporated onto this molecular array, instead of the usual triangular bi-layer islands [4], single atomic height nanoclusters are formed. The obtained structures are characterized as a function of coverage and temperature by means of Scanning Tunneling Microscopy. We find that both parameters affect the resulting nanodot sizes implying that a certain control can be exerted on its fabrication. Moreover, X-ray Magnetic Circular Dichroism experiments onto these samples show that the Fe nanostructures, which are stable at room temperature, significantly change the magnetic anisotropy compared to the case when the molecular layer is missing [5].

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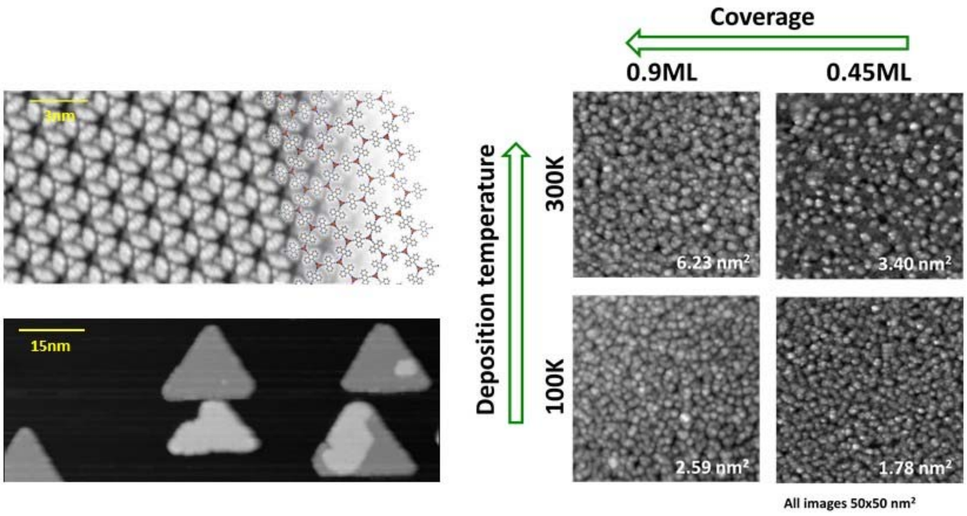

Top left: STM image with a schematic model superimposed of the network. Left bottom: STM image of Fe/Cu(111) triangular islands. Right: Fe nanodots formed on the DCA network as a function of preparation parameters.

ID: 03984, 15/07/2019 18:20 - 15/07/2019 18:35, Conference Hall (Floor -1)
S8. Trends in Magnetism
(Oral)

High pressure synthesis and magnetic properties of $MnRMnSbO_6$ double perovskites (R=La-Gd)

Regino Saez Puche[1] , Andres Chiquero Ovejero[1] , Jose Manuel Gallardo Amores[1] , Antonio Dos santos Garcia[2] , Clemens Ritter[3] , Elena Solana Madruga[4] , Angel Arevalo López[4] , Paul Attfield[4]

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6) School of Chemistry and CSEC, University of Edinburgh, Scotland.
7) School of Chemistry and CSEC, University of Edinburgh, Scotland.
8) School of Chemistry and CSEC, University of Edinburgh, Scotland.

** Regino Saez Puche, rsp92@ucm.es*

High pressure and high temperature conditions (HPHT),10-13GPa and 1473K, have been used to prepare new double perovskites $MnRMnSbO_6$ (R=rare earth). In the case of $MnRMnSbO_6$ (R=La-Sm) a new type of double-double perovskites(DDP) have been obtained, showing tetragonal symmetry, S.G. $P4_2/n$, with the Mn and R ordered in columns at the A-site, while the B-sites are occupied by Mn^{2+} and Sb^{3+}having a rock salt order. X-ray diffraction data for the smaller rare earths, Eu and Gd, lead to conventional monoclinic rock salt double perovskites, S-G. $P2_1/n$ [1].

Magnetic susceptibility data reveal that the Mn-sublattices are antiferromagnetic with a net ferromagnetic moment corresponding to the R^{3+}. Powder neutron diffraction data reveal low-temperature magnetic order in $MnRMnSbO_6$ (R=La, Pr and Nd) DDPv. At T_C=76 K, it can be observed the onset of magnetic peaks such as (200) and (020) for Nd and Pr derivatives, and the data are fitted by an antiferromagnetic model in which Mn A-site moments are antiparallel toMn B-sites ones, with all moments in the z direction. On cooling below 42 K a second magnetic transition appears in the case of the MnNdMnSbO6, indicated by the onset of the magnetic peaks such as (002) grows in intensity while (200) decreases. This result reveals a spin reorientation transition driven by order of the Nd moments in the xy-plane driven by single-ion anisotropy of Nd^{3+} [2]. In the case of Eu^{3+} and Gd^{3+} magnetization data obtained at 2K indicate that the magnetic moments of MnA and MnB are antiferromagnetic ordered as in the case of the DDPv derivatives. For $MnGdMnSbO_6$ the magnetocaloric effect has been determined from the isothermal magnetization curves with DS= -16.5 J/KgK at 5 K, for D*B* = 5T.

References

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Tunable Microdisks Loaded with Multifunctional Cargo for Efficient Magnetothermal Actuation

Idoia Castellanos-Rubio[1] , Rahul Munshi[2] , Yueling Qin[2] , David B. Eason[3] , Iñaki Orue[4] , Luis Lezama[1] , Arnd Pralle[2] , Maite Insausti[1]

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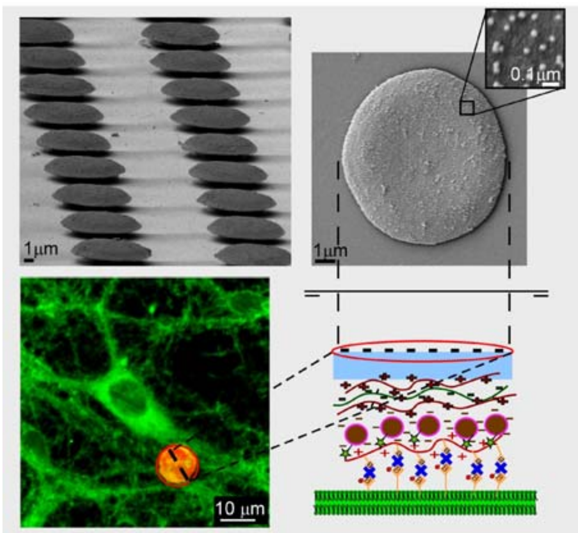
The development of magnetothermal neuromodulation and magnetic hyperthermia therapies requires magnetic nanoparticles (MNPs) with high heating power that are able to form stable and lasting attachment with cells. Nevertheless, the application of MNPs in-vivo is limited by their tendency to agglomerate and by cellular endo- or phagocytosis. Here, we show the production of novel inorganic-polymeric microdisks loaded with MNPs, fluorophores and biomolecules as long lasting sub-cellular implants for efficient magnetothermal actuation. The diameter of the disks, their thickness, the inorganic phase and the NP density on the disk surface can be easily customized. This approach allows the incorporation of Fe_3O_4 nanoparticles with permanent magnetic moments (F-MNPs) in a flat arrangement and devoid of dipolar interactions, enabling the use of the MNPs with maximally achievable heating power. Therefore, these micro-devices are presented as suitable carriers to transport flat assemblies of F-MNPs to the cell membrane unchanged and to preserve the magnetic response of the MNPs in any biological environment.

Figure 1. SEM images of microdisks (inset: F-MNPs on a microdisk´s surface). Drawing representing a cross-sectional view of a microdisck. Fluorescence micrograph showing a microdisk attached to cultured rat hippocampal neuron.



ID: 03709, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S8. Trends in Magnetism
(Poster)

2D magnetic domain wall ratchet: the limit of submicrometric holes

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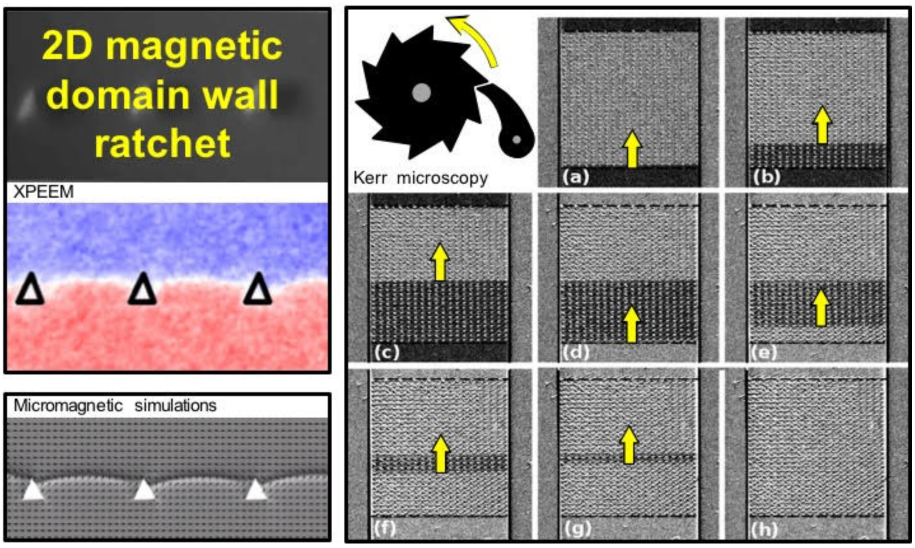
In the last decade, magnetic ratchet effect of domain walls has been proposed by several groups as a working principle for spintronic devices like magnetic diodes or shift registers. Indeed, some of the proposed strategies are promising candidates to be seen in the near future in working devices. As an alternative route, we have succeeded in producing and observing magnetic ratchet effects, as well as crossed-ratchet effects, in a ferromagnetic thin film where we have nanopatterned 2D arrays of asymmetric holes in the submicrometric limit for hole sizes. The combination of Kerr microscopy, X-Ray PhotoEmission Electron Microscopy and micromagnetic simulations has allowed a full magnetic characterisation of the domain wall (DW) propagation processes over the whole array and the local DW morphology and pinning at the holes. The simulations also allow to propose a new ratchet/inverted-ratchet effect in the submicrometric range driven by two different mechanisms: magnetic fields and electrical currents.



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S8. Trends in Magnetism
(Poster)

Rare earth role in spin-glass $RFeTi_2O_7$ compounds

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The physics of spin glass systems has been a field of scientific research in the last decades [1,2]. There is a large variety of materials showing spin glass behaviour or exhibiting spin-glass-like features, being the current experimental and theoretical research on this field of great interest.
Zirconolite oxides $R^{3+}Fe^{3+}Ti_2O_7$ (R rare earth element) are known to exhibit spin glass behaviour at low temperatures [3,4]. Here we present a detailed study of these compounds for R = Eu, Gd, Dy, Ho, and Er, together with reviewed previous measurements on Sm, Tb, Tm, Yb and Lu, with the scope of determining the role played by the rare earth in their magnetic properties. They have been investigated using X-ray powder diffraction, and further characterized by magnetization, frequency dependent ac susceptibility measurements and heat capacity. $RFeTi_2O_7$ compounds are all isostructural showing orthorhombic structure, space group *Pcnb* at 300 K. Disorder in $RFeTi_2O_7$ lattice induces spin glass behaviour at low temperatures, mainly due to the Fe sublattice. We show that magnetic rare earth ions participate in the spin glass state tuning its properties. In particular, the increase in the spin-glass temperature ΔT_{SG}^R with respect to the $LuFeTi_2O_7$, where Lu is non-magnetic correlates with the de Gennes factor multiplied by the ratio of exchange interactions J_{RFe}/J_{FeFe} (Figure a), and for increasing anisotropy the spin glass transition dynamics slows down to values typical of cluster glass (Figure b). The coercive field below the transition is increased in the same trend. Observed variations are explained as due to the anisotropic part of the R-Fe exchange interaction.

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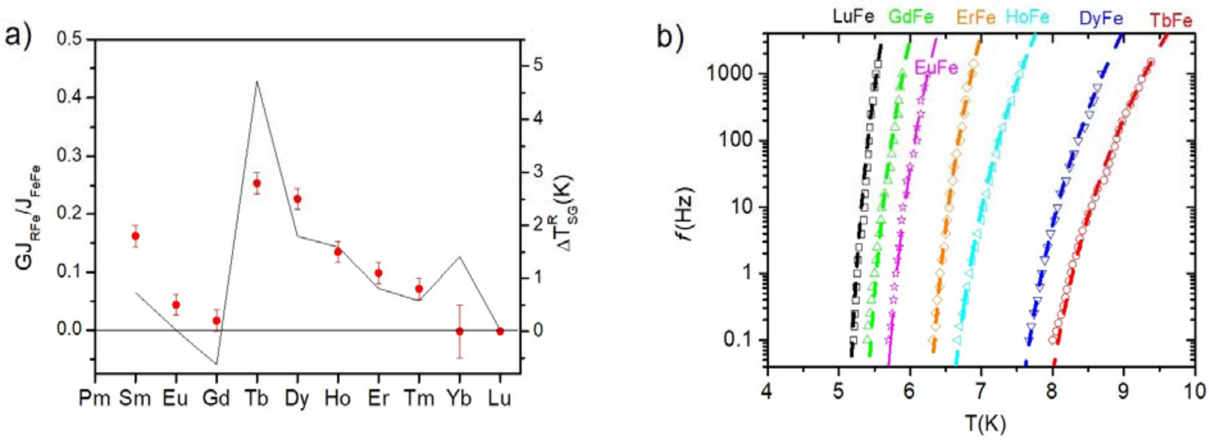

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S8. Trends in Magnetism

(Poster)

MFM-KPFM characterization of magnetic nanocomposites for bioapplications

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Magnetic nanostructures have been used in different applications in biomedicine and life science such as imaging diagnosis, drug delivery, hyperthermia and molecular detection [1]. Moreover, the effect of different physical stimuli in the cell culture has been studied. In particular, conductive or piezoelectric polymers have been used for tissue engineering applications, due to their ability to create a beneficial electroactive microenvironment to the cells [2, 3]. In this work, a fundamental study of the magnetic and electrical properties of a magnetoelectric nanocomposite is presented, which has shown applications in biomedicine [4].

The composite material is prepared by mixing magnetic nanowires 60 nm in diameter partially embedded into an AAO membrane with interpore distance of 105 nm and a piezoelectric polymer poly (vinylidene fluoride) (PVDF) thin film. Magnetic Force Microscopy-Kelvin Probe Force Microscopy (MFM-KPFM) combined system [5] has been used to characterize the electrical and magnetic properties of this material at the nanoscale. Thanks to this combined system, it is possible to distinguish the magnetic signal coming from the magnetic nanowires and the surface potential of the PVDF layer that varies with its thickness as shown in Figures 1 and 2.

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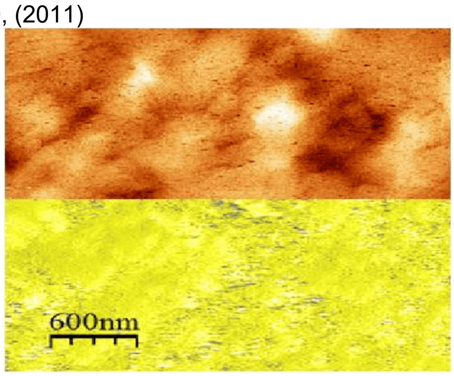

Figure 1. MFM (upper image) and KPFM (lower image) corresponding to a region with a thin polymer layer covering the partially embedded nanowires.

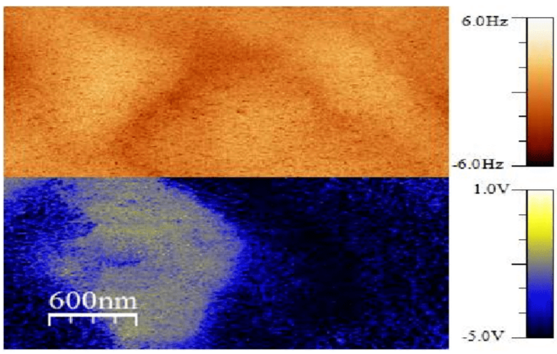

Figure 2. MFM (upper image) and KPFM (lower image) corresponding to a region with a thicker polymer layer covering the partially embedded nanowires.

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S8. Trends in Magnetism

(Poster)

Sn-doped IrO_2 thin films for spin current detection.

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IrO_2 has been proposed as the most promising material as spin-current detector [1]. In order to explain and optimize the initial results observed by Fujiwara et al. [1], we prepared for the first time Sn-doped IrO_2 thin films, $Ir_{1-x}Sn_xO_2$ (x = 0–0.6), in the amorphous and polycrystalline states, by reactive magnetron co-sputtering. Choosing Sn as the dopant element is especially interesting, since SnO_2 presents an insulating behavior and, like IrO_2, it grows in the rutile structure. The only difference is an increase in the volume cell, which makes it easier for Sn to occupy Ir sites without any drastic structural change. The electrical response and strength of the spin–orbit coupling (SOC), both key properties involved in the spin-detection process, were carefully studied in order to better understand and tailor its performance as spin current detector material.

Overall, our work proves that the resistivity of IrO_2 can be tuned over several orders of magnitude by controlling the doping content in both the amorphous and the polycrystalline state. In addition, growing amorphous samples increase the resistivity, thus improving the spin-current to charge-current conversion. As far as the SOC is concerned, the system not only remains in a strong SOC regime but it seems to undergo a slight enhancement in the amorphous state, as well as in the Sn-doped samples.

Consequently, it points to a clear new direction/approach in the quest of optimized materials for spin current detection [2,3]. From the industrial application point of view, the good results obtained in the amorphous $Ir_{1-x}Sn_xO_2$ samples are especially relevant as they are easier to fabricate. Besides, taking into account the high price of Ir, Sn-doping also considerably reduces costs.

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ID: 03857, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S8. Trends in Magnetism
(Poster)

Electronic transport properties in bidimensional ferromagnet $GdAu_2$ with atomic scale resolution

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2D materials display multiple physical properties that can be implemented in emerging applications, among them magnetic ordering, superconductivity or non-trivial electronic states. The $GdAu_2$ monolayer is known to be in-plane ferromagnetically ordered at low temperatures [1]. We have prepared $GdAu_2$ on a Au(111) crystal. It exhibits occasional structural antiphase boundaries (APB) that are atomically sharp linear defects separating structurally identical domains whose lattices are phase shifted. Our spin-polarized STM measurements unveil that the coupling among two adjacent domains is always antiferromagnetic, as demonstrated by hysteresis loops of the relative domain contrast. In this work, we measure the electrical resistance across an antiphase boundary (APB) of the $GdAu_2$ surface alloy with the tungsten tip of a scanning tunneling microscope (STM).

The transport measurements were performed by means of the recently developed Molecular Nanoprobe (MONA) technique [2]. In this technique charge carriers (electrons or holes) are injected from the tip of a scanning tunneling microscope (STM) and detected by conformational switching processes excited inelastically by hot electrons reaching dehydrogenated phthalocyanine molecules. By statistically analyzing thousands of injection sequences the charge transport between two surface spots can be evaluated.

Figure 1 – STM image of $GdAu_2$ surface alloy with antiphase boundaries 500mV@120pA

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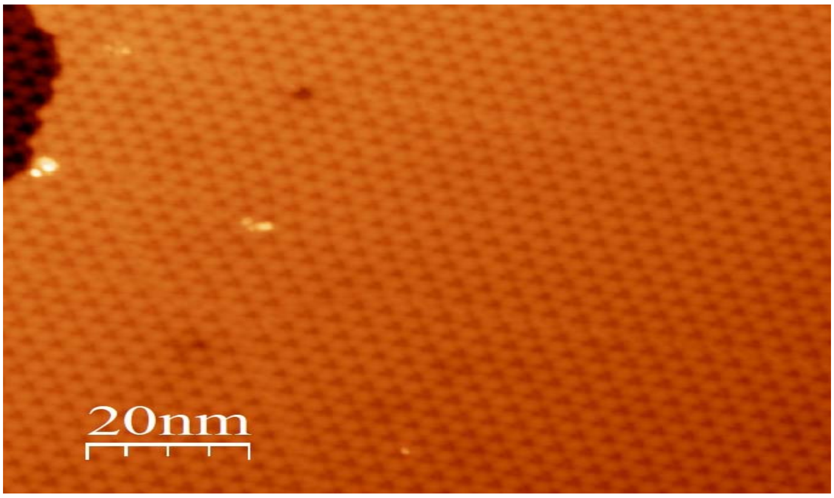

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S8. Trends in Magnetism
(Poster)

PLD-grown Iridium Oxide for Spin Seebeck detection by Inverse Spin Hall effect

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Inverse Spin-Hall effect (ISHE) has been widely exploited during last decades to convert spin currents into electrically detectable charge currents. The origin of this effect lies in the spin-orbit coupling, and usually transition metals with high atomic number such as Pt, Au or W have been used as spin-current detectors. However, conductive oxides constitute a promising alternative; not only because of their chemical stability, ease of fabrication and lower cost, but also because of their higher electrical resistivities, which can be an asset when the quantity of interest is the output voltage after the spin-to-charge conversion. This is because the measured voltage is proportional to the incoming spin current as follows:

$$\Delta V_{ISHE} \propto \theta_{SH}\rho_c I_s$$

which means that not only the spin-to-charge conversion efficiency —the so-called spin Hall angle, θ_{SH} affects the performance as detector, but also the electrical resistivity ρ_c.Fujiwara *et al.* in Ref. [1] proposed IrO_2 as a promising material for spin-current detection, finding $\theta_{SH} \approx 0.04$ for sputtering-grown polycrystalline IrO_2. Surprisingly, later on Qiu *et al.* reported that the performance of IrO_2 in detecting thermally excited spin currents in spin-Seebeck experiments (SSE) was extremely low compared to Pt [2]. This apparent contradiction indicates that spin-to-charge conversion in IrO_2 is not a closed subject.

Trying to better understand how ISHE works in IrO_2, we have performed further SSE experiment using as spin detector IrO_2 grown by means of a different technique (Pulsed Laser Deposition, PLD), studying the effect of IrO_2 thickness, temperature and underlying magnetic materia. The results allow us to establish the dominant mechanism in ISHE and point out significant differences in behaviour of PLD-grown IrO_2 with respect to previously reported IrO_2 prepared by sputtering.

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ID: 03915, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S8. Trends in Magnetism
(Poster)

Three-dimensional functional magnetic nanostructures grown by Focused Electron Beam Induced Deposition

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The fabrication of three-dimensional (3D) magnetic nanostructures is currently a central topic in nanomagnetism [1]. Ferromagnetic nanowires (NWs) and nanotubes (NTs) are potential candidates for magnetic data storage, logic and sensing, and Focused Electron Beam Induced Deposition (FEBID) could play a crucial role in the fabrication of these architectures [2].

We have developed a new approach to grow core-shell heterostructures by FEBID [3], obtaining Co@Pt and Fe@Pt NWs, and Co NTs [4], as shown in Figure 1(a-c). In addition, annealing treatments of Co NWs have been found to increase metal purity, crystallinity and magnetic induction (Figure 1(d)) [5,6].
Furthermore, we report on the fabrication of Magnetic Force Microscopy (MFM) tips by FEBID, showing great performance. Tailored Co and Fe MFM tips have been tested, both in ambient conditions and liquid environment, getting outstanding mechanical stability, resolution and sensitivity [7,8]. In particular, Fe tips with a 7 nm-wide sharp end exhibit low sample-tip magnetic interaction, which has been useful to measure complex magnetic states such as skyrmions [8].

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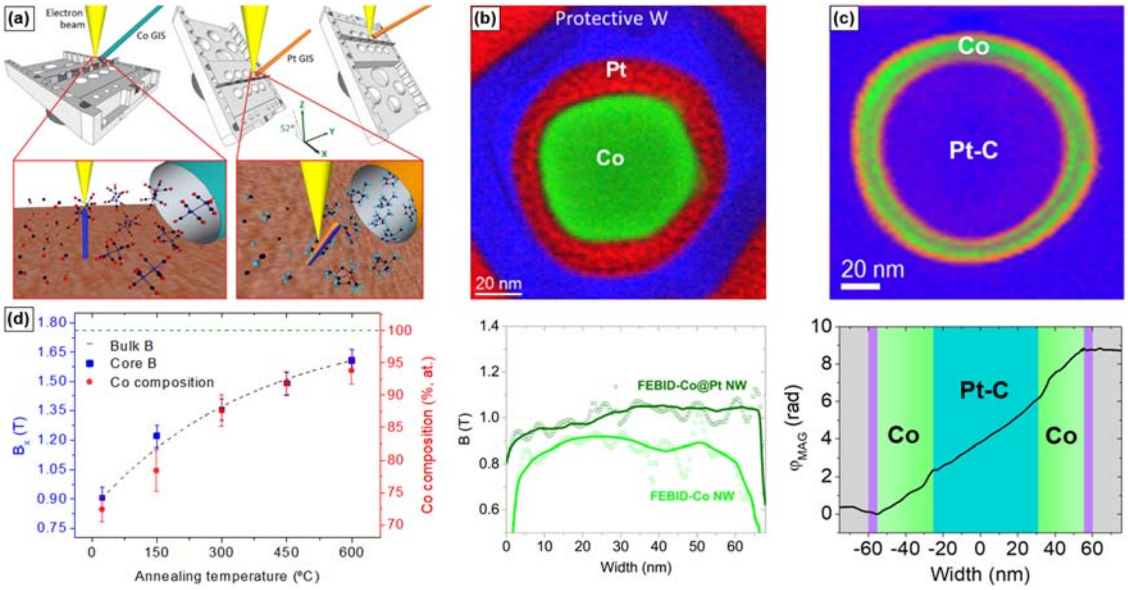
(a)
Electron beam
Co GIS
Pt GIS
52°
(b)
Protective W
Pt
Co
20 nm
(c)
Co
Pt-C
20 nm
(d)
Bulk B
Core B
Co composition
Annealing temperature (ºC)
FEBID-Co@Pt NW
FEBID-Co NW
B (T)
Width (nm)
Pt-C
Co
Co
Width (nm)

Multi-shaped individual nanoparticles investigated by nanoSQUID magnetometry at variable temperature

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Performing magnetization studies on individual nanoparticles is a highly demanding task, especially when measurements need to be carried out under large sweeping magnetic fields or variable temperature. Yet, characterization under varying ambient conditions is paramount in order to fully understand the magnetic behavior of these objects, e.g., the formation of non-uniform states, the mechanisms leading to magnetization reversal, thermal stability or damping processes. This, in turn, is necessary for the integration of magnetic nanoparticles and nanowires into useful devices, e.g., spin-valves, racetrack memories or magnetic tip probes. Here we show that $YBa_2Cu_3O_7$ nano Superconducting QUantum Interference Devices (YBCO nanoSQUIDs, see Fig.) are particularly well suited for this task. For this purpose, we have successfully characterized a number of individual nanoparticles of soft magnetic materials with different shapes (nanodots, nanodiscs and nanowires, see Figure). Samples are transported to the surface of the sensor with nanometric resolution, achieving large particle-SQUID coupling. Magnetization measurements (see Figure) performed under sweeping magnetic fields (up to ~100 mT) and variable temperature (1.4 - 80 K) underscore the intrinsic differences between samples owing to their shape and the presence (or absence) of magnetocrystalline anisotropy. Our measurements also allow us to distinguish the mechanisms leading to magnetization reversal mediated by, i.e., nucleation/propagation of domain walls or nucleation/annihilation of magnetic vortices. These studies serve to shed light on the nature and magnitude of the energy barriers separating different magnetic states, nucleation/annihilation fields and switching times [1].

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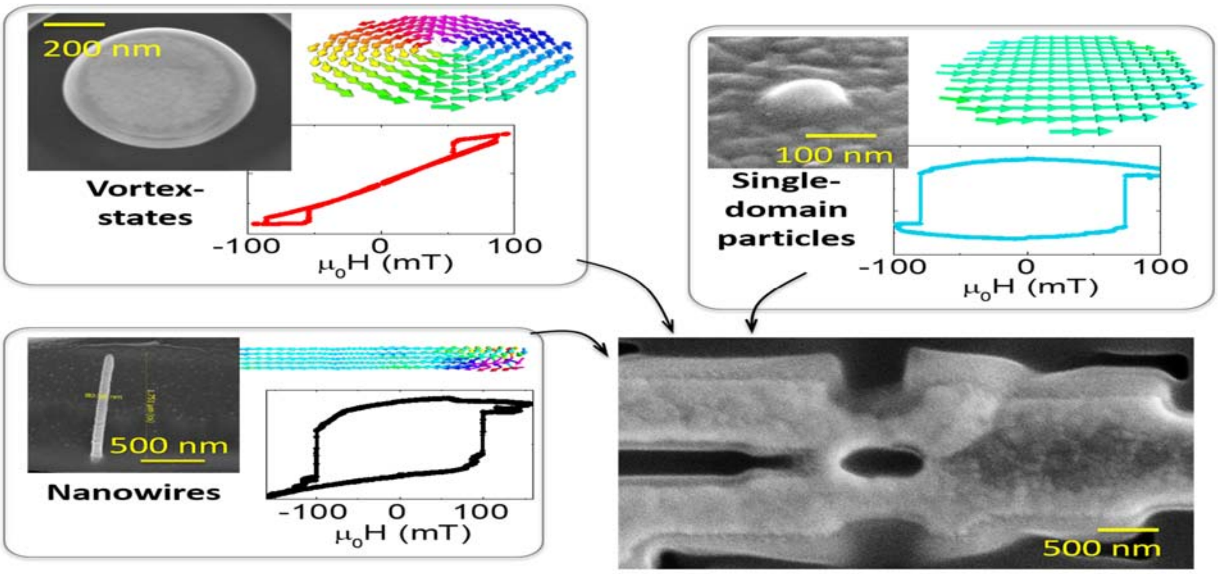
200 nm
Vortex-
states
-100
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100 nm
Single-
domain
particles
-100
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500 nm
Nanowires
-100
0
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μ_0H (mT)
500 nm

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S8. Trends in Magnetism
(Poster)

Magnetic properties and local ordering in epitaxial $Fe_{100-x}Ga_x$/MgO(001) films

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Iron-gallium alloys ($Fe_{100-x}Ga_x$) have become an important material because of their large tetragonal magnetostriction at low field for alloys around 18.4 % Ga [1]. Thin film technology offers a different route to obtain materials and adds the strain due to the substrate as a new variable to be considered. In this work, we present magnetic and structural properties of $Fe_{100-x}Ga_x$ (x < 30) films grown by Molecular Beam Epitaxy on MgO (100). We combine local/chemically selective structural probes (X-ray Diffraction and X-ray absorption spectroscopy) with magnetic techniques to determine local ordering, crystal structure, magnetic anisotropy, domain structure, and magnetoelastic (ME) stress coefficients. For substrate temperature T_s below 400 °C we obtain *bcc* films, while for x about 24 and T_s larger than 400 °C the nucleation of the *fcc* phase is observed. For both systems, a Ga anti-clustering or local range ordering phenomenon appears. The Ga/Fe composition in the first and second coordination shells of the *bcc* films is different from that expected for a random Ga distribution and is close to a $D0_3$ phase, leading to a minimization of the number Ga-Ga pairs. On the other side, a long-range $D0_3$ phase is not observed indicating than atomic ordering only occurs at a local scale. [2]. We focus on the magnetism of films grown at T_s = 150 °C. The MFM images show structures with plain micrometric areas separated by Bloch domain walls and, for x > 20, a fine corrugation of the magnetic contrast. The ME stress coefficient B_1 increment (in modulus) goes with x up to x = 15, as happens in bulk samples. After the subsequent decrement of B_1, however, a second peak of B_1 *vs* x is observed for x = 22. This is an unexpected behavior because the increment of $(3/2)\lambda_{100}$ for x > 20 in bulk is attributed to the softening of the effective elastic constant $(c_{11}-c_{12})/2$ instead of an increment of the ME stress B_1 [3]. These experimental results are explained by the microstructure obtained by the procedure used to prepare our films.

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ID: 03999, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S8. Trends in Magnetism
(Poster)

Spin waves phase shift through local X-rays irradiation of amorphous $Fe_{80}B_{20}$ microstripes

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**Unai Urdiroz, urdiroz@icmm.csic.es*

Magnonic devices, i.e. those exploiting the propagation and interaction of spin waves, allow the possibility of implementing information processing with a minimum energy consumption [1]. They have been proposed on the basis of the implementation of different interferometric logic gates [2] for which the availability of phase shifters is essential. Here we study the behaviour of spin waves travelling along amorphous $Fe_{80}B_{20}$ stripes 15 nm thick, 15 µm wide, 750 µm long, X-rays irradiated transversely to the stripe axis at µm-wide regions (IRs) (Fig. a)). We show, by using static MOKE imaging, how, for the used X-rays energies (5-25 keV), photon fluxes ($1x10^{12}$ph/s) and beam dimensions (2 µm diam.), a local transverse magnetic anisotropy is induced at the IRs. Under slowly varying longitudinal fields the IRs strongly pin the propagating domain walls mediating the magnetization switch. As for the high frequency behaviour of the irradiated stripes we observed, from TR-MOKE imaging of the spin waves propagation under static fields transverse to the long stripe axis and RF fields parallel to that axis and having frequencies in the range from 1 up to 7 GHz, that: i) for RF field frequencies and static fields values not originating the global stripe resonance, the irradiated region can act as a source of spin waves propagating with opposite phases at both sides of the IRs (Fig. c)), ii) the so nucleated spin waves get damped in the non-resonant stripe disappearing at distances from the IR of the order of a few tens of µm (large enough so as to allow the implementation of sub-µm sized devices), iii) the phases of the spin waves propagating at both sides of the IR differ on π. These results endorse the implementation of magnonic devices by X-rays irradiation.

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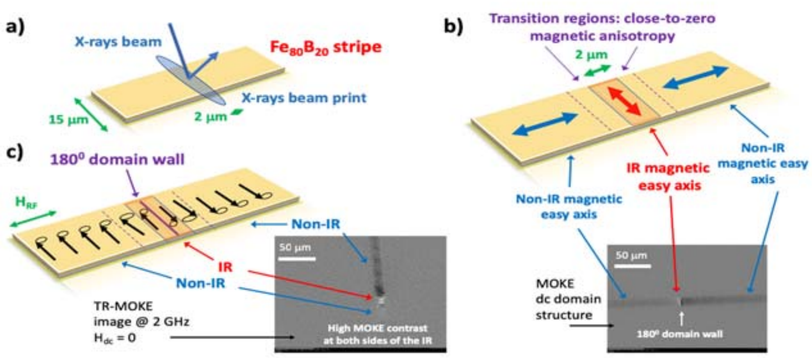

ID: 04099, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S8. Trends in Magnetism
(Poster)

Static and thermal characterization of magnetic multilayers and Ru-based thin films and its application to current and temperature sensors

Miguel Juan[1] , Diego Ramírez[1] , Jaime Sánchez[1] , Pedro J. Martínez[1] , Susana Cardoso[2] , Paulo P Freitas[3]

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** Diego Ramirez, ramirez@uv.es*

The static and thermal characteristics of magnetoresistive current sensors and ruthenium thermoresistances have been obtained. The sensitivity, offset voltage and input resistance thermal drifts were measured. The knowledge of these thermal coefficients will allow to realize a suitable thermal compensation.
Methodology: The bridge output voltage, V_o, and the differential voltage between its input terminals, V_{bridge}, were acquired. In the temperature sensor, the voltage drop V_{Ru} was measured for a bias current of 1 mA. The measurements were taken with current sweeps from -20 A to +20 A in the TMR sensor from -20 ° C to 60 ° C.
Experimental results: A positive thermal drift can be observed for the sensor sensitivity with good linearity (Fig. 2.a and c) while the input resistance of the bridge manifests a negative thermal behaviour (Fig.2.b and d). That will suggest a sensitivity temperature compensation biasing the sensor with a decreasing current value as the temperature goes up. Fig. 2.e) shows the Ru sensor thermal characterization. Goog linearity was obtained for this metallic film allowing it to design a temperature compensation method fot the TMR current sensor. Fig. 2.- Current sensor response at different temperatures (a and b); thermal drift (c and d) and Ru-based temperature sensor response (e).

Acknowledgments: This work was supported by the Spanish Ministry of Economics and Competitivity and European Fund of Regional Development (grant ESP2015-68117-C2-1-R) by the Education, Research, Culture and Sports Council of the Community of Valencia (grant ACIF-2016-330). INESC-MN thanks the Fundação para a Ciência e a Tecnologia (FCT) its financial support through the Projects LISBOA-01-0145-FEDER-031200 and NORTE-01-0145-FEDER-022090.

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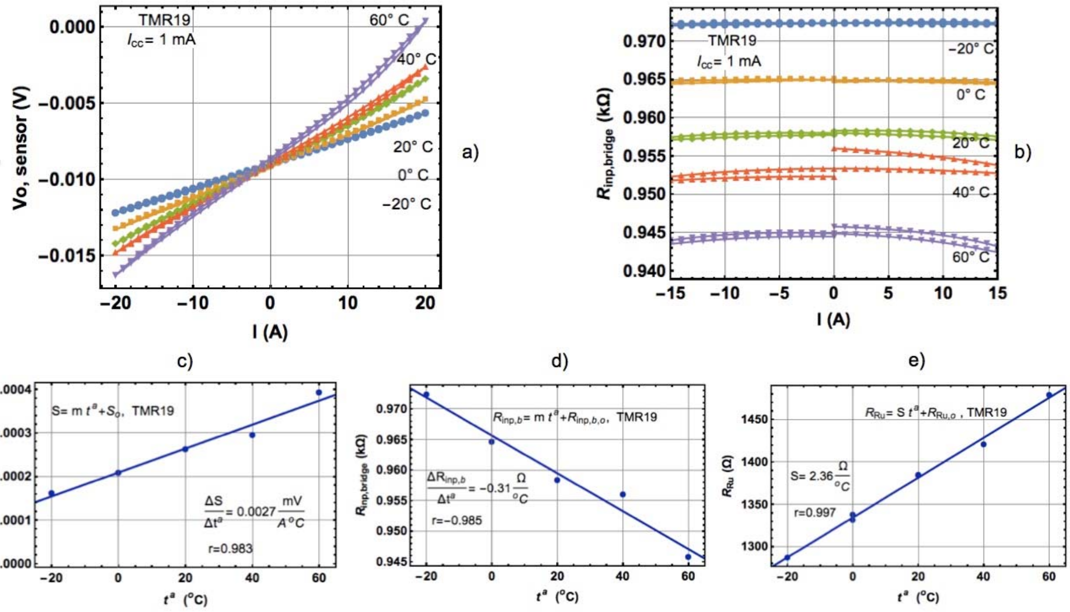
a)
TMR19
I_{cc}= 1 mA
60° C
40° C
20° C
0° C
−20° C
Vo, sensor (V)
I (A)
b)
TMR19
I_{cc}= 1 mA
−20° C
0° C
20° C
40° C
60° C
$R_{inp,bridge}$ (kΩ)
I (A)
c)
$S = m\,t^a + S_o$, TMR19
$\frac{\Delta S}{\Delta t^a} = 0.0027 \frac{mV}{A\,^oC}$
r=0.983
S (V/A)
t^a (°C)
d)
$R_{inp,b} = m\,t^a + R_{inp,b,o}$, TMR19
$\frac{\Delta R_{inp,b}}{\Delta t^a} = -0.31 \frac{\Omega}{^oC}$
r=−0.985
$R_{inp,bridge}$ (kΩ)
t^a (°C)
e)
$R_{Ru} = S\,t^a + R_{Ru,o}$, TMR19
$S = 2.36 \frac{\Omega}{^oC}$
r=0.997
R_{Ru} (Ω)
t^a (°C)

Domain wall structure and magnetization reversal processes in FeNi nanowires

Sandra Ruiz-Gomez[1] , Claudia Fernandez-Gonzalez[2] , Michael Foerster[3] , Lucia Aballe[3] , Adrian Quesada[4] , Juan de la Figuera[5] , Julio Camarero[2] , Arantzazu Mascaraque[1] , Lucas Perez[6]

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** Arantzazu Mascaraque, a.mascaraque@ucm.es*

Tailoring the magnetization processes of magnetic materials is the driving force of technical and applied magnetism. In the particular case of the magnetic nanowires, the introduction of local changes of composition (chemical barriers) can dramatically affect the domain structure and the magnetization processes of the nanostructures, giving rise to the formation of topologically protected domain walls [1]. These nanowires could be the building blocks of tridimensional racetrack memories, proposed by IBM [2], but never fabricated in a 3D configuration. To move towards the development of these 3D structures it is necessary to study the magnetic properties of arrays of permalloy nanowires with chemical barriers with different compositions

To study the behavior of magnetic domain walls in these nanowires, it is mandatory to understand the different magnetic structures that can be found in nanowires but also the pinning-depinning processes, which limits their application in real devices. To this end, we have used LEEM-PEEM and X-TEM microscopies to study the magnetization processes of individual permalloy nanowires. We have proven that chemical notches act as pinning sites for the domain walls [1]. We have used Vectorial magnetic characterization, using magneto-optical Kerr Effect (MOKE) and Vibrating Sample Magnetometry (VSM) to unravel the relationship between the global magnetization processes and the magnetic interactions between nanowires. We have been able to correlate the magnetic properties and the structural ones, paving the way to the utilization of these arrays in applications.

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ID: 04105, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S8. Trends in Magnetism
(Poster)

Magnetoresistive current sensor behaviour under a total ionizing dose (TID) process

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** Diego Ramirez, ramirez@uv.es*

In this work tunnel-based magnetoresistance (TMR) current sensors have been submitted to a total ionizing dose (TID) process wit the goal to investigate its robustness and behaviour. The current sensors were implemented in a Wheatstone bridge configuration where each of the four resistive element of the bridge was the result of a 360 magnetic tunnel junctions (MTJ) in a series connection, [1].
Methodology: The radiation procedure was designed for a total dose of 300 krad received by the sensors during two months at room temperature. The gamma irradiation was provided by a cobalt-60 gamma source with associated photon energies of 1.17 MeV and 1.33 MeV (medium value 1.25 MeV). The bridge output voltage, $V_{o,s}$, and the differential voltage between its input terminals, V_{bridge}, were acquired, in this last case with the objective to know the equivalent input resistance of the bridge, $R_{inp,\ bridge}$. The measurements were taken with current sweeps from -10 A to +10 A. The above magnitudes were taken regularly once the accumulated dose of 50, 100, 200 and 300 krad was applied.
Experimental results: Fig. 1 shows the sensors behaviour when they received a specific amount of dose. The sensor sensitivity, input resistance of the bridge and output voltage at zero current have been represented against increasing steps of radiation dose (parts b, c and d). Fig. 1.a) depicts the sensor response previous the radiation process. In this work sensor TMR1 was used as the reference and was not irradiated. A stability was observed for the parameters to be obtained during the whole radiation process.

Acknowledgments: This work was supported in part by the Spanish Ministry of Economics and Competitivity and European Fund of Regional Development (grant ESP2015-68117-C2-1-R). INESC-MN thanks the Fundação para a Ciência e a Tecnologia (FCT) its financial support through the Projects LISBOA-01-0145-FEDER-031200 and NORTE-01-0145-FEDER-022090.
Fig. 1.- TMR sensors behaviour vs. total irradiation dose.

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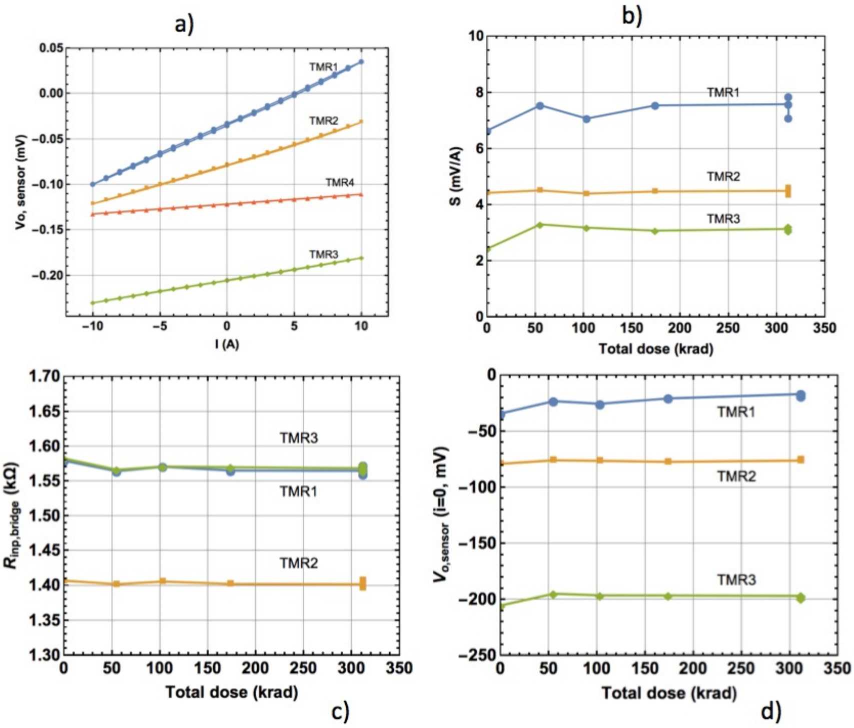
a)
b)
c)
d)
Vo, sensor (mV)
I (A)
TMR1
TMR2
TMR3
TMR4
S (mV/A)
Total dose (krad)
$R_{inp,bridge}$ (kΩ)
$V_{o,sensor}$ (i=0, mV)

ID: 04115, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S8. Trends in Magnetism
(Poster)

Magnetism of a monolayer of Cr_{10} molecular wheels deposited on Au(111)

Elena Bartolome[1], Juan Bartolome[2], Ludovica Ferrari[3] , Francesco Sedona[3] , Ana Arauzo[2] , Mirko Panighel[4] , Julia Herrero-Albillos[5] , Javier Rubín[1] , Javier Herrero-Martín[6] , Aitor Mugarza[4] , Mauro Sambi[3] , Fernando Bartolome[1]

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3) Scienzie Chimiche, Università di Padova, Padova, Italy
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5) Centro Universitario de la Defensa, Academia General Militar, Zaragoza, Spain. 6) ALBA Synchrotron, CELLSBarcelona

** Fernando Bartolome, fernando.bartolome@csic.es*

The self-assembly of magnetic molecules on supporting surfaces provides potentially very interesting magnetic nano-devices in the fields of high-density information storage, information processing and spintronics. We have previously evaporated wheel molecules of formula $\{Cr_{10}(OMe)_{20}(O_2CCMe_3)_{10}\}$, ($\{Cr_{10}\}$ from now-on) by direct sublimation in UHV on a Ag(110) single-crystal [1]. In powder form, these molecules show ferromagnetic interactions [2][3], therefore, they are good candidates as magnetic molecules in a 2D array. In this work, the molecules are deposited onto the Au(111) surface. The STM image in Fig. 1 shows a monolayer of $\{Cr_{10}\}$ molecules, self-organized in a quasi-hexagonal 2D network.

We have studied three samples: a monolayer (1ML) and a multilayer (14 ML) of $\{Cr_{10}\}$ on Au(111) as well as the $\{Cr_{10}\}$ molecular material in bulk, powder form. XMCD measurements were performed at the $L_{2,3}$ edges of Cr at T=2 K and magnetic field up to B=6T. Magnetization and susceptibility were measured by SQUID magnetometry on the multilayer and the powder sample up to B=14 T. We have measured magnetization of the three samples. Both M(H) and X(T) for the powder sample resemble the curves reported earlier [2], where the $\{Cr_{10}\}$ wheels were described in terms of a total molecule spin S=9 ground state, with overall ferromagnetic coupling (XT>0). The overall ferromagnetic coupling is lost by depositing the molecules onto the Au(111) surface on the 14 ML sample (XT< 0). Monte Carlo simulations considering the Cr(III) as Heisenberg S=3/2 spin entities describing the M(H) curves yield quantitative results consistent with this behavior: the evaporation of the molecules into 2D regular arrays on Au(111) weakens the Cr-Cr intramolecular exchange pathways, although maintaining the ground state S=9 found for the randomly oriented powder. The M(H) XMCD determination of the $\{Cr_{10}\}$ 1ML is coincident with that of the 14 ML, within experimental error.

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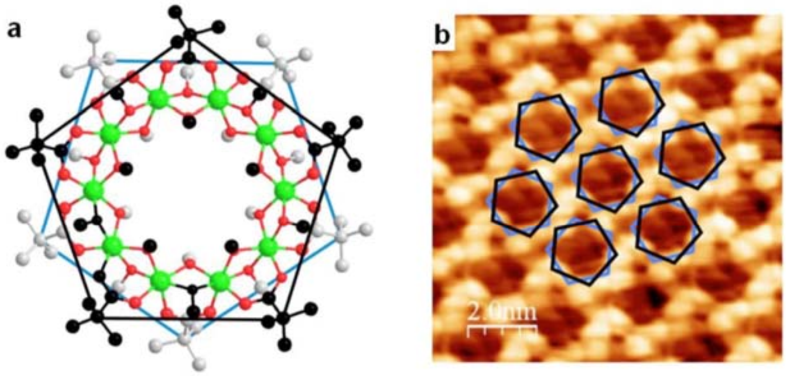

Fig. 1: (a){Cr_{10}} molecule, Colour code: Cr green, O red, C black (light grey) atoms above (below) the plane of metal atoms. (b) STM image of the {Cr_{10}} molecular 2D monolayer array deposited on Au(111)

S9. Física Teórica y de Partículas (DFTP)

Organizadores:

Antonio Dobado, *Universidad Complutense de Madrid*
Manuel Asorey, *Universidad de Zaragoza*

S9. Theoretical and Particle Physics (DFTP)

Organizers:

Antonio Dobado, *Universidad Complutense de Madrid*
Manuel Asorey, *Universidad de Zaragoza*

ID: 04030, 15/07/2019 15:00 - 15/07/2019 15:20, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Neutrino physics beyond the Standard Model en DUNE

Mariam Tórtola[1]

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** Mariam Tórtola, mariam@ific.uv.es*

In the last decades, neutrino physics has experienced a great progress. Nowadays, there is no doubt that neutrinos are massive and mix, giving rise to the flavour oscillation mechanism, rather well characterized by current data. However, there are still some uncertainties in the oscillation mechanism that will be addressed by the next generation of neutrino experiments, such as DUNE. Likewise, DUNE will explore the presence of new physics beyond the Standard Model (SM) through its effects in the neutrino signal. In this talk, I will discuss DUNE\'s sensitivity to some of these scenarios of new physics beyond the SM.

ID: 03863, 15/07/2019 15:20 - 15/07/2019 15:40, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Neutrinos in the LHT

Jose María Pérez Poyatos[1]

1) Universidad de Granada

** Jose María Pérez Poyatos, jmperezpoyatos@gmail.com*

In the Littlest Higgs model with T-parity the Higgs boson is a pseudo-Goldstone boson which can eventually receive large mass contributions at two loops. In the following we discuss their relation with the heavy neutrinos present in the model and with the mechanism for giving masses to the light neutrinos.

ID: 03891, 15/07/2019 15:40 - 15/07/2019 16:00, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Novel method for the direct measurement of the τ^+ lepton dipole moments

Joan Ruiz Vidal[1] , Fernando Martínez Vidal[1] , Louis Henry[1] , Nicola Neri[2] , Daniele Marangotto[2] , Andrea Merli[2] , Jinlin Fu[2] , Marcello A. Giorgi[3]

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2) INFN Sesione di Milano and Università di Milano
3) INFN Sezione di Pisa and Università di Pisa

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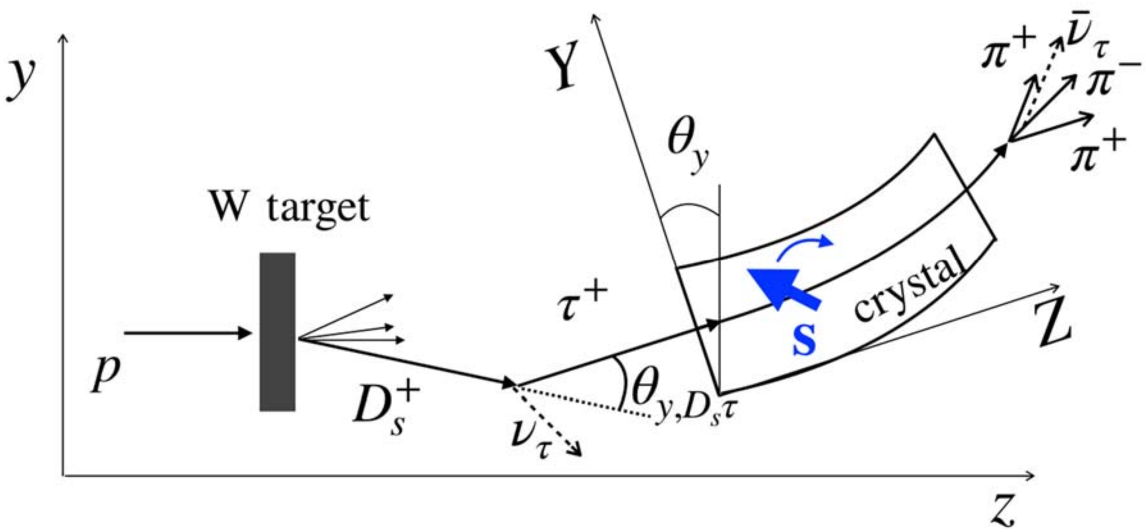
A novel method for the direct measurement of the elusive magnetic and electric dipole moments of the tau lepton is presented. The experimental approach relies on the production of tau+ leptons from $D_s^+ \to \tau^+ \nu_\tau$ decays, originated in fixed-target collisions at the LHC. A sample of polarized τ^+ leptons is kinematically selected and subsequently channeled in a bent crystal. The magnetic and electric dipole moments of the τ^+ lepton are measured by determining the rotation of the spin-polarization vector induced by the intense electromagnetic field between crystal atomic planes. The experimental technique is discussed along with the expected sensitivities.



ID: 03718, 15/07/2019 16:00 - 15/07/2019 16:20, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Search for Higgs boson pair production in the final state with 13 TeV *pp* collision data collected by ATLAS

Ivan Sayago Galvan[1]

1) IFIC - CERN

** Ivan Sayago Galvan, ivasaygal@ific.uv.es*

The CERN Large Hadron Collider (LHC) is nowadays the largest and most powerful particle accelerator in the world. It collides proton beams at a centre-of-mass energy of 13 TeV in four crossing points where the experiments are positioned: ATLAS, CMS, LHCb and ALICE. ATLAS is a general-purpose detector designed to exploit all the LHC capabilities to perform a broad range of high energy physics studies. Its main purpose is to perform precise measurements of Standard Model processes and to search for new physics beyond the Standard Model. ATLAS and CMS were the two LHC experiments involved in the discovery of the Higgs boson in 2012.

This abstract presents a search for both resonant and non-resonant Higgs boson pair production in the $\gamma\gamma b\bar{b}$ final state [1]. This is one of the most promising channels, since it can provide a good sensitivity due to the large branching ratio of the decay channel paired with the low background levels in the decay channel. First limits on the Higgs boson pair production were obtained using the data recorded by ATLAS in 2015 and 2016 corresponding to an integrated luminosity of 36.1 fb^{-1}. For the non-resonant Higgs boson pair production, limits were set corresponding to 22 times the predicted Standard Model cross-section. One of the most interesting parameters to study is the Higgs boson self-coupling ($\kappa_\lambda = \lambda_{HHH}/\lambda^{SM}_{HHH}$) that was constrained at 95% confidence level to $-8.2 < \kappa_\lambda < 13.2$. In Figure 1, we present the exclusion limits for the resonant Higgs boson pair production, through $X\to HH \to\to \gamma\gamma b\bar{b}$, that were obtained ranging from 1.1 pb to 0.12 pb for masses of 260 GeV < m_χ< 1000 GeV. This analysis is being extended to use the full Run-2 dataset (2015-2018) which corresponds to an integrated luminosity of 140. The larger statistics will allow to explore new processes such as diHiggs production via vector boson fusion using multivariate analysis techniques. The latest results of this analysis will be presented.

References

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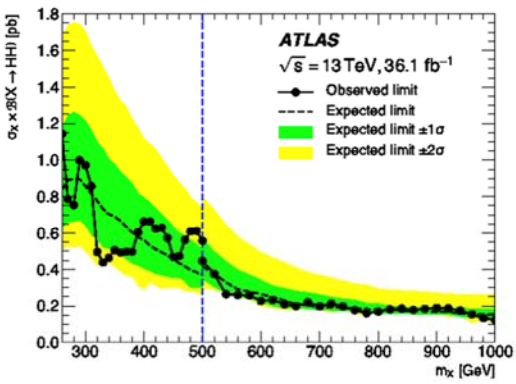

Figure 1. The expected and observed 95% CL limits on the resonant production $X \to HH \to \gamma\gamma b\bar{b}$ as a function of m_X. A loose selection is used for $m_X \leq 500$ GeV, while a tight selection is used for $m_X \geq 500$ GeV. This is delineated with the vertical dashed line.

ID: 03806, 15/07/2019 17:30 - 15/07/2019 17:50, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Prospects of a top quark mass measurement at 13 TeV with the ATLAS detector

Alberto Prades[1] , Esteban Fullana[1] , Davide Melini[1] , Juan Fuster[1] , Marcel Vos[1]

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Key words: *top quark, running mass, pole* mass

The top quark mass (m_t) is one of the fundamental parameters in the Standard Model (SM) and a high precision measurement of this quantity has a great importance by its own. Furthermore, m_t is important in self-consistency checks of the SM and in many new physics scenarios. The ATLAS and Future colliders group at IFIC, in collaboration with DESY, developed a method to measure m_t from the observable of Fig.1. It leads to a precise measurement in a well defined theoretical framework [1]. ATLAS applied such method to data collected at energies of 7 TeV obtaining a precision on the top-quark pole mass of +2.3 -2.1 GeV [2]. A recent analysis with 8 TeV data is currently on going and a more precise result is expected.

The 13 TeV dataset is way larger than the 7 and 8 TeV ones and will help in increasing the precision on m_t. Not only the statistical uncertainty will be reduced, but also the systematic uncertainties can be reduced by using a stricter event selection criteria and by increasing the observable sensitivity (choosing a smaller binning).

Figure 1: Shape of the observable used in this analysis and its sensitivity to m_t. The red arrows represent the increase in the sensitivity in each analysis.

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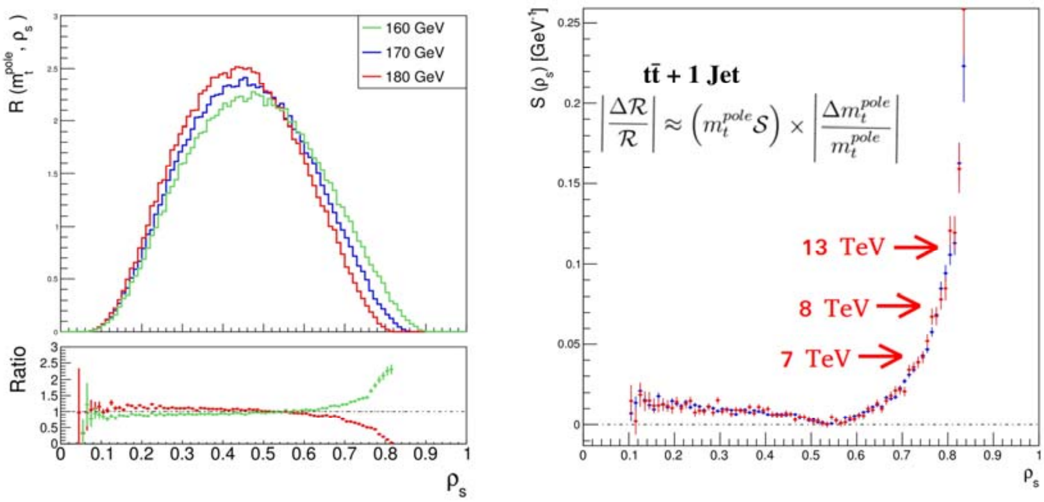

ID: 03788, 15/07/2019 17:50 - 15/07/2019 18:10, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Prospects for a search of invisible particles produced in association with single-top quarks with the ATLAS detector at 14 TeV at the HL-LHC

Josep Navarro González[1] , Florencia Luciana Castillo[1] , Jose Enrique García García Navarro[1] , Carlos Escobar Ibáñez[1]

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Astrophysical and cosmology observation have provided that about 80% of the mass in Universe consists of dark matter (DM). Unlike normal matter, DM does not interact electromagnetically. This means it does not absorb, reflect or emit light, making it extremely hard to spot. It is affected by gravity and could interact weakly (WIMP). Thus DM could be produced and discovered in colliders like the Large Hadron Collider (LHC) or the future High Luminosity LHC (HL-LHC). Consequently, colliders search focus on events with production of a Standard model (SM) particle(s) with large transverse momentum named mono-X signature. The expected sensitivity of a search for events with one top quark and large missing transverse momentum is estimated using simulated proton–proton collisions at a centre-of-mass energy of 14 TeV with the ATLAS experiment at the HL-LHC. A non-resonant production of an exotic state decaying to a pair of invisible dark-matter particles in association with a right-handed top quark is considered. Only the topologies where the W boson from the top quark decays into an electron or a muon and a neutrino are considered. The number of signal and background events are estimated from simulated truth particle-level information after applying smearing functions to mimic an upgraded ATLAS detector response in the HL-LHC environment. The expected exclusion limit at 95% CL on the mass of the exotic state is 4.6 TeV using a multivariate analysis based on a boosted decision tree and assuming an integrated luminosity of 3000 fb^{-1}. The discovery reach obtained is 4.0 TeV. If improvements in systematics would be translated in to a reduction of the uncertainties by a factor 2, the expected exclusion (discovery) would increase by 80 (50) GeV.

ID: 03725, 15/07/2019 18:10 - 15/07/2019 18:30, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Recent single top differential cross section measurements at CMS

Víctor Rodríguez Bouza[1] , Sergio Sánchez Cruz[1] , Enrique Palencia Cortezón[1] , Bárbara Álvarez González[1] , Isidro González Caballero[1]

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Single top quark production is the subleading production process of top quarks at the LHC after the top quark pair production. The recent differential measurements of single top quark production cross sections will be presented using data collected by CMS at 13 TeV. The cross sections are measured as a function of various kinematic observables of the top quarks and the jets and leptons of the events in the final state. The results are confronted with precise theory calculations.

ID: 03655, 15/07/2019 18:30 - 15/07/2019 18:50, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

IFIC-Valencia ATLAS Tier-2 perspective on computing over the next years

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Since the beginning of the WLCG Project the IFIC Tier2 ATLAS computing center has participated with reliable and stable resources as well as personnel for the ATLAS Collaboration. Our contribution to the ATLAS Tier2s resources (disk and CPUs) in the last 10 years has been around 4-5%. In 2016 an international advisory committee recommended to revise our contribution according to the participation in the ATLAS experiment. With this scenario, we are optimizing the federation of the resources, considering that the ATLAS collaboration has developed workflows and tools to flexibly use all the resources available to the collaboration, where the tiered structure is somehow vanishing. In this contribution, we would like to show the evolution and technical updates in the ATLAS Spanish Tier2. Some developments we are involved in, like the Event Index project, as well as the use of opportunistic resources will be useful to reach our goal. We discuss the foreseen/proposed scenario towards a sustainable computing environment for the Spanish ATLAS community in the High Luminosity (HL-LHC) period.

ID: 03724, 15/07/2019 18:50 - 15/07/2019 19:10, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Explore dark matter production with mono-top signatures at ATLAS

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Astrophysical and cosmology observation have provided that about 80% of the mass in universe consists of dark matter (DM). This form of matter does not interact with the electromagnetic force. This means it does not absorb, reflect or emit light. It is affected by gravity and could interact weakly (WIMP). Thus DM could be produced and discovered in colliders like the Large Hadron Collider (LHC). Consequently, colliders search focus on events with production of a Standard model (SM) particle(s) with large E_T^{miss} named mono-X signature.

Recent results on the mono-X searches employed by the ATLAS and CMS collaborations for LHC Run-2 are presented. Showing that the SM predictions are consistent with the observed data in all search channels.

One of the channels which could be sensitive to DM is the mono-top. The contribution will show the expected sensitivity for events with one top quark and large missing transverse momentum using proton--proton collisions at a centre-of-mass energy of 13TeV corresponding to an integrated 36 fb^{-1}. In this search the resonant and non-resonant production of DM particles associated with a top-quark are considered and two channels are included, depending on the leptonic or the hadronic decays of the W boson from top quark. Absent of significant deviations from SM is observed.

Mono-top signature appears in different models like SUSY, Little Higgs or two-Higgs doublet models (2HDM), prospects of new searches within these models using full statistics collected for Run-2 with ATLAS will be also shown.

References:

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[2] ATLAS Collaboration, Search for large missing transverse momentum in association with one top-quark in proton-proton collisions at 13 TeV with the ATLAS detector JHEP (2018), arXiv: 1812.09743 [hep-ex].

ID: 03747, 16/07/2019 15:20 - 16/07/2019 15:40, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Test beam characterization of irradiated 3D pixel sensors

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Due to its large instantaneous luminosity, the future HL-LHC upgrade is going to set strong requirements on the radiation hardness of the CMS detector inner tracker. The 3D pixel technology, with its superior radiation hardness, complies with these extreme conditions.

A full study and characterization of pixelated 3D sensors fabricated by CNM and FBK is presented here. The sensors were bump bonded to the RD53A and ROC4SENS readout chips and measured at several LHC SPS and DESY test beams. Results on hit efficiency, cluster size and hit position residuals for fresh and irradiated samples are presented. The response against bias voltage and temperature is also considered.

ID: 03927, 16/07/2019 15:40 - 16/07/2019 16:00, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Radiation Aging studies of the CMS DT Muon Detector

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During the operation of the HL-LHC (High Luminosity Large Hadron Collider), the Drift Tube (DT) muon chambers instrumenting the return yoke of the CMS experiment need to operate with an integrated dose ten times higher than the expected during the first phase of LHC, at a factor of five larger collision rate than so far achieved in operation. Irradiations have been performed to assess the performance of the detector under such conditions and to characterize the aging due to exposure to radiation. Here we present results for the DT chambers, which are wire gaseous detectors used to identify, reconstruct and trigger on muons. Spare DT chambers were installed at the Gamma Irradiation Facility (GIF++) [1] at CERN and irradiated with a high activity Cessium 137 source over several months.

During the irradiation, the High Voltage currents and the dose received by the chamber were monitored in order to extrapolate the behavior of the detector to HL-LHC conditions. Several corrections had to be made due to the large dimension of the DT chamber and the non-uniform irradiation both geometrically and in time over the various months. As a result, from all these corrections, the currents provided by the DT wires as a function of the integrated dose will be presented. Moreover, using this data, and with the previous knowledge of the relationship between HV and gain in the chamber, the curve of the loss of gain expected versus the dose has been calculated. This loss of gain has been extrapolated for the most exposed chambers to the values expected during HL-LHC [2].

Different mitigation techniques are being implemented in the DT detector such as operating at lower gain and shielding the outer part of the detector to avoid the irradiation from collision products escaping the inner CMS detector.

References

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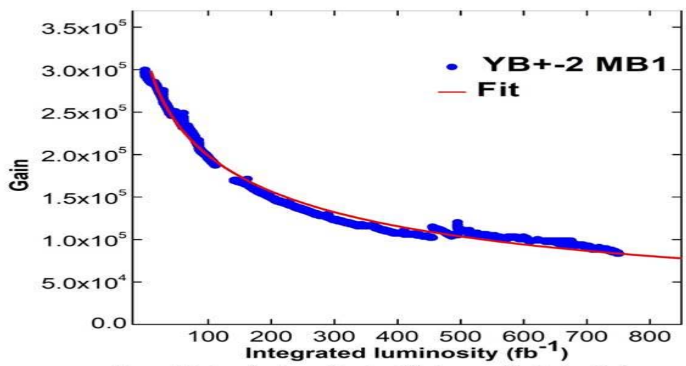

Figure 1: Estimated gain as a function of the integrated luminosity for the MB1 YB ± 2 chambers at HL-LHC

The results obtained allow predicting a degradation in the DT chambers in the order of a factor 3 in gain for the region of the detector with higher exposure to irradiation. This results into a tolerable degradation of the hit efficiency which has been simulated not to affect the system muon reconstruction efficiency.

ID: 03965, 16/07/2019 16:00 - 16/07/2019 16:20, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Prototipo del calorímetro hadrónico con lectura semi-digital de CALICE

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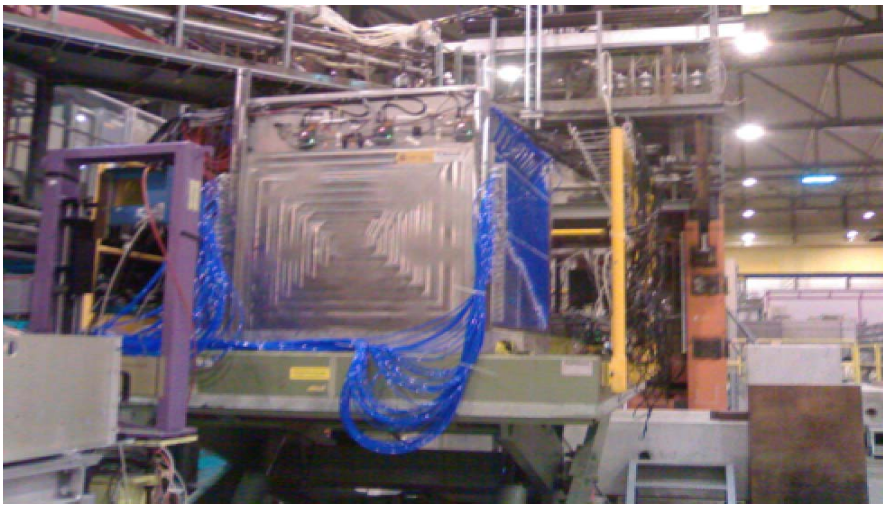
CALICE (*CAlorimetry for the Linear Collider Experiment*) es una colaboración internacional que realiza I+D en calorímetros altamente segmentados destinados a la futura familia de aceleradores lineales, entre los que se encuentra el ILC (*International Linear Collider*), optimizados para hacer uso del PFA (*Particle Flow Algorithm*). Para ello se requiere de una alta capacidad de distinción de trazas también en los calorímetros, siendo imprescindible una alta segmentación tanto longitudinal como transversal, lo que supone un importante reto tecnológico debido a los cientos de millones de canales de lectura.

Entre los calorímetros que se desarrollan en CALICE se encuentra el SDHCAL (*Semi-Digital Hadronic CALorimeter*), que es un calorímetro hadrónico de muestreo con lectura semi-digital formado por detectores gaseosos altamente segmentados intercalados entre planos de acero inoxidable, y el SIW-ECAL (*Silicon-Tungsten Electromagnetic CALorimeter*), que consiste en un calorímetro electrónico compacto formado por sensores pixelados de silicio entre placas de tungsteno.

Desde el año 2012 el prototipo del calorímetro hadrónico fue expuesto a diferentes haces de partículas que permitieron realizar estudios de eficiencia y multiplicidad de las GRPC del calorímetro usando los muones procedentes del haz, obteniéndose una eficiencia media del 94% y una multiplicidad para MIPs en torno a 1.7 *"pads".* A su vez se realizaron estudios de resolución en energía e identificación de trazas individuales dentro de la cascada hadrónica, que mostraron que este calorímetro es adecuado para su uso en experimentos en colisionadores, siendo en la actualidad una de las dos opciones para el detector ILD (International Large Detector) y la opción principal del detector del Colisionador Electrón-Positrón Circular (CEPC). En Octubre de 2018 ambos prototipos fueron expuestos juntos en el SPS del CERN a diferentes haces de partículas con los que se están realizando estudios de eficiencia, tamaño de *"pad"* y resolución para el SDHCAL.



ID: 03707, 16/07/2019 17:30 - 16/07/2019 17:50, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

In-situ calibration of Large-R jet energy and mass in 13 TeV proton-proton Collisions with the ATLAS dectector

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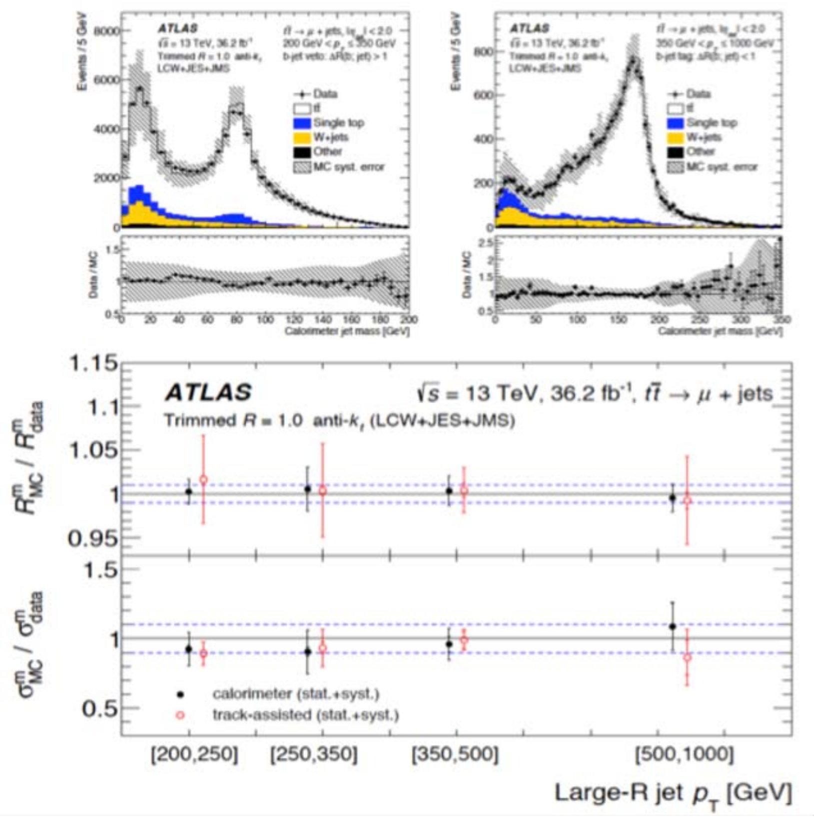
One of the main challenges of the ALTAS experiment at CERN is the proper reconstruction of high energy particles produced in proton-proton collisions and collected in the ATLAS detector. Signatures with high transverse momentum, massive particles such as Highs boson, top quarks and W or Z bosons have become ubiquitous during Run 2. Due to their large transverse momentum, the decay products become collimated and may be reconstructed as a single jet with large Radius parameters (R=1). The sensitivy of searches and measurements that use Large-R jets depends on an accurate knowlegde of he transverse momentum and mass responses of the detector. This study presents the in-situ Large-R jet energy and mass calibration by means of two methods where we were highly involved: the first one, which aims to calibrate the jet energy, is based on systems where the Large-R jet transversum momentum is balanced against a photon (which energy is measured more precisely than that of jets); the second one extracts the relative mass scale and resolution from high purity signal samples of boosted W and top quark hadronic decays by selecting ttbar events in the lepton+jet final state, allowing in this way to characterize the mass calibration factors in two separate regions of high physical interest, namely the W and top quark mass windows. These two methods are combined with further studies and techniques within the in-situ Large-R jet calibration effort, yielding the most accurate results accomplished so far (https://doi.org/10.1140/epjc/s10052-019-6632-8).



ID: 03748, 16/07/2019 17:50 - 16/07/2019 18:10, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics

ATLAS Inner Detector alignment: Radial distortion studies

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ATLAS is one of the two general-proposal detectors placed in LHC at CERN [1]. The ATLAS detector is composed for three main detection systems: the Muon spectrometer, the Calorimeters and the Inner Detector (ID).

The ID is formed by 3 subdetectors in cylindrical layers that use 3 different technologies: silicon pixels, silicon microstrip and straw tubes. The knowledge of the position of all the different components in the ID is crucial to achieve the track parameters resolution demanded by the Physics Analysis. To know the positions of the elements in the ID, a process known as alignment is implemented

The alignment process is based on a X^2 minimisation method. The ID alignment determines the position and the orientation of each one of the 6000 silicon modules and more than 200000 straw tubes. However, there are some kinds of detector distortion to which this method is not sensitive, known as weak modes. These modes preserve both the alignment process and the helicoidal path of the tracks. An example of weak mode is the radial distortion, which is a geometrical deformation of the ID in which a track is radially displaced by a value proportional to its radial position [2].

To explain the radial distortion, let us consider a radial shift δR small enough to discard second order effects, what change the layer position. This shift affects to transverse momentum (p_T), the polar angle, leaving the longitudinal momentum (p_Z) invariant. The J/ψ, Y mesons and Z boson resonances decaying to muon pair are used to obtain the value of the radial distortion, since their invariant masses are affected by this shift.

The analysis of the peak of the invariant mass distribution of Z boson and J/ψ meson shows a clear dependence between the invariant mass and the azimuthal angle (Φ) (Fig.). This fact implies that the radial distortion could be a real distortion of the ID itself.

References

[1] ATLAS Collaboration, JINST 3 (2008)

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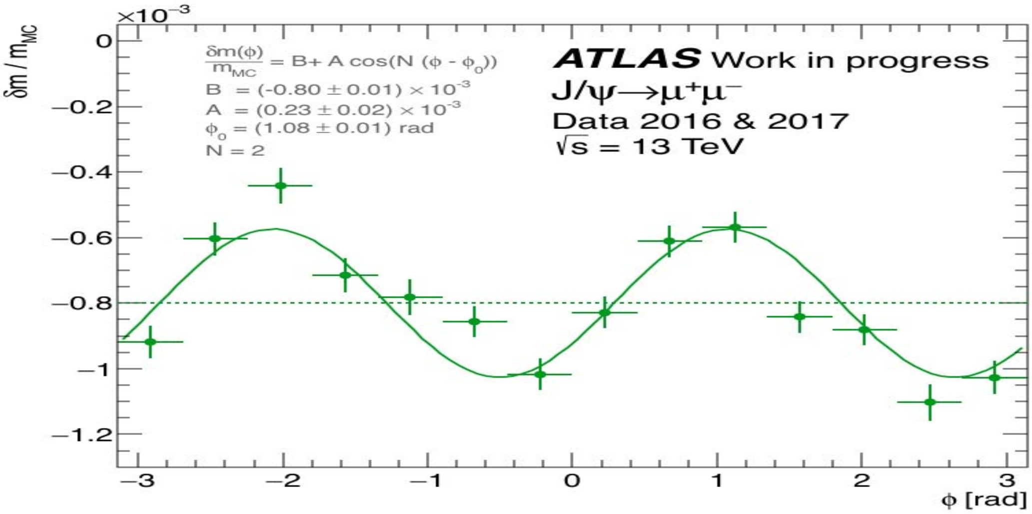

ATLAS Work in progress
J/ψ→μ⁺μ⁻
Data 2016 & 2017
√s = 13 TeV
δm(φ)/m_MC = B+ A cos(N (φ - φ_0))
B = (-0.80 ± 0.01) × 10^-3
A = (0.23 ± 0.02) × 10^-3
φ_0 = (1.08 ± 0.01) rad
N = 2
δm / m_MC
φ [rad]

ID: 03580, 16/07/2019 18:10 - 16/07/2019 18:30, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

A Monolithic Active Pixel Sensor Pixel detector for the outer barrel of the ITK of the ATLAS experiment

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The upgrade of the ATLAS experiment for the High-Luminosity LHC requires the installation of a new Inner Tracker detector to cope with the 5 fold increase in luminosity and a 10 fold increase in number of interactions per bunch crossing. A Monolithic Active Pixel Sensor prototype, MALTA, has been developed on 180 nm TowerJazz CMOS imaging technology, following the latest developments in CMOS sensor processing combining high-resistivity substrates with on-chip high-voltage biasing to achieve a large depleted active sensor volumes, to meet the radiation hardness requirements (1.5x10^15 1 MeV neq/cm2) of the outer barrel layers of the ITK Pixel detector. MALTA combines low noise (ENC< 20 e-) and low power operation (1uW/pixel) with a fast signal response (25 ns bunch crossing) in small pixel size (36.4 x 36.4 um2), and a small collection electrode (3um), with a novel high-speed asynchronous readout architecture to cope with the high hit-rates expected at HL-LHC. Extensive lab testing and characterisation in particle beam tests have been conducted on this design and compared with previous prototypes of the same technology. An overview of the sensor technology and readout architecture are presented along with the preliminary results from laboratory tests, radioactive source tests and beam tests.

ID: 04043, 16/07/2019 18:30 - 16/07/2019 18:50, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

A new trigger algorithm for the upgrade of the CMS Drift Tube detector at the HL-LHC

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The Large Hadron Collider (LHC) is a proton-proton collider which has been taking data for almost a decade with a maximum energy in the center of mass of 13 TeV and an instantaneous luminosity of up to 2×10 34 cm −2 s −1. In order to increase its discovery reach it will undergo an upgrade program that will allow increasing the integrated luminosity by a factor 10. This will be the so-called High-Luminosity LHC (HL-LHC), which will start taking data after the Long Shutdown 3 (2024-2025).

The Drift Tube detector is one of the muon detectors of the CMS (Compact Muon Solenoid) experiment, and for HL-LHC, will need to replace its readout and trigger electronics. The new on detector electronics will forward the time digital information from the cell signals through an asynchronous link at full resolution and with reduced dead time. The new backend system will receive these time stamps and build the chamber trigger primitives exploiting the full resolution of the detector.

In this paper we will show a new algorithm designed for the DT trigger system. This algorithm is capable of receiving the asynchronous hits, which have a resolution of 1 ns (instead of present 12.5 ns), but an uncertainty of 400 ns due to the cell drift time, and reconstruct the bunch crossing number where the muon was generated, together with the track position and angle.

To study its performance, we have used real data samples filtered to contain mostly events with one Z boson decaying to two muons. From studies in this data and in simulation we obtain results of around 95 % efficiency, less than 5 ns resolution in the bunch crossing time computation, position resolutions of less than 0.15 mm and slope resolution of less than 0.010 rad. These last two results are almost 4 and 3 times better than the ones we have nowadays with the present system. In addition, this algorithm has been implemented in firmware and it is currently being tested for triggering in cosmic ray muons.

ID: 03733, 18/07/2019 15:00 - 18/07/2019 15:20, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Probing the *Wtb* structure in *t*-channel single top-quark production using the ATLAS detector at the LHC

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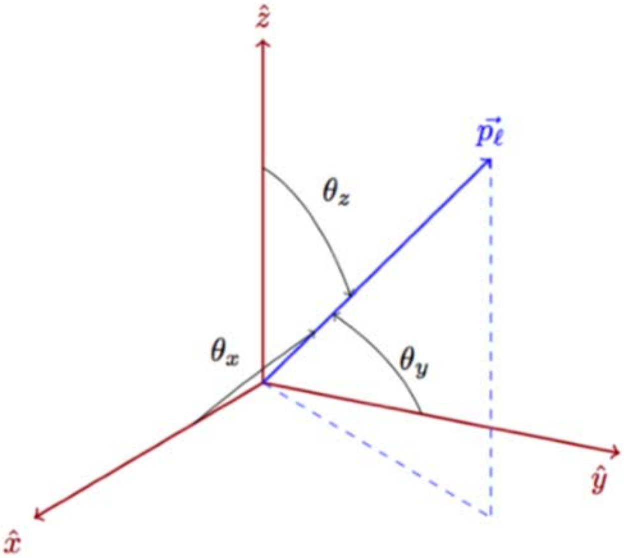
It is a well-known fact that the *Wtb* vertex is primordial in order to perform high precision tests of the SM predictions in the top-quark sector. This vertex mediates both top-quark decays and single top-quark production. In the *t*-channel, which is the most dominant source of single top-quark production at the LHC, top-quarks are produced along with a so-called spectator light quark. According to SM predictions, these top-quarks will be highly polarized in the spectator quark direction given the vector-axial-vector form of the *Wtb* vertex [1,2]. Furthermore, given that the top-quark decays almost exclusively to a *W* boson and a bottom quark, there are not QCD interactions to randomize its spin, allowing to access its spin orientation through the angular distribution of its decay products.

In the context of an effective field theory (EFT) the new physics corrections in the *Wtb* vertex can be parametrized in terms of four couplings: $V_{L,R}$ and $g_{L,R}$. In the SM at tree level the coupling V_L is the V_{tb} element of the CKM matrix that is close to one, while the *anomalous couplings* V_R and $g_{L,R}$ are all zero. Deviations from these values would imply the presence of new physics and, concretely, complex phases in these parameters would imply that the top-quark has a CP-violating component.

These anomalous couplings would affect directly the angular distributions of the top-quark decay products, and therefore by measuring the distributions of three angles defined in Fig. 1, these parameters can be constrained.

In this project the dataset collected by the ATLAS experiment at 13 TeV center of mass energy during 2015, 2016 and 2017, corresponding to an integrated luminosity of 80.5 fb^{-1}, is used to perform high precision measurements of the top-quark polarization in three directions.



ID: 04018, 18/07/2019 15:20 - 18/07/2019 15:40, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Chiral symmetry restoration and the thermal f_0(500) state.

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We analize the role played by the thermal f_0(500) state or σ in chiral symmetry restoration. The temperature corrections to the spectral properties of that state are included in order to provide a better description of the scalar susceptibility X_S around the transition region. We use the Linear Sigma Model to establish the relation between X_S and the σ propagator, which is used as a benchmark to test the approach where X_S is saturated by the f_0(500) inverse self-energy. Within such saturation approach, a peak for X_S around the chiral transition is obtained when considering the f_0(500) generated as a ππ scattering pole within Unitarized Chiral Perturbation Theory at finite temperature. That approach yields results complying with lattice data when the uncertainties of the low-energy constants are taken into account. Those uncertainties and the unitarization method are used to check the robustness of this approximation. A comparison with the Hadron Resonance Gas is also studied in this context. Finally, we will discuss some recent results within the chiral lagrangian framework related to the topological susceptibility and its connection with chiral and U_A(1) restoration.

ID: 03807, 18/07/2019 15:40 - 18/07/2019 16:00, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Some Results on Lepton Flavour Universality Violation

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Motivated by recent experimental measurements on flavour physics, in tension with Standard Model predictions, we perform an updated analysis of New Physics violating Lepton Flavour Universality, by using the effective Lagrangian approach and in the *Z\'* and S_3 leptoquark models. We explicitly analyze the impact of considering complex Wilson coefficients in the analysis of *B*-anomalies, by performing a global fit of R_K and R_{K^*} observables, together with ΔM_S and A_{CP}^{mix}. The inclusion of complex couplings provides a slightly improved global fit, and a marginally improved ΔM_S prediction.

ID: 03684, 18/07/2019 16:00 - 18/07/2019 16:20, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Unitary predictions for dynamical vector resonances emerging at VBS-LHC

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The LHC phenomenology of a strongly interacting electroweak symmetry breaking sector is studied by means of the Electroweak Chiral Lagrangian (EChL) and the Inverse Amplitude Method (IAM). We encode the beyond Standard model (BSM) physics inside a MadGraphv 5 UFO model, where the unitarized scattering elements have been included as effective vertices of a Proca Lagrangian. Several channels are being considered.

We extend a previous analysis of the elastic scattering $w^+z \to w^+z$, to include $w^+w^- \to w^+w^-$ scattering processes. On the medium term, our goal would be providing the collider physics community with a complete and tested MadGraph v5 UFO model that reproduces the collider phenomenology of Vector Boson Scattering (VBS) of the EChL unitarized via IAM.

ID: 03699, 18/07/2019 17:30 - 18/07/2019 17:50, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Triggering the QCD phase transition through acceleration

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The possibility of restoring chiral symmetry through the Unruh effect is considered. The Thermalization Theorem formalism and the large *N* limit (with *N* being the number of pions) are employed to solve the lowest-order approximation to QCD at low energies in Rindler spacetime. We shall show that chiral symmetry is restored for accelerations higher than the critical value $a_c=4\pi f_\pi$ with f_π being the pion decay constant, in complete analogy with the inertial, finite-temperature case.

ID: 03678, 18/07/2019 17:50 - 18/07/2019 18:10, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Physics in a momentum space geometry

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Special relativity (SR) postulates Lorentz invariance as an exact symmetry of Nature. It is at the base of our quantum field theories of the fundamental interactions, and has surpassed all experimental tests up to date. A quantum gravity theory, however, is expected quite generally to modify this symmetry. A heuristic reasoning is that Lorentz invariance is a symmetry of spacetime, and the classical picture of a continuum spacetime must break down somehow at the Planck scale, where quantum effects of gravity (in the form of creation and evaporation of virtual black holes) should take place. From this point of view, the symmetries of SR would constitute a good long-distance, or low-energy, approximation that could be modified at a certain high-energy scale.

An alternative to a pure violation of Lorentz invariance is a deformation of this symmetry. This is what Doubly Special Relativity (DSR) considers. In this theory, the Einstein relativity principle is generalized adding a new relativistic invariant to the speed of light c, the Planck length l_P. In order to keep the relativity principle (all inertial observers agree in the laws of physics) a new deformed kinematics appears: there is a modification in the dispersion relation, modified Lorentz transformations, and a non-additive composition law for the momenta.

Following the initial idea of Born in the 30's, which considered a duality between spacetime and momentum space leading to a curved momentum space, we show that a maximally symmetric curved momentum space can be related to a relativistic kinematics: the flat case corresponds to SR, while de Sitter (hyperboloid) or anti de Sitter (sphere) cases are associated to a modified kinematics. Specifically, the very much studied example of DSR, κ-Poincaré is obtained for a de Sitter momentum space.

ID: 04220, 18/07/2019 18:10 - 18/07/2019 18:30, Room 0.8 (ground floor)
S9. Theoretical and Particle Physics
(Oral)

Searches for Dark Matter combined with top quarks at CMS

Cedric Prieels[1]

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A search for dark matter produced in association with a single top or a pair of top quarks in data from proton-proton collisions at a center-of-mass energy of 13 TeV at the LHC will be presented. The data corresponds to 35.9 fb-1 and has been collected with the CMS detector during the year 2016. The results are then compared and interpreted in the context of simplified models of dark matter production. No dark matter candidates have been found, and upper limits on the value of the production cross-section of the eventual dark matter particles have been set.

ID: 04217, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S9. Theoretical and Particle Physics
(Poster)

Dark matter production with mono-top signatures at ATLAS

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Astronomical and cosmological observations support the existence of invisible matter that can only be detected through its gravitational effects, thus making it very difficult to study. Dark matter (DM) makes up about 27% of the known universe. Experiments like the Large Hadron Collider (LHC) of the CERN laboratory searches new particles that can explain this element. DM production consists of an excess of events missing momentum of energy ($E^{miss}{}_{T}$) a visible object (X) is needed to identify the process, called mono-X (X=jet, Z, W, H, top) signal searches.

Prospects search using mono-top signature is shown, here the framework studied is proton-proton collision at 14 TeV energy of center of mass considering 300 fb^{-1} (mainly known as High Luminosity (HL) phase of the LHC, starting at half of 2026) using ATLAS detector for the non-resonant flavour-changing neutral-current (FCNC) signal. Only leptonic decays of the W boson from top quark are considered. No significant deviations with respect to standard model predictions is observed.

Consequently, the expected mass limit at 95% C.L. is 4.6 TeV for particle mediator mass. The mainly result is the improvement for the value of the exclusion limit compared to Run2 results (13TeV, 36 fb^{-1}, hadronic + leptonic decays), being about 2.6 TeV, using 80 times more data (expected reach for HL-LHC).

Reference

[1] Cid Vidal , X. el al. Beyond the Standard Model Physics at the HL-LHC and HE-LHC}(2018) (<https://arxiv.org/abs/1812.07831>https://arxiv.org/abs/1812.07831)

S10. Astrofísica y Astropartículas (GEAS)

Organizadores:

José M Rodríguez, *Instituto Astrofísico de Canarias*

S10. Astrophysics and Astroparticles (GEAS)

Organizers:

José M Rodríguez, *Instituto Astrofísico de Canarias*

ID: 04008, 16/07/2019 15:00 - 16/07/2019 15:15, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Underground argon for DarkSide-20k

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1) CIEMAT

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The DarkSide-20k (DS-20k) experiment is a 20-ton active argon detector which plans to operate radio-pure underground argon (UAr) for dark matter direct searches. A major worldwide effort is on-going in order to procure the radio-pure argon required for this experiment. The Urania project will extract and purify the UAr from the CO_2 wells at the Kinder Morgan Doe Canyon Facility located in Cortez (USA) at a production rate of ~100 kg/day. It will be necessary to make a chemical purification of the UAr before deployment into the LAr TPC of DS-20k, bringing the chemical impurity levels below 1 ppm. The Aria project will serve to chemically purify the UAr using a cryogenic distillation column called Seruci-I, located in Sardinia (Italy). The ultimate goal of Aria is to process about 150 kg/day of argon, in order to achieve an additional depletion factor between 10 and 100. Assessing the purity of UAr in terms of ^{39}Ar is key for the physics programme of DS-20k. DART is a small (∼1 L) chamber that will measure the depletion factor of ^{39}Ar in UAr. The detector will be immersed in the LAr active volume of ArDM (LSC, Spain), which will act as a veto for gammas stemming from the detector materials and from the surrounding rock. Data taking is planned for 2019. In this talk, I will review the status and prospects of the UAr projects.

ID: 03938, 16/07/2019 15:15 - 16/07/2019 15:30, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Status of the TREX-DM experiment at the Canfranc Underground Laboratory

Juan Francisco Castel[1] , Susana Cebrián[1] , Theopisti Dafni[1] , Javier Galán[1] , Igor García Irastorza[1] , Gloria Luzón[1] , Cristina Margalejo[1] , Héctor Mirallas[1] , Alfonso Ortiz de Solórzano[1] , Alberto Peiró[1] , Elisa Ruiz-Chóliz[1] , María Pilar Sampériz[1]

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TREX-DM (TPC Rare Event eXperiment for Dark Matter) [1] is intended to look specifically for Weakly Interacting Massive Particles (WIMPs) that could be pervading the galactic dark halo having low-mass (below 10 GeV/c^2). It is an approved experiment by the Canfranc Underground Laboratory (LSC), in the Spanish Pyrenees.

The search for low-mass WIMPs requires the use of light elements as target and detectors with very low energy threshold; TREX-DM is conceived to fulfil these requirements using a gas time projection chamber (TPC) equipped with novel micromesh gas amplification structures (Micromegas) [2]. The detector can hold about 20 litres of pressurized gas up to 10 bar, which corresponds to 300 g of Argon, or alternatively, 160 g of Neon. The Micromegas readout planes allow for effective thresholds below 0.4 keV. An exhaustive material screening campaign developed at LSC has allowed to construct the detector and shielding with the state-of-the art radiopurity specifications. The background model developed by Monte Carlo simulations suggests that levels of the order of 1-10 counts keV^{-1} kg^{-1} d^{-1} are expected in the region of interest [3], making TREX-DM competitive. A roadmap to further decrease it down to 0.1 counts keV^{-1} kg^{-1} d^{-1} is underway.

The commissioning of the detector at LSC is almost finished. Operation with Neon first and (depleted) Argon afterwards is foreseen. In this communication, the status of the installation and first operation in Canfranc will be reviewed, presenting the preliminary results concerning the energy threshold and the background level achieved; the complete background model developed will also be described and the corresponding expected WIMP sensitivity discussed.

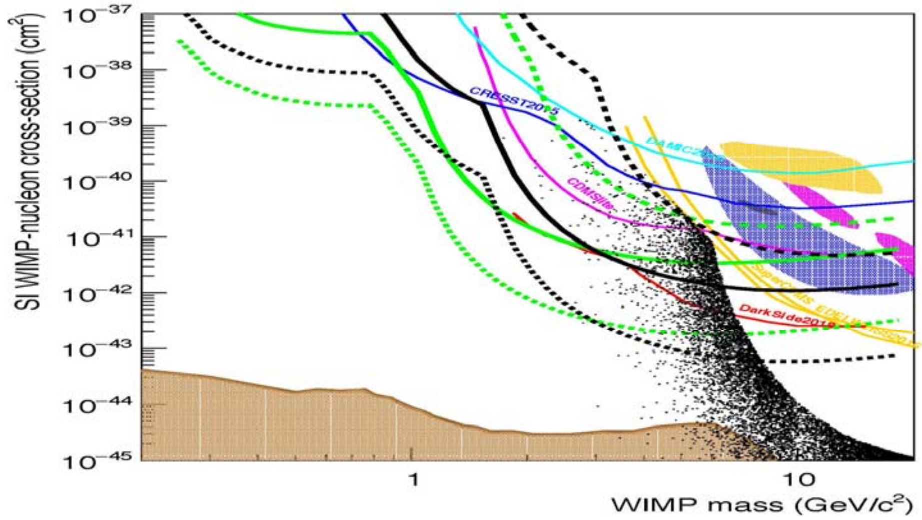
References

[1] F.J. Iguaz et al., Eur. Phys. J. C 76, 529 (2016).

[2] I.G. Irastorza et al., JCAP 01, 034 (2016).

[3] J. Castel et al, arXiv:1812.04519v1 (2018).

Figure: Sensitivity under different conditions of exposure, background and energy threshold for operation with Neon (green lines) and Argon (black lines).



ID: 04011, 16/07/2019 15:30 - 16/07/2019 15:45, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

ANAIS-112 sensitivity in the search for dark matter annual modulation

Iván Coarasa[1] , Julio Amaré[1] , Susana Cebrián[1] , Clara Cuesta[3] , Eduardo García[1] , María Martínez[2] , Miguel Ángel Oliván[4] , Ysrael Ortigoza[1] , Alfonso Ortiz de Solórzano[1] , Jorge Puimedón[1] , Ana Salinas[1] , María Luisa Sarsa[1] , José Ángel Villar[1] , Patricia Villar[1]

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2) Universidad de Zaragoza, Laboratorio Subterráneo de Canfranc, Fundación ARAID
3) Universidad de Zaragoza, CIEMAT 4) Universidad de Zaragoza, Fundación CIRCE

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ANAIS [1] (Annual modulation with NaI(Tl) Scintillators) is a direct detection dark matter experiment aiming at the confirmation or refutation of the DAMA/LIBRA [2,3] positive annual modulation signal in the low energy detection rate, using the same target and technique. Other experiments exclude the region of parameters singled out by DAMA/LIBRA. However, these experiments use different target materials, so the comparison of their results depends on the models assumed for the dark matter particle and its distribution in the galactic halo. ANAIS-112, consisting of nine 12.5 kg NaI(Tl) modules produced by Alpha Spectra Inc., disposed in a 3 x 3 matrix configuration, is taking data smoothly at the Canfranc Underground Laboratory, Spain, since August, 2017. In this talk, we present the model independent analysis of the first 1.5 years of data, searching for a potential annual modulation in the event rate [4]. ANAIS-112 data are consistent with the null hypothesis. The best fits for the modulation hypothesis are consistent with the absence of modulation, resulting in modulation amplitudes of -0.0044 ± 0.0058 cpd/kg/keV and -0.0015 ± 0.0063 cpd/kg/keV for [2-6] and [1-6] keV energy ranges, respectively. These results are in agreement with our estimated sensitivity for the 157.55 kg x y accumulated exposure, supporting our projected goal of reaching a 3σ sensitivity to the DAMA/LIBRA result in 5 years of data taking [5].

References

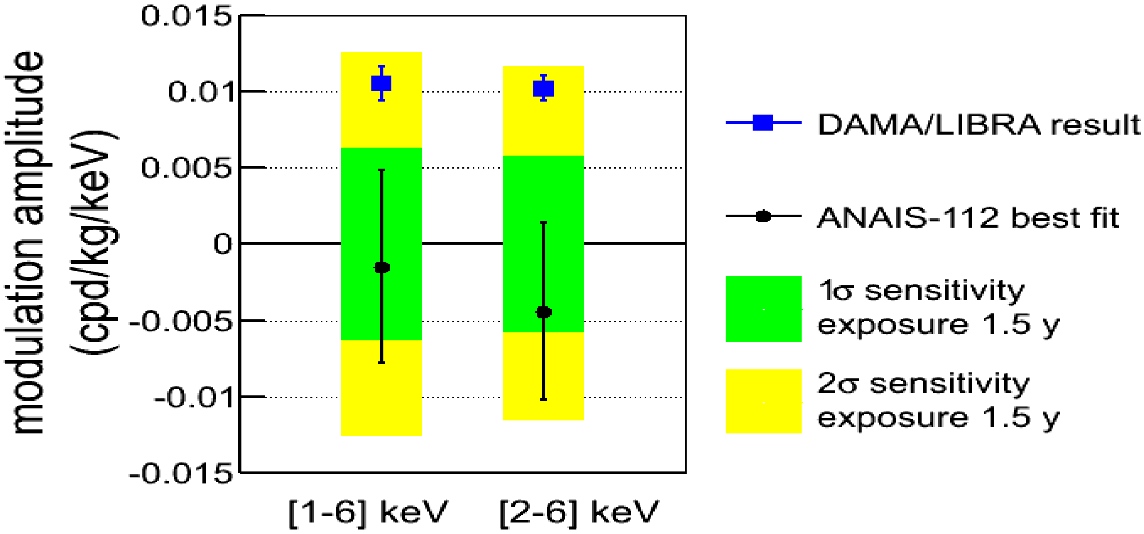
[1] J. Amaré et al., Performance of ANAIS-112 experiment after the first year of data taking. Eur. Phys. J. C **79**, 228 (2019).

[2] R. Bernabei et al., Final model independent result of DAMA/LIBRA-phase1. Eur. Phys. J. C **73**, 2648 (2013).

[3] R. Bernabei et al., First model independent results from DAMA/LIBRA-phase2. Nucl. Phys. At. Energy **19**, 4 (2018) 307.

[4] J. Amaré et al., First results on dark matter annual modulation from ANAIS-112 experiment. Submitted to Phys. Rev. Lett., arXiv:1903.03973 (2019 preprint)

[5] I. Coarasa et al., ANAIS-112 sensitivity in the search for dark matter annual modulation. Eur. Phys. J. C **79**, 233 (2019).


modulation amplitude
(cpd/kg/keV)
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
[1-6] keV
[2-6] keV
DAMA/LIBRA result
ANAIS-112 best fit
1σ sensitivity
exposure 1.5 y
2σ sensitivity
exposure 1.5 y

ID: 03995, 16/07/2019 15:45 - 16/07/2019 16:00, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Search for secluded dark matter with the ANTARES and KM3NeT neutrino telescopes

Cristina Lagunas Gualda[1] , Sara Rebecca Gozzini[1] , Filippo Sala[2]

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** Cristina Lagunas Gualda, lagual@alumni.uv.es*

Dark matter scenarios starring WIMPs (weakly interacting massive particles) at the GeV-TeV scale have been intensively investigated, among others by neutrino telescopes with indirect searches. So far no WIMP candidate particle has been observed. At the same time, collider experiments are pushing the scale of the needed new physics much beyond the TeV range, and such heavy sectors (e.g. Supersymmetry) have long been known to provide dark matter candidates in the same mass range. This situation strongly motivates the exploration of DM scenarios with masses at and above 10-100 TeV.

'Secluded' frameworks then emerge as an ideal target for searches of the annihilation products of such heavy Dark Matter: they allow to naturally evade the unitarity bound on the dark matter mass, and at the same time to reliably compute the annihilation spectra of relevance for experiments.

These perspectives open a new territory accessible to neutrino telescopes such as ANTARES and KM3NeT. Promising dark matter sources such as the Galactic Centre are in good visibility for these telescopes, that perform an unbinned-likelihood analysis in search for high-energy neutrinos produced in a dark matter pair-annihilation process. Current limits on WIMP pair annihilation cross section encourage the extension at higher energy, where the highest sensitivity is reached. The current status of secluded dark matter searches with ANTARES and the sensitivity achieved with KM3NeT are presented.

ID: 03822, 16/07/2019 16:00 - 16/07/2019 16:15, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Measurement of Cosmic Positrons with AMS-02

Carmen Mª Gámez López[1] , Jorge Casaus Armentano[1] , Miguel Ángel Velasco Frutos[1] , Jesús Manuel Vizán García[1]

1) CIEMAT

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The Alpha Magnetic Spectrometer (AMS) is an experiment located onboard the International Space Station. AMS is designed to carry out precise measurements on cosmic rays, in particular, the flux of positrons and electrons. To this end, it is comprised of different subdetectors to measure the properties of the particles. The trajectory, the rigidity and the charge with its sign of the cosmic ray particle can be measured with a precision silicon tracker. Protons can be separated from electrons and positrons using estimators based on the emitted transition radiation on TRD and the shower on the electromagnetic calorimeter ECAL. The signals from positrons can be separated efficiently from the background using a template fitting technique. The dominant source of background in the analysis is due to charge confusion electrons, which are distinguised by means of a charge confusion estimator.
AMS collaboration has published the latest measurement of the positron flux up to 1 TeV, based on a data sample of 1.9 million positrons collected from 2011 May to 2017 November. The results show a flux escess starting from 25.2 ± 1.8 GeV and a sharp drop-off above 284^{+91}_{-64} GeV, and are consistent with a finite energy cutoff of the source at E_s = 810 GeV with a significance of more than 4σ. One of the possible models of this results is based on dark matter particle annihilation, thus, the measurement of antimatter cosmic rays particles allows indirect searches for dark matter.
By the end of the mission on 2024, an improved analysis on the high energy positrons flux could be carried out due to the larger statistics accumulated. We expect to extend the measurements to 2 TeV and determine precisely whether the flux drops-off or presents a continuous spectrum with a significance of 5σ.

ID: 04049, 16/07/2019 16:15 - 16/07/2019 16:30, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Tick, silicon CCDs to search for DArk Matter within the DAMIC-M Experiment

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Independently of the Dark Matter theoretical motivations, it is important to recognize that current dark matter experiments have limited sensitivity to dark matter electron interactions, and a light dark matter particle may have well-escaped detection. Most of the interactions of dark matter result in the production of a few charges, requiring the detector to be able to resolve individual electrons, as well as with a very low dark current is a prerequisite to search for light DM.

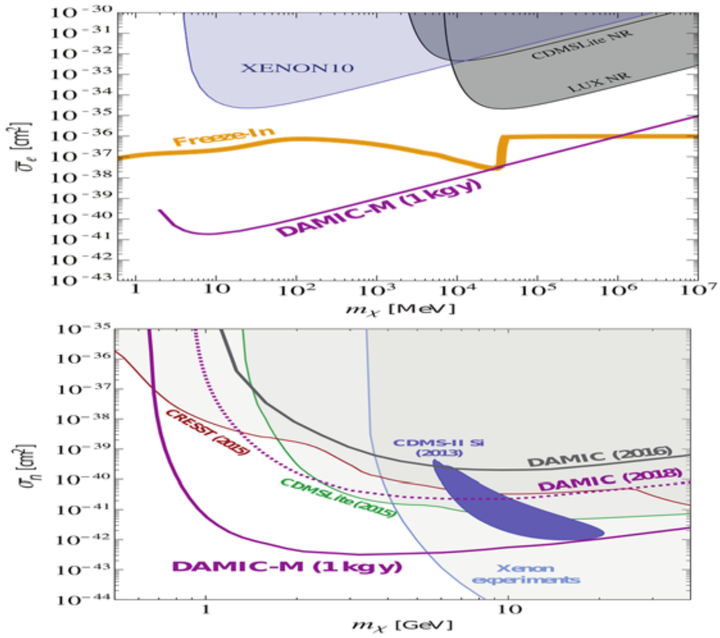
This talk will address the general feature of the unconventional use of CCDs to search for Dark Matter through the **DAMIC** Experiment (*DArk Matter in CCD*) and include some results of the improved DAMIC-M devices, the next stage of DAMIC detector currently under construction. DAMIC employs the bulk silicon of thick, fully-depleted CCDs as a target for ionization signals produced by interactions of particle dark matter from the galactic halo. I will present an overview of the response of these CCDs to low-energy nuclear recoils and their unique capabilities, including the use of high spatial resolution for both the rejection and study of backgrounds [1]. I will prove the performance of the detector presenting the current results of DAMIC, and provide measurements of the background contamination and demonstrate the potentiality for DM searches, with only ~40 grams of detector mass [2].

Finally, I will also present the status of the next phase of the DAMIC experiment, **DAMIC-M**, with a kg-sized detector, implementing the most massive CCDs ever built. I will include some results on the improved detector which feature skipper-style readout capable of single electron resolution, as well as, present some of the improvements in the detector design, construction materials and CCD packaging in order to decrease the background level to fractions of dru. DAMIC-M will be able to achieve unprecedented sensitivity to low-energy dark matter particles (see figure).

References

[1]arXiv:1506.02562

[2]arXiv:1611.03066



XENON10
CDMSLite NR
LUX NR
Freeze-In
DAMIC-M (1kgy)
$\overline{\sigma}_e$ [cm^2]
m_χ [MeV]
CDMS-II Si (2013)
DAMIC (2016)
DAMIC (2018)
CRESST (2015)
CDMSLite (2015)
DAMIC-M (1kgy)
Xenon experiments
σ_n [cm^2]
m_χ [GeV]

ID: 03877, 16/07/2019 17:30 - 16/07/2019 17:45, Room 0.6 (ground floor)

S10. Astrophysics and Astroparticles (GEAS)

(Oral)

Anisotropy of Cosmic Rays Arrival Directions with AMS-02 on the International Space Station

Miguel Molero Gonzalez[1] , Jorge Casaus Armentano[1] , Miguel Ángel Velasco Frutos[1] , Carlos Mañá Barrera[1]

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AMS-02 is a particle physics detector installed onboard the International Space Station, which provides precise measurements of the different cosmic ray species. The AMS results have revealed unpredicted features on their spectra, which cannot be accounted within the current understanding of the production and propagation of galactic cosmic rays.

On the one hand, the positron flux shows an excess above ~10 GeV [1] which cannot be explained by a pure secondary origin. For most of the explanations the inclusion of primary sources is required; typically, being classified in two scenarios: dark matter and astrophysical sources.

On the other hand, the proton [2] and nuclei [3] spectra deviate from a single power law and the spectral index progressively hardens above ~ 100 GV. The origin of these effects may also reveal the existence of local sources or a change in their propagation mechanisms.

In all cases, the contribution of nearby sources may induce some degree of anisotropy in the arrival directions of the different cosmic ray species that would support or disfavor some of the aforementioned scenarios.

The directionality can be studied by comparing the data sample to a reference map, which represents the expectation for an isotropic flux; any deviation will be regarded as a signal. The large scale anisotropy can be described at first order by a dipole which is determined by its projection onto three orthonormal axes.

Results on the dipole anisotropy in galactic coordinates for different charged cosmic rays from the first 7.5 years of data taking with AMS-02 will be presented. The expected upper limits on the dipole amplitude are 1.7% for positrons above 16 GeV, whereas for protons, helium, carbon and oxygen is 0.23%, 0.42%, 2.6% and 2.7% respectively, for rigidities above 300 GV.

References

[1] M. Aguilar *et al.* (AMS Collaboration), PRL 122, 041102

[2] M. Aguilar *et al.* (AMS Collaboration), PRL 114, 171103

[3] M. Aguilar *et al.* (AMS Collaboration), PRL 119, 251101

ID: 04125, 16/07/2019 18:00 - 16/07/2019 18:15, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Machine Learning for Pattern Recognition in Dark MAtter Searches.

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2) Instituto de Física Corpuscular (IFIC)

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After the work of the Swiss Astronomer Fritz Zwicky in the 1930s, most physicist and astronomers have been convinced that dark matter exist in our universe, being furthermore one of the main evidences of physics beyond de Standard Model. This has given birth to a wide variety of experiments trying to find or reject dark matter candidates such as WIMPs, Axions and sterile neutrinos to list some. In particular, the Antares telescope, among other topics, searches for neutrinos coming from WIMP annihilations. However, this kind of experiments face the issue of distinguishing interesting events from the vast atmospheric neutrino background, which consist mostly of muons.

To optimize the event selection Machine Learning Algorithms (MLA) are applied. The aim of this work is to show that a high atmospheric muon background suppression can be achieved using trained MLA to determine neutrino signal in dark matter searches.

ID: 04044, 16/07/2019 18:15 - 16/07/2019 18:30, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Constraining branon dark matter from observations of the Segue 1 dwarf spheroidal galaxy with the MAGIC Telescopes

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The nature of dark matter (DM) is still an open question for modern physics. In the particle DM paradigm, this elusive kind of matter cannot be made of any of the known particles of the Standard Model (SM). Many efforts have been made in order to model the nature of the DM. Among others, and beyond the SM of particle physics, we focus on brane world theory as a prospective framework for DM candidates. Branons are new degrees of freedom that appear in flexible brane-world models corresponding to brane fluctuations. They are a natural DM candidate, because branons behave as weakly interacting massive particles (WIMPs), that are one of the most favored candidates for DM. The ground-based gamma-ray telescope MAGIC could potentially detect DM indirectly, by observing secondary products of its annihilation into SM particles. In this contribution, we set constraints on branon DM from already published observations of the Segue 1 dwarf spheroidal galaxy with the MAGIC Telescopes, by using almost 160 hours of good-quality data and a full likelihood analysis.

ID: 04045, 16/07/2019 18:30 - 16/07/2019 18:45, Room 0.6 (ground floor)

S10. Astrophysics and Astroparticles (GEAS)

(Oral)

Application of deep convolutional neural networks to enhance the performance of imaging atmospheric Cherenkov telescopes

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Imaging atmospheric Cherenkov telescopes (IACTs) are excellent tools to inspect the very-high-energy (few tens of GeV and above) gamma-ray sky. IACTs capture images of the air showers, originated by the absorption of gamma rays and cosmic rays by the atmosphere, through the detection of Cherenkov photons emitted in the shower. One of the main factors determining the sensitivity of IACTs to gamma-ray sources in general is how well reconstructed the properties of the primary particle triggering the air shower are: specifically, this particle reconstruction enables us to classify gamma-ray events from the much more frequent background of cosmic-ray events. In this contribution we present how deep convolutional neural networks (CNNs) are being explored as a promising method for IACT event reconstruction, and illustrate it with some preliminary results obtained with CTLearn, a package for IACT event reconstruction through deep learning.

ID: 03875, 17/07/2019 15:00 - 17/07/2019 15:15, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

2D SFR studies in the nearby universe with the J-PLUS photometric survey

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** Rafael Logroño-García, rlgarcia@cefca.es*

The Javalambre Photometric Local Universe Survey (J-PLUS; Cenarro et al. 2018), is observing thousands of square degrees of the northern sky from the Observatorio Astrofísico de Javalambre (OAJ) in Teruel, Spain. The survey is being carried out with the 0.83 meter JAST/T80 telescope and the panoramic camera T80Cam with a 2 deg² FoV. A set of twelve broad, intermediate, and narrow band optical filters is used. The large FoV, the position of the filters, and the survey strategy; are suitable to perform science that will expand our knowledge in many fields of astrophysics. More concretely, the J0660 narrow-band filter covers the Hα emission-line flux of nearby galaxies up to z~0.017, making J-PLUS a powerful tool to study the 2D star formation rate (SFR) properties of these galaxies (Logroño-García et al. 2019). The fact of being an imaging survey enables us to count on a large contiguous area with unselected samples of galaxies, whose whole extent is covered, preventing from aperture selection effects. The filters placed at the key emission lines, allow us to construct IFU-like 2D maps of emission. The techniques developed for J-PLUS will be expanded to the upcoming J-PAS survey (Benitez et al. 2014), that with 54 narrow-band and 5 broad-band filters, will offer low-resolution spectra for every pixel of the sky. In this talk, we present the first 2D SFR results with J-PLUS DR1, (Cenarro et al. 2019), with 1022 deg². A sample of 850 star-forming galaxies has been selected, lying along the well known main sequence of star formation. We study the deviation from this main sequence of galaxies in several mass bins, and try to establish the underlying causes, such as interactions, environmental density, nuclear activity, stellar mass or morphology. This is done for both global and 2D SFR, observing the radial distributions.

ID: 03702, 17/07/2019 15:15 - 17/07/2019 15:30, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

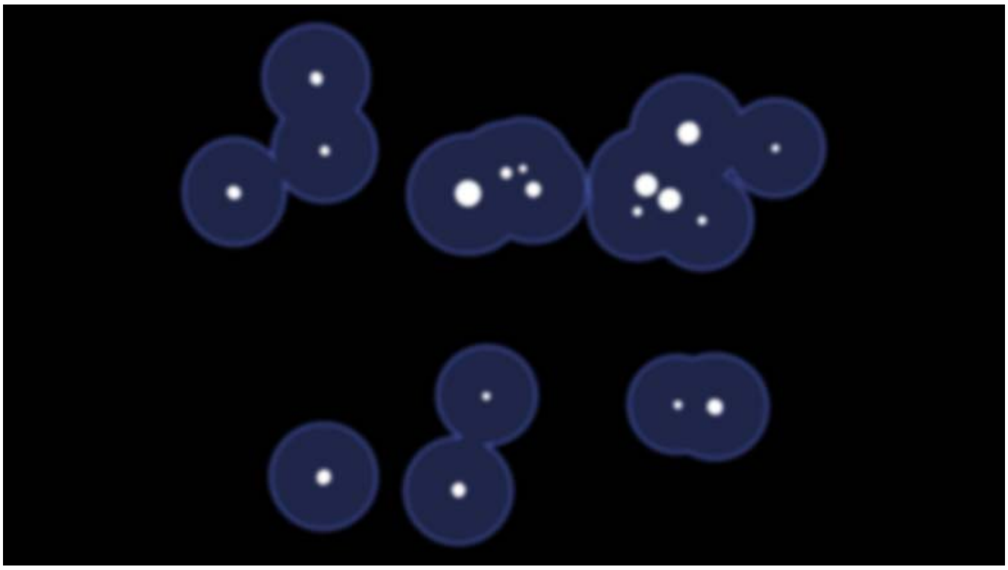
An ionised bubble before the epoch of re-ionisation

Jose Miguel Rodríguez Espinosa[1] , J Miguel Mas Hesse[2] , Rosa Calvi[1]

1) Instituto de Astrofisica de Canarias 2) Centro de Astrobiología INTA-CESIC

** Jose Miguel Rodríguez Espinosa, jre@iac.es*

We have performed a search for Lyman Alpha sources around two spectroscopically confirmed star forming sources in the Subaru Deep Field. I will show how these sources form a proto-cluster, and how they reside in an ionised bubble of at least 11400 Mpc^3. This is the first time that an ionised bubble has ben seen before the epoch of re-ionsation of the Universe. I will show that not only the bubble is ionised, but that there is still a large quantity of ionising photons escaping the bubble and contributing to the re-ionisation of the Universe.



ID: 03876, 17/07/2019 15:30 - 17/07/2019 15:45, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Effects of tetraneutron condensation on properties of Neutron Star matter

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1) University of Salamanca

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We investigate the possible condensation of tetraneutron resonant states in dense nuclear matter typical in the interior of Neutron Stars (NSs). Our effective field theoretical approach includes, besides tetraneutrons, nucleons, Δ-isobars and a set of light clusters (^{3}He, α particles, deuterium and tritium), while interaction is mediated by σ, ω and ρ mesons. Scanning the yet uncertain range of the coupling strengths of the tetraneutron states to the mesonic fields considered we study how their presence could significantly impact the properties of NS matter. We find that for weak coupling strengths of tetraneutrons to the σ field tetraneutrons may appear over a range of densities belonging to the NS crust while for higher strengths they can be found in the core. In this latter case a non negligible suppression of both the Δ-isobar fraction and superfluid phases of paired nucleons would arise as a manifestation of the tetraneutron condensate. We discuss further implications of such findings.

ID: 03829, 17/07/2019 15:45 - 17/07/2019 16:00, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

J-PLUS : Status and updates in photometric calibration

Carlos López San Juan[1] , on behalf of the J-PLUS collaboration .[2]

1) Centro de Estudios de Física del Cosmos de Aragón (CEFCA) 2) several institutions worldwide

** Carlos López San Juan, clsj@cefca.es*

The J-PLUS (Javalambre Photometric Local Universe Survey) is scanning the accesible sky from the Observatorio Astrofísico de Javalambre (OAJ, Sierra de Javalambre, Teruel) with a filter set of 5 broad bands (ugriz) + 7 unique medium bands located on key spectral features of stars and nearby galaxies.

We present the main results from the first data release (DR1, 1022 deg2 published one year ago), the current status of the survey (more than 1700 deg2 observed), the plans for the DR2 next year, and the improvements in the photometic calibration of the survey.

The current reference method for the photometric calibration, based on the so-called "stellar locus regresion" (SLR) that ensures consistent photometry along all the surveyed area, has been updated with the inclusion of the stellar extiction of the reference sources thanks to Gaia distances and Pan-STARRS 3D dust maps, a precise macth to the Pan-STARRS photometry in the gir bands, the homogeneization of all the J-PLUS observations with the SLR, and a novel absolute flux calibration performed with the white dwarf locus derived from models. The achived accuracy is bellow 20 millimagnitudes in all the J-PLUS filters.

ID: 03686, 17/07/2019 16:00 - 17/07/2019 16:15, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

An extremely energetic tidal disruption event with a resolved radio jet in a galaxy merger

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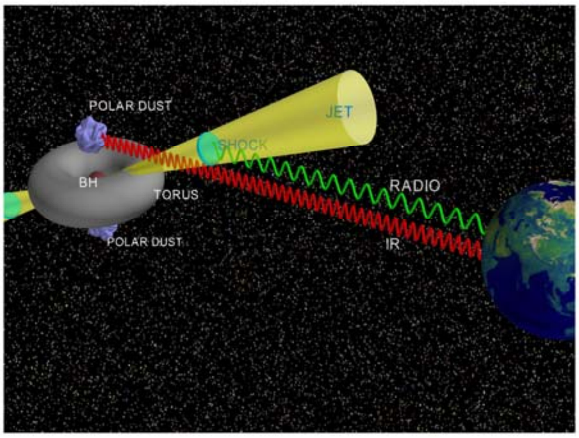
Tidal disruption events (TDEs) are transient flares produced when a star is ripped apart by the gravitational field of a supermassive black hole (SMBH). We have observed a transient source in the western nucleus of the merging galaxy pair Arp 299 that radiated >1.5 × 1052 erg at infrared and radio wavelengths but was not luminous at optical or x-ray wavelengths. We interpret this as a TDE with much of its emission reradiated at infrared wavelengths by dust. Efficient reprocessing by dense gas and dust may explain the difference between theoretical predictions and observed luminosities of TDEs. The radio observations resolve an expanding and decelerating jet, probing the jet formation and evolution around a SMBH.

Our observations indicate that much of the emission from the TDE must have been reprocessed by dense gas, and re-radiated at infrared wavelengths by dust, suggesting a possible way for reducing the tension between theoretical luminosity predictions and observations of TDEs. Such events are not detectable by optical, UV nor soft X-ray observations and could be just the tip of the iceberg of a missed TDE population in the local Universe, which could be more numerous at high redshifts where luminous infrared galaxies are more common.

Our results have been published in:
***Science* 03 Aug 2018: Vol. 361, Issue 6401, pp. 482-485**
DOI: 10.1126/science.aao4669



ID: 03766, 17/07/2019 16:15 - 17/07/2019 16:30, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Water. What else? ASW computational study and experimental comparison

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The density of amorphous water ice (or Amorphous Solid Water, ASW) is a long-standing subject of great interest in the Astrophysics field. Large differences exist for measurements of bulk density (including porous in its structure) and intrinsic density (strictly speaking, amount of mass per unit volume). Experimental measurements of either magnitude exist in the literature. We focus here on the second, as measured e.g. in Refs. [1] and [2]. We have set out a computational model and methodology to study the structure and energetic properties of ASW as a function of density. Our model consists in a cell containing 12 H_2O molecules, where the density of the sample can be adjusted by choosing the dimension of the cell. The structure of the sample is made amorphous by a Monte Carlo-type dynamics at a selected temperature, T_{amorph}, using the Amorphous Cell modulus of Materials Studio [3]. The amorphous structure is then relaxed looking for a minimum in its Potential Energy Surface (PES) using CASTEP [4]. The energy of the minimum vs the density of the sample is the relevant information, to be compared to the experimental intrinsic density. All these calculations are done at Density Functional Theory (DFT), using plane waves and pseudopotentials as implemented in CASTEP.

We are carrying out a set of calculations for various densities and T_{amorph} values. We present in Fig. 1 a schematic view of our sample at two densities, 0.6 and 1.2 g cm-3, after the relaxation procedure. Our results of the variation of energy with density will be discussed at the meeting.

References

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ID: 04089, 17/07/2019 17:30 - 17/07/2019 17:45, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Nonlinear evolution of Alfvén waves in a partially ionized plasma

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In the past, the nonlinear evolution of standing shear Alfvén waves in fully ionized plasmas has been studied in depth. These studies use a model which includes the interaction of the waves with density perturbations excited by the ponderomotive force. In a low-β plasma, it is shown that the ponderomotive force can lead to large density enhancements due to nonlinear coupling with slow magnetoacoustic waves. Using the single-fluid approximation, we have studied the nonlinear evolution of standing shear Alfvén waves when ambipolar diffusion is taken into account in a partially ionized plasma. First of all, for low- and finite β plasma, we study the nonlinear evolution of standing shear Alfvén waves using a perturbation expansion, and the results show that in the case of low-β plasma ambipolar diffusion avoids the development of large density enhancements. In the case of a finite β plasma, the relative importance of the ponderomotive force and ambipolar diffusion determines which one has the leading role to induce or prevent the development of large density enhancements. Finally, the full nonlinear MHD equations have been solved and the results show a good agreement with those obtained using the perturbation approach.

ID: 03754, 17/07/2019 17:45 - 17/07/2019 18:00, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Background model for IAXO-D0, prototype of the IAXO (International AXion Observatory) experiment

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Axion helioscopes convert solar axions into detectable x-rays by means of a strong magnetic field. The fourth generation axion helioscope IAXO aims to detect axions and axion like particles (ALPs) originating in the Sun via Primakoff effect. IAXO will be 4-5 orders of magnitude more sensitive than CAST, the most powerful axion helioscope to date [1]. One of the proposed detection technologies is an ultra-low background Time Projection Chamber (TPC) detector coupled to a highly granular Micromegas readout. Microbulk Micromegas detectors have a very stable performance, high gain and good energy resolution in the IAXO region of interest. They provide topological information of the detected events and they allow for very low background levels by using radiopure materials and appropriate shielding, making them suitable for detecting the weak signal expected from solar axions [2]. To test the performance and the background levels of the IAXO detector, a prototype called IAXO-D0 has been commissioned at the University of Zaragoza. IAXO-D0 background model simulations are being computed in order to fully understand the detector background observed during data taking campaigns. Both simulations and data analysis are performed with REST, a generic data analysis framework based on ROOT. The preliminary background levels using Ar+2% isobutane as active gas show that cosmic background is dominant, being of order 10^{-5} counts/keV/cm^2/s for muons, 10^{-4} counts/keV/cm^2/s for neutrons (10 MeV-1 GeV), and 10^{-6} counts/keV/cm^2/s for high energy neutrons (1-10 GeV), being the detector intrinsic radioactive background of order 10^{-8} counts/keV/cm^2/s. Future work regarding the background model includes a deeper study of muons and cosmic neutrons, refining the x-ray selection algorithms based on laboratory calibration data, making data and simulations directly comparable, and developing a Xenon+1% isobutane model.

ID: 03844, 17/07/2019 18:00 - 17/07/2019 18:15, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

Adsorption of volatile molecules on interstellar carbonaceous dust analogs

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The interaction of volatile molecules with the surface of dust grains is crucial for the physics and chemistry of interstellar clouds. The degree of chemical complexity attainable in hot cores or protoplanetary systems is largely dependent on the binding, diffusion and reaction of these molecules on grain surfaces. The chemical composition of these regions influences the thermal balance and its evolution to form stars and planetary systems.

Different groups have investigated the low-temperature interaction of small molecules with various solids like water-ice or silicates present in interstellar grains (see for instance [1-3]). In this work we study the adsorption of interstellar volatile molecules like H2O, CO2, CO, CH4,… on solid deposits of amorphous hydrogenated carbon (HAC) which are taken as analogs of the carbonaceous component of interstellar dust grains.

Our experiments are designed as a two step process. First we generate different HAC samples through deposition on Al substrates in RF plasmas of suitable precursors (CH4, C2H2). In the second step we transfer the substrates with HAC deposits to our ultra-high-vacuum chamber (base pressure ‐ 1 x 10-10 mbar) and place them in the cold head of He cryostat. We then introduce the volatile species into the chamber trough multichannel arrays and deposit them on the HAC samples at selected temperatures down to 15 K. We apply reflection absorption IR spectroscopy (RAIRS) and line-of-sight thermal programmed desorption (TPD) to determine binding energies and HAC specific surface areas by application of simple theoretical models. We will discuss at the meeting the astronomical implications of the results.

Acknowledgments:

We acknowledge funding from ERC-2013-Syg 610256 (NANOCOSMOS) and FIS2016-77726-C3-1-P.

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ID: 03759, 17/07/2019 18:15 - 17/07/2019 18:30, Room 0.6 (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Oral)

A binary nucleus in Mrk 622?

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Based on WHT spectroscopy we find that Mrk 622 shows triple peaks in its emission line spectra. BPT diagrams show that the the blue and red-shifted lines have properties typical of AGN, while the central, and systemic velocity lines show the characteristic of Starburst galaxies. Based on this facts, we claim that Mrk 622 is a binary nuclei orbiting a starburst galaxy. In the talk I will show the optical spectroscopy as well as high spatial resolution images that have been obtained with the European VLBI network, that are not yet analysed, but will be by the time of the conference. This radio observation will confirm whether we have indeed a binary nuclei or alternatively it is a bipolar out- or inflow what we are seeing.

ID: 03303, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Poster)

Jose Gómez[1]

1) Independent scholar

** Jose Gómez Cazorla, jccazorla39@gmail.com*

Recientes observaciones de Planck Satelite, tienen estimaciones del valor de la densidad en el vacío cuántico en 5.96*10^-27 Kg / m3, este estudio propone que este es el valor de la textura del espacio, por esta razón, el vacío cuántico, actúa como el espacio donde yace la masa. La energía contenida en la masa es capaz de doblar el espacio, debido a la resistencia de la masa que ofrece el vacío cuántico. Cómo explica la Teoría de la Relatividad, este efecto de flexión es responsable de la gravedad. Aquí la fórmula propuesta es Dv * VC = m * c2, donde Dv = δv * c2 indica la energía del vacío cuántico y Vc el volumen de curvatura, esto sugiere que la elasticidad del espacio es enorme y directamente proporcional a la energía de la masa. En un Universo en una expansión acelerada, la densidad del vacío cuántico, que se deriva de la Constante Cosmológica de Einstein, es un valor variable.

ID: 04106, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Poster)

Measurement of the Relative Efficiency Factor for nuclear recoils in NaI(Tl) crystals for Dark Matter detection

David Cintas[1] , Julio Amaré[2] , Susana Cebrián[2] , Iván Coarasa[2] , Eduardo García[2] , María Martínez[3] , Miguel Angel Oliván[4] , Ysrael Ortigoza[2] , Alfonso Ortiz de Solórzano[2] , Jorge Puimedón[2] , Ana Salinas[2] , María Luisa Sarsa[2] , Patricia Villar[2]

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ANAIS (Annual modulation with NaI Scintillators) [1,2] is a dark matter direct detection experiment located at the Canfranc Underground Laboratory (LSC, Spain). Its main goal is to verify or refute in a model independent way the DAMA/LIBRA positive result [3]: an annual modulation in the low-energy detection rate compatible with the expected signal induced by dark matter (DM) particles. This signal is in strong tension with the negative results of other experiments. However, they use a different target than DAMA/LIBRA, so the comparison depends upon assumptions on the DM model and on some experimental parameters. Among the latter, the most important is the relative efficiency factor (REF) of a signal produced by a nuclear recoil in the NaI(Tl) -as expected from a DM interaction - and the signal of an electron recoil of the same energy. The scintillation process is more efficient for electrons and therefore they produce more “visible energy” than a nuclear recoil of the same energy. As the detectors are calibrated with gamma sources, the energy spectra have to be corrected by the REF in order to be interpreted as produced by DM particles. Several measurements of the REF for NaI(Tl) can be found in the literature [4,5], showing a dependence with energy and certain spread in the results. In order to disentangle the experimental effects from intrinsic ones, we have performed a series of measurements of small crystals grown by the same company as the ANAIS detectors, with NaI(Tl) powders of different qualities. The measurements were carried out at the at TUNL (Duke University, NC, USA), bombarding the crystals with a monoenergetic neutron beam (570 keV) and measuring the recoil energy as a function of the scattering angle of the neutron. Here we will present the preliminary results of these measurements.

References

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ID: 03790, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Poster)

Experimentarl carbon dioxide porosity testing Effective Medium Theories to obtain porosity from the refractive index

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Porosity is directly obtained from the average density obtained by means a Quartz Crystal Microbalance measuring the mass deposited per unit area divided by the thickness of a thin film deposited at low temperature. Two interference fringes obtained at two angles of incidence consent to obtain the actual real part of the refractive index of the ice film. The intrinsic density value is obtained from the literature.
The Effective Medium Theories (EMAs): Lorentz-Lorenz, Maxwell-Garnett and Bruggeman, largely used to obtain optical properties and porosities of pure and ice mixtures have been experimentally tested in this work. The goal is validate these theories to other molecules than CO_2 that has been used in this test

Despite experimental and theoretical values show similar trends, theoretical ones present higher values than experimental ones. In conclusion the EMAs can give the general behavior of the porosity of a molecule deposited at different temperatures but must be carefully considered and tested to validate the results obtained by this methods.

ID: 04014, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S10. Astrophysics and Astroparticles (GEAS)
(Poster)

Analysis of radioactive backgrounds for the ANAIS-112 dark matter experiment

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** Susana Cebrian,* scebrian@unizar.es

The ANAIS (Annual modulation with NaI(Tl) Scintillators) experiment aims at the confirmation or refutation of the DAMA/LIBRA positive annual modulation signal in the low energy detection rate at the Canfranc Underground Laboratory (LSC) in Spain. ANAIS-112, consisting of nine 12.5 kg NaI(Tl) modules produced by Alpha Spectra Inc., is taking data in "dark matter search" mode since August, 2017. A large effort has been carried out to characterize the background of sodium iodide detectors before unblinding the data and performing the first annual modulation analysis corresponding to 1.5 years of data taking, which has been just presented [1].

In this contribution, the background models developed for all the nine ANAIS-112 detectors will be shown [2]. Measured spectra from threshold to high energy in different conditions are well described by the models based on quantified activities independently estimated following several approaches. In the region from 1 to 6 keV (visible energy) the measured, efficiency corrected background level is 3.58±0.02 keV^{-1} kg^{-1} d^{-1}; NaI crystal bulk contamination is the dominant background source being ^{210}Pb, ^{40}K, ^{22}Na and ^{3}H contributions the most relevant ones. The evolution in time of the rates in different energy windows predicted by the background models has also allowed to support the assumed trends in the annual modulation analysis; moreover, the comparison of this time evolution with that registered during the 1.5 years of unblinded data will serve as an additional cross-check of the models.

References

[1] J. Amaré et al., First results on dark matter annual modulation from ANAIS-112 experiment, submitted to Phys. Rev. Lett., arXiv:1903.03973

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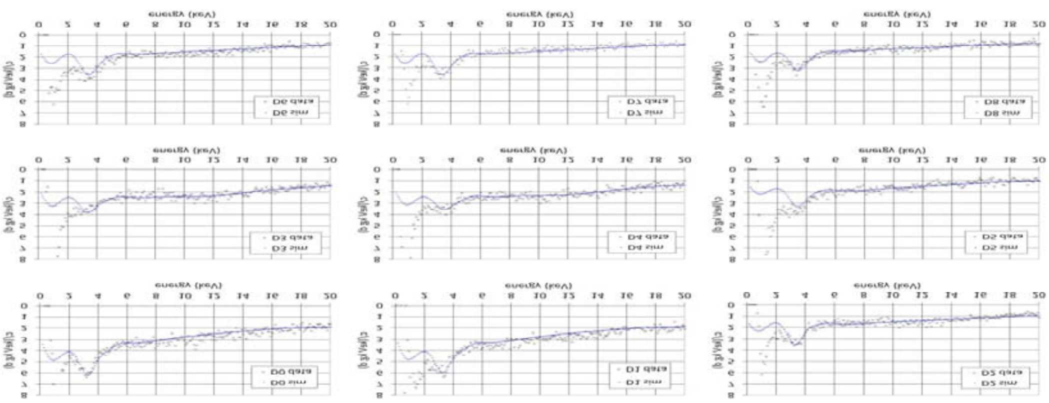
Figure: Comparison of the anticoincidence energy spectra in the region of interest measured for each detector with the corresponding background model summing all the simulated contributions. The shown data correspond to the 10% of unblinded data of the first year of data taking after filtering and efficiency correction.



S11. Física de la atmósfera y el océano (GEFAO)

Al igual que en ocasiones anteriores, GEFAO (Grupo especializado de Física de la Atmósfera y el Océano) de la RSEF celebrará un simposio durante la Reunión Bienal. Su objetivo es reunir a los miembros del grupo y a otros científicos interesados en intercambiar experiencias recientes sobre los temas de investigación de sus respectivos equipos de trabajo. Los temas a tratar incluyen:

- Observación de la Atmósfera y el Océano
- Modelización a diferentes escalas espacio-temporales
- Interacciones Atmósfera-Océano
- Variabilidad y Cambio climático
- Análisis y modelización de fenómenos extremos y sus impactos.
- Calidad del aire, composición atmosférica e interacciones con el clima

Las contribuciones se realizarán en forma de presentaciones orales y posters y se pretende dar especial visibilidad a los trabajos realizados por jóvenes investigadores

Organizadores:
Ricardo García Herrera, *Universidad Complutense de Madrid*

S11. Physics of the Atmosphere (GEFAO)

As in previous occasions, GEFAO (RSEF Specialized Group on the Physics of the Atmosphere and the Ocean) will hold a symposium during the Biennial Meeting. Its objective is to bring together the members of the group and other scientists interested in exchanging recent results from their respective work teams. The topics to be discussed include:

- Observation of the Atmosphere and the Ocean
- Modeling at different spatial and temporal scales
- Interactions Atmosphere-Ocean
- Variability and Climate change
- Analysis and modeling of extreme phenomena and their impacts
- Air quality, atmospheric composition and interactions with climate

Contributions can be in the form of oral presentations and posters. It is our intention to give special visibility to work carried out by young researchers.

<u>Organizers:</u>

Ricardo García Herrera, *Universidad Complutense de Madrid*

ID: 03752, 17/07/2019 15:00 - 17/07/2019 15:30, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

Pyrheliometer measurements in Madrid (1910–1929): trends in atmospheric column transparency

Alejandro J. P. Aparicio[1] , Manuel Antón[1] , María Cruz Gallego[1] , Arturo Sánchez-Lorenzo[1] , José M. Vaquero[2]

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2) Departamento de Física, Centro Universitario de Mérida, Universidad de Extremadura

** José M. Vaquero, jvaquero@unex.es*

Due to the scarcity of SSR data during the first half of 20th century, the behavior of the surface solar radiation (SSR) during this period is an open issue. This contribution focuses on the evaluation of the pyrheliometer measurements in Madrid Astronomical Observatory between September 1910 and January 1929. Metadata regarding the state of the solar disk during each pyrheliometer record have been used in order to remove measurements affected by thin clouds. Our analysis of the atmospheric column transparency from the pyrheliometer data showed two periods with opposite sign in the trends of this variable: (1) a decrease of $(-2.9 \pm 0.2)\%$ per decade between 1910 and 1925, followed by (2) a strong increase of $(+15.0 \pm 2.5)\%$ per decade up to 1929. Both trends were statistically significant at the 95% confidence level. These results suggest a decrease of direct SSR in Madrid during the second decade of the 20th century, in agreement with the final stage of the "early dimming" observed at several European sites. Moreover, the marked positive trend found in this work is in accordance with the beginning of the SSR recovery in Europe which was observed up to late 1940s (so-called "early brightening").

ID: 03833, 17/07/2019 15:30 - 17/07/2019 15:45, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

Water vapor and aerosol effects in short-wave surface radiation in Valladolid

Javier Vaquero-Martinez[1] , Manuel Antón[1] , Victoria Cachorro[2] , José Pablo Ortiz de Galisteo[3]

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2) Grupo de Óptica Atmosférica, Universidad de Valladolid, Valladolid (Spain)
3) Agencia Estatal de Meteorologia (AEMET), Valladolid, Spain

** Javier Vaquero-Martinez, javier_vm@unex.es*

Water vapor and aerosol radiative effect (WVRE and ARE, respectively) in the short wave (0.28 - 4.00 microns) are obtained by means of a radiative transfer model. The radiative effects are calculated as the difference between the neat surface radiation in a real atmosphere and the neat surface radiation in an atmosphere without the component (either water vapor or aeorsols). The data used to feed the model are integrated water vapor (IWV) from GPS station in Valladolid, and Cimel aerosol optical depth (AOD) and Angstrom exponent (α) at 440 nm. Other data (albedo and total column ozone) are retrieved from ERA-Interim Reanalysis.

Cimel aerosol data is averaged around GPS hourly data with a time window of ±30 min. The hourly data is fed to the radiative transfer model in three ways: first, using the actual data; second, setting the water vapor to zero; third, setting aerosols to zero. Then the output of the model allows to calculate the ARE and WVRE.

Both ARE and WVRE exhibit a seasonal cycle, but it is stronger for WVRE. Values are negative, and stronger in the case of WVRE (-70 Wm^{-2}) than in the case of ARE (-7 Wm^{-2}). Trends of these effects were also calculated

ID: 03800, 17/07/2019 15:45 - 17/07/2019 16:00, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

Sensitivity of water vapour in lower stratospheric monsoon anticyclones to different processes

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** NURIA PILAR PLAZA MARTIN, npplamar@upo.es*

Lower stratospheric water vapour is affected by a number of processes from ice formation and removal to methane oxidation. It is therefore necessary to develop model parametrizations covering these processes. Although they can reproduce the general picture of stratospheric water vapour varibility, current model simulations still show significant differences to observations, particularly in monsoon regions. For instance, satellite observations from the most recent version of the Microwave Limb Sounder experiment (MLS) show climatologically similar water vapour maxima at 100 hPa in the Asian (AM) and North American (NA) monsoon regions. On the contrary, Lagrangian models driven by different reanalyses show a much stronger water vapour signal in the Asian monsoon at that pressure. Therefore, it is crucial to study if these differences arise from the effect of the parametrizations included in the model.

We use the modular structure of the Lagrangian atmospheric model CLaMS in its diabatic version to perform several runs, disabling parametrizations included in the model. Thus we have covered a wide range of configurations: from simple trajectory runs to full chemistry-transport model runs. The three dimensional structure and relative strength of the AM and NA monsoon water vapour signals are analysed and compared between the different simulations. This procedure gives us clues about the effect of the applied parametrizations on the main sources of water vapour during boreal summer in the LS. Besides it helps to identify which parametrization is behind the differences between CLaMS and MLS.

ID: 03834, 17/07/2019 16:00 - 17/07/2019 16:15, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

Obtaning and Validating Integrated Water Vapor Estimates from a cheap IR themometer

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The importance of water vapor for the climate systems is well acknowledged in the scientific community. For some activities, like agriculture, water vapor play a fundamental role. In this work, a cheap IR thermometer is pointed to the sky in the zenithal direction in Badajoz and the temperature measured is used to obtain an estimate of water vapor. This instrument is cheaper than photometers and, as they are based in the IR spectrum, can measure in day or night.

Water vapor is well-known as one of the main greenhouse gases. Therefore, it is the main absorbant in the IR region, and the main emissor. This feature makes the IR thermometer a proper tool to measure water vapor. This instruments absorbs the IR radiation emited by the atmospheric gases and transforms it in a measurement of the temperature.

A Cimel sun-photometer in Badajoz is used to calibrate the instrument. The Cimel IWV has been averaged in a window of ±15 min around the IR thermometer measurement. This instrument has been used not only for calibration, but also for validation of the IR themometer water vapor measurements. The period for calibration was 2015-2017, and the period for validation the year 2018. The IR themometer measures once in a day. Clouds where found to have a strong influence disturbing the measurements and therefore the only measurements consideres are those under clear-sky.

It has been found that a simple linear regresion gives a high degree of correlation (R^2 = 0.70), although an exponential model gives better results (R2 = 0.72). The regression line was log(IWV) = -10.72 + 0.0427 * T,where IWV is in cm and T is the temperature in K.

The errors in the validation are between -0.75 cm and 0.5 cm, which represent relative differences of -20 to 40 %. This kind of instrument, thanks to its good price-efficiency ratio, can be used for educational purposes or to have a rough estimate of IWV, which can be useful in agriculture.

ID: 03776, 17/07/2019 16:15 - 17/07/2019 16:30, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

El concepto de monzón global: variabilidad secular del monzón

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Los monzones son el resultado de la interacción entre el contraste térmico continente-océano y la migración estacional de la Zona de Convergencia Intertropical en respuesta al forzamiento solar. En este contexto, el monzón puede entenderse como un sistema de escala global. No obstante, cada zona monzónica tiene características propias y sigue siendo imprescindible la generación de índices diferentes en cada sub-región para estudiar el monzón global.

Tradicionalmente, los índices diseñados para cuantificar las características de los monzones se han basado en el análisis de la precipitación. Sin embargo, debido al caracter marcadamente local de esta variable, actualmente suelen preferirse los índices dinámicos basados en el viento. Estos índices se fundamentan en el análisis del viento zonal en el nivel de 850 hPa. Aunque estos índices son muy potentes, sólo pueden calcularse desde mediados del siglo XX, ya que dependen de la disponibilidad de observaciones de viento en el nivel de 850 hPa en regiones subtropicales.

En este trabajo se presenta una colección de nuevos índices para los principales monzones (India, el Pacífico Occidental, Australia y África Occidental) basados en el tratamiento de observaciones directas de dirección de viento tomadas a bordo de navíos desde inicios del siglo XIX. Entre los principales resultados podemos destacar el incremento de la intensidad del monzón de Australia desde inicios del siglo XIX hasta la actualidad, la existencia de un periodo anómalamente húmedo en el Sahel durante la segunda mitad del siglo XIX o la inestabilidad en la relación entre la intensidad del monzón de pacifico occidental y el ciclo El Niño / Oscilación del Sur.

Agradecimientos

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ID: 04023, 17/07/2019 16:30 - 17/07/2019 16:45, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

Examining the NAO-EA relationship and the jet variability since 1685

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Previous studies have shown that the concomitant state of the North Atlantic Oscillation (NAO) and the East Atlantic (EA) account for much of the winter North Atlantic eddy-driven jet stream variability. However, the limited understanding of the jet stream variability is partially hampered by the short observational record, in particular the evolution of the EA before the mid-19th century remains unknown, and the few existing studies considering NAO and EA are limited to the 20th century. In this work, we present the longest (1685-2014) instrumental records of winter NAO and EA indices as well as estimates of the North Atlantic eddy-driven jet stream speed and latitude for the same period using wind direction records from ships' logbooks.
An analysis of the different combinations of NAO/EA indices reveals the role of EA in modulating the North Atlantic action centers and the associated European climate responses to NAO. Regarding the eddy-driven jet stream, the results indicate that the jet speed is more affected by the NAO, while NAO and EA are of comparable importance but have opposite effects in the jet latitude.
Finally, an analysis of the last three centuries uncover multidecadal periods dominated by specific NAO/EA states, indicating that the past atmospheric circulation cannot be properly described by the state of the NAO alone. In fact, transitions in the NAO/EA phase space explain non-stationary NAO signatures, such as the displacement of the NAO action centers in the late 20th century as well as some disagreements between instrumental NAO indices.

ID: 03841, 17/07/2019 16:45 - 17/07/2019 17:00, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

Air stagnation in the Euro-Mediterranean region

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Air stagnation situations are characterised by stable weather conditions, weak winds in the lower to mid-troposphere and absence of precipitation. These conditions impede the horizontal dispersion and vertical mixing in the lower troposphere as well as the washout of pollutants, favouring the occurrence of poor air quality events. Climate model projections suggest that air stagnation will increase north of the Mediterranean in the future, but these projections are subject to large uncertainties due to poorly represented dynamical processes. In addition, past changes in air stagnation over the region and the associated dynamical mechanisms have remained largely unexplored before this work.

We have characterised the spatiotemporal variability of air stagnation over the Euro-Mediterranean area for the 1979–2016 period by using a simplified air stagnation index. The index considers that stagnation occurs over a given area when daily near-surface and mid-tropospheric wind speeds as well as daily accumulated precipitation are simultaneously below predefined thresholds. Results from applying this index to both a meteorological reanalysis and observations indicate a reasonably good agreement between both datasets. There is considerable spatial heterogeneity in stagnation patterns (i.e. occurrence of stagnation days and events) over the area of study. Therefore, we have applied a clustering algorithm to the occurrence of stagnant days, obtaining five distinct regions where air stagnation follows consistent patterns: Scandinavia, Northern-Europe, Central-Europe, South-West and South-East. We have also examined the temporal variability of stagnation in these regions and found that stagnation maxima are associated with different states of the atmospheric circulation, depending on the region and season. Finally, we have proved the strong impact of stagnation on the concentrations of two major air pollutants, ozone and particulate matter.

ID: 04139, 17/07/2019 17:30 - 17/07/2019 17:45, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

The Mediterranean atmospheric modes: variability and trends

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The projections of the fifth assessment report of the Intergovernmental Panel of Climate Change (IPCC 2013), based in observational and modeling studies, include a drying trend for future Mediterranean climate conditions. However, there are large uncertainties concerning the anthropogenic climate change contribution to this trend, and a need to increase our limited knowledge of the internal climate variability at multidecadal and centennial timescales.

Two atmospheric modes, the Mediterranean Oscillation (MO) and the Western Mediterranean Oscillation (WeMO), were found to contribute to the anomalous climatic variability in the Mediterranean region. Each of these modes is characterized by their respective indexes. The MO index [1] measures the SLP anomalous gradient across the whole Mediterranean Sea. The WeMO index [2] accounts for the slanted SLP gradient in the western Mediterranean.

In this study, the seasonal MO indices and the station-based WeMO indices were examined for trends and preferred timescales of variability between 1870 and 2005. The existence of a trend was probed first with nonparametric tests and conventional linear regression methods. Similarly, preferred time scales of variability are identified using spectral analysis. Then an Empirical Mode Function Decomposition analysis [3] was applied to all the seasonal indexes. In this way, physically meaningful intrinsic modes function of variability can be extracted and nonlinear trends identified without assuming stationarity in the time series.

A significant multidecadal component was extracted from the MO indices analysis, very similar to another significant component found in the WeMO indices ones. A significant trend was found significant by both, linear and nonlinear techniques, in some of the WeMO seasonal indices. The covariability of the atmospheric modes with other teleconnection indices (North Atlantic Oscillation, Tropical North Atlantic, Tropical South Atlantic) and with other data fields of interest (i. e. Mediterranean Sea surface temperature, precipitations) were also investigated.

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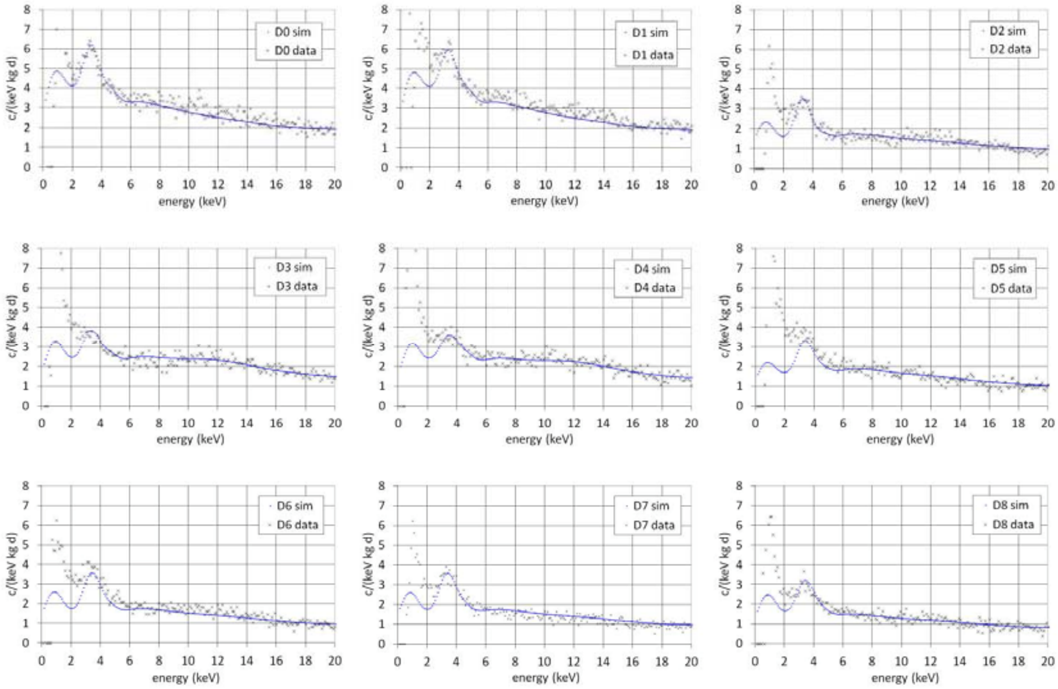
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ID: 03782, 17/07/2019 17:45 - 17/07/2019 18:00, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

ANALYSIS OF ACTINOMETRIC MEASUREMENTS FOR THE PERIOD 1913-1923 IN CÁCERES (SPAIN)

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Systematic measurements of solar radiation are available since the second half of the 20th century and we only have a few records before 1950 [1]. Studies analyzing long-term records of surface radiation measurements suggest a decrease in surface solar radiation between the 1950s and 1980s (“global dimming”), with a more recent partial recovery at many locations (“brightening”) [2]. However, there is a controversy about the trend of the solar radiation at the Earth\'s surface in the first half of the 20th century.

Fortunately, actinometric measurements were recorded in Cáceres (Spain) for the period 1913-1923 with an Arago actinometer and cloud cover measurements were also taken. Actinometric data are used as an indirect measurement of solar radiation. In spite of being a short series, the analysis of the actinometric data recovered in Cáceres (Spain) for the period 1913-1920 can contribute to clarify this controversy. Thus, trends from recovered actionometric data were analyzed in Cáceres for the period 1913-1920.

From the results of the analysis, it has been found a decrease of (-0.16 ± 0.03) °C/year, statistically significant at the 95% confidence level. Under cloud-free conditions, a statistically significant decrease of (-0.26 ± 0.04) °C/year at the 95% confidence level has also been found.

These results suggest a decrease of solar radiation in Cáceres during the second decade of the 20th century. It is in accordance with the final stage of the long-term negative trend in solar radiation data observed at several European sites from late 19th century to the beginning of the 20th century (“early dimming") [3].

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ID: 03723, 17/07/2019 18:00 - 17/07/2019 18:15, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

Análisis de seguimiento de chubascos en el área urbana de Barcelona utilizando una red pluviométrica de microescala

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Se ha realizado un estudio sobre el movimiento de chubascos en el área de Barcelona, analizándose 394 episodios de lluvia registrados entre 1994 y 2017 por al menos 10 de los pluviómetros de su red urbana durante más de 30 minutos, con un mínimo de intensidad de 20 mm/30 min para alguno de ellos. Se han utilizado dos técnicas de seguimiento de células de precipitación y se ha analizado la influencia de los vientos predominantes, la orografía y la presencia del litoral marítimo en su evolución, con el objetivo de contribuir a una mejor gestión de los sistemas de drenaje de la ciudad.

La mayor parte de los métodos de estimación del movimiento de chubascos consiste en el seguimiento sobre la red de pluviómetros de alguna característica reconocible del patrón de precipitación, como el centroide de su hietograma o el instante en el que se produce su pico máximo de intensidad [1]. Si (x_k, y_k) son las coordenadas de cada pluviómetro k y t_k los instantes de tiempo de interés, el conjunto de puntos (x_k, y_k, t_k) se ajusta a un plano ax+by+c=t por regresión planar. La velocidad y la dirección de movimiento o evolución del chubasco se pueden calcular a partir de la pendiente máxima de dicho plano. El seguimiento de los centroides y los picos máximos de los chubascos analizados (véase figura) ha dado como resultado que la mayoría se mueven o evolucionan en dirección a la costa, E-SE [2]. Un segundo grupo se mueve en dirección N-NE, que corresponden en general a situaciones con vientos del S y SW en altura, con fuerte cizalladura vertical y vientos de levante en superficie, y en su movimiento también influye el efecto de canalización producido por la sierra de Collserola (512 m de altitud) casi paralela a la línea de costa. Más de un 80% de las velocidades estimadas se encuentra en el rango entre 2 y 15 m/s.

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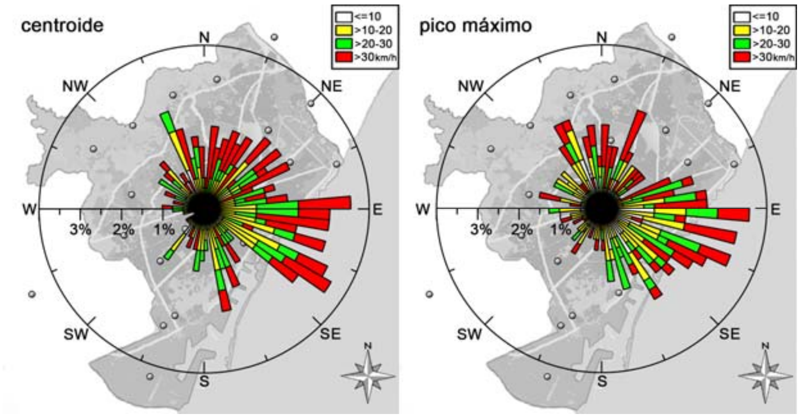
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ID: 04036, 17/07/2019 18:15 - 17/07/2019 18:30, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

RELATION BETWEEN EXTREME PRECIPITATION AND CLIMATE CHANGE OVER THE MIÑO-SIL BASIN

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The Miño-Sil basin is located in the northwestern Iberian Peninsula. The basin goes through three different political and administrative regions, Galicia, Asturias, and Castilla-Leon and is the place for a huge number of hydropower stations, representing approximately the 10% of the power generation capacity installed in the Iberian Peninsula. Extreme weather events represent a great risk for infrastructures, the operation of energy markets and energy security. It is well known that climate change has increased the frequency of such events over the last decades. In this work, we research the impact of climate change and extreme weather on the Miño-Sil basin. For it, we use observational data and a large ensemble of climate model simulations generated with the regional model HadRM3 nested in the global model HadAM3P from the project Weather@home. Return periods of accumulated precipitation for 15, 30 and 90 days are computed and changes over the last decades analysed. We also demonstrate that the model HadRM3/HadAM3P simulates reasonably well the precipitation over the basin but with a dry bias.

ID: 04091, 17/07/2019 18:30 - 17/07/2019 18:45, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

Very large climate ensembles using Cloud Computing: a case study.

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Climate and meteorological oriented software and simulations usage in Cloud Systems is growing and has proven to be a feasible and solid solution for these scientific applications.

In previous works, we exposed how Cloud systems can be the base to run climate simulations for researchers that can not or do not want to manage the needed computational resources.

Here we present a case study of simulation of an extreme weather event run in a Cloud Computing environment. Computational details, the performance of the experiment and potential applications are discussed.

ID: 04034, 17/07/2019 18:45 - 17/07/2019 19:00, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

Results of a systematic review. Wind and wind power forecasting in the Iberian Peninsula and the Canary Islands.

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One of the renewable energy sources experiencing a major boost in the last decades in Europe has been wind energy. Along the last years Spain and Portugal have seen an increase in the average annual electricity demand covered by wind.

For power production forecasting, meteorological and climate models are critical in order to make an appropriate geographical choice of the areas to be exploited and to get appropriate planning of power production.

In the last 20 years, wind forecast has seen a lot of improvement for the short-term (1 day-7 day). However, this is only valuable for immediate decisions. When it comes to medium or long-term planning of renewable production, it is necessary to go for the seasonal and subseasonal forecast. The aim of this work is systematically analyse the existing literature and to determine the state of the art of the different methods to forecast wind power in seasonal and sub-seasonal scales in the Iberian Peninsula and the Canary Islands. The selected studies take into account only these regions or other biggest regions that include them. A search of scientific literature was conducted on Google Scholar and to select the most relevant studies we developed a software that we present jointly with this work.

The results show that there are only a few studies of seasonal and subseasonal wind and wind power forecast that provide sensitive and useful information for the studied regions. This highlights the need for increasing research efforts on this topic.

ID: 04088, 17/07/2019 19:00 - 17/07/2019 19:15, Room 0.8 (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Oral)

Current status of scientific reproducibility in geophysics: from climate models to journal policies

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Scientific reproducibility has become a hot topic over the last year, in some way linked to research advances using artificial intelligence. However, the issue of lack of scientific reproducibility has been on the table for quite a long time. Geophysics has not been out of the debate. Indeed, climate science has been criticized for relying on climate models. Here we discuss the current policies for publication of results using all kind of software by some of the major journals in the field of geophysics, discuss and show results on the state of the art of computational reproducibility of models from the Climate Model Intercomparison Project (CMIP) and introduce tools and discuss best practices to improve the current situation.

ID: 03780, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Poster)

THE RELATIONSHIP BETWEEN ROGATION CEREMONIES IN EXTREMADURA REGION AND THE NAO INDEX

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Proxies are required when climate of the Past is to be studied and instrumental measurements do not exist. Rogation ceremonies are religious requests to God and are celebrated for different reasons. Most of this rogation ceremonies are due to the lack of water and the need for rain (“pro-pluvia” rogations) and rough weather (“pro-serenitate” rogations). Thus, pro-pluvia and pro-serenitate rogations suggest dry and wet conditions, respectively. Rogation ceremonies have been used for different purposes. Some authors have used pro-pluvia rogations to detect historical droughts [1-2].

Climate of Extremadura region (SW of Spain) is strongly dominated by the North Atlantic Oscillation (NAO) [3-4]. Therefore, rogation ceremonies can be associated to the NAO index and the purpose of this contribution is to analyze the relation between “pro-pluvia” rogations and the NAO index from 1821 to the present.

In this study, ecclesiastical archives and different documents have been consulted. In total, 35 “pro-pluvia” rogations celebrated in that period have been rescued. Each rogation has been celebrated in a given date (month (n) and year). The NAO value in that date has been associated to the rogation. Also, the relation has been analyzed for the previous months (n-1, n-2 and n-3) of the NAO index. The study is performed by the chi-squared test.

From the results of the whole analysis, the most relevant results are found in the relationship between pro-pluvia rogations and the NAO index for the previous month n-2, being statistically significant at 95% confidence level. Thus, the results confirm that rogation ceremonies in Extremadura are a good proxy for the NAO index.

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ID: 03867, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Poster)

PRELIMINARY STUDY OF THE VARIABILITY OF SUNSHINE DURATION IN BADAJOZ DURING 1928-1950

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This work analyses the temporal variability of the annual and seasonal long-term trends of daily sunshine duration (SD) for both all-sky and cloud-free (less than one tenth in cloud coverage) conditions in Badajoz during the 1928-1950 period. Dataset from AEMET is used. Focusing on the SD linear trends, there is found an increase (called early brightening) in either SD annual time series for all-sky conditions or SD time series for cloud-free conditions in, both with 95% of signification. Overall, there is a positive trend of around (0.37 ± 0.22) hours per decade on annual basis for SD with all-sky conditions and a positive one of (0.024 ± 0.008) fraction per decade on annual trend for SD with cloud-free conditions. Thinking on the seasonal trends, there is found that only in summer and autumn the brightening is 95% significant for SD with all-sky conditions, whereas SD with cloud-free conditions has positive significant trends in all seasons. Also, the temporal variability of the cloud-coverage (CC) is analysed. There is observed that CC has not trend in neither annual nor seasonal studies. Due to a non-correlation between SD and CC, we can assume that positive linear trends in SD might be related to a decrease in aerosols, represented by the optical depth.

ID: 03886, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Poster)

Frist steps in the study of flash droughts in Spain

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Drought is one of the main natural hazards that affects a society and environment around the world. Drought has a slow development and it is difficult to identify in time and space. Recently, a new type of drought known as “flash drought” has begun to be studied in United States [1], China and Southern Africa. This type of drought is characterized by a rapid development phase and intensification of severity as a result of the combination of a marked deficit of precipitation and strong atmospheric evaporative demand, causing significant agricultural and economic losses.

We study for the first time flash droughts in peninsular Spain and Balearic Islands. We propose a new methodology for the identification of flash droughts through two of the most widely used drought indices i.e. Standardized Precipitation Index and Standardized Precipitation Evapotranspiration Index. This methodology is based on the analysis of large decrease in the value of the indices at weekly resolution. The use of these indices, easily obtained from common meteorological variables, allows us to analyze the evolution of flash droughts in a long time period 1961-2017 [2].

The preliminary results show that SPI has a greater number of events in spring and autumn, while SPEI has similar number of events during the year, except in winter. Likewise, a great variability of the flash droughts in time and space has been observed, but there is no clear trend in the period analyzed. Therefore, more studies are needed to characterize and analyze flash droughts in Spain.

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ID: 03760, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Poster)

Impact of the North Atlantic jet on winter particulate matter concentrations in Europe

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The North Atlantic jet stream controls the variability of the climate and weather in North America and Europe, but its influence on the surface concentrations of air pollutants in Europe has not been examined in detail so far. We present the first analysis of the impact of the jet on PM_{10}(particulate matter with aerodynamic diameter ≤ 10 μm) in Europe during a 10-year winter period.

The daily PM_{10} observations used in this study are provided by the European Environment Agency\'s air quality network, while the daily latitude and strength of the jet have been detected over the eastern North Atlantic (0°–15° W) from a meteorological reanalysis. Four preferred jet positions have been identified before assessing the impact on the PM_{10} concentrations: southern (south of 41° N), central-southern (between 41° N and 51° N), central-northern (between 51° N and 63° N) and northern (north of 63° N).

We have found that the PM_{10} concentrations are more sensitive to the jet latitude than to the jet strength. Consequently, our analyses have focused on the impact of the jet latitude on PM_{10}, including the occurrence of PM_{10} extremes (exceedances of the local winter 95th percentiles). From the four preferred jet positions, two of them are associated with anticyclonic conditions and therefore enhanced PM_{10} over different parts of Europe. In particular, the northern jet position yields a 35% rise (~9 μg m^{-3}) in the average concentrations and threefold increases in the occurrence of PM_{10} extremes over northwestern/central Europe. Similar results have been found for PM_{10} in southern Europe when the jet is in its central-northern position.

As there is considerable spread in climate change projections of the future evolution of the jet, our results may have implications to understand discrepancies in model projections of PM_{10} and other air pollutants.

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S11. Physics of the Atmosphere (GEFAO)
(Poster)

Main results of IMDROFLOOD project

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The IMDROFLOOD (*Improving Drought and Flood Early Warning, Forecasting and Mitigation using real-time hydroclimatic indicators)* project has been supported by WaterWorks 2014. The project is focused on the mitigation of the impact of droughts and floods at the catchment level. IMDROFLOOD includes research institutes, universities and companies from six countries (Spain, Portugal, Estonia, Romania, Moldova and South Africa) and it is focused on five river basins which have different environmental conditions and specific problems (Tagus, Ebro Prut, Emajõgi and Limpopo). The main objective of IMDROFLOOD is to enhance flood and drought risk management at the catchment level through the development of novel flood and drought information tools. The specific objectives of the project are:

1. To obtain drought indices for different sectors useful for drought monitoring and early warning, using new monitoring networks and remote sensing data.
2. To develop drought vulnerability curves for natural and managed ecosystems.
3. To determine the role of vegetation type and density on modulating the severity of hydrological droughts and floods downstream.
4. To improve short and medium term meteorological probabilistic forecast of high precipitation events.
5. To integrate meteorological predictions with hydro-ecological rainfall-runoff and hydrodynamic models for better flood prediction and the analysis of the destructive capacity of floods.
6. To implement operative drought and flood early warning systems to establish risk thresholds and to help improve risk management.

This presentation shows the main results of the project. For more information you can follow the project at http://imdroflood.csic.es/ and consult the special issue “Hydroclimatic extremes and impacts at catchment to regional scales” inspired by the project in the Natural Hazards and Earth System Science journal.

ID: 03795, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Poster)

Nueva metodología para identificar fechas de interés en la estación monzónica en el noroeste del Océano Pacífico.

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En este estudio se presenta una nueva metodología para identificar las fechas de inicio y fin del monzón del noroeste del Océano Pacífico (WNPSM, por sus siglas en inglés) así como sus periodos de debilitamiento o breaks. La novedad de este método es el uso exclusivo de observaciones de dirección de viento tomadas en barcos, disponibles en la base de datos ICOADS (International Comprehensive Ocean-Atmosphere Data Set).

El inicio del monzón muestra una gran variabilidad interanual, pudiendo ocurrir entre principios de Mayo y principios de Agosto. En cambio, el fin del WNPSM es menos variable y tiende a ocurrir a mediados de Octubre. Ambas fechas están moduladas por ENSO, de manera que se confirma la conocida relación entre las fechas del WNPSM y ENSO en las últimas décadas. Así, el monzón tiende a empezar antes (más tarde) y terminar más tarde (antes) en condiciones La Niña (El Niño). Sin embargo, se ha encontrado un debilitamiento de esta relación antes de la década de los 1980.

Por otra parte, se ha podido calcular por primera vez la climatología de los breaks del WNPSM a escala diaria desde 1949 hasta el presente. Es común encontrar uno o dos breaks por año, lo que representa el 38% y 24% de los casos, respectivamente. Las fechas más frecuentes de estos eventos son desde Agosto hasta principios de Septiembre, aunque también se pueden detectar entre finales de Junio y mediados de Julio. En relación a su duración, más del 75% de los breaks duraron entre 15 y 30 días.

Finalmente, se ha evaluado la influencia de los breaks en la trayectoria de los ciclones tropicales (TC) en el Océano Pacífico. Así, los TC tienden a atravesar el norte de las Islas Filipinas hacia Indochina y el sudeste de China durante los días de monzón activo, mientras que tienden a desplazarse hacia latitudes más altas durante los breaks.

La investigación ha sido financiada por el Ministerio de Economía, Industria y Competitividad mediante el proyecto INCITE (CGL2013-44530-P, BES-2014-069733).

ID: 03866, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Poster)

Long term variability of the northerly winds over the Eastern Mediterranean as seen from historical wind observations

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The summer low-level circulation over the eastern Mediterranean is characterized by a persistent northerly wind regime whose interannual variability is modulated both by mid and tropical latitudes. In this work, we made use of historical wind observations taken aboard ships to assemble the first purely instrumental index quantifying this wind system since 1880, the so-called "Northerly Wind Index". This has allowed evaluating the long-term variability of the northerlies over the longest time period so far. Our results indicate that the first half of the 20th century was characterized by more frequent and persistent northerly winds in the eastern Mediterranean than the second half. Besides, we have found that the well-known teleconnection between the eastern Mediterranean northerlies and the Indian Summer Monsoon, with enhanced northerlies concurrent with a stronger monsoon, has not been steady along the 20th century. Our results revealed a significant positive correlation during the 1960-1990 period, more markedly in July and August, in agreement with recent studies. However, the correlation fades out in the first half of the 20th century and in the 1990-2010 period, even showing significant negative values around the 1920-1950 subperiod. We show that this unstable correlation pattern is related with changes in the Rossby-like circulation due to the monsoon convection. Indeed, it is shown that the Indian summer monsoon modulation of convection over the western Indian ocean plays a crucial role in the strength of this teleconnection.

This work has been developed as a part of the proyect INCITE financed by the Spanish Ministerio de Economia y Competitividad under grant CGL2013-44530-P.

ID: 03787, Mon-Thur 16:30 - Mon-Thur 17:30, Hall (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Poster)

Caracterización de la corriente del Chocó mediante observaciones históricas de viento

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En el Pacífico ecuatorial oriental conviven dos corrientes en chorro en niveles bajos de direcciones opuestas. El denominado “Chorro del Occidente Colombiano” o “Chocó-jet”, con origen en los vientos alisios del hemisferio sur, sopla desde el oeste y entra en Centroamérica a la altura del paralelo 5ºN. El transporte de humedad desde el Pacífico hacia el continente en el seno de este sistema hace que esta sea una de las regiones más lluviosas del mundo. En algunas localidades como Lloró en el norte de Colombia, se han llegado a registrar precipitaciones anuales superiores a 13,000 mm. Existe otra corriente en chorro de bajo nivel que se origina en el Caribe (Caribbean Low Level Jet) que llega a Centroamérica y el norte de Suramérica como una corriente en chorro predominantemente del este.

ENSO modula profundamente la interacción entre las corrientes del Chocó y del Caribe. Durante el verano del hemisferio norte, los episodios de El Niño están relacionados con corrientes del Chocó débiles y corrientes del Caribe fuertes y en gran parte del Pacífico Oriental ecuatorial, el viento presenta una componente este predominante. Durante episodios La Niña, la modulación es inversa y el viento en la misma región sopla con una componente predominantemente del oeste. Esta característica ha permitido generar un índice para la corriente del Chocó utilizando exclusivamente medidas de dirección del viento tomadas a bordo de navíos en el Pacífico ecuatorial. Los resultados muestran que esta circulación ha sido relativamente estable a lo largo del último siglo, aunque se ha producido un cambio moderado en su ciclo estacional que podría estar relacionado con un cambio en la distribución estacional de la parte de la precipitación con origen en el Pacífico en el norte de Sudamérica y América Central.

Agradecimientos

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ID: 04094, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S11. Physics of the Atmosphere (GEFAO)
(Poster)

Dynamical drivers of the synoptic heatwaves in different regions of Iberia.

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In the ongoing Global Warming, heatwave events (HWs) are becoming more frequent, intense, and longer. Among HWs, we were interested in synoptic events, which are those with most dramatic consequences for the human population, as they lead to temperature anomalies of extraordinary amplitude, affecting a large area and persisting in time up to several weeks.

In this work, first of all, we have developed a new HW detection algorithm, which focuses in the HW pattern instead of detecting these events in a given area. Therefore, for the first time, with our algorithm we can follow their spatio-temporal evolutions and main characteristics not only when the events affect our study area, but also along their whole trajectory and life cycle. This work focuses in Iberia. We found that most of the events started inside Iberia, where they experienced their mature stage, and, after leaving Iberia, they affected other areas in the European Continent in the decaying phase.

To explore the synoptic configuration influence in HWs, the Weather Regimes (WRs) affecting Iberia, using the Self Organizing Maps (SOMs) technique, were computed. The synoptic patterns were classified in 4 WRs, with similar frequencies. Nevertheless, when only the HW days were considered there was a clear predominance of one WT characterized by positive Z500 anomalies over western Europe, which caused an anomalous southeastern flow over Iberia.

Finally, to study the different HW characteristics, an automatized cluster analysis of these events (using the SOM technique) was done. Four different clusters were obtained, affecting western, southern, northern and eastern Iberia respectively. The main similarity among clusters is that for all of them the synoptic configuration was the main triggering factor. However, the HW characteristics and their spatio-temporal evolution had important differences.

S12. Termodinámica y Análisis Térmico (GECAT-GET)

El Grupo Especializado de Termodinámica destaca por su transversalidad, reuniendo a investigadores que contribuyen con aportaciones tanto experimentales como teóricas en ámbitos como generación y optimización energética, fluidos aplicados a procesos industriales, nuevos materiales o nanotecnología. Por su parte, la Calorimetría, el Análisis Térmico y el estudio de las propiedades térmicas de la materia tienen su base en la termodinámica, incluyendo tanto la simulación de procesos como su aplicación en ámbitos concretos de la química, la biología o los materiales.

Organizadores:

J.J. Suñol, *Universitat de Girona*
Manuel Martínez Piñeiro, *Universidade de Vigo*

S12. Thermodynamics and Thermal Analysis (GECAT-GET)

The Specialized Group of Thermodynamics stands out for their transversal character. This symposium will bring together researchers that make experimental and theoretical contributions to diverse areas such as energy generation and optimization, the application of fluids to industrial processes, new materials or nanotechnology. For its part, calorimetry, thermal analysis and, in general, the study of the thermal properties of matter are based on Thermodynamics, and include both the simulation of processes and their application in specific areas of Chemistry, Biology or Material Science.

Organizers:

J.J. Suñol, *Universitat de Girona*
Manuel Martínez Piñeiro, *Universidade de Vigo*

ID: 03694, 15/07/2019 15:00 - 15/07/2019 15:30, Room 1.3 (First floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Oral)

CHARCOAL AS A BACTERIOLOGICAL ADHERENT OF THE BIOMETHANATION

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This paper analyses the improved energy and environmental performance of the biomethanation of a mixture of sheep manure (20% by weight) and cheese whey (80% by weight) in a reactor of 2 litres capacity containing 2 grams of charcoal in the form of a fixed bed with respect to the same process but without the charcoal in the reactor (control experiment). The Hydraulic Retention Time (HRT) in in both cases it was 14 days, and the experiments were carried out for long periods of time - 168 days - in order to check the stability of the bioreaction [1]. The results showed increased methane production of 27.05% over that obtained in the control and a reduction of the H_2S content in the biogas of 34.7%. The improvement is due to the content of highly electropositive metals such as K and Ca in the charcoal which, through chemical reactions that take place during the biomethanation phases, can increase the pH and thus favour the process of methanogenesis and sulfate reduction [2], showing the carbon to act as a bacteriological catalyst for the biomethanation of the waste that was studied.

Acknowledgements

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ID: 03956, 15/07/2019 15:30 - 15/07/2019 15:45, Room 1.3 (First floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Oral)

Definition of frame-invariant Soret coefficients for ternary mixtures

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The definition of Soret coefficients for a binary mixture includes a concentration prefactor, $x(1-x)$ when mole fraction x is used, or $w(1-w)$ when mass fraction w is used. In this presentation the physical reasons behind this choice are reviewed, emphasizing that the use of these prefactors makes the Soret coefficient invariant upon changing in the concentration representation, using either mole fraction or mass faction. Then, it is shown how this invariance property can be extended to ternary mixtures by using appropriate concentration prefactors in matrix form. The presentation is completed with some considerations about: generalization to un-steady stituations and definition of thermodiffusion coefficients, molar concentrations and extension to multi-component mixtures.

ID: 03909, 15/07/2019 15:45 - 15/07/2019 16:00, Room 1.3 (First floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Oral)

Optimization of nanofluids derived from Graphene and Fluorinated Ionic Liquids for applications of capture of fluorinated gases

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Suspensions of nanometric size graphene platelets have been proposed as heat exchange working fluids, due to their enhanced thermal profile and high electrical conductivity. Nevertheless, their use presents long-term stability issues. Chemical functionalization of the nanoplatelets surface has been employed as a promising alternative to improve system stability. Suspensions of graphene nanoplatelets in fluorinated ionic liquids (FILs-Gr) have been used to enhance the functionality and segregation of graphene nanofluids.

The objective is to investigate the potential of (FILs-Gr). The highly nanostructured nature of FILs [1], improved by the addition of the fluorinated counterpart, is responsible for enhancing the accommodation of solutes such as gases. The strong tendency to self-assemble, and the versatility to rearrange in several conformational features may permit the stabilization of nanocolloidal systems. A screening on the phase and structural behaviour of these (FILs-Gr) is considered in order to find out and develop the optimal systems for recycling and recovering fluorinated gases. Their stability was tested using DLS, TGA, and DSC [2]. FILs present a rich phase equilibrium behaviour, and the aggregation of graphene nanoplatelets affects their nanostructure. The formation of a nanosegregated domain modifies the solid crystalline phases. SAXS-WAXS experiments have been performed showing the effect of graphene on the crystallization of FILS. However, further investigations on the structure of nanofluids with higher graphene concentration are required to evaluate the influence of the concentration in the structure.

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ID: 03697, 15/07/2019 16:00 - 15/07/2019 16:15, Room 1.3 (First floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Oral)

Systems of two aqueous polymeric phases + sodium salts

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Introduction

The study of the physico-chemical properties of aqueous-aqueous systems has developed significantly in recent years. It is noteworthy that in the systems of two aqueous phases the components involved are polymers and / or salts. Its final applications are developed in various fields such as the separation of ethanol by microorganisms, in the cosmetic industry, food field or lubricating oils.

Phisical properties

In this work, two Tween-20 and Triton X-102 polymers are compared with two cations that are sodium salts and the study of physical properties [1,2] is carried out as a refractive index [1-4], density [1 2,3,5] and speed of sound at atmospheric pressure. Subsequently, the derived properties that are the isentropic compressibility and the volume of excess are obtained at atmospheric pressure.

The following systems have been studied: (Tween 20, Triton X-102) + (Na2SO4, Na2S2O3) at atmospheric pressure and in the temperature range from 288.15 K to 318.15 K. The salts are partially soluble in water, in the case of Na2SO4 is saturated at a concentration of 25% and for Na2S2O3 about 33% is saturated

Acknowledgments:

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ID: 03964, 15/07/2019 16:15 - 15/07/2019 16:30, Room 1.3 (First floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Oral)

Thermal conductivity of Fullerene C60 Nano-Fluid using the Transient Hot-Wire Method

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Presented in this paper is an investigation on the thermal conductivity of a nano-fluid obtained by dispersing in 1,2,3,4-Tetrahydronaphthalene varying concentrations of Fullerene C60. A custom-made transient hot-wire apparatus was employed. The transient hot-wire method is the calorimetry technique generally used to measure the thermal conductivity of liquids. The technique was implemented by adopting a measurement protocol that involved the use of a calibration fluid of known thermal conductivity; so as to reliably utilize the transient hot-wire method to the mixtures as a function of temperature. The study was conducted within the temperature range of 263 K to 324 K.

ID: 04062, 15/07/2019 17:45 - 15/07/2019 18:00, Room 1.3 (First floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Oral)

An experimental set-up to study the blockage problem in the flow of liquid helium (LHe) in small impedances

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The presence of Hydrogen (H_2) traces in LHe has disastrous consequences for some laboratory equipment such as evaporation cryostats, PPMS and MPMS. The working principle of those equipment to achieve temperatures below 4.2 K consists in pumping LHe through a capillary tube. If LHe contains H_2 traces, that capillary will get blocked after some time. In order to unblock it, it is needed to heat the equipment at room temperature (RT) with the loss of liquid He and time. With the aim to solve this problem, the University of Zaragoza in collaboration with Quantum Design company developed a method to produce H_2 free LHe [1].

In this work, we present a study to determine what is the minimum H_2 concentration in He gas that can generate blockages when the He gas is liquified. To carry out this proposal, we have developed an experimental setup to produce LHe contaminated with H_2 in a controller manner. This setup can be divided in two stages (see figure): the first one consists in mixing the He gas (at RT and pressure larger than atmospheric) with a known H_2 concentration to then be liquified (at 4.2 K and atmospheric pressure), whereas the second one consists in the detection of H_2 traces present in the liquified He-H_2 gas mixture by using a H_2 detector developed by us, whose effectiveness has been proved in other labs around the world.[2] This device consists of a flow microimpedance assembled to a stainless steel thin tube. The microimpedance is immersed in LHe while the other end of the tube is connected to a vacuum pump and a pressure sensor. If the tested LHe contains H_2 traces (with an enough concentration to produce blockages), the pressure reading will decrease (in a few minutes) to the baseline of the vacuum pump.

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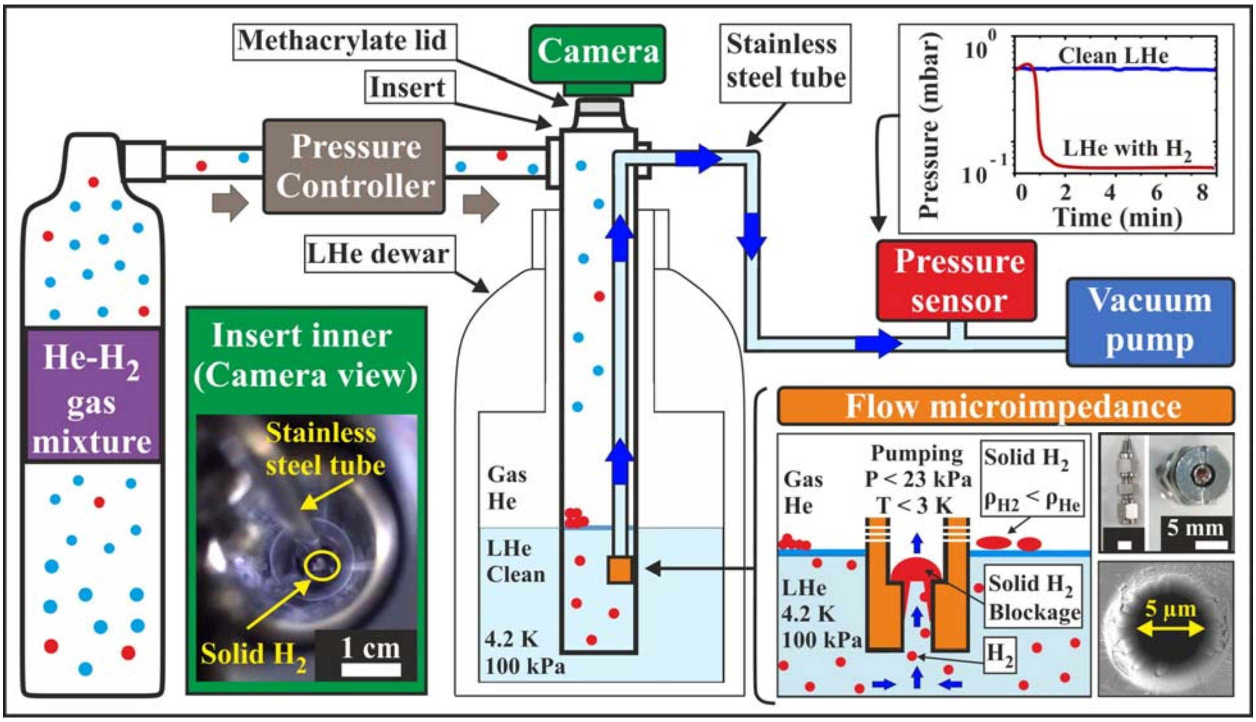

Methacrylate lid
Insert
Camera
Stainless steel tube
Pressure (mbar)
Clean LHe
LHe with H_2
Time (min)
Pressure Controller
He-H_2 gas mixture
LHe dewar
Insert inner (Camera view)
Stainless steel tube
Solid H_2
1 cm
Pressure sensor
Vacuum pump
Gas He
LHe Clean
4.2 K
100 kPa
Flow microimpedance
Gas He
Pumping
P < 23 kPa
T < 3 K
Solid H_2
$\rho_{H2} < \rho_{He}$
LHe
4.2 K
100 kPa
Solid H_2 Blockage
H_2
5 mm
5 µm

ID: 03933, 15/07/2019 18:00 - 15/07/2019 18:15, Room 1.3 (First floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Oral)

Room temperature magnetic refrigeration: design and construction of a test prototype

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The design of a magnetocaloric effect (MCE) refrigerator is a challenging multidisciplinary problem. This technology still has demanding technical, economic and geostrategic issues to be solved.
Simulating and prototyping MCE refrigeration devices has had a remarkable scientific output; however, a competitive working design has not yet been accomplished, and further work is still needed to test new designs and efficient magnetocaloric materials (MCM).
The most important challenges of this technology are unfolded and some proposed solutions presented. Also, the design and construction of a new prototype with modular, graded active magnetic regenerator (AMR) is presented. This machine uses different kinds of MCM in form of spherical particle beds and allows the use of shorter AMR stacks. It has been modelled to carry out simulations, using a modified version of the procedure described in [1]. The AMR consists of eight beds, with alternative activation in groups of four. The magnet rotates around the core and the AMR. The fluid flow sequence is controlled by means of software activated high speed solenoid valves.
The eight AMR beds work in parallel pairs connected in series with another pair for the return flow, with the cold spot in between. The cold spot is a metallic block with four circuits, which allows good thermal contact but no fluid mix among them.
The magnet design has been optimized in angular width and direction of each NdFeB sector's magnetization. Having the AMR filled with a typical MCM, the resulting average fields on each bed, when rotating over the 45° regions of maximum and minimum fields are $< B_{max}>=1.76$ T and $< B_{min}>=0.016$ T.

References

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ID: 04022, 15/07/2019 18:15 - 15/07/2019 18:30, Room 1.3 (First floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Oral)

Calorimetric set-up to measure the Specific Absorption Rate Coefficient (SAR) of Gold nanoparticles colloidal suspensions

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New materials emerging from nanotechnology offer potential solutions for drug delivery, bio-imaging, biosensors and therapies [1]. Optical hyperthermia uses metallic nanoparticles, like gold nanorods (GNRs), that dissipate heat under laser irradiation, increasing the temperature of the tumour, causing irreversible damage and finally killing the cancer cells. One of the key parameters for the optimization of this therapy is the Specific Absorption Rate (SAR), measured as W/mg_{Au} or W/m^3, which quantifies the heating capacity of the metallic nanoparticle system. This parameter depends on nanoparticle-intrinsic factors like composition, shape and size, and extrinsic factors such as coating, dispersive medium, concentration and laser irradiance (W/m^2). In order to design an optimal GNR for the therapy it is necessary to study the correlation between SAR and the mentioned parameters.

We have developed a calorimetric system based on a differential scanning calorimeter (DSC) to measure the SAR of GNRs colloidal suspension. The system uses a laser diode at a wavelength of 830 nm working in the 100-500 W/m^2 irradiance range. The sample is irradiated and the heat power dissipated by the sample is determined using DSC. In order to discern the sample contribution from the pan contribution, a thermal model is proposed taking into account the radiation losses by reflection and the heat power dissipated by the pan itself.

Using the set-up, we measured the SAR of three GNRs colloidal suspensions with similar aspect ratio of 4.3 and we compared them in terms of coating and agglomeration. Morphological and analytical techniques have been used to characterize the factors affecting SAR and to study the effects of coating and agglomeration on the SAR parameter.

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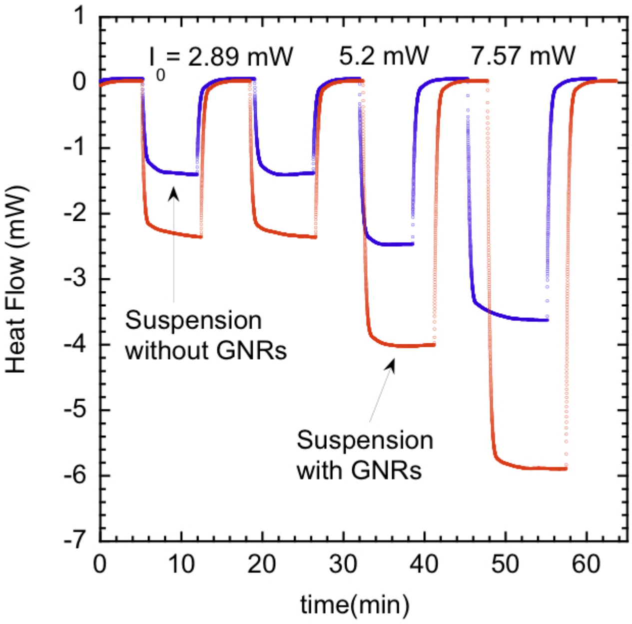

I_0 = 2.89 mW
5.2 mW
7.57 mW
Heat Flow (mW)
time(min)
Suspension without GNRs
Suspension with GNRs

ID: 03714, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Poster)

ANÁLISIS DE LA ESTABILIDAD DE MEZCLAS TERNARIAS DE NUTRICIÓN PARENTERAL CON MEDIDAS DE VISCOSIDAD REALIZADAS A DIFERENTES DÍAS TRAS SU ELABORACIÓN.

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La nutrición parenteral (NP) es una técnica de alimentación que permite aportar nutrientes directamente al torrente circulatorio. Son mezclas ternarias que tienen una composición compleja, aportando simultáneamente macronutrientes (aminoácidos, hidratos de carbono y lípidos) y micronutrientes (electrolitos, vitaminas y oligoelementos). Debido a su composición, resulta difícil predecir inequívocamente su estabilidad y seguridad, dados los numerosos procesos fisicoquímicos que pueden ocurrir. Un tipo de pacientes a los que va dirigida esta terapia son los recién nacidos prematuros, en los que el tracto gastrointestinal todavía es incapaz de manejar y absorber los nutrientes necesarios para su desarrollo.
En este trabajo se estudia la estabilidad de mezclas ternarias de NP con medidas de viscosidad.
Las muestras son preparadas por personal especializado bajo técnicas asépticas en cabinas de flujo laminar horizontal. Se calculan un total de 7 composiciones distintas diseñadas para cubrir los requerimientos de un recién nacido prematuro de 1 Kg durante la primera semana de vida. Las muestras son de 100ml y los nutrientes se aumentan en cada una.
Para la determinación de la viscosidad se usó un viscosímetro Anton Paar AMV 200. Para determinar la viscosidad dinámica, se calcula la densidad con un densímetro Anton Paar DMA4500.
Las medidas se realizan en el día +1 y día +7 tras la preparación y a 25ºC y 35ºC. Las muestras se almacenaron en nevera.
No se han encontrado diferencias significativas entre las medidas a día 1 y día 7 a 25ºC ($p = 0,910$) ni a 35ºC ($p = 0,247$).
Las muestras se mantienen estables durante el periodo de almacenamiento en base a las medidas de viscosidad.

ID: 04096, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Poster)

Thermal and thermomagnetic analysis of magnetic shape memory Heusler alloys

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Thermal and thermomagnetic analysis is usually applied to magnetocaloric materials. These materials are used as refrigerants in magnetocaloric refrigeration, which is an alternative to vapor compression based refrigeration. Heusler alloys have attracted much attention in the last decades owing to their useful properties as the magnetocaloric effect. Their advantages are related to the strongly coupled magnetic and structural degrees of freedom due to the first order martensitic transformation and the second order magnetic transformation [1].

In this work, differential scanning calorimetry is applied to determine parameters as: the transition and equilibrium temperatures, the specific heat, the enthalpy change, the elastic energy, the dissipated energy and the entropy change of the martensitic transition [2]. DSC scans of the reversible and hysteretic martensitic transformation is shown in the figure. Furthermore. from thermomagnetic measurements performed in a vibrating sample magnetometer. The shift of the martensitic transformation temperatures induced by the external magnetic field is given by the Clausius-Clapeyron equation. This equation is a relationship between the applied magnetic field and the magnetization and entropy changes induced in the material. Furthermore, the magnetocaloric effect is also linked to the magnetic properties of the materials via the thermodynamic Maxwell relationship. In particular, we apply these methods to some Ni-Mn-Sn and Ni-Mn-Sn Heusler alloys. A comparison with literature data is also performed [3].

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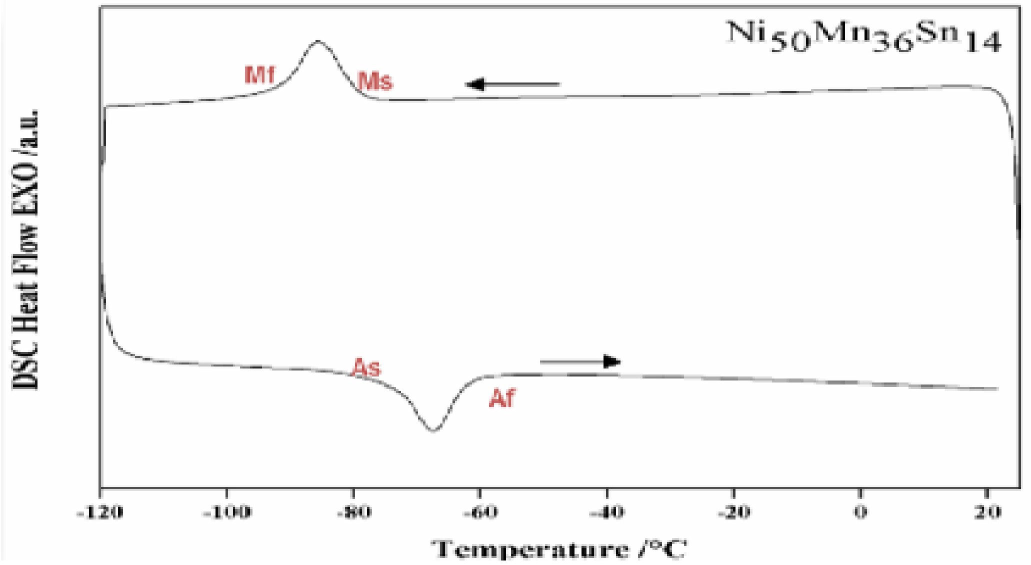

Ni50Mn36Sn14
Mf
Ms
As
Af
DSC Heat Flow EXO /a.u.
-120
-100
-80
-60
-40
-20
0
20
Temperature /°C

ID: 03726, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Poster)

ESTUDIO DE LA TENSION SUPERFICIAL DE SISTEMAS TERNARIOS DIALQUILCARBONATO (DIMETILCARBONATO Y DIETILCARBONATO) + *n*-DECANO + *p*-XILENO A LAS TEMPERATURAS DE 288.15, 298.15 y 308.15 K

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Continuando los estudios de mezclas ternarias de carbonatos + n-alcano + p-xileno [1-3], presentamos en este trabajo un estudio experimental de la tensión superficial de los sistemas ternarios dialquilcarbonato (dimetilcarbonato y dietilcarbonato) + *n*-decano + *p*-xileno. Todas las medidas se han realizado a presión atmosférica y a las temperaturas de 288.15, 298.15 y 308.15 K.
Los productos utilizados en este trabajo fueron suministrados por Fluka, (Pureza≥ 99%). Para la preparación de las mezclas se ha utilizado una balanza Mettler AE-240.
La tensión superficial se ha medido usando un tensiómetro automático Lauda TVT2 [3,4]. La densidad se midió utilizando un densímetro tubo vibrante Anton Paar DMA 4500 [5].
Los valores de tensión superficial para el sistema ternario de dimetilcarbonato + *n*-alcano + *p*-xileno disminuyen con el aumento de la temperatura. Además, para todas las temperaturas, la tensión superficial experimental aumenta ligeramente al aumentar los átomos de carbono del alcano.
Las tensiones superficiales de los sistemas estudiados son menores que las ideales, lo que supone desviaciones negativas del incremento en la tensión superficial.

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ID: 04016, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Poster)

On-chip nanocalorimetry

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2) Instituto de Nanociencia de Aragón (INA) y Universidad de Zaragoza

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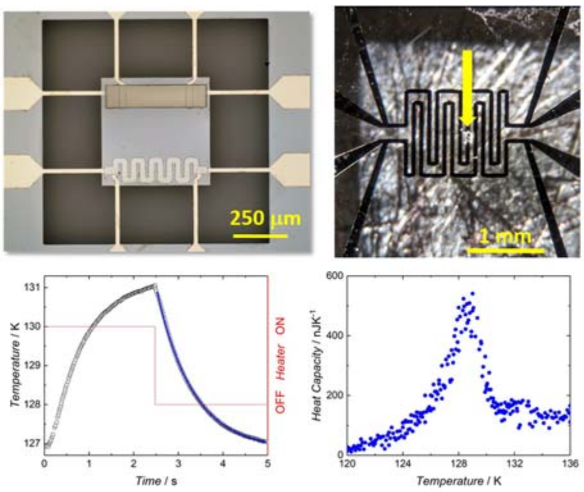
Calorimetry is a very powerful technique that gives a great deal of information on fundamental properties, providing direct and quantifiable insight into, e.g., densities of state and phase transitions. Many interesting materials are obtained in the form of sub-microgram single-crystals, thin films or even grafted monolayers. The contribution of these samples in the calorimetric output is reduced accordingly to their mass, being hence not sufficient for conventional calorimetry. The main limitation in sensitivity is the “addenda”, i.e., the inevitable background due to the heat capacity of each component of the calorimeter, which ideally has to be smaller than the sample heat capacity.

Using micromachining technology, we fabricate and develop different types of membrane-based nanocalorimeters. They can work in either modulation (AC) calorimetry or relaxation calorimetry, over a broad range of temperatures and applied magnetic fields, improving the sensitivity of standard commercial calorimeters by 4-5 orders of magnitudes. We employ our devices for challenging studies on magnetic systems, including spin-crossover compounds and molecules for applications in quantum information and magnetic refrigeration on a chip.



ID: 03902, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Poster)

Green Solvents and Renewable Resources: A Framework to Share Research and Social Inclusion

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Introduction

The SPAGYRIA Project (EU Project € 1.8M) arises from one of the line extension objectives set out in the TECHNOBIOCROP Project of MINECO (0.5 M €) for the use of fractions extracts of natural products obtained through sustainable technologies. Spagyria is also a project of cooperation, solidarity and innovation that aims to create a line of plant extracts for the production of ECO-cosmetics. The project involves seven partners including tutelary associations of groups at risk of social exclusion to help improve their employability. The aim is to capitalize on the experience and economic development of the partners on both sides of the Spanish-French border, both at the level of cultivation and conditioning of aromatic plants and at the level of sustainable extraction and evaluation of prepared products.

Results and discussion

At the moment, agronomic trials are being carried out in parallel in three different locations (Huesca, Pamplona and Toulouse) to determine the best growing conditions of eight aromatic and medicinal plants (Figure 1). The first studies of supercritical extraction and concentration of active principles using carbon dioxide as an anti-solvent agent indicate some species of sage, calendula and lemon balm as one of the most suitable for the preparation of ECO-cosmetic ingredients [1].

El proyecto ha sido cofinanciado al 65% por el Fondo Europeo de Desarrollo Regional (FEDER) a través del Programa Interreg V-A España-Francia-Andorra (POCTEFA 2014-2020). El objetivo del POCTEFA es reforzar la integración económica y social de la zona fronteriza España-Francia-Andorra. Su ayuda se concentra en el desarrollo de actividades económicas, sociales y medioambientales transfronterizas a través de estrategias conjuntas a favor del desarrollo territorial sostenible.

References

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ID: 03897, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Poster)

Excess isobaric heat capacity modelling of binary mixtures between some natural aromatic monoterpenes and ethanol or propan-1-ol

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GATHERS researching activity have been focused in the last years on supercritical extraction processes of natural compounds from vegetable material (herbal plants, among others) with carbon dioxide and short chained alcohols on the field of sustainable chemistry.

In this work we compare excess molar isobaric heat capacity, $C^{E}_{P,m}$, (obtained from the isobaric molar heat capacity, $C_{P,m}$, which has been experimentally determined [1]), with the corresponding calculated values obtained by means of the software COSMO-RS [2-3].

Both experimental and calculated $C^{E}_{P,m}$ values have been obtained at the four temperatures ranging from 298.15 – 328.15 K , every 10 K and in the whole composition range for the binary mixtures between a natural aromatic monoterpene (p-cymene, carvacrol or eugenol) and a short chained alcohol (ethanol or propan-1-ol). In general, acceptable predictions have been obtained and little differences have been found when changin from ethanol to propan-1-ol for a given monoterpene. In the following adjoint figure, both experimentally and calculated values of $C^{E}_{P,m}$, in the whole composition range and at the four working temperatures, are depicted for the binary mixtures between p-cymene (1) and ethanol or propan-1-ol (2) (on the left and on the right respectively).

Acknowledgements

The authors thank the financial support of MINECO-FEDER (Project CTQ2015-64049-C3-2-R) and also of Gobierno de Aragón-FSE-FEDER "Construyendo Europa desde Aragón" (Group E39_17R).

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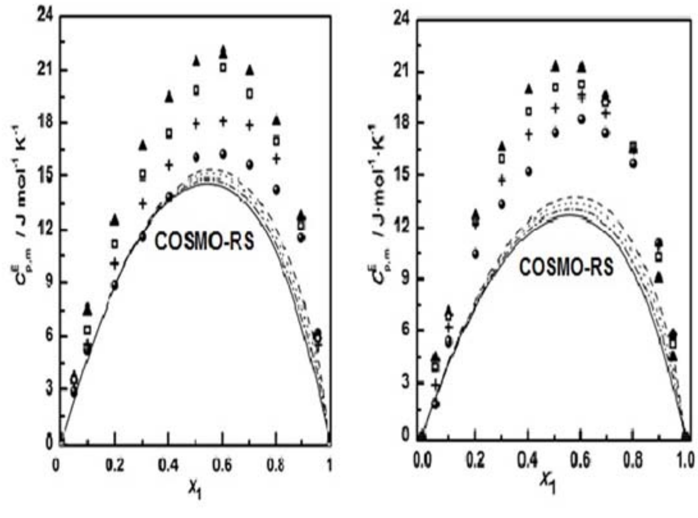
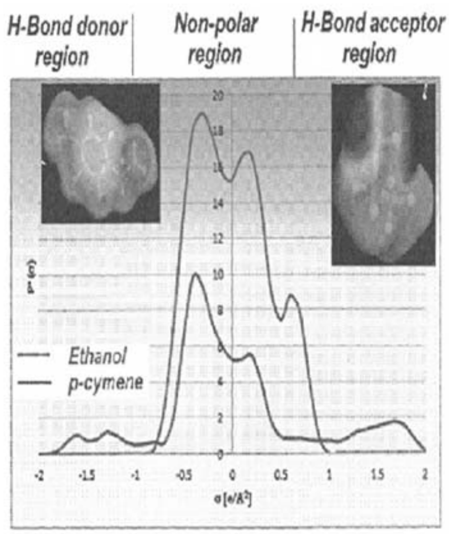

COSMO-RS
$C^E_{p,m}$ / J mol^{-1} K^{-1}
x_1
COSMO-RS
$C^E_{p,m}$ / J·mol^{-1}·K^{-1}
x_1


H-Bond donor region
Non-polar region
H-Bond acceptor region
Ethanol
p-cymene
σ [e/Å²]

ID: 03929, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Poster)

DIFFUSION OF Li^+ IN NOVEL ELECTROLYTES COMPOSED BY dMSO, Li-TFSI AND/OR MPPyrr-TFSI IN FUNCTION OF TEMPERATURE

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In this communication we present the electrical behavior of a new set of electrolytes formed by a lithium bis(trifluoromethyl sulfonyl)imide (Li-TFSI) salt, mixed with dimethyl sulfoxide (dMSO) and/or the ionic liquid (IL) 1-methyl-1-propyl pyrrolidinium TFSI (MPPyrr-TFSI), in different concentrations. These mixtures have a great potential as electrolyte due to the characteristics of the salt, IL and solvent used [1]. To perform the study, we have measured the ionic conductivity and the diffusion coefficient (using NMR-dosy technique) of Li^+ in three different binary mixtures of the IL with different dMSO concentrations (25, 50 and 75 wt%), all saturated with the Li-TFSI salt. The solubility of this salt is quite high, thus the salt concentration ranging from 1260 ppm of Li^+ cation in binary IL-salt mixtures, up to more than 5000 ppm in the ternary mixture with the highest concentration of dMSO. In addition, we have prepared binary mixtures without the IL but with different salt concentrations (from saturated to very diluted) looking for the maximum of conductivity. The main aim is to compare the mobility of the Li^+ cation in both environments (with and without IL).

The samples were characterized using FTIR spectroscopy to observe the possible formation of new bonds after the mixing process. Also, for all samples we have measured its ionic conductivity vs. temperature (ranging from 5 ºC up to 85 ºC). As it was expected, ionic conductivity of the ternary mixture increases with solvent concentration up to a maximum, and then decreases to be null for the pure dMSO. When the salt is added to pure dMSO, conductivity increases up to a maximum, as usual. Moreover, the measured diffusion coefficient of the Li^+ cation has a direct correlation with its ionic conductivity. Finally, all data will be analyzed with Bahe-Varela pseudo-lattice model [2].

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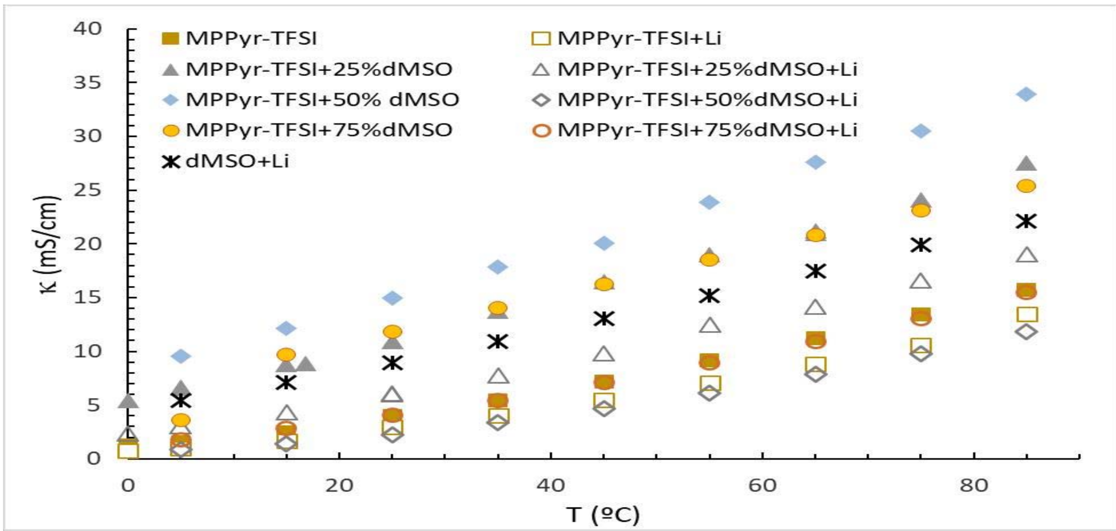

MPPyr-TFSI
MPPyr-TFSI+Li
MPPyr-TFSI+25%dMSO
MPPyr-TFSI+25%dMSO+Li
MPPyr-TFSI+50% dMSO
MPPyr-TFSI+50%dMSO+Li
MPPyr-TFSI+75%dMSO
MPPyr-TFSI+75%dMSO+Li
dMSO+Li
κ (mS/cm)
T (ºC)
0
5
10
15
20
25
30
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ID: 03888, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Poster)

Dielectric behaviour of mixtures 1,8-cineole (eucalyptol) + short chain alcohol at 298.15 K

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Introduction

1,8-Cineol is a natural compound of renewable origin, biodegradable and non-toxic. Their special chemical-physical properties allow its use as a solvent respectful of environment (T_b = 449.5 K and P_v (20 ºC) = 8.7 torr).

Among the many polar solvents, alcohols have traditionally been used because of their high polarity controlled by the association between their molecules.

When alcohol-1,8-cineole mixtures are formed, a balance between breaking and formation of hydrogen bonds produce an alteration of the polarity of the mixtures making possible their study through the dielectric behaviour while allowing to modulate their solvation power according to its composition and the length of the hydrocarbon chain in the alcohol.

In this work the dielectric permitivities have been measured at 298.15 K of four binary systems formed by 1,8-cineol + ethanol, or + 1-propanol, or + 2-propanol, or + 1-butanol in the entire range of composition. From the experimental data, the excess dielectric permitivities and the Kirkwood-Fröhlich correlation parameter [1], which is a measure of the local order in a polar liquid, have been calculated.

Experimental

The measurement of dielectric permittivity was performed with a WTW dipolmeter (model DM 01) that works according to the heterodyne beating method at a fixed frequency of 2 MHz.

Results

The figure shows the experimental excess dielectric permittivity and point out that the dielectric behaviour is controlled from the breaking of hydrogen bond in the alcohol and the dilution effect of the OH group when the length of the chain increases.

The variation of the Kirkwood-Fröhlich correlation factor, g, with the composition shows the process of destruction of the local order, present in the alcohols at the pure state, when molecules of alcohol are replaced by molecules of 1,8-cineol.

Authors thank the financial support to MINECO-FEDER CTQ2015-64049-C3-2-R

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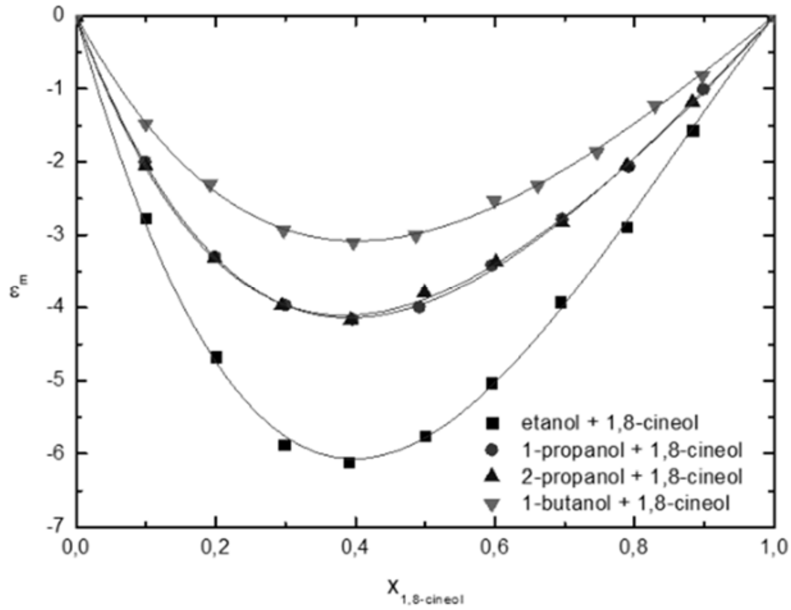

ID: 03730, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Poster)

Conductividad eléctrica del nanofluido CuO (12 nm) + agua a bajas concentraciones y distintas temperaturas

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En este trabajo se estudia la conductividad eléctrica, σ, del nanofluido de óxido de cobre, CuO (12nm), utilizando como fluido base agua. Se estudia el comportamiento con la concentración y la temperatura hasta un valor del 2% en volumen y a seis temperaturas entre 298,15K y 348,15K. En la preparación de las mezclas no se añadieron surfactantes para no enmascara el efecto de las nanopartículas y permitir estudiar estas mezclas desde el punto de vista fundamental. Para describir los valores experimentales se utilizaron algunas ecuaciones empíricas de la bibliografía. El estudio muestra la influencia de la fracción volúmica y la temperatura en el comportamiento de la conductividad eléctrica. La influencia de la naturaleza de las nanopartículas se muestra comparando los resultados experimentales obtenidos con los del sistema γ-alúmina (15nm) + agua que se caracterizó utilizando el mismo equipo experimental y los mismos métodos. Se determina la ratio de la conductividad eléctrica, σ/σ_W, respecto de la del fluido base, σ_W. Se encuentra que $\sigma/\sigma_W > 1$. Se argumenta porqué esos valores positivos son considerados mayores de lo que sería esperado. La aplicación del modelo de Hill a este sistema predice una cooperación positiva de la primera lámina de moléculas de agua que rodean las nanopartículas. Mediante un estudio teórico se separan las contribuciones a la conductividad eléctrica procedentes del agua y de las nanopartículas.

Agradecimientos

Los autores agradecen la ayuda ED431C 2016-034 de la Xunta de Galicia para realizar este trabajo. M.F.C. agradece al Instituto Superior de Engenharia do Porto la concesión del permiso de ausencia para llevar a cabo el trabajo experimental en la Universidad de Vigo.

ID: 03785, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)

S12. Thermodynamics and Thermal Analysis (GECAT-GET)

(Poster)

A Magnet for Caloric Applications: Design, Optimization, and Experimental Results

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Permanent magnets are being used as sources of high magnetic fields for caloric applications using the magnetocaloric effect.

The main handicap for a generalization of the magnetocaloric technology is the high cost of the magnets to obtain the necessary field for an efficient caloric effect. It is of paramount importance to use optimized fields and minimize the costly hard magnetic material. An optimized magnet has been design to be used in a rotary cooling prototype, presenting regions of high and uniform field and regions of almost zero field. Most of the magnetic circuit is soft Fe and the sectors of NdFeB have an optimized width and direction of magnetization.

The configuration starts with the two-pole magnet reported by Eriksen et al. [1]. Our magnet has been designed to have eight separated sectors of magnetocaloric material, each one covering 45º of the ring and working alternatively in groups of four, in which two of them are in a high field region and the other two in the low field region. The external ring of the magnet is meant to turn at a constant speed, creating a sweeping field through the magnetocaloric sectors. With the general geometry represented in the figure, the magnetic flux density B has been calculated for each point, taking constant values for the radii and for the magnetization modulus of the permanent magnet sectors. The finite element method has been used to determine $B(x,y)$. The six defining parameters of the angular width and magnetization direction of the magnetic sectors have been adjusted to maximize a functional defined for an optimum magnetocaloric cooling effect.

The experimental measurements on the constructed magnet agree very well with the shape of the calculated field, improving significantly the maximum value and the region of low field with respect to a standard sinusoidal shape.

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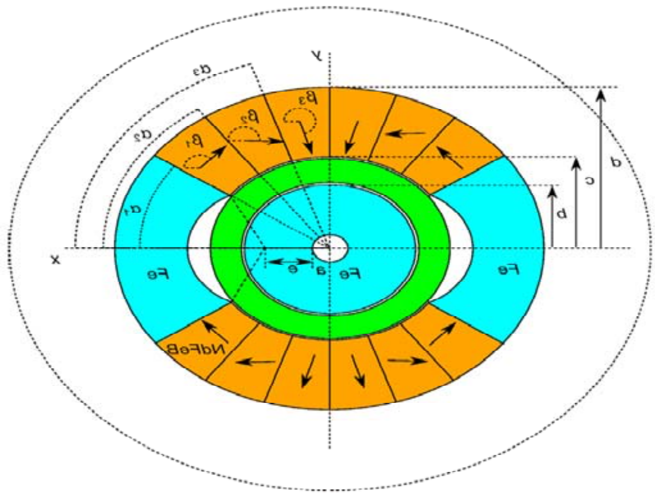

Figure 1. General configuration of the magnet, following the model of Eriksen et al. [1].

ID: 04129, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S12. Thermodynamics and Thermal Analysis (GECAT-GET)
(Poster)

Comportamiento dieléctrico de un compuesto ternario sinterizado, Resina-epoxi/$BaTiO_3$/Cu_2O, en la banda 0-6 GHz,

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En este trabajo, investigamos y modelamos el comportamiento dieléctrico de un compuesto ternario preparado a temperatura ambiente, con una mezcla de resina epoxi (RE), titanato de bario ($BaTiO_3$) y óxido de cobre (Cu_2O) a varias proporciones y posteriormente sinterizado a tres temperaturas diferentes (150 °C, 200 °C y 250 °C) con el fin de determinar el efecto de la temperatura de sinterizado sobre estos medios.

La caracterización experimental de las muestras, en el rango DC- 6GHz, se realiza por reflectometría en el dominio de tiempo (TDR) utilizando el protocolo de múltiples reflexiones. Los compuestos sinterizados muestran una buena estabilidad dieléctrica con respecto a la frecuencia y una fuerte dependencia con la concentración de $BaTiO_3$.

Un proceso de relajación dieléctrica tiene lugar a baja frecuencia atribuible principalmente a la resina. Para describir y predecir el comportamiento dieléctrico de estos medios materiales en función de la concentración de cada una de los diferentes componentes, así como con la temperatura de sinterizado se utiliza finalmente un modelo modificado de Lichtenecker.

(Este trabajo ha sido financiado parcialmente por DGA-FSE)

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S13. Energía y Sostenibilidad (GEE)

El simposio cubrirá temas relacionados con la Transición Energética 2030 en España, energías renovables (solar, eólica, biomasa, etc.), energías tradicionales (nuclear, carbón, gas, hidroeléctrica, etc.), eficiencia energética en generación eléctrica, transporte, edificación, etc, almacenamiento energético (hidroeléctrico, baterías, hidrógeno, P2G, etc.), emisiones de CO_2 y escenarios para su disminución (2020-2050). También incluirá una mesa redonda sobre "La Transición Energética 2030 en España".

Organizadores:
José M. Martínez-Duart, *Universidad Autónoma de Madrid*
Silvia Serrano

S13. Energy and Sustainability (GEE)

The symposium will cover topics related with the 2030 Energy Transition in Spain, renewable energies (solar, wind, biomass, etc.), traditional energies (nuclear, coal, gas, hydroelectric, etc.), energy efficiency in the power sector, transport, buildings, etc, energy storage (hydroelectric, batteries, hydrogen, P2G, etc.), CO_2 emissions and reduction scenarios (2020-2050). It will also include a round table focused on the "2030 Energy Transition in Spain".

Organizers:

José M. Martínez-Duart, *Universidad Autónoma de Madrid*
Silvia Serrano

ID: 03789, 16/07/2019 15:00 - 16/07/2019 15:40, Conference Hall (floor -1)
S13. Energy and Sustainability (GEE)
(Invited Symposio)

Estudio teórico de materiales fotovoltaicos avanzados basados en Perovskitas

Pablo Palacios[1] , Gregorio García[2] , Pablo Sanchez-Palencia[2] , Jesus Eduardo Castellanos[3] , Ana Lilian Montero Alejo[4] , Eduardo Menendez-Proupin[5] , Jose Carlos Conesa[6] , Perla Wahnon[2]

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En este trabajo se presenta el estudio teórico de materiales basados en perovskitas que se proponen como capa absorbente para su uso en aplicaciones fotovoltaicas. Las perovskitas son uno de los materiales que hoy día se consideran que pueden revolucionar el mundo fotovoltaico abaratando los paneles mientras se conserva la eficiencia de las células actuales. La modificación de estos materiales mediante hiperdopaje que se realiza en nuestra propuesta contribuiría al aumento de la eficiencia a través de un bombeo en dos etapas utilizándose fotones de energía mas baja que la banda prohibida del semiconductor de partida utilizado para crear el material. Además, se tendrá el bombeo ordinario de electrones de la banda de valencia a la banda de conducción con un fotón de mayor energía. Hemos verificado en años anteriores a partir de cálculos utilizando la teoría del funcional de la densidad (DFT) y métodos mas avanzados como el HSE y GW que materiales semiconductores tipo calcopirita, espinela o en estructura laminar pueden generar esta situación cuando un catión en su estructura se sustituye parcialmente por un metal de transición seleccionado adecuadamente. Además del estudio del material absorbente, se incluyen en nuestros estudios, el fin de aumentar nuestro conocimiento del posible dispositivo fotovoltaico a crear, cálculos sobre la formación de heteroestructuras entre la perovskita de partida y materiales inorganicos transportadores de huecos. El objetivo final es conocer a nivel atómico la naturaleza de la heterounión y el posible alineamiento de bandas entre los materiales.

ID: 03816, 16/07/2019 15:40 - 16/07/2019 16:00, Conference Hall (floor -1)
S13. Energy and Sustainability (GEE)
(Oral)

Tribochemical stability of pyrite films

Esmeralda Muñoz-Cortés[1] , Elisa Roman[2] , Yves Huttel[2] , Carlos Sánchez[1] , Isabel J. Ferrer[1] , José Ramón Ares[1] , Roman Nevshupa[3]

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Metal sulfides are very attractive compounds to be used in numerous energy related-fields (thermoelectricity, photovoltaic, photocatalysis). In particular, iron sulfide (FeS_2) is an abundant and not expensive raw material. From the catalytic point of view, pyrite plays an important role in H_2 production, N_2 and CO_2 reduction and coal waste treatment [1]. However, many of those reactions are thermally activated and they require high temperatures to be effective. In this context, using mechanical energy, e.g. frictional, for activation of chemical reactions could open a new perspective [2]. Nevertheless, tribochemical process in pyrite has been hardly explored so far. This work is aimed at understanding of tribochemical reactions for synthetic pyrite thin films prepared by direct sulfuration of iron deposited on glass substrates. Micro-mechanical deformation was applied on FeS_2 in the subNewton force range. The gases released were analyzed using a quadrupole mass-spectrometer coupled to a dynamic expansion system in order to investigate Mechanical Stimulated Gas Emission (MSGE-MS), which arises from mechanochemical reactions occurring in a buried interface. CO_2 emission was dominating among numerous emitted species such as CO, CS_2 and COS, which were not observed under thermal degradation at high temperatures (>500ºC) (Fig. 1a). These measurements were complemented by *ex situ:* surface (X-ray photoelectron spectrometry (XPS), Electron Stimulated Desorption (ESD)) and bulk characterization techniques (infrared m-reflectance, m-Raman spectrometry, electronic-microscopy (SEM) (see Fig 1b), indentation, TGA-MS, etc.). The atoms, molecules and groups on the topmost adsorbed layer on a pristine surface were identified using ESD and included sulfur, its oxides as well as hydrocarbons (CH_3, CH_2H_3, etc.), which might be originated from the airborne contamination. It was suggested that mechanical deformation and shearing led to chemical reaction between the carbonaceous and sulphurous compounds yielding unusual reaction products. These findings revealed the important role of even traces of carbon in tribochemical processes of pyrite.

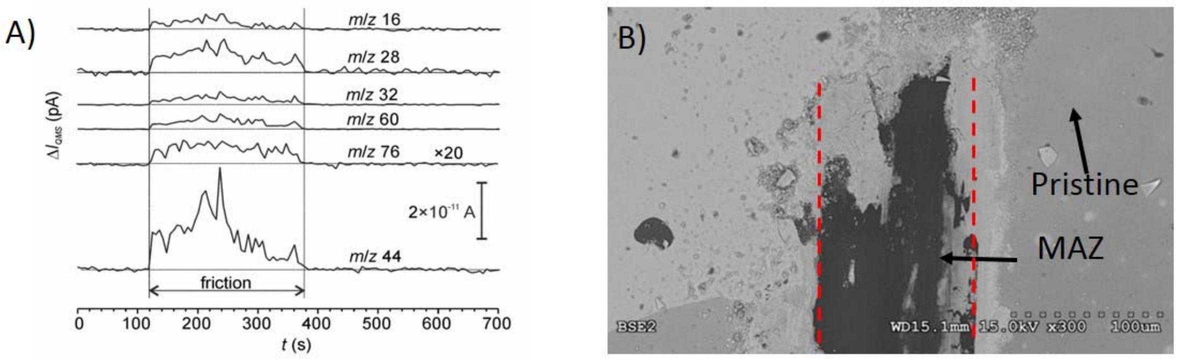

Figure 1 A. representative set of mass-spectrometer time series during tribological activation of FeS_2 thin film.
B. SEM image of the sample surface with the mechanically affected zone (MAZ) marked by dashed lines.

ID: 03742, 16/07/2019 16:00 - 16/07/2019 16:20, Conference Hall (floor -1)
S13. Energy and Sustainability (GEE)
(Oral)

Towards more efficient central tower gas turbine thermosolar plants

Rosa Pilar Merchán Corral[1] , María Jesús Santos Sánchez[1] , Alejandro Medina Domínguez[1] , Irene Heras Pérez[1] , Julián González Ayala[1] , Antonio Calvo Hernández[1]

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In this work a comprehensive physical model for a thermosolar gas turbine power plant is presented as a search for better overall efficiency and so, competitive prices for the generated electricity. In these plants a heliostat field collects solar power that is concentrated in a solar receiver located atop a central tower. Model for the solar subsystem incorporates receiver dimensions, heliostat field geometry and reflectivity, and losses associated to the cosine factor, blocking, shadowing, spillage, and atmospheric attenuation. The primary combustion chamber ensures that by night or during low solar irradiation periods the plant power output remains constant. This means that the produced electricity is predictable and independent of irradiation fluctuations (avoiding storage systems). The gas turbine develops a Brayton like-cycle. Pressure losses, non-isentropic compressors and turbines, and irreversibilities in heat absorption and heat release processes are accounted. The model is capable to predict overall plant efficiency and other records not only at fixed on-design conditions, but also at real changing solar irradiance. Moreover, the number of compressors and turbines can be varied, the role of recuperation explored and different working fluids analyzed [1]. Numerical results are presented for a plant with the dimensions of GEMASOLAR (Seville, Spain), a commercial Rankine cycle central tower plant of about 20 MW with molten salts storage. Expected efficiencies at optimum pressure ratios can reach values about 0.19 for air, nitrogen and CO_2 and about 0.34 for helium which are promising values. Fuel consumption results and Sankey diagrams showing the main energy flows and losses are also presented.

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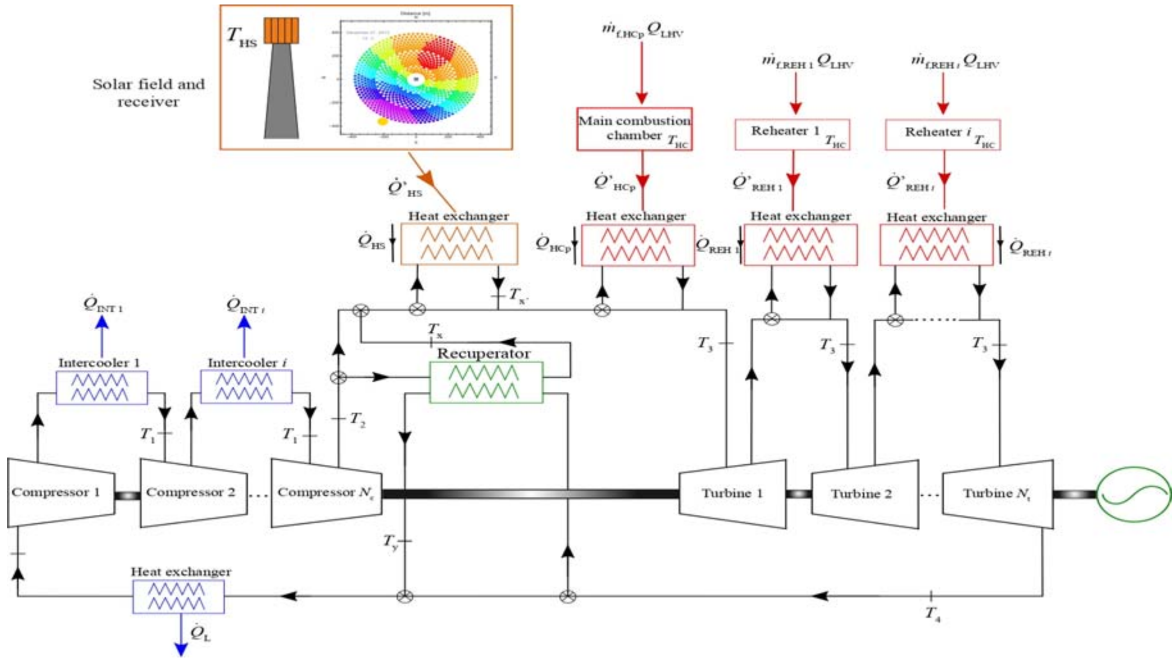

Solar field and receiver
T_{HS}
$\dot{m}_{f,HCp}\,Q_{LHV}$
$\dot{m}_{f,REH\,1}\,Q_{LHV}$
$\dot{m}_{f,REH\,i}\,Q_{LHV}$
Main combustion chamber T_{HC}
Reheater 1 T_{HC}
Reheater i T_{HC}
$\dot{Q}'_{HS}$
$\dot{Q}'_{HCp}$
$\dot{Q}'_{REH\,1}$
$\dot{Q}'_{REH\,i}$
Heat exchanger
$\dot{Q}_{HS}$
$\dot{Q}_{HCp}$
$\dot{Q}_{REH\,1}$
$\dot{Q}_{REH\,i}$
$T_{x'}$
T_x
$\dot{Q}_{INT\,1}$
$\dot{Q}_{INT\,i}$
Intercooler 1
Intercooler i
Recuperator
T_1
T_2
T_3
T_4
T_y
Compressor 1
Compressor 2
Compressor N_c
Turbine 1
Turbine 2
Turbine N_t
$\dot{Q}_L$

ID: 03770, 16/07/2019 17:30 - 16/07/2019 17:50, Conference Hall (floor -1)
S13. Energy and Sustainability (GEE)
(Oral)

Simulation of an Hybrid Thermoelectric-Magnetocaloric Refrigerator

Jesús Francisco Beltrán López[1] , Elías Palacios Latasa[1] , Ramón Burriel Lahoz[2]

1) Universidad de Zaragoza
2) Instituto de Ciencia de Materiales de Aragón. XCSIC-Univ. Zaragoza

** Elías Palacios Latasa, elias@unizar.es*

The new trends in efficient refrigeration are dominated by systems based on two "irreconcilable" physical procedures, the Peltier effect and the magnetocaloric (MC) effect. Both have pros and cons. Thermoelectric systems are simple, they do not use fluids or mobile parts, but at the current stageof development they have low thermodynamic efficiency [1]. MC systems [2] are very efficient, with a coefficient of performance (COP) near the theoretical Carnot limit, but they also have drawbacks.

First, the temperature span is very limited, imposing regenerative systems working in battery. Moreover, the heat transmission to or from the cold and hot sources, and between different parts of the regenerator is an additional problem. We show here a combination of both procedures, working in four stages (Figure). (1), a MC material heats up near the hot sink temperature Th when magnetized. (2), a Peltier cell is activated transferring heat to the hot sink. (3) the MC is demagnetized, cooling down near the temperature of a cold source Tc. (4) a second Peltier is then activated transferring heat from the cold source to the MC material. The MC acts as a thermal "elevator" while the Peltier cells work with small temperature gradients, when they are efficient. A numerical simulation has been made of a system formed by two standard Peltier cells and a typical MC material (gadolinium). In steady operation the temperature profile T(x) adopts a descending ramp (oppositely to the usual pure MC systems with fluid regeneration) allowing the heat to move towards the hot sink. The results show a much higher efficiency than in the case of two Peltier cells working alone.

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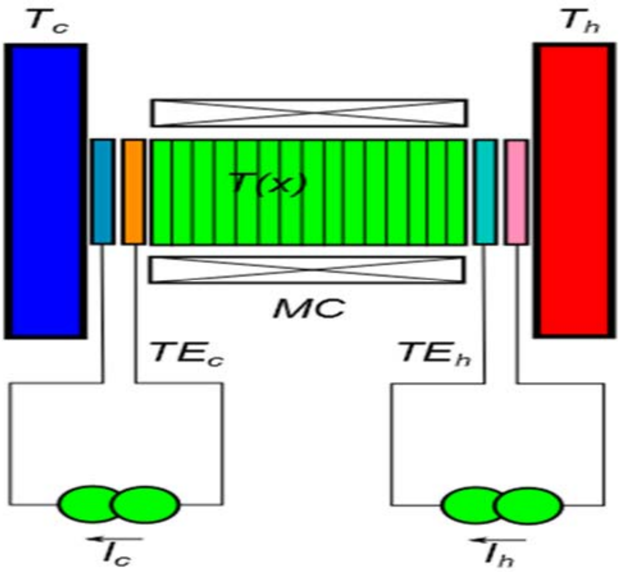

T_c
T_h
$T(x)$
MC
TE_c
TE_h
I_c
I_h

ID: 04055, 16/07/2019 17:50 - 16/07/2019 18:10, Conference Hall (floor -1)
S13. Energy and Sustainability (GEE)
(Oral)

Quantification of the energy footprint of bottom-up energy transitions by using the Global Multiregional Input-Output methodology

Estitxu Villamor[1] , Ortzi Akizu-Gardoki[1] , Juudit Ottelin[2] , Gorka Bueno[1] , Jukka Heinonen[3] , Jose Manuel Lopez-Guede[1]

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The relevance of decentralized bottom-up energy transitions, as complementary to the top-down state-based initiatives, has been previously studied. This is the case of different self-sustained communities in Germany [1] or the Renewable Energy Cooperatives in Spain [2]. In the present communication we study the energy transition of the self-sustained neighborhood of Errekaleor (in the city of Vitoria-Gasteiz, Basque Country), as well as its contribution to the Spanish and Basque scenarios. More specifically, in addition to the direct energy consumption, we account for the energy footprint on a local scale by measuring the hidden energy flows of this community, embodied in goods and services that are being consumed from both the national and international energy trade exchanges.

The global multi regional input-output (GMRIO) methodology has been previously used in order to quantify the energy footprint on a national scale, by using the “EORA 26” economic data base [3] and the total primary energy supply (TPES) data from the International Energy Agency [4]. Thus, it is nowadays possible to identify the embodied energy of whole countries when creating top-down national energy transition strategies.

In bottom-up initiatives, however, the dependence with national welfare and productive systems is difficult to estimate, and has not been normally measured. This research provides a way to compare both local and national realities using the GMRIO methodology together with regional economic data.

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ID: 03794, 18/07/2019 15:00 - 18/07/2019 15:20, Conference Hall (floor -1)
S13. Energy and Sustainability (GEE)
(Oral)

Nuevos materiales fotovoltaicos de alta eficiencia: La importancia de absorber fotones por debajo del gap.

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La modificación de la composición química del material absorbente de una célula solar puede usarse para producir cambios en su estructura electrónica que conduzcan a una mejora de su eficiencia fotovoltaica. Concretamente, se ha demostrado que la sustitución catiónica con metales de transición adecuados puede conducir a la introducción de nuevos estados electrónicos dentro de la anchura de la banda prohibida de algunos de estos materiales, lo que permitiría la absorción adicional de fotones con una energía menor que la marcada por el gap. En esa línea, se presentan en este trabajo una serie de nuevos materiales con un potencial significativo para su uso como materiales absorbentes fotovoltaicos. Se parte así de materiales semiconductores con un gap en torno a 2 eV, óptimo para maximizar la eficiencia, para los cuáles se estudia de manera teórica, por medio de cálculos cuánticos basados en la Teoría del Funcional de la Densidad (DFT), los cambios producidos en la estructura electrónica tras el hiperdopaje o sustitución del catión por el metal de transición. Se presentan de tal modo materiales basados en compuestos con largo recorrido dentro de la industria, como el disulfuro de estaño (SnS_2) o el fosfuro de indio (InP), así como otros completamente novedosos basados en estructuras cristalinas más complejas, como soluciones sólidas de Ge, N y Sn con estructura de espinela. Teniendo en cuenta que los cálculos DFT suelen conducir a una subestimación en la determinación del gap, tras un primer estudio básico de selección de los sustituyentes más adecuados para cada material, se han realizado estudios mas precisos para los materiales más prometedores. Para ello, se han llevado a cabo cálculos de quasiparticula, en la aproximación GW, que nos permiten conocer en mayor grado de detalle las propiedades electrónicas del material.

ID: 03691, 18/07/2019 15:40 - 18/07/2019 16:00, Conference Hall (floor -1)
S13. Energy and Sustainability (GEE)
(Oral)

El Tabaco como Cultivo Energético

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La producción media anual de tabaco es de 31 400 t a lo largo de unas 10 000 ha de terreno. Las restricciones al cultivo del tabaco apoyadas por la Política Agraria Común (PAC) hace necesario que se busquen alternativas al uso tradicional del mismo.
En este trabajo se propone el uso de esta planta como cultivo energético con el fin de obtener biogás mediante la Digestión Anaerobia (DA) de una mezcla del 15%de tabaco fresco y un 85% de agua. Bajo condiciones controladas en el laboratorio, se obtiene una producción de 53,84 Nm^3 de CH_4 / t de tabaco fresco, tras un Tiempo de Retención Hidráulica (TRH) = 16 días [1] [2]. Ello nos da una producción aproximada de unos 7.300 Nm^3 de CH_4 / ha de cultivo. Si tenemos en cuenta el poder calorífico del metano, obtendríamos una energía térmica anual de 73 MWh / ha. Asumiendo que este metano es inyectado a la red de gas natural al precio de 50 € / MWh, obtendríamos unos **beneficios anuales de 3.650 € / ha de cultivo.** Hay que indicar que el cultivo del tabaco es estacional, por lo que sería necesario contar con otro cultivo energético que se desarrollase en la estación de Otoño-Invierno. Un posible candidato sería el brócoli.

Los autores agradecen a la Junta de Extremadura y Fondos FEDER la ayuda recibida a través del Proyecto GR18081, así como a la Unión Europea (Programa INTERREG) a través del Proyecto 0330_IDERCEXA_4_E.

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Distributed energy: the challenge of solar parabolic dishes

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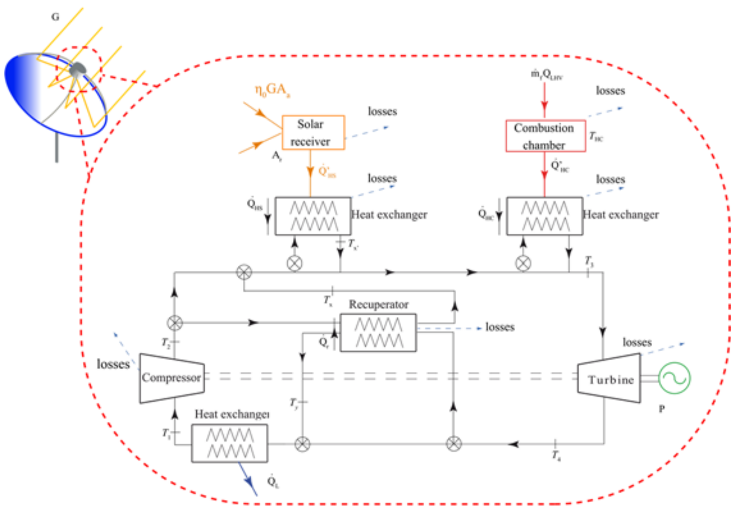
This work is focused on the possibilities of clean and renewable electricity generation in a distributed way, where the electric network is not accessible. A thermodynamic model for a Brayton-like micro-turbine in combination with a solar parabolic dish in order to evaluate its efficiency under any ambient condition is developed. The thermodynamic cycle is a recuperative Brayton cycle with internal irreversibilities in the recuperator, compressor and turbine and external losses associated to the heat transfers in the solar receiver, the combustion chamber, and the environment. All the losses sources have been taken into account in the model. Home-software implemented in *Mathematica* [1,2] was developed for numerical simulation.

Model validation is done by comparing with results provided by Semprini *et al.* [3]. An analysis of hybrid and sunless performance is carried out for different micro-turbine power outlets (7 to 30 kWe) and for a representative day of each month of the year for three different locations in Spain, namely Salamanca, Santander and Sevilla. The greenhouse emissions are also calculated for off-design conditions and for different power output levels. This study also presents a thermo-economic model for these hybridized power plants in different regions of Spain, considering the climatic conditions and resources of each location.



ID: 03682, 18/07/2019 17:30 - 18/07/2019 17:50, Conference Hall (floor -1)
S13. Energy and Sustainability (GEE)
(Oral)

Critical Assessment of the 2030 Power Sector Transition in Spain

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The main objective of this paper is the study of the evolution of the power sector in Spain taking into account the United Nations Paris 2015 Paris Agreement on Climate Change and the further European Union Directives. In particular, we have studied the substitution by renewable energies of all coal plants before 2030. For this study we have applied linear programming optimization techniques to make optimal the large deployment of the extra needed wind and solar resources. If, in addition to the substitution of coal plants, we add the expected increase in demand for the period 2019-2030, we found that the present park of renewables should be increased by a factor of about 115 %. We have also statistically analyzed the amounts of surpluses and shortages in energy assuming that the demand curve would have a daily shape similar to the present one. As a result, we have found that an additional storage capabilities of around 6 GW and 55 GWh would be needed, in order not to waste more than 25% surplus energy by curtailment. As for backup, we propose in a first step to use the overwhelming amount of gas combined cycle units which are available.

ID: 03744, 18/07/2019 17:50 - 18/07/2019 18:10, Conference Hall (floor -1)
S13. Energy and Sustainability (GEE)
(Oral)

An study of the driving forces of CO2 emissions in the member states of the European Union (EU-28)}

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This work analyzes the evolution of CO$_2$ emissions in the European Union during the period 1995-2015, using an extension of the Kaya identity and the Logarithmic-mean Divisia index (LMDI). To such end, it is used the extension of the Kaya identity

This analysis has been carried out using the LMDI methodology in an additive and multiplicative way as a function of the time, using as reference the initial year of the studied period. The driving forces that conform the CO2 emissions in this model are population, gross domestic product (GDP) per capita, energy intensity and matrix energy. The results obtained for the 28 member states are quite diverse and do not show a common trend, however, there are certain common features, namely, the main factor inducing the increase of CO2 emissions is the increase of the GDP per-capita, however, the energy intensity is the main force that leads to a reduction of CO2 emissions, even more intensively that the contribution of renewable energies through the change of the matrix energy. Finally, this analysis shows that the tendency in the latest years of the period shows steadily decreasing, maybe owing to the more stringent EU policy due to the CO2 emission target fixed its National Determined Contribution.

ID: 03775, 18/07/2019 18:10 - 18/07/2019 18:30, Conference Hall (floor -1)
S13. Energy and Sustainability (GEE)
(Oral)

Amperia: Virtual Power Plant for Dynamic Optimal Aggregation of Energy Storage

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The project proposes the development of Amperia, an integrated Virtual Power Plant (VPP) through the aggregation of distributed smart Battery Energy Storage Systems (BESS) coupled with solar photovoltaics at residential level. The proposal considers the multiple services that BESS can provide to the end user individually and to the grid in an aggregated way, coupling the current intelligent system that performs peak shaving, smart charge and discharge with time of use electricity tariffs with self-consumption optimization, with automatic voltage and frequency regulation, and an orchestrated operation for offering services to the grid. These services allow a revenue stacking for the use of BESS and extra incomes for the prosumers. The economic benefit for the user is maximized, without affecting the base case of self-consumption functionality they were devised for. The possibility is also envisaged for users to perform peer-to-peer energy transfers, by the development of appropriate mechanisms, to directly trade among them the surpluses of battery capacity.

Technologies incorporated in the project consider the ageing modeling of the energy storage system, optimization for the dynamic management of the elasticity of distributed energy storage units, energy consumption forecasting models, communication standards for VPP's in the Smart Grids environment, VPP management systems and Blockchain technology.

The development is being done by Ampere Energy with the help of three research centers: the Universitat Jaume I of Castelló (UJI), the Universitat Politècnica de València (UPV) and the Instituto Tecnológico de la Energía (ITE).

The Amperia project is co-financed by the Center for Industrial Technological Development (CDTI) and the European Regional Development Funds (ERDF).

ID: 03734, 17/07/2019 15:00 - 17/07/2019 17:30, Hall (ground floor)
S13. Energy and Sustainability (GEE)
(Poster)

Wind Energy Modelling Using ERA5 Wind Reanalysis

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We analyze wind and Aeolian power data obtained from observation in wind farm Morocco Abdelkhalek Torres hourly in 2016. Location coordinates are: Latitude= 35.8184 N, Longitude= -5.4538 W. Wind observation are compared whit wind data from ERA5 reanalysis for that region. The data covers the Earth on a grid of 30 km (41*41). Agreement between observation and reanalysis wind data is tested comparing their characteristic probability distribution (pdf), cumulative distribution (cdf) and lagged covariance functions. Agreement is better in the case of the 10 m Uwind and in any case is very seasonally dependent. The 10m Vwind seems to be less successfully simulated. Further results on time series analysis will be presented.

Keywords: ERA5;Wind Power Modelling:Observaton Data Analysis; Uwind; Vwind.

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ID: 03648, 17/07/2019 15:00 - 17/07/2019 17:30, Hall (ground floor)
S13. Energy and Sustainability (GEE)
(Poster)

Transparent and p-type conductive thin films for energy conversion devices

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Transparent conductive oxides (TCOs) in thin films are used in a variety of energy conversion devices ranging from light emitting diodes to smart windows and photovoltaic cells [1-2]. For these applications metal oxides with n-type conductivity are commonly used, but the development of efficient p-type TCOs remains a challenge, because the localized nature of the O 2p derived valence band leads to difficulty in achieving shallow acceptors and small hole effective masses [3].

Metals with d orbitals close to the O 2p can be used to favor the formation of hybridized orbitals that raise the valence band maximum level and facilitate p-doping. In this sense, Cu_2O and NiO are good candidates because the $3d^{10}$ configuration of Cu^+ and the $3d^8$ of Ni^{2+}. Moreover, in SnO the $4d^{10}5s^2$ configuration of Sn^{2+} allows hybridization of the cation s states with the O 2p orbitals, leading to a greater dispersion of the valence band. Other anions like S^{2-} can also modify the valence band so that the holes effective mass decreases.

Evaporation and sputtering systems in our lab were adjusted to obtain Cu_2O, NiO and SnO thin films with p-type conductivity, minimizing the formation temperature. Copper sulfide and oxysulfide were also obtained. In order to compare the various samples, the Haacke\'s figure of merit is employed, which takes into account the optical transmittance at λ=550 nm as well as the electrical conductivity. For each material, values were first calculated from the data measured on films with about 100 nm thickness and then extrapolated for a wider range, as illustrated in Fig. 1.

Acknowledgments: This work has been supported by MINECO through the MAT2015-66649-R project.

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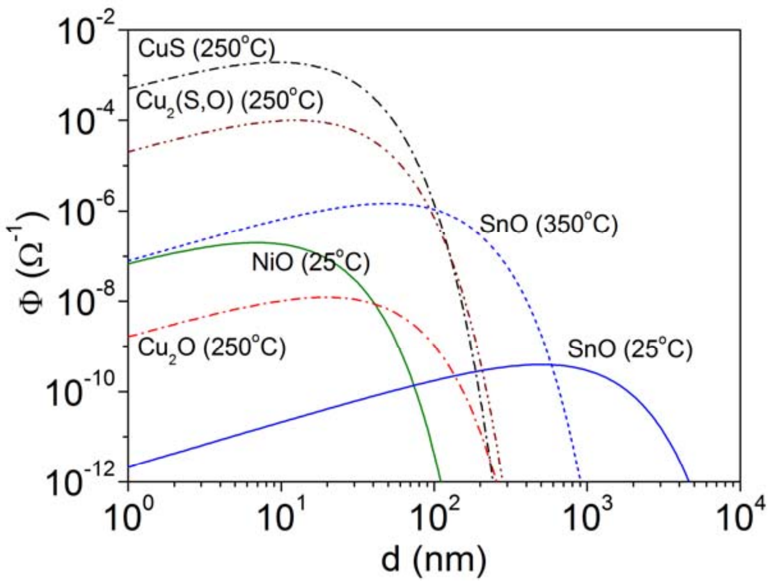

Fig. 1. The Haacke\'s figure of merit as a function of the film thickness for various p-type semiconductors grown at different temperatures.

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S13. Energy and Sustainability (GEE)
(Poster)

Study of the electronic structure of Li_xCoO_2 near the metal-insulator transition by angle-resolved photoemission spectroscopy

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Li_xCoO_2 (LCO) and related intercalation oxides are extensively used in Li-ion batteries as cathode materials and in the future for neuromorphic computing [1, 2]. Most of their relevant properties are related to compositional changes to LixCoO2. Li removal creates a variety of structural and electronic phase transitions in the material, and notably a metal-insulator phase transition (MI-PT) at x=0.95, which has been interpreted as being either of Mott or of Anderson type [3].

Epitaxial thin films of LCO of high structural quality were grown on Nb-doped $SrTiO_3$(111) by pulsed laser deposition. The Li contents was tuned following an in-situ delithiation process in UHV conditions. Angle-resolved photoemission spectroscopy (ARPES), X-ray Photoemission Spectroscopy (XPS) and X-Ray Absorption Spectroscopy (XAS) were performed for different Li compositions using synchrotron radiation. The results were complemented with Resonant Photoemission studies at the Co L absorption edge.

We find that the metallization is due to an overall shift of the valence band main peak towards the Fermi level, accompanied by an increase of the density of states at the Fermi energy. The metallization induces a change of the band topology near normal emission. Resonant Photoemission as a function of Li content in the Co L-edge shows a rich behavior in the valence band structure and highlights the changes in the band curvature. Changes in the spectral function shed light on the nature of the phase transition, which is also probed from simultaneous XAS spectra, sensitive to Co unoccupied electronic states. The results are interpreted based on the different theoretical descriptions of the phase transition and are used to understand the origin of the metallic state.

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ID: 03739, 17/07/2019 15:00 - 17/07/2019 17:30, Hall (ground floor)
S13. Energy and Sustainability (GEE)
(Poster)

Stabilizing wind power supply: seasonal evaluation of useful spatial patterns in the variability of winds over the Iberian peninsula

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Wind power is progressively gaining relevance worldwide in covering the electric energy demand. It now supplies around 4.4 % of the global energy consumption, and is expected to account for up to 5% by 2020. In Europe, the most optimistic projections raise the fraction of eolian-generated electricity to nearly 30% in the next decades. Spain has a leading role in the exploitation of this resource, being in 2013 the first country where wind power was the main contributor to electric energy generation, with 20.9% of the total production. Its advantages notwithstanding, wind power suffers from a pronounced intermittency that poses a challenge to its inclusion in the energy networks, either because of the difficulty in assimilating sudden ramps in production, or because of relatively prolonged lapses of low generation, that request the deployment of substituting resources, leading to additional costs and reducing efficiency. The mitigation of this intermittency has been addressed in a diversity of ways, one of them relying on the particular features of climate variarions over the areas of interest. It has been found that the spatio-temporal structures peculiar to wind variability over a given domain can significantly contribute to stabilize the supply. The potential of this spatial aggregation effect has been investigated in several countries, including Spain. An alternative technique is employed in this study, based on the use of the Empirical Orthogonal Teleconnections method, which offers some advantages, partly due to the relaxation of the orthogonality constraints implicit in other procedures. This methodology is applied to 3-hourly winds over the Iberian península simulated with the regional model REMO at 11-km horizontal resolution, for years 2001 to 2012. Spatial structures with a potential for increasing the regularity in the wind power supply are identified, with a focus on their seasonal dependence.

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S13. Energy and Sustainability (GEE)
(Poster)

SISTEMAS MULTIFERROICOS OBTENIDOS MEDIANTE PROCESOS SOSTENIBLES

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Los materiales multiferroicos presentan simultáneamente al menos dos de los comportamientos que conocemos como ferroicos: ferroeléctrico, ferromagnético, ferroelástico. Dichos materiales han ido ganando relevancia dentro de los materiales funcionales dada su versatilidad y el gran número de utilidades que presentan: resonadores, sensores, transductores piezoeléctricos y sobre todo en memorias con gran capacidad de almacenamiento, alta velocidad y bajo consumo energético.

Los desafíos en este campo radican en la preparación de composites bifásicos: una fase ferroeléctrica (por ejemplo BaTiO3) y otra ferromagnética (como NiFe2O4) con fuerte acoplamiento magnetoeléctrico. Dada la tendencia actual a la miniaturización de dispositivos resulta imprescindible que sean de pequeño tamaño, pero también, y muy especialmente, que el proceso para su obtención sea sostenible y con bajo impacto negativo en el medio ambiente. El método de preparación que cumple estos requisitos es un procesamiento hidrotermal que, en contraposición a otros procedimientos más sofisticados y costosos (MBE, PLD, CVD), resulta barato y ofrece buen control sobre la cristalinidad, tamaño y homogeneidad del composite resultante. Las heteroestructuras así obtenidas presentan una gran interfaz entre los dos componentes y por consiguiente un notable aumento de los coeficientes magnetoeléctricos, algunos ordenes de magnitud mayores que los que muestran los, por otra parte, escasos, multiferroicos monofásicos.

Por otra parte, la posibilidad de manejar cualquiera de ambos campos, eléctrico o magnético, para modificar la respuesta de polarización o magnetización de estos materiales abre un abanico de aplicaciones: memorias RAM que pueden escribirse eléctricamente y leerse mediante un campo magnético; imágenes para diagnóstico que utilizan campos magnéticos para estudiar la respuesta eléctrica de la célula sin utilizar cables o electrodos, y por último para el aprovechamiento de los residuos de múltiples procesos (“harvesting”) que apunta en la dirección de reducir el enorme desperdicio de energía y hacer de nuestro entorno un lugar más justo y confortable.

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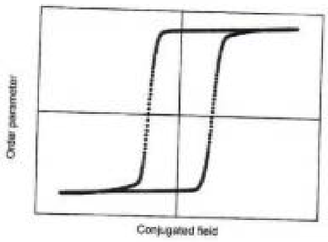
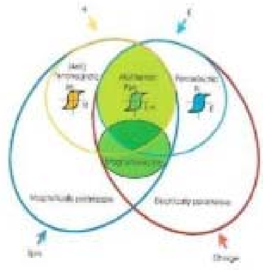

Order parameter
Conjugated field

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S13. Energy and Sustainability (GEE)
(Poster)

Reactive Dye on Sustainable Multifiber Dyeing Applying Protic Ionic Liquids as Solvents

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The textile dyeing industry generally uses traditional processes, which tend not to be environmentally friendly. Large amounts of water is used by the textile industry, up to 200 liters to produce 1 kg of textiles [1], depending on the type of fiber and dye used. In order to improve the sustainability of the process, interest in finding alternative solvents and techniques to reduce the amount of water used and improve the quality of the dyeing has increased, as well as keeping the cost of the dyeing process low. In this work, we analyzed an alternative procedure to dye multifiber fabrics with only three dyeing agents, a polyfunctional reactive dye, a cationizer (Catiofix by Coratex®) and protic ionic liquid (PIL) as solvent. Following the well-known exhaustion dyeing process, the proposed method allows PIL recycling with no appreciable loss of efficiency. A group of 4 PILs and the cationizer were studied to analyze their effectiveness as dyeing agents in terms of different dyeing quality parameters such as absorption of color and wash fastness standards of the dyed multifiber. Figure 1 shows the K/S (Kubelka-Munk parameter indicative of color strength) values for dyed samples washed into all types of fibers previously indicated The results obtained for multifiber textile, as a universal dyeing process, using PIL as solvents in the presence of the cationizer performed well when compared with standard dyeing quality parameters in the literature, in the same operational conditions, thus improving the dyeing process in the use of a universal dye for multifiber materials.

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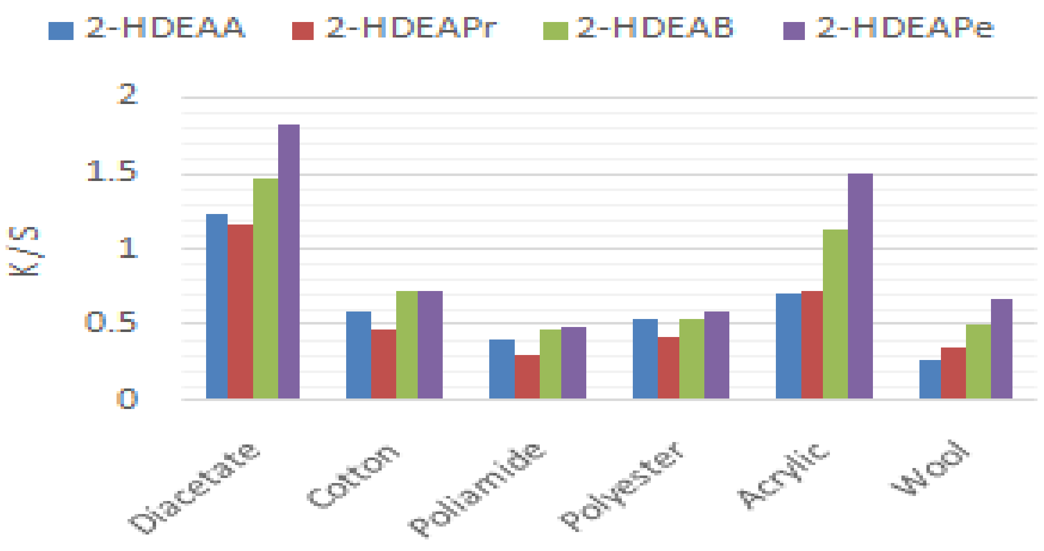

Figure 1. Color Measurement Analysis.

ID: 03945, 17/07/2019 15:00 - 17/07/2019 17:30, Hall (ground floor)
S13. Energy and Sustainability (GEE)
(Poster)

MODELADO NUMÉRICO TRIDIMENSIONAL DE CELDAS SOLARES DE PELÍCULAS DELGADAS DE $Cu(In,Ga)Se_2$

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Dentro de las energías renovables una de las opciones más interesantes es la energía solar fotovoltaica, siendo un amplio campo de estudio tanto los materiales fotoactivos como el diseño de las heteroestructuras que constituyen las celdas solares. En este trabajo se realizó el estudio de celdas solares fabricadas a partir de películas delgadas de $Cu(In,Ga)Se_2$ (CIGS) con el fin de establecer por qué su baja cristalinidad no influye en la eficiencia de conversión, siendo estas las más eficientes en su género, así como también, unas de las más económicas en el mercado actual. Mediante el software COMSOL Multiphysics® se simuló una celda solar CIGS tridimensional cuyo modelo físico está basado en las ecuaciones que describen el comportamiento de los portadores de carga en un material semiconductor a saber, la ecuación estacionaria de Poisson y las ecuaciones de continuidad teniendo en cuenta las corrientes de difusión y arrastre. El análisis de las curvas obtenidas, la variación de los parámetros del modelo y sus respectivas relaciones principales permitieron corroborar que las celdas solares CIGS presentan eficiencias del orden del 20% aun para películas policristalinas. Se compararon los valores de eficiencia cuántica, voltaje de circuito abierto, corriente de corto circuito y factor de llenado de la simulación con valores experimentales reportados por varios autores, obteniéndose resultados similares con una desviación alrededor del 8%.

ID: 03928, 17/07/2019 15:00 - 17/07/2019 17:30, Hall (ground floor)
S13. Energy and Sustainability (GEE)
(Poster)

IMPLANTACIÓN DE MINICENTRAL HIDROELÉCTRICA PARA APROVECHAR EL RECURSO ENERGÉTICO DEL EMBALSE TAHUÍN (ECUADOR)

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Los seres humanos utilizan energía en el diario vivir y es gracias a ella que se puede asegurar un ambiente confortable que facilita la vida, siendo la energía eléctrica la más importante. Su generación puede ser a través de fuentes no renovables (cantidades limitadas) o renovables (aquellas que la naturaleza reproduce continuamente). A su vez las energías renovables se clasifican en no convencionales (eólica y solar) y convencionales (geotérmica e hidroeléctrica) [1]. En la provincia de El Oro el gobierno de la república del Ecuador, construyó en los años 80 el embalse denominado “Presa Tahuín” que es alimentado por el río Arenillas, tiene un volumen de 200.000.000 m^3, con azud de 50 m, el cuerpo de agua represado se utiliza exclusivamente para riego y consumo humano. En la presente investigación se planteó el aprovechamiento del recurso hídrico disponible en dicho embalse para generar energía eléctrica con potencia instalada en bornes del generador de 3,5 MW. La investigación sobre su viabilidad capacidad de generación incluirá la observación en campo de otras minicentrales hidroeléctricas. Considerando el objetivo planteado se establecerán conclusiones y recomendaciones para optimizar la utilización de la energía generada, que será evacuada a través de una línea dedicada (1,2 km y conductor de 500 MCM (equivalente a 18 mm de diámetro) en ACAR, que interconectará a la mini central con la barra de 69 kV de la subestación reductora 10/12,5 MVA perteneciente al sistema eléctrico de la distribuidora y comercializadora CNEL de El Oro. Mediante la implantación de la minicentral hidroeléctrica se generará directamente a barra de alta tensión de la subestación denominada Arenillas una potencia que mejora el nivel de voltaje, da estabilidad al sistema eléctrico y suministra energía primaria estimada de 13,6 GWh/año, libre de emisiones de dióxido de Carbono CO_2.

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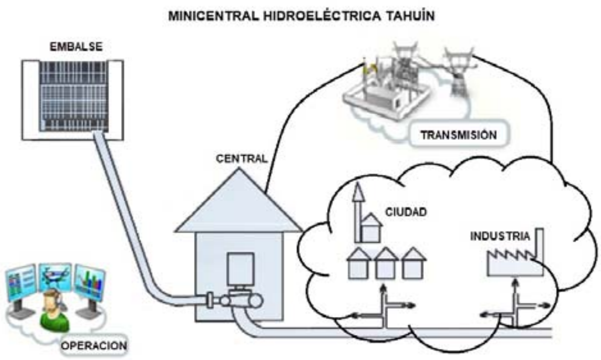

ID: 03893, 17/07/2019 15:00 - 17/07/2019 17:30, Hall (ground floor)
S13. Energy and Sustainability (GEE)
(Poster)

Evaluating the toxicity of fabrics embedded into Protic Ionic Liquids using HepG2 cytotoxicity test

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Information is available concerning the toxicity of textile chemicals, but there is limited data about the overall toxicity of textile chemicals and fabrics containing them. Although a chemical itself may be toxic, its presence in the finished material may not be harmful. In vitro tests can be useful for studying the overall toxicity of textile chemicals on their own or included in fabrics.

Recently, protic ionic liquids (PILs) have been proposed as an alternative and sustainable textile dyeing nonaqueous medium [1], and have been studied concerning its biological safety [2]. This work aims to evaluate the cytotoxicity of cotton fabrics embedded into PILs in order to evaluate the biological safety of its human use. The used protic ionic liquids were, namely, 2HDEAA, 2HDEAF, 2HDEAL, 2HDEAMa, 2HDEAOx, 2HDEAPr, 2HDEASa, 2HDEASu, 2HEAA, 2HEAAd, 2HEACi, 2HEALand 2HEAPr. This collection of PILs was designed attending to two main objectives, analyze the effect of a progressively greater anion (from 2-HDEAF to 2-HDEASa) and the effect of different number of active sites in the ions (from 2-HEAA to 2-HEACi).

The present study was performed according to the International Standards Organization (ISO / EM 10993) standards using a HepG2 cell line. The culture medium maintained in contact with the fabrics was used to treat the cells. Cell viability was determined with the MTT method. The results (Figure 1) showed that 6 of the 13 studied samples presented mean cell viability around 80%, what can be considered statistically equal to the negative control, demonstrating the absence of cytotoxicity in the evaluated fabrics.

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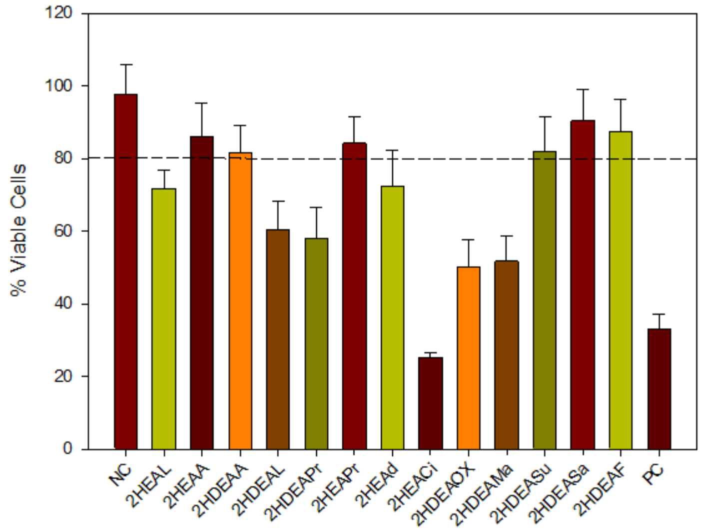

Figure 1. Percentage of viable HepG2 cells for each studied sample. NC and NP represent negative and positive control, respectively.

ID: 04102, 17/07/2019 15:00 - 17/07/2019 17:30, Hall (ground floor)
S13. Energy and Sustainability (GEE)
(Poster)

Electronic energy meter based on a magnetoresistive shunt

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An electronic energy meter is presented in which the current is processed by a unique magnetoresistive (MR) element (MR shunt) instead of a Wheatstone bridge as it was usually employed, [1, 2]. Because MR sensors are presented only in bridge topologies it was impossible to separate one element of them from the other. An electronic circuit was proposed to isolate electronically one MR element and investigate its properties as a stand-alone current sensor.

The four MR elements of a sensor bridge were characterized (curent sweep from -10 A to +10 A). A deviation from the best linear fit between 0.03 %-0.3 % was observed

An electronic interface to measure the power delivered to a load from a domestic 230 V_{rms} AC outlet was designed based on the MR element and the part ADE7755 providing a voltage signal whose frequency is proportional to the active power consumed by the load. Fig. 1 shows actual output voltage $v_o(t)$ when a current of 10 A_{rms}, 50 Hz was sensed.

Conclussions: An MR shunt is used in an energy metering application providing inherent electrical isolation and with no self-heating like dissipative shunts. This will bring the possibility to incorporate non-dissipative MR shunts to internet-of-things (IoT) devices or in smart grids systems. It offers sensor simplicity because only one MR element is required at the microfabrication time without the need to microfabricate a full Wheatstone bridge.
Fig. 1.- 10 A_{rms}, 50 Hz current sensed by the MR element.

Acknowledgments:

This work was supported in part by the Spanish Ministry of Economics and Competitivity and European Fund of Regional Development (grants ESP2015-68117-C2-1-R and ESP2014-56169-C6-4-R). INESC-MN thanks the Fundação para a Ciência e a Tecnologia (FCT) its financial support through the Projects LISBOA-01-0145-FEDER-031200 and NORTE-01-0145-FEDER-022090.

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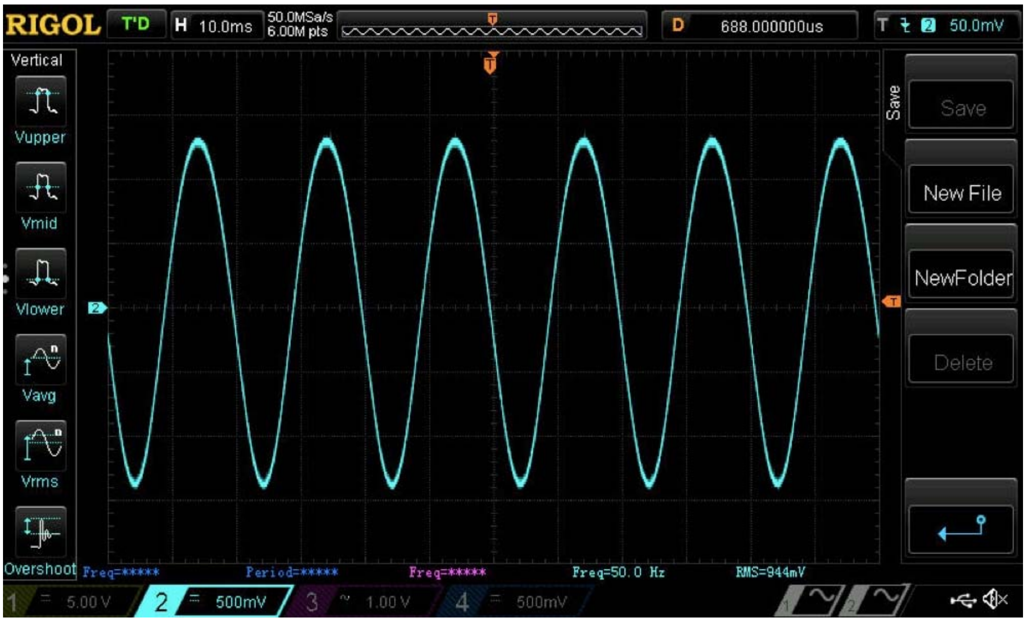

RIGOL
T'D
H 10.0ms
50.0MSa/s
6.00M pts
D 688.000000us
T 2 50.0mV
Vertical
Vupper
Vmid
Vlower
Vavg
Vrms
Overshoot
Save
Save
New File
NewFolder
Delete
Freq=*****
Period=*****
Freq=*****
Freq=50.0 Hz
RMS=944mV
1 5.00 V
2 500mV
3 1.00 V
4 500mV

ID: 03976, 17/07/2019 15:00 - 17/07/2019 17:30, Hall (ground floor)
S13. Energy and Sustainability (GEE)
(Poster)

A Simple Enviornmental Model for Air Traffic Emissions

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A simple feedback model is presented here for the relationship between the number of air traffic passengers and the associated emissions. The evolution of these variables is described by a system of ordinary differential equations [1]. The model parameters were estimated from different air traffic sources [2].

Differences in the emissions according to the type of flight are considered. Another term introduces the emissions reduction produced by the continuous improvement in the engines and design, leading to the increase efficient of the airplanes [3] Cancellation effect due in part to increased airport taxes, as a consequence of the rise in maintenance costs related to the increase in extreme events and additionally, to the passenger's environmental consciousness are also included in this model.

The stability analysis reveals that the introduction of this term did not yield any stable equilibrium point. However, for some types of flights and parameter values the CO2 growth was slowed. In other cases, a new, more complex cyclostationary behavior appeared.

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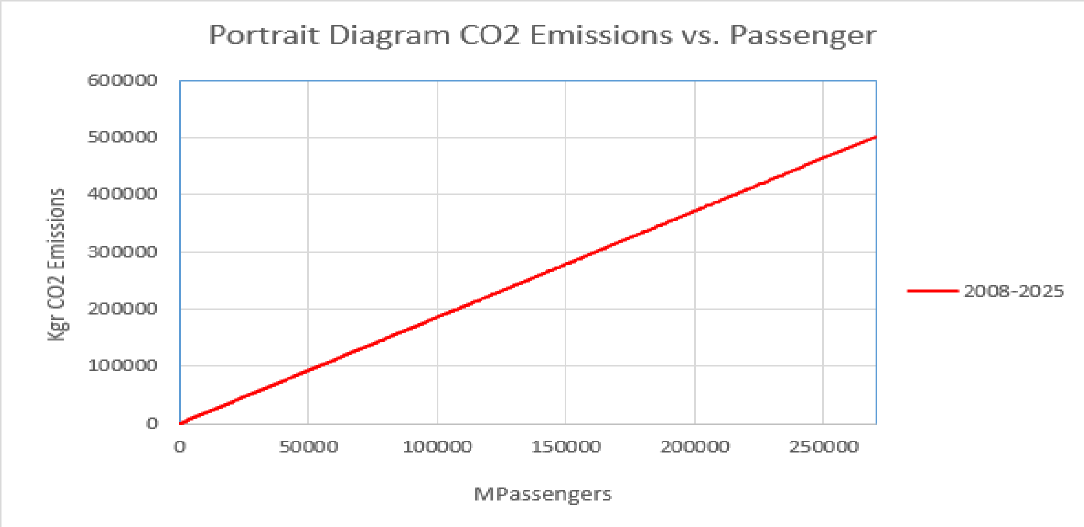

Fig. Phase Diagram of the solutions in case of short distance domestic flights.

S14. Física de Sistemas Complejos

La ciencia de sistemas complejos es un área interdisciplinar que investiga las relaciones entre los elementos constitutivos de un sistema y cómo estas relaciones conllevan comportamientos colectivos, así como la interacción del sistema con su entorno. Debido a que estos sistemas aparecen en muchos campos diferentes, el estudio de sus aspectos comunes ha convertido a los Sistemas Complejos en un área de investigación per se. El simposio pretende abarcar todos los campos de la ciencia de sistemas complejos, incluidas las redes complejas, biofísica, econofísica, sociofísica, redes tecnológicas y de comunicación, big data, etc, reuniendo a investigadores interesados en la complejidad. El Simposio se llevará a cabo del 17 al 18 de julio de 2019 e incluirá presentaciones orales seleccionadas de los resúmenes recibidos y sesiones de póster. Todos los temas que encajan dentro de Complex Systems Science son bienvenidos al simposio.

Organizadores:
Alberto Aleta, *BIFI-Universidad de Zaragoza*
Felipe M. Cardoso, *BIFI-Universidad de Zaragoza*
Carlos Gracía-Lázaro, *BIFI-Universidad de Zaragoza*
Yamir Moreno, *BIFI-Universidad de Zaragoza*

S14. Physics of Complex Systems

The Science of Complex Systems is a cross-disciplinary research area that investigates the relationships between the constituent elements of a system and how these relationships entail collective behaviors, together with the interaction of the system with its environment. As those systems appear in many different fields, the study of their common points has turned Complex Systems into an area of research per se. The symposium aims to cover all those fields of Complex Systems science including Complex Networks, Biophysics, Econophysics, Sociophysics, Technological and Communication Networks, Big Data and so on, by bringing together researchers interested in Complexity. The Symposium will take place on 17-18 July 2019 and will include oral presentations selected from the abstracts received and poster sessions. All topics that fit within Complex Systems Science are welcome to the symposium.

Organizers:

Alberto Aleta, *BIFI-Universidad de Zaragoza*
Felipe M. Cardoso, *BIFI-Universidad de Zaragoza*
Carlos Gracía-Lázaro, *BIFI-Universidad de Zaragoza*
Yamir Moreno, *BIFI-Universidad de Zaragoza*

ID: 04069, 18/07/2019 15:00 - 18/07/2019 15:30, Room 0.4 (ground floor)
S14. Physics of Complex Systems
(Oral)

Polarización política en conversaciones de Twitter sobre decisiones dicotómicas

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Political polarization is a social phenomenon that has several consequences in people's lives and whose nature is not completely understood. We say that a population is perfectly polarized when divided in two groups of the same size and opposite opinions. In this work, we have studied the polarization phenomena around Twitter conversations concerning different topics with clearly opposed opinions: electoral process with two candidates and social unrest. In each of the conversations, we have found a bipolar opinion distribution and a high value of the polarization index. In particular, we will present results of Twitter conversation around the second round of the 2017 Chilean elections [1], where voters had to choose between the final two candidates. To this end, we have applied the model proposed in [2] to estimate opinions on the retweet network.

We focus on analyzing the political polarization that emerges and tracking its temporal evolution during the week preceding the elections and the voting day. We find a shift on the opinions of users and the political polarization on the voting day. We explore to which extent this change on the behavior is explained by the engagement of new users commenting on the elections just that day or because users changed their minds during the last day. Finally, we show that the increase of the polarization observed on the previous day to the election is explained by a propaganda behavior of users who were already engaged to the conversation. However, the decrease in the polarization observed on the election day was caused by new users not so engaged to the political debate that entered the conversation acting as bridges between the two sides [1].

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ID: 04172, 18/07/2019 15:30 - 18/07/2019 16:00, Room 0.4 (ground floor)
S14. Physics of Complex Systems
(Oral)

Revisiting the Stability of a Plant-Pollinator Mutualistic Community With and Without Phenology

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The relationship between the structure of mutualistic ecosystems and their dynamics is a matter of strong debate in the ecological community, with special attention to the structure of the interaction matrix. Here, we introduce a framework based on the concept of multilayer networks, which naturally accounts for both mutualism and competition. We show that when all interactions are taken into account, mutualism does not have the same consequences on the evolution of specialist and generalist species. This leads to a non-trivial profile of biodiversity in the parameter space of competition and mutualism. Our findings emphasize how the simultaneous consideration of positive and negative interactions can contribute to our understanding of the delicate tradeoffs between topology and biodiversity in mutualistic ecosystems. We also address the question of the stability when incorporating the information on phenology. We observe that, when taking into consideration the overlap of activity periods, the persistence of species increases significantly. Furthermore, species with shorter periods are more prone to extinction when the initial times of activity are shifted. Our results show that phenology is a key factor that leads to considerations on the community stability that, otherwise, cannot be predicted by the network's topology alone.

ID: 04173, 18/07/2019 16:00 - 18/07/2019 16:30, Room 0.4 (ground floor)

S14. Physics of Complex Systems

(Oral)

Self-exciting Dynamics of Discussion Threads in Online Boards

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Research on the spreading of information in online media has mainly focused on social networks. In these platforms users have a profile, which often contains a lot of information about their offline life, and connections to other users. Thus, it is possible to follow the path of information across the whole network of users. However, there are also other types of platforms in which online discussions can be carried out by thousands of users that do not posses an underlying social network, online boards. In these platforms information no longer travels from user to user. Instead, there is a common place where all the information is gathered and then each user can choose which topic to discuss. Thus, information no longer follows a clear path as the population is completely unstructured. In this work we will focus on studying the dynamics of the largest discussion board in Spain, Forocoches, as self-exciting Poisson processes. As shown in figure 1, we found that threads that are active for less than 2 hours can be effectively modeled using Homogeneous Poisson processes. However, for threads lasting for longer than 2 hours it is necessary to introduce a self-exciting component, signaling that the discussions that arise between users are the ones allowing the information to spread for longer. After characterizing the dynamics of the system, we focus ourselves in analyzing some of these discussions in order to detect the main features that drive information spreading. We show that the reach of information not only depends on features related to the information itself, such as the topic or the user posting it, but also on exogenous factors like the hour of the day when the discussion was initiated.

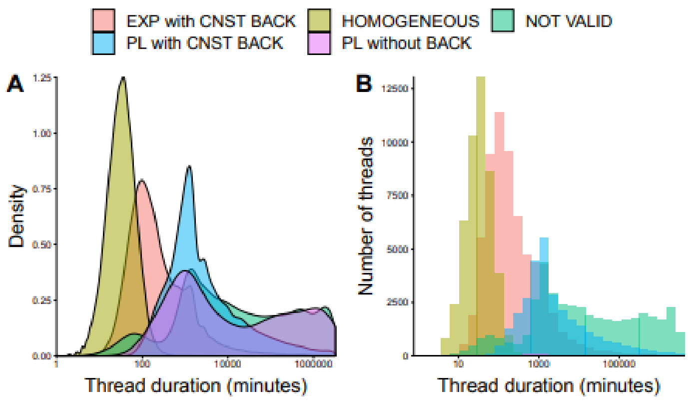

Figure 1: Distribution of threads that can be modelled as self-exciting processes as a function of the total duration of the thread. In picture A) the distribution is normalized, while in B) the total number of threads is shown. Each color represents the kernel that best fits the dynamics of the thread.

ID: 03781, 18/07/2019 17:30 - 18/07/2019 18:00, Room 0.4 (ground floor)

S14. Physics of Complex Systems

(Oral)

Separation of geometrical and kinematic influences in the probability of clogging a granular silo

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The granular flow in the discharge of silos may be interrupted by the formation of arches (in 2D) or domes (in 3D) if the orifice is few times greater than the typical particle size. Zuriguel et al. [1] showed that this probability is always constant in time, generating exponential avalanche distributions. Also, the dependence of the mean avalanche (and also of the clogging probability) on the orifices size is very strong[2]. To explain it some authors developed geometrical models over the years[3][4].

However, none of them has taken account of a possible influence of the particles velocity in clogging. In fact, when changing the outlet size, we are altering both the number of possible arches that can form in the orifice and also the grains velocity, it depends on the square root of the outlet size. Hence, a change in the orifice leads to the modification of two different properties that may affect the clogging probability in different degrees.

Aiming at separating both influences, we performed experiments in a quasi-two-dimensional silo by changing the partuicles velocity with a conveyor belt placed just below the grains exit. Then, we obtained the clogging probability p_c that the silo gets clogged when a single particle cross the orifice for several orifice sices and belt velocities.

The dependence of p_c on the grains velocity resulted to be truly significant, changing up to almost two orders of magnitude in the whole range of belt velocities for the biggest orifice studied. In addition, we managed to decouple both influences by including a kinematic term in the geometrical model recently proposed by Thomas and Durian.

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ID: 03710, 18/07/2019 18:00 - 18/07/2019 18:30, Room 0.4 (ground floor)
S14. Physics of Complex Systems
(Oral)

Are low-temperature "anomalies" of glasses really *universal*?

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Glasses (amorphous solids) are known to universally exhibit *anomalous* properties at low temperatures very different from their crystalline counterparts. Specifically, below 1-2 K the specific heat $C_p(T)$ of glasses shows a linear temperature dependence and the thermal conductivity $\kappa(T)$ a quadratic dependence on temperature - in contrast with the expected cubic behavior of crystals following Debye's theory-, that has been ascribed to the ubiquitous existence of tunneling two-level systems (TLS). Moreover, at a few K, $\kappa(T)$ of glasses exhibits a *plateau* and the specific heat a broad peak in C_p/T^3, which has been associated to an excess in the Debye-reduced $g(\omega)/\omega^2$ vibrational density of states (the "boson peak").

In the last decades, some disordered crystals such as *orientational glasses* (a.k.a. "glassy crystals"), obtained by quenching a plastic crystal phase, have been found to present the very same glassy features, which are ascribed to the orientational disorder embedded in the crystalline lattice. Nevertheless, recent works are casting doubts about this *universality* of "glassy behavior". On the one hand, some genuine amorphous solids have been found to lack TLS at low temperatures, whereas some truly crystalline solids, devoid of orientational disorder, seem to exhibit those glassy features.

We will discuss this fascinating topic by presenting recent experiments on different molecular solids, both truly amorphous solids (toluene [1], ultrastable glasses [2,3]) and crystals with a minimal amount of disorder such as pentachloronitrobenzene [4] or halomethanes $CCl_{4-n}Br_n$ crystals [5], aiming to shed light on this issue.

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ID: 04060, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S14. Physics of Complex Systems
(Poster)

Model for Anomalous Diffusion with Finite Moments in Complex Medium

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Within our model, where the anomalous diffusion arises due to the permanent affect of a random environment on a single particle resulting in a population of different relaxation times and diffusion coefficients, we are able to reproduce a superdiffusive motion, which has both properties of Lévy flights (similar time and position scalings of the probability density functions (PDFs)) and that of Lévy walks (finite mean squared displacement and its scaling in time, shape of PDFs at large times). On the other hand, we found strong differences of our model from the mentioned ones. For example, the small times regimes have a different time scaling for the PDFs; the higher-order displacement moments are monoscaled and the motion does not exhibit a strong anomalous diffusion. An important feature of our model is that jumps in space are *decoupled* from waiting times.

We believe, our results will make an experimentalist more flexible in distinguishing between the available models of anomalous superdiffusion and choosing the most simple yet appropriate one.

S15. Información Cuántica (GEIC)

Organizadores:
J. J. García-Ripoll, *IFF-CSIC*
David Zueco, *ICMA-CSIC*

S15. Quantum Information (GEIC)

Organizers:

J. J. García-Ripoll, *IFF-CSIC*
David Zueco, *ICMA-CSIC*

ID: 03918, 15/07/2019 15:00 - 15/07/2019 15:30, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Oral)

Analog quantum chemistry simulation with ultra-cold atoms

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** Alejandro González-Tudela, alejandrogonzaleztudela@gmail.com*

Solving quantum chemistry problems with a quantum computer is one of the most exciting applications of future quantum technologies. Current efforts are focused on finding on efficient algorithm that allow the efficient simulation of chemistry problems in a digital way. In this talk, I will present a complementary approach to the problem which consists in simulating quantum chemistry problems using ultra-cold atoms. I will first show how to simulate the different parts of the Hamiltonian, and then benchmark it with simple molecules.

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[1] J. Argüello, A. González-Tudela, T. Shi, P. Zoller, J. I. Cirac, arXiv: 1807.09228

ID: 04038, 15/07/2019 15:30 - 15/07/2019 15:45, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Oral)

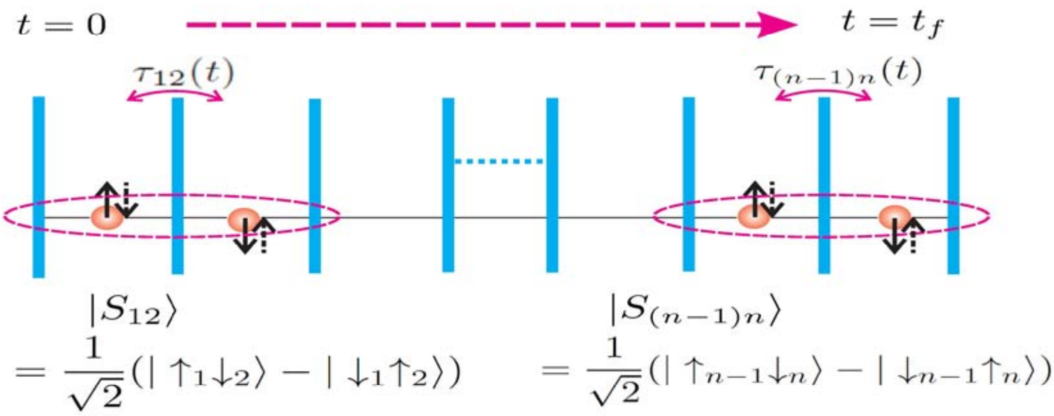
Spin entangled state transfer in quantum dot arrays: Coherent adiabatic and speed-up protocols

Yue Ban[1] , Xi Chen[2] , Sigmund Kohler[1] , Gloria Platero[1]

1) Instituto de Ciencia de Materiales de Madrid, ICMM-CSIC 2) Department of Physics, Shanghai University

** YUE BAN, ybanxc@gmail.com*

Long-distance transfer of quantum states is an indispensable part of large-scale quantum information processing. We propose a novel scheme for the transfer of two-electron entangled states, from one edge of a quantum dot array to the other by coherent adiabatic passage. This protocol is mediated by pulsed tunneling barriers, see Figure. In a second step, we seek for a speed up by shortcut to adiabaticity techniques. This significantly reduces the operation time and, thus, minimizes the impact of decoherence. For typical parameters of state-of-the-art solid state devices, the accelerated protocol has an operation time in the nanosecond range and terminates before a major coherence loss sets in. The scheme represents a promising candidate for entanglement transfer in solid state quantum information processing.



ID: 03975, 15/07/2019 15:45 - 15/07/2019 16:00, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Oral)

Fast and high-fidelity quantum logic gates with superconducting circuits.

Juan José García Ripoll[1] , Érik Torrontegui Muñoz[1] , Andrés Ruiz Chamorro[2]

1) Instituto de Física Fundamental, CSIC 2) Facultad de Ciencias Físicas, UCM

** Andrés Ruiz Chamorro, andrui03@ucm.es*

We implement high-fidelity two-qubit gates for the Xmon circuits of Google. By modifying the frequency of one of the qubits using optimal control, we design efficient protocols to generate a CZ and iSWAP logic gate. These fast protocols enable gates with fidelities > 0.99 at times faster than standard optimized adiabatic passages.

ID: 03836, 15/07/2019 16:00 - 15/07/2019 16:15, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Oral)

Dynamics of two-point correlation functions in quantum many-body systems

Alvaro Alhambra[1] , Luis Pedro Garcia Pintos[2] , Jonathon Riddell[3]

1) Perimeter Institute for Theoretical Physics
2) University of Massachusetts Boston
3) McMaster University

** Alvaro Alhambra, aalhambra@perimeterinstitute.ca*

We give rigorous analytical results about the behavior of two-point correlation functions in quantum many body systems undergoing unitary dynamics (also known as dynamical response functions or Green's functions). These functions appear in the characterization of a wide range of statistical and non-equilibrium phenomena, such as scattering experiments, quantum transport, fluctuation-dissipation theorems and linear response theory.

First, using recent results from large deviation theory, we are able to show that in a large class of models the correlation functions factorize at late times <A(t)B>→<A><B>, thus proving that dissipation emerges out of the unitary dynamics of the system. We also show that the fluctuations around this late-time value are bounded by the "effective dimension", which generally decays exponentially with system size. This last result connects the behavior of correlation functions to the physics of equilibration of quenched systems.

Moreover, for autocorrelation functions such as <A(t)A> (including the symmetrized and antisymmetrized versions) we provide an upper bound on the timescale at which they reach the "dissipated" late time value. Remarkably, this is a function of local expectation values only, and it is thus constant with system size. We give numerical examples that illustrate how this upper bound is in fact a good estimate, and we argue this timescale can be understood in terms of emergent fluctuation-dissipation theorems.

Our study extends to larger classes of two point functions. In particular, we also show that the Kubo correlation function that controls the linear response theory evolves under a similar timescale.

ID: 03779, 15/07/2019 16:15 - 15/07/2019 16:30, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Oral)

Entanglement through qubit motion and the dynamical Casimir effect

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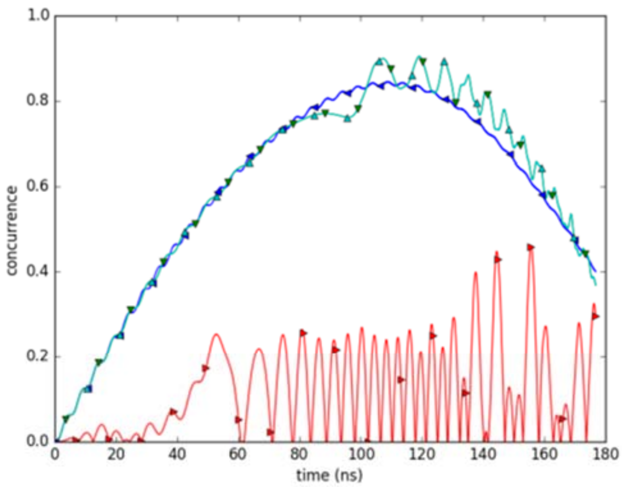
** Andrés Agustí Casado, andragus@iff.csic.es*

We explore the acceleration radiation and the dynamical Casimir effect (DCE) in the field of superconducting quantum technologies, analyzing the generation of entanglement between two qubits by means of the DCE in several states of motion. We show that the correlated absorption and emission of photons is crucial for entanglement, which in some cases can be linked to the notion of simultaneity in special relativity.



In this figure, the entanglement between qubits is represented in different states of motion. In dark blue (left facing triangles) concurrence produced by static qubits. In green (down-facing triangles) the trajectories allow the qubits to absorb and emit photons *synchronously*, producing some extra entanglement. In light blue (up-facing triangles) the same concurrence is produced with different trajectories found through a symmetry in the Hamiltonian (see [1] for more information). In red (right-facing triangles) one of the many trajectories that exhibit no correlated absorption suppresses the generation of entanglement.

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ID: 03818, 15/07/2019 17:45 - 15/07/2019 18:00, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Oral)

Bounding correlations in quantum causal networks

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2) Perimeter Institute for Theoretical Physics
3) Institute for Quantum Optics and Quantum Information (IQOQI)

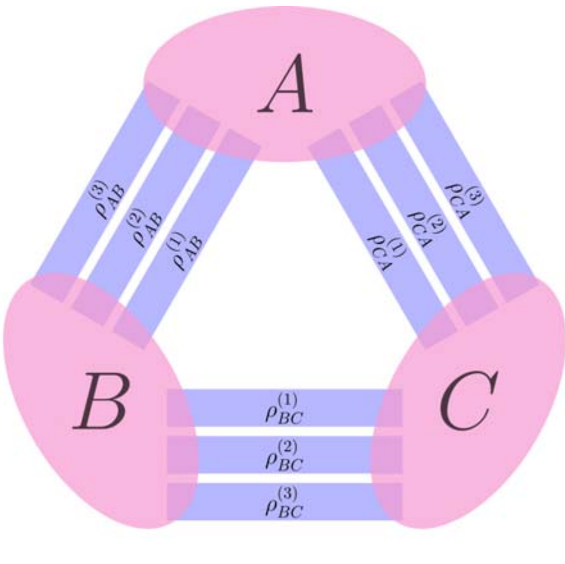
** Alejandro Pozas-Kerstjens, alejandro.pozas@icfo.es*

Causality is a seminal concept in science: any research discipline, from sociology and medicine to physics and chemistry, aims at understanding the causes that could explain the correlations observed among some measured variables. One of the consequences of Bell's theorem is that quantum causes can reproduce correlations for which an analogue classical explanation is impossible. Furthermore, it is also known that there exist correlations that cannot be reproduced even by quantum causes.

The development of the Navascués-Pironio-Acín (NPA) hierarchy was a cornerstone of quantum causality that provided numerically-efficient methods to know whether a correlation could be generated via quantum causes, allowing the rise of the device-independent paradigm. While incredibly successful, the NPA hierarchy is designed for networks where all variables are correlated to each other via a common quantum cause, so even for simple networks such as that underlying entanglement swapping, there is a lack of tools to analyze the quantum correlations that can be generated on them.

We address such issue and present a method, quantum inflation, that allows to falsify whether a given quantum causal model can explain some correlations. Quantum inflation generalizes the inflation technique for classical causal inference, and thus can be used for analyzing quantum correlations in arbitrary causal networks. By making use of it we provide bounds on the set of quantum correlations in the so-called triangle scenario, and we present a novel, natural notion of genuinely-multipartite nonlocality and entanglement.

Given the success the NPA hierarchy achieved in bipartite quantum causality, we expect quantum inflation to find applications in many fields: not only in the characterization of correlations and the design of device-independent protocols in complex quantum networks such as the sought-after quantum internet, but also in the study of quantum effects in thermodynamic and biological processes.



ID: 03803, 15/07/2019 18:00 - 15/07/2019 18:15, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Oral)

Sobre el teorema PBR
About the PBR theorem

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1) Universidad de Granada

** María C. Boscá Díaz-Pintado, bosca@ugr.es*

Resumen: La publicación en 2012 del teorema de PBR (Pusey-Barrett-Rudolph) en Nature Physics [1] fue recibida por algunos como "un teorema que sacude los fundamentos cuánticos" (E. Reich). Su trabajo fue entendido como la demostración de que cualquier modelo que suponga que el estado cuántico representa información sobre el estado físico de un sistema conduce inevitablemente a predicciones que contradicen las de la teoría cuántica. Una de sus consecuencias fue que se propagó el malentendido de que se había demostrado que un estado cuántico no puede interpretarse como real. El contenido y el propósito de esta comunicación es mostrar que, lejos de ser el caso, el teorema de PBR es un resultado de alcance limitado y, en particular, que es completamente ajeno a la interpretación ortodoxa de la teoría cuántica.

Abstract: The publication in 2012 of the PBR (Pusey-Barrett-Rudolph) theorem in Nature Physics [1] was received by some as "a theorem that shakes the quantum foundations" (E. Reich). His work was understood as the demonstration that any model which assumes that the quantum state represents information about the physical state of a system inevitably leads to predictions that contradict those of quantum theory. One of its consequences was that the misunderstanding that it had been demonstrated that a quantum state can not be interpreted as real was spreaded. The content and purpose of this communication is to show that, far from being the case, the PBR theorem is a result of limited scope and, in particular, that it is completely oblivious to the orthodox interpretation of quantum theory.

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ID: 03963, 15/07/2019 18:15 - 15/07/2019 18:30, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Oral)

Quantum key distribution secure against malicious providers

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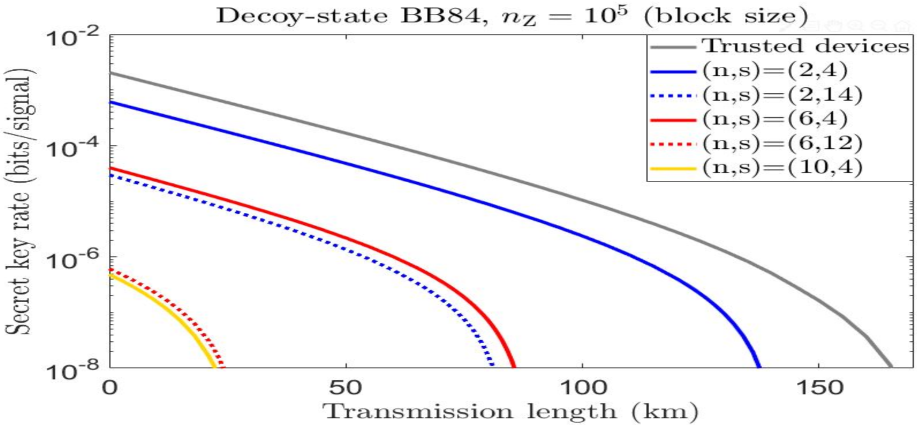
1) Universidad de Vigo

** Víctor Zapatero, vzapatero@com.uvigo.es*

The security of quantum key distribution (QKD) relies on one fundamental assumption, which often remains unnoticed: all the legitimate users' devices are honest. This includes both the quantum devices used to generate correlated data (i.e., the raw key) by exploiting quantum-mechanical effects, as well as the classical post-processing units that distill a secret key from the raw data via error correction and privacy amplification. Unfortunately, this assumption is very hard to justify in practice, as it forces the parties in a QKD link to trust all their hardware providers. Indeed, even trusted providers do not manufacture all the chips and optical components by themselves, but they typically rely on secondary and tertiary supplies. This renders the verification of all QKD components a very difficult task.

On the other hand, the presence of malicious devices could totally compromise the security of QKD: once the key is distilled, it is a classical object and thus it can be copied. Once copied, the malicious devices could easily send the secret key to an eavesdropper in the channel by using covert communication techniques. Importantly, this security problem affects both device-dependent and device-independent QKD setups.

To restore the security of QKD, the authors of [1] proposed a solution based on the assumption that the number of malicious devices is limited. With this assumption in hand, one can use privacy amplification techniques, together with verifiable secret sharing (VSS) schemes (see, e.g. [2]), to guarantee the security of QKD in the presence of possibly malicious providers. A small drawback of this approach is, however, that VSS schemes require the redundant use of the authenticated classical channel, which implies an overhead in the consumption of secret key bits for authentication purposes ([1], [3]). In this work, we introduce a more efficient solution (also based on VSS) that can reduce such authentication cost, and we apply it to well-known QKD protocols. Our results demonstrate the feasibility of applying these techniques to guarantee the security of QKD with malicious devices.



n = Number of QKD pairs (out of which $n-1$ are dishonest at most)
s = Number of CP units per user (out of which $\lfloor \frac{s-1}{3} \rfloor$ are dishonest at most)
$\epsilon_{\rm sec} = \epsilon_{\rm cor} = 10^{-10}$, $\epsilon_{\rm rob} = 10^{-3}$

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[3] Fung, C.-H. F., et. al. "Practical issues in quantum-key-distribution post-processing." Physical Review A 81, 012318 (2010).

ID: 04052, 15/07/2019 17:30 - 15/07/2019 17:35, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Poster-Flash Talks)

Asymmetric decoy-state estimation for twin-field quantum key distribution

Álvaro Navarrete[1] , Federico Grasselli[2] , Marcos Curty[1]

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2) Institut für Theoretische Physik III, Heinrich-Heine-Universität Düsseldorf, Universitätsstraße 1, D-40225 Düsseldokf, Germany

** Alvaro Navarrete, anavarrete@com.uvigo.es*

Quantum key distribution (QKD) allows two separated parties to generate two identical secret bit strings with information-theoretic security. Due to the loss in the quantum channel, the performance of point-to-point QKD generally decreases with the distance, being unpractical for far-distance applications. Indeed, it has been recently derived fundamental limits which state that the secret key rate scales basically linearly with the channel transmittance. Surprisingly, a novel QKD protocol, so-called twin-field (TF) QKD [1], can overcome these limits and deliver a key rate that scales with the square root of the channel transmittance, just by using an intermediate untrusted node making a simple interferometric measurement. Since the original proposal, various versions of TF-QKD have been introduced, each of them with its own security proof. Specifically, here we focus in the TF-QKD scheme presented in [2], which can provide a secret key rate about one order of magnitude higher than previous proposals. Its security is based on the use of phase-randomized coherent states in the test basis, in combination with the decoy-state technique. In doing so, it is possible to upper bound the phase error rate by upper bounding some Fock state statistics. This could be done by using the analytical method introduced in [3]. A drawback of this technique is, however, that it behaves poorly when the two users are connected to the central node by quantum channels with different transmittances. In this work, we derive upper bounds on the required Fock state statistics for the most general scenario where the users can choose different intensity settings. Our results demonstrate the feasibility of long-distance QKD with practical sources.

References

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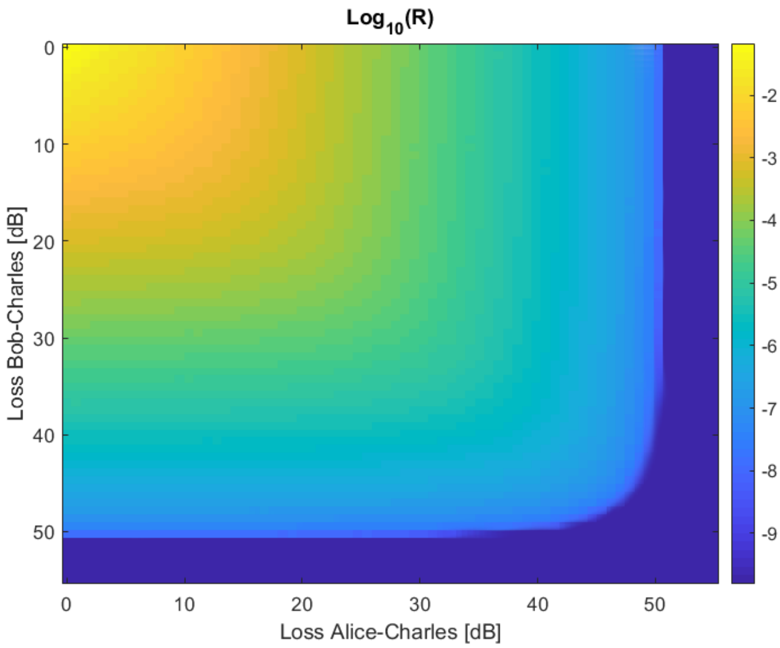

$Log_{10}(R)$
Loss Bob-Charles [dB]
Loss Alice-Charles [dB]
0
10
20
30
40
50
-2
-3
-4
-5
-6
-7
-8
-9

ID: 04047, 15/07/2019 17:35 - 15/07/2019 17:40, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Poster- Flash Talks)

Direct detection of clock transitions in molecular magnets by heat capacity measurements

Marcos Rubín[1] , María Stuckart[2] , Talal Mallah[3] , David Zueco[4] , Alejandro Gaita-Ariño[5] , Eugenio Coronado[5] , Fernando Luis[6]

1) Universidad de Zaragoza
2) Institute of Organic Chemistry (IOC)
3) Institut de Chimie Moléculaire et des Matériaux d'Orsay (ICMMO)
4) Instituto de Ciencia de Materiales de Aragón (ICMA)
5) Instituto de Ciencia Molecular (ICMol)
6) Consejo Superior de Investigaciones Científicas (CSIC)

** Marcos Rubín, marcos1917r@gmail.com*

The existence of a large quantum tunnel splitting in molecular magnets gives rise to a level anti-crossing, or magnetic clock transition, that can measured by heat capacity experiments ([1], [2]). These states are known to have a remarkable stability against magnetic field fluctuations, which leads to long coherence times [3]; thus they are of utmost interest to encode robust spin qubits. In order to manipulate these qubits, the energies of the clock transitions must be in the range of those of commercial EPR cavities.

The proposed systems are trigonal bipyramidal Ni(II) complexes ([Ni(Me_6tren)Cl](ClO_4)) [4] and Ho(III) polyoxopalladate cubes ($HoPd_{12}$) [5]. In the Ni(II) ion (S = 1) of [Ni(Me6tren)Cl] a clock transition between the ground and first excited states gives rise to a Schottky anomaly in the magnetic contribution to the heat capacity. These experiments allow a direct determination of the quantum tunneling gap and its magnetic field dependence. In the Ho(III) ion (S = 8) of $HoPd_{12}$ a very stable energy gap between the ground and first excited states, which results from the deformation of the cubic symmetry around the magnetic ion, has also been observed and determined experimentally. A molecular design, based on these results, has led to the synthesis of related structures with more suitable transition energies.

Figure a: Structure of the cation in [Ni(Me_6tren)Cl](ClO_4) and evolution of its heat capacity with the magnetic field. Figure b: Effective energy gap of the transition between the ground and first excited states of [Ni(Me_6tren)Cl](ClO_4).

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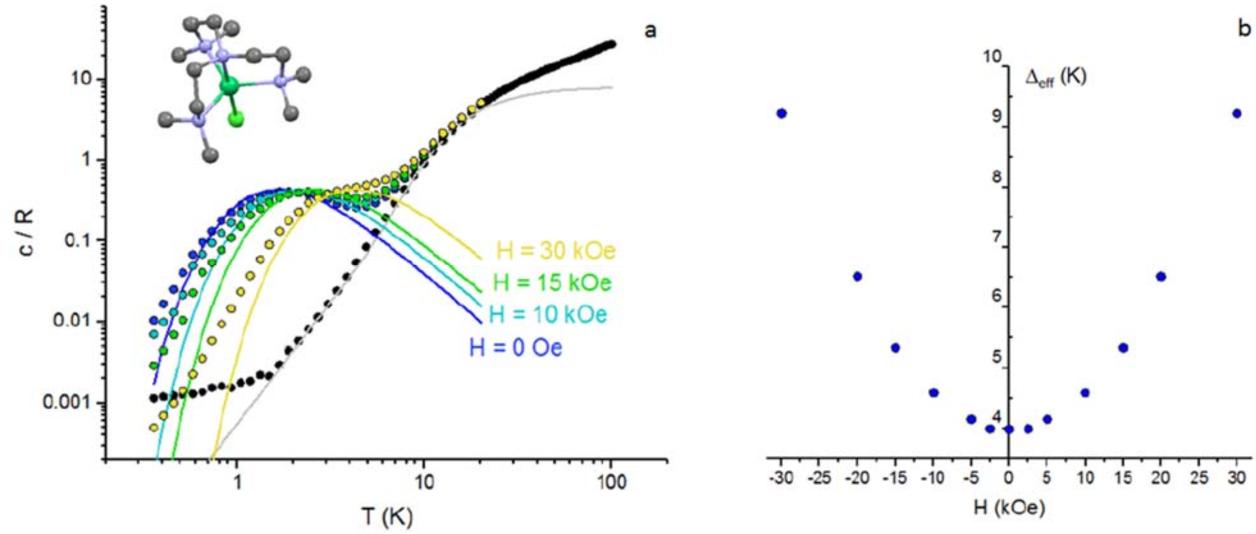

a
c / R
T (K)
H = 30 kOe
H = 15 kOe
H = 10 kOe
H = 0 Oe
b
Δ_{eff} (K)
H (kOe)

ID: 04221, 15/07/2019 17:40 - 15/07/2019 17:45, Room 1.5 (first floor)
S15. Quantum Information (GEIC)
(Poster- Flash Talks)

Dynamics and spectrum of a molecule coupled to a vibrational mode, study of emissions in nanocavities.

Jorge Calvo-Ibar[1] , D. Zueco[1] , L. Martín-Moreno[1]

1) Universidad de Zaragoza

** Jorge Calvo, jorge8686@hotmail.es*

The study of the individual emissions and the dynamics of molecules in nanocavities, coupling them to vibrational modes, is an interesting topic in the field of QED. In literature (e.g. Frank C. Spano “Absorption and photoluminescence in organic cavity QED”, PHYSICAL REVIEW A, 95, 053867 (2017)) the topic is focused on the study of the collective regime i.e. one or several molecules coupled to a discrete spectrum of several vibrational modes. In our case we will study the coupling of one molecule with a vibrational mode through the Huang-Rhys factor using a Holstein-Rabi Hamiltonian with losses with an environment. We will use numerical and analytical techniques (such as Polaron transformation, exact diagonalization, master equation, the Python environment Qutip.) in order to study the spectrum and dynamics of the system. The study has been continued with the effects on the noise spectrum of this matter-vibration coupling. Finally, we have studied our system embedded in a waveguide and the influence of that coupling in the dynamics and bound states of the system

S16. Tecnologías Cuánticas (GEIC-GEOCONL)

Organizadores:
J. J. García-Ripoll, *IFF-CSIC*
Ramón Vilaseca, *Universitat Politècnica de Catalunya*

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KEYSIGHT TECHNOLOGIES

S16. Quantum Technologies (GEIC-GEOCONL)

The symposium is organized jointly by the Quantum Information and Computation Group (GEIC) and the Quantum Optics and Nonlinear Optics Group (GEOCONL) of the RSEF. It is dedicated to theoretical and experimental developments quantum information and quantum optics applied to quantum technologies such as computing, simulation, metrology and communication. It includes new tecnologies of quantum optics with superconductor circuits, quantum simulation with ultra-cold atoms, spins or trapped ions; quantum communication with photons, quantum sensors, etc.

Organizers:

J. J. García-Ripoll, *IFF-CSIC*
Ramón Vilaseca, *Universitat Politècnica de Catalunya*

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ID: 03935, 16/07/2019 15:00 - 16/07/2019 15:18, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

Long- and short-range qubit-qubit interactions in quasi-one-dimensional photonic baths

Eduardo Sánchez Burillo[1] , Alejandro González Tudela[2]

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** Eduardo Sánchez Burillo, eduardo.sanchez-burillo@mpq.mpg.de*

Long-range interactions in condensed-matter physics or atomic systems give rise to a plethora of interesting phenomena, such as new phases of matter or a spread of information beyond the light-cone limit. Atom-atom interactions can be mediated by a reservoir, such as a photonic bath. In this work, we prove that, for the particular case of quasi-one-dimensional photonic baths with tight-binding-like hopping terms, the effective qubit-qubit interactions decay exponentially in the long-distance limit. We connect this result to the 2D case, where long-range interactions are possible. Besides, we discuss how to circumvent the conditions of the theorem in 1D in order to get long-range interactions, such as logarithmic tails or power laws.

ID: 04067, 16/07/2019 15:18 - 16/07/2019 15:36, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

Towards long distance entanglement between a photon and a solid-state quantum memory

Samuele Grandi[1] , Jelena Rakonjac[1] , Dario Lago-Rivera[1] , Alessandro Seri[1] , Hugues de Riedmatten[1]

1) ICFO - The Institute of Photonic Sciences

** Samuele Grandi, samuele.grandi@icfo.eu*

A reliable way of transferring quantum information between distant locations is becoming ever more crucial. Photons are widely accepted as excellent carriers due to their speed and low decoherence, but losses of transmission and the impossibility of cloning quantum information still pose a great challenge. The quantum repeater architecture, where the information encoded in an input state is transferred to a new one through entanglement swapping, was suggested as a solution [1].

Our system of choice for a quantum repeater combines a solid-state quantum memory with a source of photon pairs**.** The memory is based on a Rare-Earth Doped crystal, where qubits can be stored as a collective, long-lived spin excitation using the Atomic Frequency Comb technique [2]. Photon pairs are generated by parametric down conversion in a periodically-poled crystal inside a bow-tie cavity. This source generates narrow band photons pairs, where the signal is spectrally matched to the memory, while the idler is in the telecom band [3]. This configuration allows us to benefit from the high performance of the memory and from the low propagation losses of telecom photons.

The first step, whose progresses are presented in this work, is the successful demonstration of energy-time entanglement between the idler and the signal photon, stored as spin-wave excitation [4]. In this direction we have doubled the efficiency of the storage protocols, beneficial to count rates and signal-to-noise ratio, as well as improved the spectral-matching between the source and the memory [5]. Demonstration of the successful transfer of quantum information between the signal photon and the long-lived solid-state excitation will open the way to the demonstration of long-distance entanglement between individual nodes in a quantum network.

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ID: 04064, 16/07/2019 15:36 - 16/07/2019 15:54, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

Quantum Storage of Frequency-Multiplexed Heralded Single Photons

Dario Lago-Rivera[1] , Alessandro Seri[1] , Andreas Lenhard[1] , Giacomo Corrielli[2] , Roberto Osellame[2] , Margherita Mazzera[1] , Hugues de Riedmatten[3]

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Quantum memories for light are important devices in quantum information, in particular for applications such as quantum networks and quantum repeaters [1]. Multimode quantum memories able to store independently multiple modes would help the scaling of quantum networks by decreasing the entanglement generation time between remote quantum nodes. Current research focuses mostly on time multiplexing in rare-earth doped crystals and in spatial multiplexing in atomic gases. Beyond these demonstrations, rare-earth doped crystals, thanks to their large inhomogeneous broadening, are a unique system, which could also add another degree of freedom, the storage of multiple frequency modes. In this contribution, we report on the first demonstration of quantum storage of a frequency multiplexed single photon into a laser-written waveguide integrated in a praseodymium (Pr) crystal.

We use a cavity-enhanced SPDC source to generate frequency multiplexed photon pairs, with one photon resonant with the transition of the Pr and the other at telecom wavelength.
We use the atomic frequency comb (AFC) protocol [2] to demonstrate storage of the multiplexed heralded photon. We show that we can store its spectrum consisting of 15 modes. This increases our count-rate by 5.5 with respect to the single frequency mode storage. We make a detailed analysis of the multiplexed-biphoton state after the storage. We study the non-classicality of the stored photons after being stored for 3.5 us. The measured cross-correlation violates the classical bound, as well as the heralded autocorrelation of the stored photons.

Together with the 9 temporal modes, stored as an intrinsic property of the AFC protocol, we demonstrate the storage of more than 130 modes. Combining several multiplexing capabilities in one system would open the door to the realization of massively multiplexed quantum memories.

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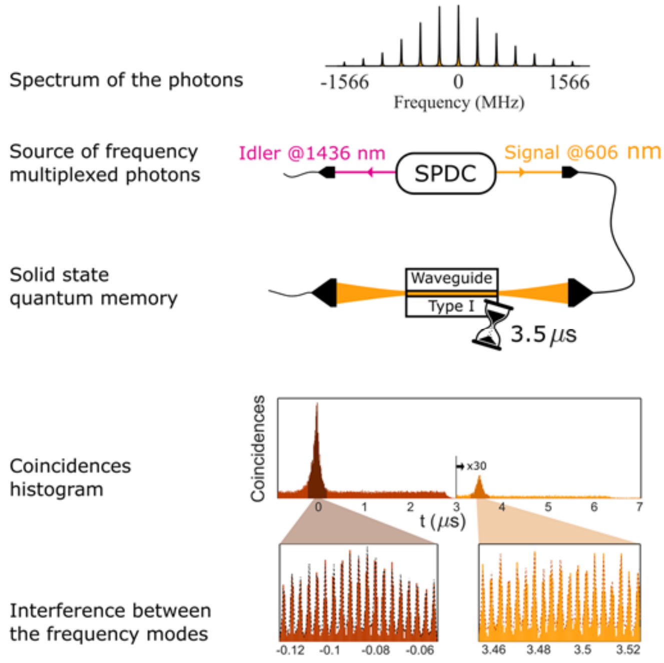

Spectrum of the photons
-1566
0
1566
Frequency (MHz)
Source of frequency multiplexed photons
Idler @1436 nm
SPDC
Signal @606 nm
Solid state quantum memory
Waveguide
Type I
3.5 μs
Coincidences histogram
Coincidences
x30
t (μs)
Interference between the frequency modes

ID: 04103, 16/07/2019 15:54 - 16/07/2019 16:12, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

Towards a spin-photon interface based on InAs/GaAsSb quantum dots

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Accessing and sharing quantum information across heterogeneous quantum networks is of paramount importance for scalable quantum computing. One key element of these architectures is spin-photon interfaces, where matter and light can exchange quantum information coherently. A single InAs QD covered by GaAsSb embedded in a photonic cavity could provide such a building block. Sb-based semiconductors are characterized by large spin-orbit coupling constants and, some of them, also by strong emission rates in relevant optical frequencies. Both characteristics could be exploited to, for instance, map the RF electric field in a superconductor circuit (SC) to a propagating photon state [1].

With this idea in mind, we have already demonstrated that the orbital confinement of the hole wavefunction can be controlled by applying an external voltage to the InAs/GaAsSb system [2]. The type-II band alignment of this system forces the hole to be confined in the GaAsSb layer exhibiting either a dot- or a ring-like geometry depending on the polarization of the voltage. More recently, we have extended this work applying a magnetic field to unveil the orbital and spin magnetic properties of the system and their voltage modulation [3]. We find that the integrated intensity and the degree of circular polarization oscillate as a signature of the Optical Aharonov-Bohm Effect. More relevant for our application, we also find that the voltage also changes the hole's spin properties, as a clear signature of the spin-orbit coupling in the Sb-bearing layer. Both results are explained by a combination of microscopic and effective models.

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ID: 03719, 16/07/2019 16:12 - 16/07/2019 16:30, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

CLOSE-UP ANALYSIS OF SPIN-CLOCK TRANSITIONS IN MOLECULAR SPIN QUBITS BY ON-CHIP BROAD-BAND SPECTROSCOPY

Ignacio Gimeno Alonso[1] , Yan Duan[2] , Alejandro Gaita Ariño[2] , Thomas Astner[3] , Johannes Majer[3] , Eugenio Coronado Miralles[2] , David Zueco Lainez[1] , Fernando Luis Vitalla[1]

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The spins of lanthanide ions host by artificial molecules are attractive candidates to encode qubits.[1-4] Besides having two well-defined energy levels between which a transition can be externally induced, e.g. via the application of external microwave radiation, a solid-state qubit must also show sufficiently long spin coherence times. Recently, it was shown that properly chosen molecular coordinations, which induce large spin tunnelling splittings, give rise to states that are protected against magnetic field fluctuations even in non-diluted samples.[5,6] A detailed characterization of these “spin-clock transitions” is crucial to choose the best operation conditions (temperature, frequency and magnetic field) for the qubit. In this study, a crystal of $Na_9[Ho(W_5O_{18})_2]$ molecules was studied at low temperatures using broad-band on-chip spectroscopy. The crystal was coupled to an open superconducting transmission line under the action of an orientable ***H***. Transmission measurements (Fig. 1) provide direct and complete information on the energy level scheme for frequencies up to 14 GHz, showing how the clock transitions depend on the orientation of ***H*** with respect to the molecular axes. A quantitative analysis allows reconstructing the spin wave function near the clock transitions and evaluating the coupling of these spin qubits to superconducting quantum circuits.

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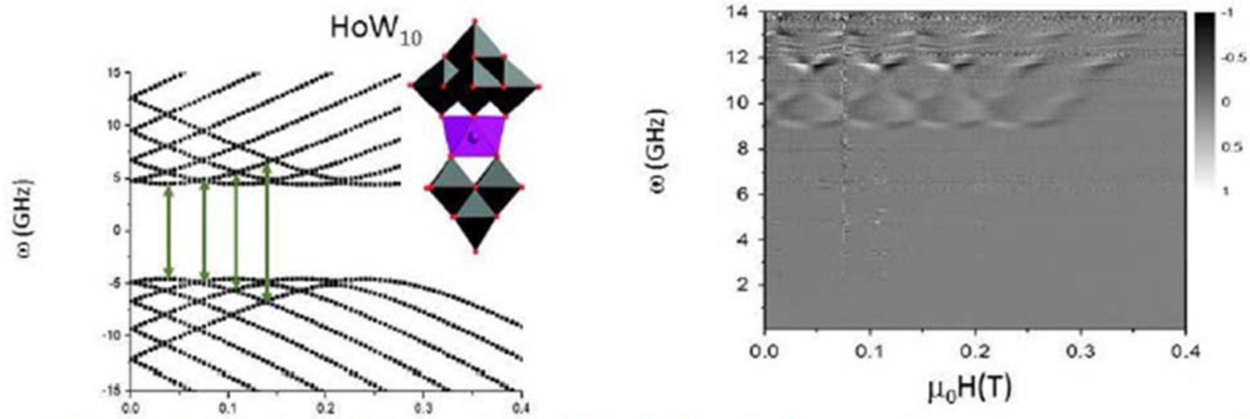

Figure 1. Energy level scheme of the molecule HoW_{10} (left) and microwave transmission measurement as a function of frequency and magnetic field (right).

ID: 03802, 16/07/2019 17:30 - 16/07/2019 17:48, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

Quantum synchronization in dimer atomic lattices

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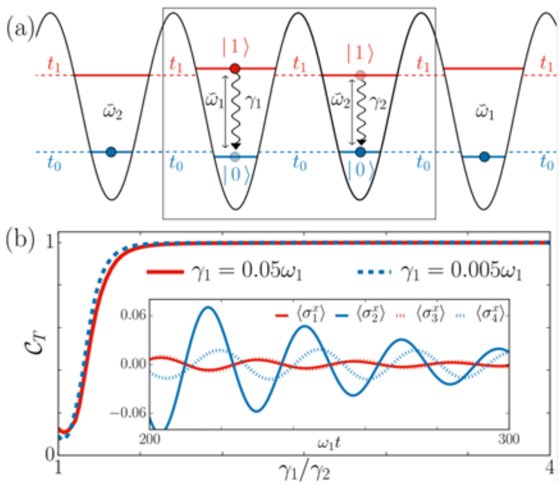
Synchronization phenomena have been recently reported in the quantum realm at atomic level due to collective dissipation. In this work we propose a dimer lattice of trapped atoms realizing a dissipative spin model where quantum synchronization occurs instead in presence of local dissipation. Atoms synchronization is enabled by inhomogeneity of staggered local losses in the lattice and is favored by an increase of spins detuning. A comprehensive approach to quantum synchronization based on different measures considered in the literature allows to identify the main features of different synchronization regimes.

In panel (a) of the attached figure, we show a scheme of the atomic proposal to implement an effective 1D dissipative XX spin chain. The atomic system is described by a two-band Bose-Hubbard model in the Mott-Insulator regime. Lattice anharmonicity, strong on-site atom-atom repulsion, and perturbative contributions due to weak coupling lead to the desired effective spin model. Engineered dissipation is accomplished by optically addressing the internal (Λ) structure of the atomic states in the Lamb-Dicke regime. In panel (b) we show how spontaneous synchronization emerges when the decay rates become staggered (the order parameter for synchronization C_T goes to one). Finally, in the inset, we show an example of synchronized trajectories for the coherences of a chain of four spins. We can appreciate how, in spite of the different intrinsic frequencies of the spins, they oscillate at the same frequency and with the relative phases locked.



ID: 03858, 16/07/2019 17:48 - 16/07/2019 18:06, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

Simulation of chiral topological phases in driven quantum dot arrays

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Off all topological matter, topological insulators (TIs) are of special interest due to their tantalizing properties: the presence of robust edge states. As a consequence, a great effort is being made to engineer their effective Hamiltonian upon other systems whose properties can be controlled more easily.

Recent experimental evidence on scalable quantum dot (QD) devices demonstrates a reproducible and controllable 12-QD device, which opens up the possibility of simulating 1D TIs upon QD chains. A canonical example of TI in 1D is the SSH model, which captures the non-trivial fingerprints of topology thanks to two key ingredients: the presence of chiral symmetry and the bond ordering of nearest-neighbour couplings.

Following this criteria, generalized 1D arrays including long-range hoppings can be studied from a topological point of view, provided that these extra couplings do not break chiral symmetry nor the bond order. In this work, we discuss how to use QD arrays with long-range hoppings as simulators for 1D chiral topological phases using time-dependent modulations. We show that all hopping amplitudes can be modified at will, imprinting bond-order and thus effectively producing structures such as dimers, trimers, etc. Mainly, our driving protocol allows for the simultaneous suppression of all the undesired hoppings, enhancement of the necessary ones, and hence provides a way to maintain certain key symmetries. In addition, we have discussed its implementation in a 12-QD array with two interacting electrons, and found correlation effects in their dynamics.

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ID: 03831, 16/07/2019 18:06 - 16/07/2019 18:24, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

Reducing readout overhead in silicon quantum computing by sequential redout

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Quantum computing is the ultimate step towards computing speed up. Its innovative algorithms unleash all the potential of purely quantum effects. The basic unit of a quantum processor is a qubit (quantum bit), which can be realised by any two-level system. A functional quantum processor should be able to initialise, control and readout a qubit with high fidelity. In current quantum processors, qubits are wired one by one by one. This bottleneck was already faced by digital computers in the 1960s. Digital computers reduced the number of input-output connections thanks to DRAM technology and time-domain multiplexing. Both of them require individual addressability of multiple bits using the same input line (conditional readout) and retaining the information while the other bits are read out. These same techniques are at the core of the proposed architectures for a digitally-interfaced quantum processor.

We perform the first experimental demonstration of a conditional readout cell. A conditional readout cell contains a quantum device interfaced via a field-effect transistor (FET). The cell is measured via gate-based dispersive sensing using a single lumped-element resonator [1]. Both FET and qubit are fabricated in the same chip using complementary metal-oxide-semiconductor (CMOS) processes, compatible with semiconductor industry nanofabrication. We obtain a charge sensitivity of $\delta q=95 \times 10^{-6}\ e\mathrm{Hz}^{-1/2}$, comparable to results without the control FET, and a retention time on the order of a second. We go one step further and demonstrate sequential dynamic readout of two of these cells interfaced by the same resonator. This is a crucial step towards the development of a readout architecture for larger qubit arrays [2].

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ID: 03729, 16/07/2019 18:24 - 16/07/2019 18:42, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

Intrinsic and extrinsic effects on the transport properties of nanodevices based on topological insulator Bi_2Se_3

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Topological insulators (Tis) have emerged as a novel class of quantum materials predicted to possess an insulating bulk and spin-momentum locked metallic states at the surface produced by a non-trivial topology of the band structure [1]. The spin-momentum locking protects the surface states against backscattering and provides them with robustness, which makes them interesting to overcome decoherence problems in quantum technological systems.

Bi_2Se_3 is considered one of the most promising TIs, due to its relatively large band gap of 0.3 eV and its simple surface band structure. Although several works have identified the presence of surface states in transport measurements [2], it is still challenging to separate the contribution of the bulk, that turns out to be intrinsically metallic.

In our work, we study the electronic properties in Bi_2Se_3 devices and we try to identify the existence of surface states starting either from epitaxial thin films [3] with different thicknesses or from single crystals. This allows us to study the effect of the geometry of the device, the presence of a substrate or the crystallographic orientation, on the transport. To do that, we combine optical lithography and focused ion beam lithography for the fabrication of the devices, and we measure transport properties in a wide range of external magnetic fields and temperatures.

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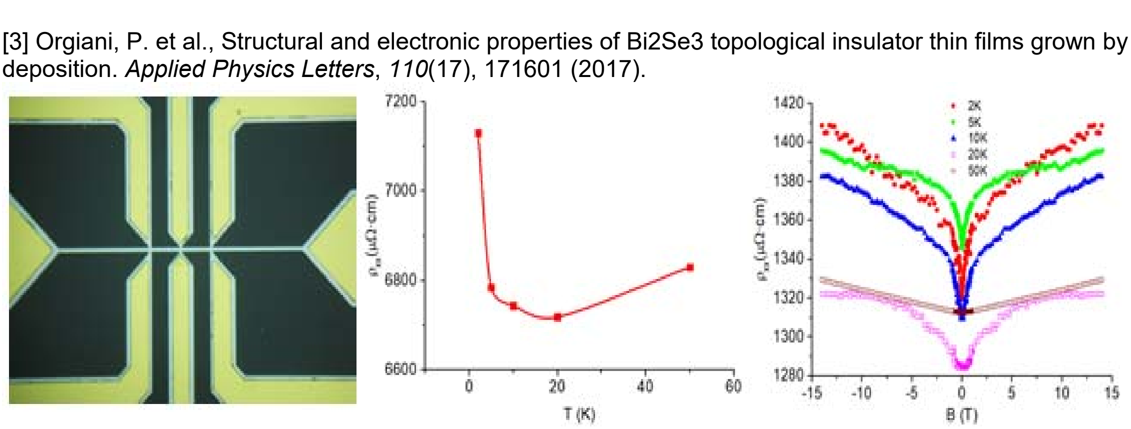

ID: 03755, 16/07/2019 18:42 - 16/07/2019 19:00, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

Majorana excitations in Rashba nanowire-based transmon qubits: a new path in the quest of Majorana detection

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Majorana modes in condensed matter physics have become the target of a rather intensive research because of their potential application to fault tolerant quantum computing. A proposed method to study Majorana signatures is based on the superconducting charge-qubit architecture in the transmon regime [1], where a Josephson junction based on a proximitized Rashba semiconducting nanowire replaces the standard tunnel Josepshon junction element in the superconducting qubit. This is to be combined with microwave photon-assisted measurement techniques, which provide rather good precision and tunability on these devises.

While simplified theoretical modellings have been performed on this platform [2], however, fully microscopic simulations are so far still pending. Here we show preliminar results of a more systematic approach based on tight-binding models, which render neat signatures of bulk topological transition in nanowires.

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ID: 03706, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Poster)

Non-Hermitian topology: a unifying framework for the Andreev versus Majorana states controversy

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Andreev bound states (ABSs) in hybrid semiconductor-superconductor nanowires can have near-zero energy in parameter regions where band topology predicts trivial phases. This surprising fact has been used to challenge the interpretation of a number of transport experiments in terms of non-trivial topology with Majorana zero modes (MZMs). We show that this ongoing ABS versus MZM controversy is fully clarified when framed in the language of non-Hermitian topology, the naturaldescription for open quantum systems. This change of paradigm allows us to understand topological transitions and the emergence of pairs of zero modes more broadly, in terms of exceptional point (EP) bifurcations of system eigenvalue pairs in the complex plane.

Within this framework, we showthat some zero energy ABSs are actually non-trivial, and share all the properties of conventional MZMs, such as the recently observed $2e^2/h$ conductance quantization. From this point of view, any distinction between such ABS zero modes and conventional MZMs becomes artificial. The keyfeature that underlies their common non-trivial properties is an asymmetric coupling of Majoranacomponents to the reservoir, which triggers the EP bifurcation.

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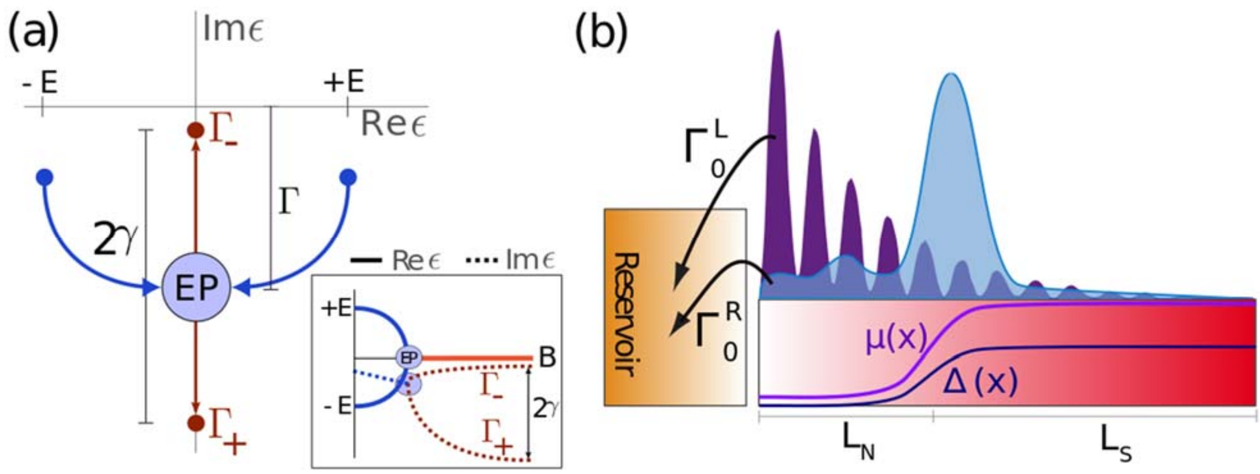

ID: 04226, 16/07/2019 18:50 - 16/07/2019 19:08, Room 1.5 (first floor)
S16. Quantum Technologies (GEIC-GEOCONL)
(Oral)

Multiqubit control system based in specific FPGA IP designs

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Preventing decoherence is critical in realizing a quantum computer. Control instrumentation is used to prepare and accurately measure qubit states to create well-controlled entangling operations. One of the most critical factors for controlling a qubit is the stability of the signals. Stability is important in maintaining the state of the qubit. To add more qubits into the experiment, synchronization of multiple signals is necessary. As experiments move beyond the range of two to five qubits, as currently seen in many researchers set ups, the scalability of the control instrumentation becomes of greater concern.

Running quantum algorithms involves applying several gates to single or multiple qubits. These gates are applied by applying several signals to the qubits at precise frequencies and time durations. Reading out the status of the qubits also involves sending readout microwave pulses and then detecting changes such as phase shift or amplitude. To reduce the number of connections, and thereby the amount of RF equipment, techniques such as frequency-division multiplexing (FDM) are used.

Because the qubits are very fragile, it is necessary to use quantum error-correction techniques. These involve using ancilla qubits that keep track of the data qubits. Periodic readout of the ancilla qubits is done to ascertain if correction pulses need to be applied to the data qubits. Because qubit lifetime is measured in microseconds, the latency of this operation must be as low as possible. Practical systems can achieve this in few hundreds of nanoseconds. The ability to quickly send correction pulses to the qubits determines how many gates can be performed within the lifetime of the qubit. Latency of the feedback signal is crucial.

S17. Óptica Cuántica y Óptica No Lineal (GEOCONL)

Organizadores:
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S17. Quantum Optics and Nonlinear Optics (GEOCONL)

Organizers:

Ramón Vilaseca, Universitat Politècnica *de Catalunya*
Eugenio Roldán, *Universitat de València*

The symposium is organized by the Quantum Optics and Nonlinear Optics Group (GEOCONL) of the RSEF. It is dedicated to theoretical and experimental developments in the study of the nature of light and its interaction with matter, when quantum and/or nonlinear optical phenomena occur. It includes quantum states of light, coherence effects, physics of lasers and amplifiers, nonlinear and multi-photon processes, nonlinear materials, ultra-short and/or ultra-intense light pulses and high harmonic generation, applications of quantum phenomena and nonlinear photonics, etc."

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ID: 04142, 17/07/2019 15:13 - 17/07/2019 15:38, Room 1.4 (first floor)

S17. Quantum and Non-Linear Optics (GEOCONL)

(Invited Symposio)

Theoretical methods for attosecond molecular dynamics

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One of the most successful strategies to track electron dynamics in matter is the use of pump-probe setups, where the availability of attosecond time resolution is the key requirement, rather than the production of ultrashort pulses. Typical gas-phase experiments use an attosecond pulse train or a single pulse in the VUV/XUV region triggering excitation or ionization, whose dynamics is then probed by a time-delayed IR field or, ideally, by a second VUV/XUV pulse. We theoretically examine the relevance of electron-electron and electron-nuclear correlation in experiments using XUV/IR pump-probe protocols, where the XUV ionizes a molecule into a coherent superposition of ionic states and the IR field traces the dynamics. An accurate description of the coupled electron-nuclear motion is a requirement when light atoms are involved as proven in a recent joint experimental-theoretical study employing a RABBITT (reconstruction of attosecond beating by interference of two-photon transitions) technique in H_2 [1]. We then discuss recent applications using more complex molecules.

Furthermore, novel strategies using single chirped VUV/XUV pulses or pairs of identical attosecond pulses to trace the ultrafast electron-nuclear dynamics are also discussed. Typical attosecond pulses are not produced with a flat spectral phase (i.e. as transform-limited pulses), but have an intrinsic chirp that can be manipulated using dispersive optical elements. Realistic single chirped UV pulses can be thus employed to retrieve time-resolved images of molecular wave packets with attosecond resolution, by controlling the relative arrival times of different frequencies, i.e. using the chirp parameter as a control knob. This strategy could provide an alternative to the long-awaited UV-pump/UV-probe attosecond schemes [2].

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ID: 03865, 17/07/2019 15:38 - 17/07/2019 15:51, Room 1.4 (first floor)

S17. Quantum and Non-Linear Optics (GEOCONL)

(Oral)

Light with Self-Torque: Extreme-Ultraviolet Pulses with Time-Dependent Orbital Angular Momentum

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Light beams carrying orbital angular momentum (OAM) are well known due to their powerful capabilities for applications in many fields: optical communications, microscopy, quantum optics or microparticle manipulation [1]. Here we introduce a new class of light beams that possess a unique property associated with a temporal variation of their OAM: the self-torque of light [2]. Self-torque is found in other physical systems that can self-induce a temporal variation of their angular momentum but, until now, it was not even realized that light could possess self-torque.We define the self-torque of light as $\xi=dL(t)/dt$, $L(t)$ being the inherent OAM variation along a pulse.

In this work, we theoretically predict, and experimentally validate, that self-torque naturally arises in extreme-ultraviolet (EUV) beams generated through the extreme nonlinear process of high-harmonic generation (HHG), when driven by two time-delayed infrared pulses carrying different OAM (Fig. 1a). The dynamical HHG process imprints a “continuous” temporal OAM variation into the EUV pulses, where all intermediate OAM states are present (Fig. 1b). The excellent agreement between our quantum simulations and experiments (Fig. 1c) confirms the creation of EUV self-torqued beams, where the amount of self-torque can be precisely controlled via the time delay and duration of the driving pulses. Our work not only presents and confirms an inherently new property of light beams, but also opens up a route for the study of systems with time-varying OAM. In addition, thanks to their ultrafast nature, EUV self-torqued beams can be extraordinary tools for laser-matter manipulation on attosecond time and nanometer spatial scales.

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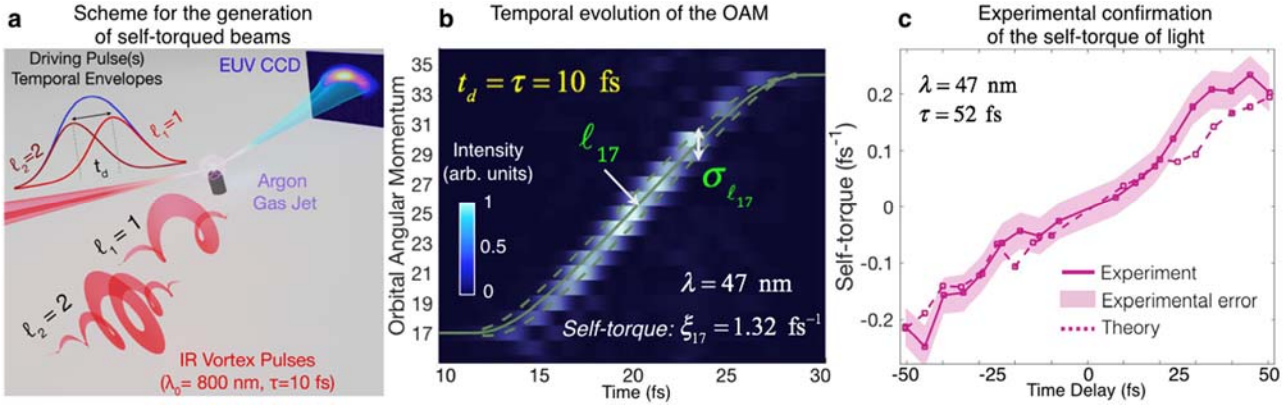
a
Scheme for the generation of self-torqued beams
Driving Pulse(s) Temporal Envelopes
EUV CCD
Argon Gas Jet
IR Vortex Pulses (λ_0= 800 nm, τ=10 fs)
b
Temporal evolution of the OAM
$t_d = \tau = 10$ fs
Intensity (arb. units)
Orbital Angular Momentum
$\lambda = 47$ nm
Self-torque: $\xi_{17} = 1.32$ fs^{-1}
Time (fs)
c
Experimental confirmation of the self-torque of light
$\lambda = 47$ nm
$\tau = 52$ fs
Self-torque (fs^{-1})
Experiment
Experimental error
Theory
Time Delay (fs)

ID: 03880, 17/07/2019 15:51 - 17/07/2019 16:04, Room 1.4 (first floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Oral)

Efficiency optimization of coherent extreme-ultraviolet radiation through pulse shaping in high harmonic generation

Roberto Boyero-García[1] , Luis Plaja[1] , Henry C. Kapteyn[2] , Margaret M. Murnane[2] , Carlos Hernández-García[1]

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** Roberto Boyero-García, robertobg@usal.es*

High harmonic generation (HHG) stands as a unique nonlinear source of coherent extreme-ultraviolet (EUV)/soft x-ray radiation [1-3]. The use of 13 nm coherent sources is of particular interest for materials science and the imaging of nanofabricated devices. When combined with diffractive imaging techniques, spatial resolution in the nanometer scale can be achieved, and thus wavelength-limited nano-imaging can be performed. Though HHG radiation exhibits an excellent coherence –both temporally and spatially–, when compared to other sources as x-ray free electron lasers, its flux is considerably weaker.

In this work we study the optimization of the 13 nm HHG source, based on phase-matching engineering and pulse shaping of the driving field. The coherent build-up of the harmonic signal in extended targets, such as gas-filled waveguides, determines the available harmonic flux. Based on time-dependent phase-matching [4], we perform HHG simulations in different gas-filled waveguides (argon, neon, helium), at different driver wavelengths (from 0.8 μm to 2.0 μm), to optimize the phase-matched 13 nm signal. In addition, we have optimized the phase mismatch produced by the influence of the intrinsic phase of each harmonic using a semiclassical approach. Our simulations demonstrate that this pre-compensation results in an increase of the harmonic efficiency conversion. Using this information, we have developed a genetic algorithm to optimize HHG through modifications of the driver pulse. Our results show that the 13 nm (92 eV) harmonic yield can be increased by several orders of magnitude, paving the way to obtain intense EUV radiation through HHG.

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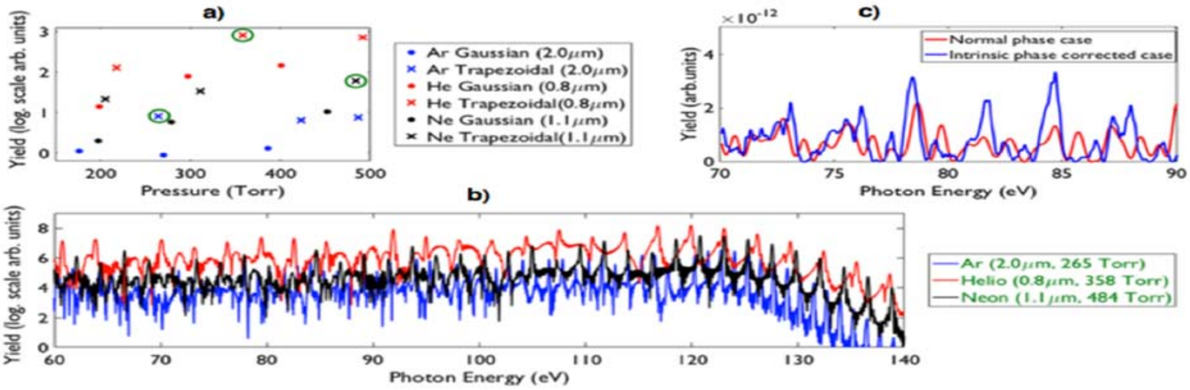
a)
Yield (log. scale arb. units)
Pressure (Torr)
Ar Gaussian (2.0μm)
Ar Trapezoidal (2.0μm)
He Gaussian (0.8μm)
He Trapezoidal(0.8μm)
Ne Gaussian (1.1μm)
Ne Trapezoidal(1.1μm)
c)
Normal phase case
Intrinsic phase corrected case
Yield (arb.units)
Photon Energy (eV)
b)
Yield (log. scale arb. units)
Photon Energy (eV)
Ar (2.0μm, 265 Torr)
Helio (0.8μm, 358 Torr)
Neon (1.1μm, 484 Torr)

ID: 03871, 17/07/2019 16:04 - 17/07/2019 16:17, Room 1.4 (first floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Oral)

Polarization control of non-perturbative high-order harmonics in gapless graphene

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High harmonic generation (HHG) in atomic or molecular targets stands as a robust mechanism to produce coherent ultrashort pulses with controllable polarization in the extreme-ultraviolet. Several techniques have recently succeeded in generating elliptically and circularly polarized harmonics in atomic gases, using rather sophisticated configurations. High density targets, such as crystalline solids, have become increasingly interesting due to their higher efficiency in harmonic conversion and the flexible design of target geometries. Among solid targets, single layer graphene is of special interest due to its particular electronic structure, which conveys unique optical properties. Recent reports revealed that HHG in graphene is enhanced by elliptically polarized excitations, and that circular-polarized harmonics can be obtained from circular-polarized drivers. In this work we present a detailed theoretical study of the polarization characteristics of the harmonics induced by a few-cycle infrared laser pulse, as a function of the driver polarization parameters. Our results demonstrate an extraordinarily complex photon-spin conversion, leading to a rich scenario for harmonic polarization control: optical rotation, tunable polarization and ultrafast transient polarization (see figure) [1]. In addition, our results reveal that the harmonic pulses are produced with femtosecond time-varying ellipticity, thus showing the ultrafast change of the harmonic polarization state. We believe that our work represents a significant step forward in the investigation of the optical nonlinear response of graphene, providing the key results to control and tailor the polarization properties of high-frequency pulses towards the extreme-ultraviolet regime.

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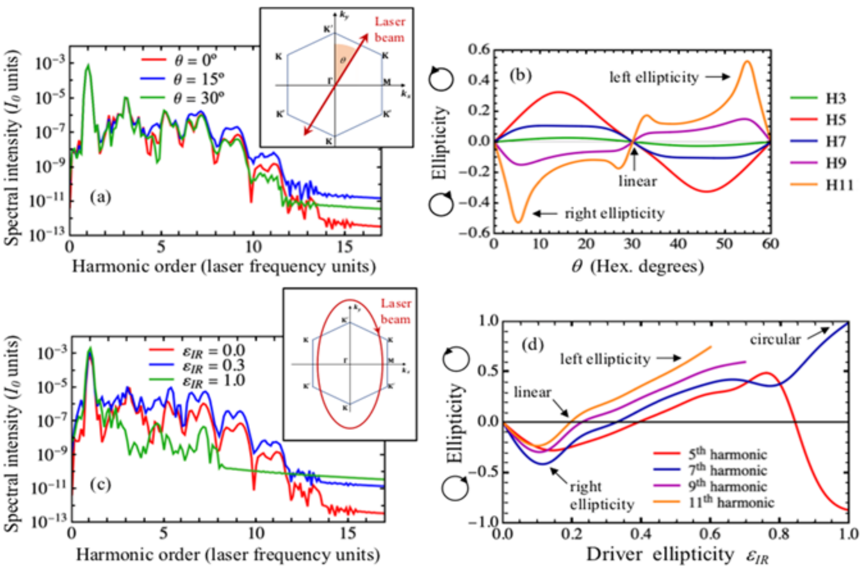

ID: 04027, 17/07/2019 16:17 - 17/07/2019 16:30, Room 1.4 (first floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Oral)

Optomechanical locking of a non-degenerate optical parametric oscillator

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Optical parametric oscillators (OPO's) are the most important sources of squeezed and continuous-variable entangled optical states, which are essential in quantum technologies like metrology and continuous-variable quantum information.

OPO's are based on parametric down-conversion and can be either non-degenerate (signal and idler modes have different frequencies) or degenerate (the signal and idler modes are the same), and the quantum properties of the emitted light turn out to be very different in the two cases. The degenerate case (DOPO) produces quadrature squeezed light close to the emission threshold, while the non-degenerate OPO produces entangled states between the two involved modes above oscillation threshold: the difference between signal and idler intensities displays fluctuations below vacuum level, while the phase difference between the signal and idler modes diffuses, which is at the origin of this essential difference between the degenerate and non-degenerate cases.

In this work we are proposing a way to lock the signal and idler modes' phases in a non-degenerate OPO, which consists in using an optical cavity containing an oscillating end-mirror (hence an optomechanical cavity) whose resonance is close to the frequency difference between signal and idler modes.

We consider the special case in which the moving end-mirror is externally and resonantly driven. We will show that this type of driving leads to a phase-bistable, phase-locked stable solution above threshold as a consequence of a phase-sensitivity in the system. The most important result is that below threshold, high levels of quadrature squeezing are predicted, the larger when the mechanical driving is strong and at resonance with the frequency difference between signal and idler. In other words, the resonant forcing of the moving end-mirror can convert the non-degenerate OPO into a source of quadrature squeezing, and this in two different modes, signal and idler, simultaneously.

ID: 04136, 17/07/2019 17:30 - 17/07/2019 17:55, Room 1.4 (first floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Invited Symposio)

Many-body bosonic models in quantum simulators subject to particle non-conserving processes

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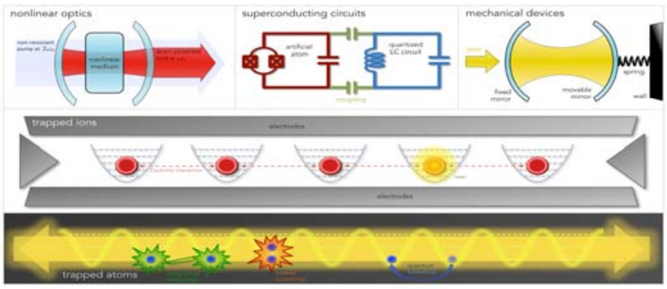
Many-body bosonic Hamiltonians are a cornerstone of condensed-matter physics. On the other hand, quantum simulators, that is, quantum-controlled atomic, optical, or solid-state experimental platforms, hold the promise to explore such models with a degree of precision and flexibility unthinkable in real materials.

Common Hamiltonians emerging in condensed-matter preserve the number of particles. In contrast, quantum simulators are intrinsically driven-dissipative systems, where processes that break particle-number conservation can be naturally induced either coherently or incoherently. We explore the physics of the extended Bose-Hubbard model under the action of down-conversion-type Hamiltonians which break particle-number conservation, but keep interesting Z_2 or U(1) symmetries. The bare model accounts for tunneling and interactions between neighbours and on-site interactions, and presents a variety of phases ranging from superfluid to insulating (Mott, density-wave, and Haldane types). We show that the addition of down-conversion terms potentially adds more phases, e.g., predicting Ising-type spontaneous symmetry breaking or supersolid behavior under certain conditions.

As a side-product, we study general quadratic bosonic Hamiltonians, whose understanding is useful prior to adding interactions. In contrast to fermionic models, the particle-non-conserving terms can make the Hamiltonian turn from stable (bounded) to unstable (unbounded), with standard Bogoliubov theory covering only the former. We generalize such theory, providing a transformation for any Hamiltonian to a combination of just harmonic oscillators and resonant down-converters, which allow to understand the physics of the model in a very clean and meaningful fashion.

We discuss potential implementations of our ideas in modern quantum-controlled platforms such as trapped atoms and ions, nonlinear optics, superconducting circuits, and mechanical devices, examples of which are depicted in the figure.



ID: 03861, 17/07/2019 17:55 - 17/07/2019 18:08, Room 1.4 (first floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Oral)

Vortex trapping and steering by means of Nonlinear Bessel Beams in nonlinearly absorbing Kerr media.

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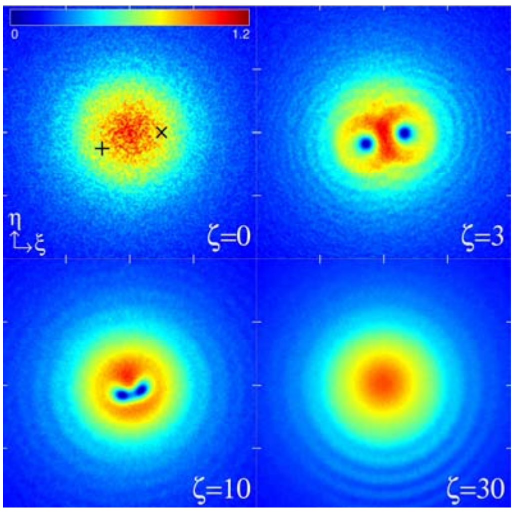
2) Universitat Politècnica de València

** José Luis García Riquelme, jluis.garcia@upm.es*

Recent developments in complex light optics have brought great interest in mechanisms to control the motion of vortices during propagation, as vórtices present diverse applications such as particle trapping, wave guiding or classical and quantum communications. Nonlinear Bessel Beams (NBB) produced in self-focusing or self-defocusing Kerr media that also present multiphoton absorption, are shown here to propagate stably without any attenuation and to be able to attract and guide an arbitrary number of vortices. NBBs create an effective attraction basin in their propagation axis by which any number of vortices placed at arbitrary positions in the beam cross section steer towards the center and combine together, forming a new high-order,vortex NBB with total topological charge equal to the sum of the individual charges of the vortices attracted, and whose propagation is extremely robust against perturbations.The fundamental laws that govern the attraction and subsequent mode conversion of the attracting NBB are found to be the preservation of the topological charge and of the inward-directed power current that sustains the stationary propagation.

Typical configurations of interest as vortex trapping, vortex combination, and annihilation of vortex dipoles and speckle fields are presented. The figure shows the spontaneous annihilation of a vortex dipole placed in a NBB propagating in a self-defocusing Kerr medium. Some immediate applications would be the creation of stable, multiply charged vortices without tight alignment
requirements but by spontaneous vortex combination, the mixing of waves or particles that the vortices can guide, the fast annihilation of vortex dipoles, and cleaning of speckled beams by massive annihilation of vortices.

We also show that the trapped vortices in a NBB can be decoupled from it by means of one or more, more intense NBBs travelling parallel to the original vortex-carrying NBB, to whose deeper attraction basins the vortices are directed and coupled.



ID: 04111, 17/07/2019 18:08 - 17/07/2019 18:21, Room 1.4 (first floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Oral)

Phase locked harmonic generation in the opaque region of GaAs

Laura R. Suñé[1] , Jose Trull[1] , Michael Scalora[2] , Ramon Vilaseca[1] , Crina Cojocaru[1]

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** Crina Cojocaru, crina.maria.cojocaru@upc.edu*

When an intense laser beam is tuned in the transparency region of a generic nonlinear crystal, three components of second (SH) harmonic signal are generated: one backward, in reflection and two forward, in transmission. The first transmitted SH component comes from the homogeneous solution of the nonlinear equation and travels with the group velocity and absorption coefficient according to material dispersion at the SH wavelength. The second component corresponds to the inhomogeneous solution and it propagates with the same phase velocity and absorption coefficient as the fundamental beam, regardless of the material dispersion. This component is known as “phase locked” (PL) harmonic component. These two components of the SH can only be distinguished under particular working conditions and were measured first in transparent materials [1]. Later it was demonstrated that the PL phenomena leads to the inhibition of linear absorption of the harmonics, when the pump is tuned to a transparency region and the harmonics well below the absorption edge of the nonlinear material. As a result, the PL SH component propagates inside the material under conditions of strong absorption, in the opaque region of the spectrum. [2,3]

In this work we study the generation of the PL SH generation in the opaque region of GaAs, combining measurements in reflection and in transmission. Our aim is to infer the different mechanisms leading to SH generation and identify different surface and bulk nonlinear sources. We contrast our experimental results with numerical simulations, using a hydrodynamic model that accounts for all salient aspects of the dynamics, including surface and bulk generated harmonic components. In the figure below we display the dielectric constant of GaAs (a) and the SH efficiencies in transmission: simulation results (b) and experimental results (c). Although the PL harmonic generation in absorbing materials has a very low efficiency, it becomes especially interesting because of the many potential applications that semiconductors find in optical technology.

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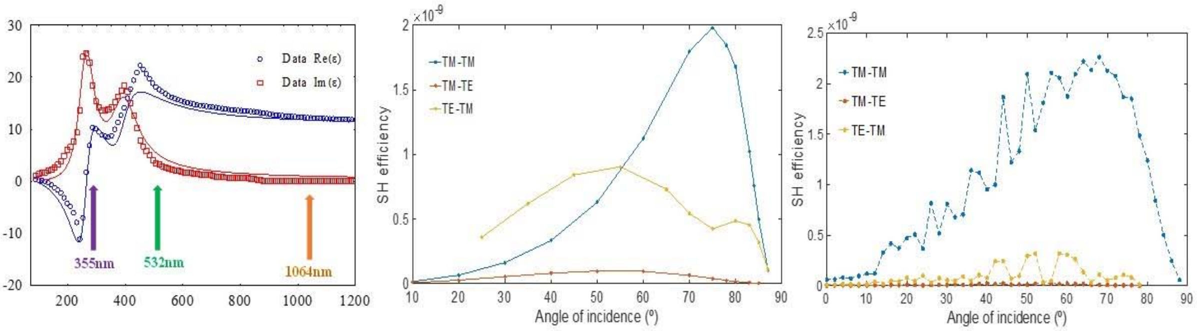

(a) Dielectric constant of GaAs (b) Transmitted PL SH - simulation (c) Transmitted PL SH - experiment

ID: 03889, 17/07/2019 18:21 - 17/07/2019 18:34, Room 1.4 (first floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Oral)
Nonlinear Propagation of Vector Beams in Hollow-Core Fibers

Aurora Crego[1] , Íñigo Sola[1] , Benjamín Alonso[1] , Warein Holgado[1] , Julio San Román[1] , Enrique Conejero Jarque[1]

1) University of Salamanca

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The generation of ultrashort laser pulses with space-varying polarization distributions have drawn attention during the last decade for their special features and their applications. Vector beams can reach high peak powers due to the tighter focusing, which turns them into a useful tool for high-resolution microscopy, material processing, particle trapping, particle acceleration, etcetera [1]. To generate ultrashort laser beams, the standard post-compression scheme is based on the nonlinear propagation of a pulse inside a hollow-core fiber (HCF) filled with gas [2], where the Kerr effect induces the spectral broadening that is necessary to obtain short pulse durations.

In this work we have studied the nonlinear propagation of azimuthally and radially polarized beams inside a HCF filled with gas. We have developed a theoretical (2+1)D model based on the nonlinear Schrödinger equation which includes all the spatio-temporal effects that appear during the nonlinear propagation of the pulse inside the HCF. In the experiment, we have coupled azimuthally and radially polarized laser pulses from a Ti:Sapphire laser system (100 fs, ~400 microJ, 800 nm) into a gas-filled HCF. We have observed that the polarization structure of the vector beams is conserved after nonlinear propagation in the HCF, as can be seen in Fig. 1. The analysis of the output intensity pattern gives a good agreement with the theoretical model [3]. These results pave the way to the generation of few-cycle vector beams in the near infrared.

References

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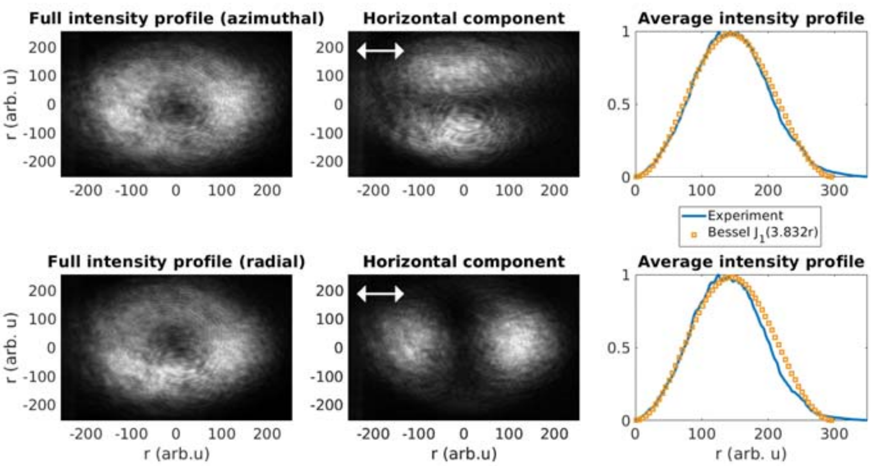

ID: 04051, 17/07/2019 18:34 - 17/07/2019 18:47, Room 1.4 (first floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Oral)

Quantum sensing using imbalanced counter-rotating Bose-Einstein condensate modes

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Overcoming the current limits of sensing technologies is one of the main challenges of modern physics, opening the door to high-precision measurements of fundamental constants, as well as to applications in many different areas of science. In particular, the extraordinary degree of control of ultracold atomic systems makes them ideal platforms for precision measurements [1]. We propose a novel device to measure with high precision non-linear interactions, scalar magnetic fields and rotations [2]. It consists of an imbalanced superposition of the orbital angular momentum modes of a Bose-Einstein condensate (BEC) in a ring trap with opposite winding numbers, for which a line of minimum atomic density appears. A weak two-body interaction between the atoms of the BEC leads to a rotation of the line of minimum atomic density whose angular frequency is directly related to the strength of such interactions. We derive an analytical expression that relates the angular rotation frequency of the minimum density line with the strength of non-linear atomic-atomic interactions and the difference between the populations of the counter-propagating modes. In addition, we propose a complete experimental protocol based on direct fluorescence imaging of the BEC that allows to measure all the quantities involved in the analytical model and to use the system for detection purposes.

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ID: 03704, 17/07/2019 18:47 - 17/07/2019 19:00, Room 1.4 (first floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Oral)

Optimal control theory for quantum electrodynamics: an initial state problem

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2) Max Planck Institute for the Structure and Dynamics of Matter and Center, Hamburg (Germany)
3) Max Planck Institute for the Structure and Dynamics of Matter and Center, Hamburg (Germany); Center for Computational Quantum Physics (CCQ), Flatiron Institute; Nano-Bio Spectroscopy Group, Universidad del País Vasco

** Alberto Castro, acastro@bifi.es*

In conventional quantum optimal control theory, the parameters that determine an external field are optimised to maximise some predefined function of the trajectory, or of the final state, of a matter system. The situation changes in the case of quantum electrodynamics, where the degrees of freedom of the radiation field are now part of the system. In consequence, instead of optimising an external field, the optimal control question turns into a optimisation problem for the many-body initial state of the combined matter-photon system. In the present work, we develop such a optimal control theory for quantum electrodynamics. We derive the equation that provides the gradient of the target function, which is often the occupation of some given state or subspace, with respect to the control variables that define the initial state. We choose the well-known Dicke model to study the possibilities of this technique. In the weak coupling regime, we find that Dicke states are the optimal matter states to reach Fock number states of the cavity mode with large fidelity, and vice versa, that Fock number states of the photon modes are the optimal states to reach the Dicke states. This picture does not prevail in the strong coupling regime. We have also considered the extended case with more than one mode. In this case, we find that increasing the number of two-level systems allows to reach a larger occupation of entangled photon targets.

Parallel generation of vortex beams with a two dimensional optimal triplicator geometric phase design

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2) Departamento de Ciencias Físicas, Universidad de La Frontera, Temuco, Chile
3) Departamento de Ciencia de Materiales, Óptica y Tecnología Electrónica. Universidad Miguel Hernández de Elche. 03202 Elche, Spain

** David Marco Castillo, davidmarco1991@gmail.com*

In Orbital Angular Momentum (OAM) multiplexing it is key to develop efficient systems for detecting and generating equally intense vortex beams with different topological charges [1]. Dammann vortex gratings have been used to generate equi-intense vortices, nevertheless other grating profiles offer better efficiency. In this work we design a grating based on a continuous phase-only profile that generates three orders with equal intensity and maximum diffraction efficiency (η=93%) derived by Gori et al. [2]. We present the design and characterization of a liquid-crystal geometric phase diffraction grating. This grating creates a bidimensional array of 3x3 diffraction orders, obtained by combining two phase-only Gori's triplicators, one along the horizontal direction and another along the vertical direction. In addition, spiral phases of charges ℓ=1 and ℓ=3 were embedded in each direction. As a result, the grating generates in these nine diffraction orders vortex beams of topological charges that range from ℓ=-4 to ℓ=+4. Figure (a) shows the phase values of our grating as a grayscale image. The phase values are encoded as a geometric phase in the fabricated element. Figure (b) shows the diffracted field when the grating is illuminated with linearly and right circularly polarized light. For input linear polarization there are two sets of diffraction orders with different polarization. We prove that this is a consequence of Gori's triplicator design, that includes a π /2 phase shift between the central order and the lateral orders [3], which was not reported before. We show that this grating can also be used as a vortex beam detector, where the charge is detected by seeking the diffraction order where the singularity is cancelled.

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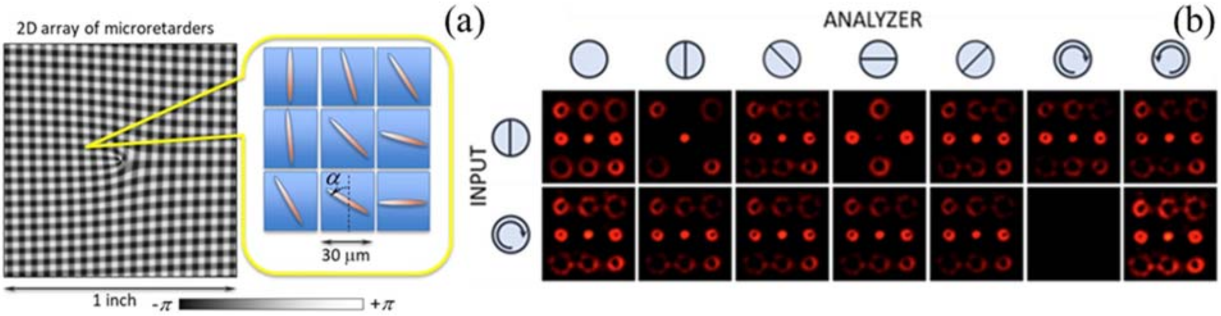

ID: 03804, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Poster)

Structured Ultrafast Attosecond Pulses With Controllable Spin and Orbital Angular Momentum

Laura Rego[1] , Kevin M. Dorney[2] , Emilio Pisanty[3] , Julio San Román[1] , Nathan J. Brooks[2] , Chen-Ting Liao[2] , Jennifer Ellis[2] , Quynh L. Nguyen[2] , Justin M. Shaw[4] , Antonio Picón[5] , Maciej Lewenstein[3] , Luis Plaja[1] , Henry C. Kapteyn[2] , Margaret M. Murnane[2] , Carlos Hernández-García[1]

1) University of Salamanca (Spain)
2) JILA, University of Colorado at Boulder (USA)
3) ICFO Institut de Ciencies Fotoniques (Spain)
4) National Institute of Standards and Technology NIST (USA) 5) Universidad Autónoma de Madrid (Spain)

** Carlos Hernandez-Garcia, carloshergar@usal.es*

Angular momentum can be routinely transferred to visible/infrared (IR) light beams using waveplates, or spatial light modulators, among other techniques. However, it becomes a lot harder in the extreme-ultraviolet (EUV) and x-ray regimes, where those techniques are inefficient. This challenging goal is very much worth the effort: imprinting spin (SAM) and/or orbital (OAM) angular momentum into the EUV/x-ray regimes will bring the applications of structured light down to the nanometric and ultrafast scales. The extreme nonlinear frequency upconversion of an intense IR femtosecond laser pulse through high harmonic generation (HHG) is an established technique capable of providing short-wavelength ultrafast coherent radiation. T

This talk reviews our recent work in the generation of coherent, EUV high-harmonic beams—and attosecond pulses—with full, simultaneous control of both spin angular momentum (SAM) *and* orbital angular momentum (OAM) [1, 2]. By harnessing the quantum coherence of HHG, we uncover a new form of all-optical SAM-OAM interplay showing, experimentally and theoretically, that this phenomenon allows for unprecedented control over the polarization and vortex charge of attosecond EUV vortex beams. This work opens the route to perform ultrafast studies of magnetic materials and chiral systems, among others.

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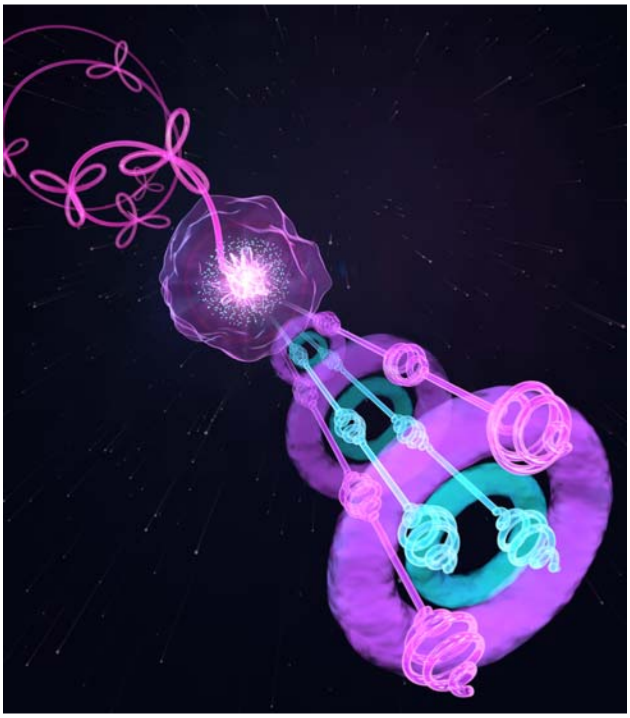

ID: 03872, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Poster)

Nonclassicality as an alternative resource for quantum metrology

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Quantum fluctuations impose fundamental limits to the sensitivity of the detection of weak signals. The aim of our work is to optimize detection processes to increase the sensitivity achievable for fixed resources. We analyze a general metrological scheme where the signal to be measured is encoded by a different transformation in each case, and the Fisher Information is used to quantify the minimum variation detectable [1].

We have seen that energy could be a not as convenient resource as it was thought [2]. Contradictory results in the relation between the energy involved and the minimum uncertainty achievable have been found for linear transformations. We examine whether nonclassicality is a more useful account of resource [3]. Moreover, for completeness we include all the resources employed in the full measurement process including the final measurement performed. We specifically use gaussian states for modeling both probe and detector states for their practical value and in order to easily quantify the nonclassicality. In addition, we analyze the contribution of the squeezing of measurement states to the total amount of nonclassicality of the process finding an optimum relation to the squeezing of the probe state.

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ID: 03821, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Poster)

Nonlinear Bessel vortex beams: Robust vortices of arbitrary topological charge in self-focusing Kerr media

Márcio Carvalho[1] , José Luis García-Riquelme[1] , Carlos Ruiz-Jiménez[1] , Miguel Ángel Porras[1]

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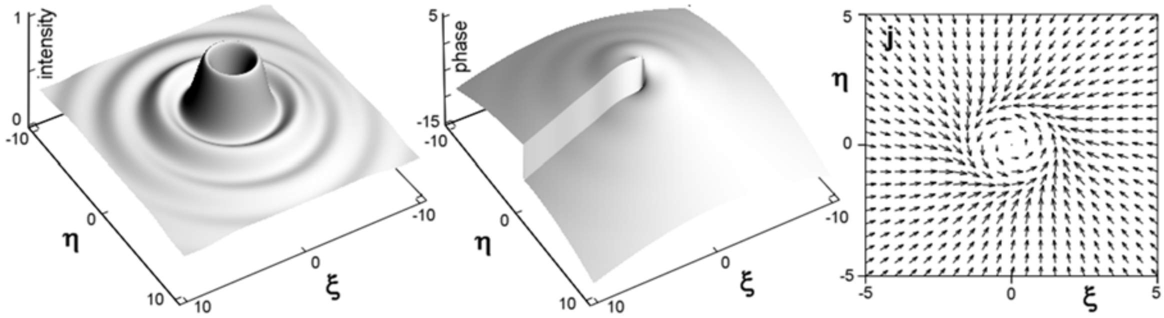
We describe nonlinear Bessel vortex beams as localized and stationary solutions with embedded vorticity to the nonlinear Schrödinger equation with a dissipative term that accounts for the multi-photon absorption processes taking place at high enough powers in common optical media. In these beams, power and orbital angular momentum are permanently transferred to matter in the inner, nonlinear rings, at the same time that they are refueled by spiral inward currents of energy and angular momentum coming from the outer linear rings, acting as an intrinsic reservoir. The Figure shows an example of the intensity, phase and energy current in the transversal plane of a nonlinear Bessel vortex beam. Unlike vortex solitons and dissipative vortex solitons, the existence of these vortex beams does not critically depend on the precise form of the dispersive nonlinearities, as Kerr self-focusing or self-defocusing, and do not require a balancing gain. They have been shown to play a prominent role in "tubular" filamentation experiments with powerful, vortex-carrying Bessel beams, where they act as attractors in the beam propagation dynamics. Nonlinear Bessel vortex beams provide indeed a new solution to the problem of the stable propagation of ring-shaped vortex light beams in homogeneous self-focusing Kerr media. A stability analysis demonstrates that there exist nonlinear Bessel vortex beams with single or multiple vorticity that are stable against azimuthal breakup and collapse, and that the mechanism that renders these vortices stable is dissipation. The stability properties of nonlinear Bessel vortex beams explain the experimental observations in tubular filamentation experiments.



ID: 04012, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Poster)

Estabilidad y evolución del espectro de una fuente de Supercontinuo

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El Supercontinuo (SC) es un tipo de espectro con una anchura extraordinariamente amplia. Por ello, tiene muchas aplicaciones, en campos como las comunicaciones, el análisis espectral de explosivos y de sustancias biológicas, y en la caracterización espectral de dispositivos ópticos [1].

Últimamente hemos desarrollado una fuente de SC con unas buenas propiedades espectrales, basada en fibras de salto de índice altamente no lineales [2]. En esta línea, nos hemos centrado en la optimización del espectro consiguiendo una anchura de una octava (entre 1100 y 2200 nm), así como en estudiar sus potenciales aplicaciones [3, 4].

Presentamos aquí un estudio de la evolución del SC frente a diversos parámetros. Por un lado, tenemos medidas de estabilidad a lo largo del tiempo, mostrando una estabilidad comparable a la de la propia fuente láser. Además, se ha hecho un estudio de la estabilidad para diferentes longitudes de onda y potencias de bombeo. Para completar el estudio, se ha analizado la evolución del SC para diferentes longitudes de fibra, comparándolo con los espectros para diferentes potencias de bombeo. De estas medidas puede extraerse información muy interesante acerca de los mecanismos que forman el SC. Los resultados muestran una fenomenología muy amplia, dando lugar al espectro SC con unas propiedades destacables. Todos estos fenómenos constituyen una buena colección de los efectos que se pueden obtener en Óptica No Lineal.

Este trabajo ha sido financiado por la Diputación General de Aragón, Dirección General de Investigación e Innovación (T20_17R).

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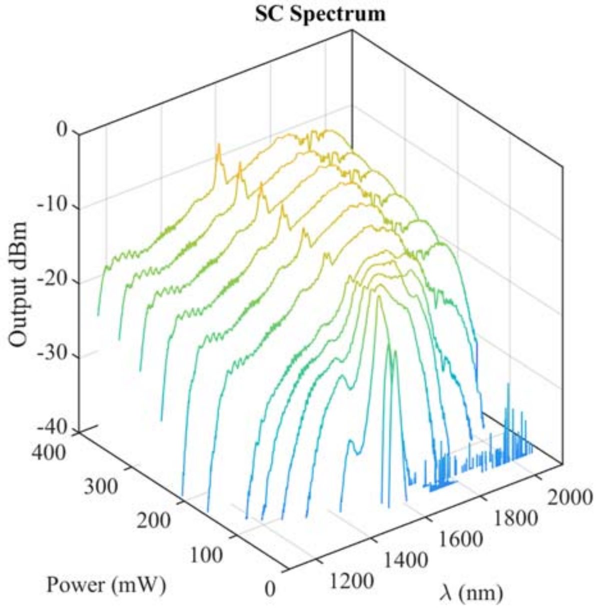
SC Spectrum
Output dBm
0
-10
-20
-30
-40
400
300
200
100
0
Power (mW)
1200
1400
1600
1800
2000
λ (nm)

ID: 04072, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S17. Quantum and Non-Linear Optics (GEOCONL)
(Poster)

Interferometric Transient Detection Imaging in a Photorefractive Crystal

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In this work, we report experimental results on differential phase detection of moving objects by combining Transient Detection Imaging, first proposed by Cudney et al. [1], with Interferometry, showing the direct measurement of phase changes without need of calibration, as well as improving measurement contrast, especially important for low power signals. Therefore, this work opens up new possibilities on transient phase detection and its applications [2].
The experimental set up is based on a single frequency solid-sate frequency-doubled Nd:YVO_4 laser emitting at 532 nm with horizontal polarization, and a SBN photorefractive crystal. The main laser beam is split into a signal beam, a pump beam and a reference beam. The signal and pump beams intersect in the nonlinear crystal with the c-axis oriented in order to get energy transfer from signal to pump. Therefore, the transmitted signal beam contains the images of only the moving objects on the test slide. The test is imaged on crystal and directly imaged into a CCD camera. The complex field is obtained through interference between the signal and reference beam at an angle. The phase of moving object is retrieved by cutting away all except one of the diffraction orders and inverse Fourier transformation. Figures 1 shows examples of interferograms and differential phase measurements for both static and moving object (squared phase object). The phase measurement of moving object shows the differential phase of 2.6 rad, between initial and final position of object, corresponding to phase change of object respect to background of 1.3 rad.

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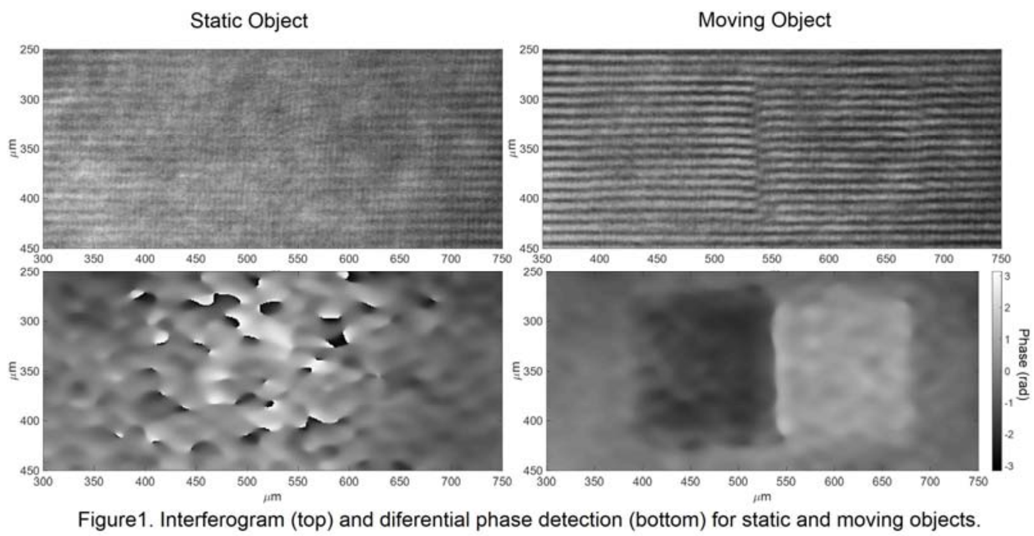

Figure1. Interferogram (top) and diferential phase detection (bottom) for static and moving objects.

S18. Física de Plasmas (GEFP)

El Simposio de Física de Plasmas pretende ser punto de encuentro de los investigadores de todas las edades e instituciones dentro y fuera de España que realicen su investigación en los distintos y numerosos campos que abarca tal área científica. Está abierto a contribuciones de carácter teórico, experimental y tecnológico; a plasmas de todos los grados de energía, desde plasmas fríos a plasmas de fusión, y a todos los aspectos relacionados con este tema.

Organizadores:

Isabel Tanarro, *IEM-CSIC*
Francisco L. Tabarés, *CIEMAT*
Nerea Bordel, *Universidad de Oviedo*
José Muñoz, *Universidad de Córdoba*

S18. Plasma Physics (GEFP)

The Symposium of Plasma Physics aims to be a joint opportunity for researchers of all ages and from all institutions working in the different and widespread fields covered by this scientific area in Spain and in other countries. It is open to theoretical, experimental and technological contributions; to plasmas of all energies, from cold plasmas to fusion plasmas, and to all issues related with this subject.

Organizers:

Isabel Tanarro, *IEM-CSIC*
Francisco L. Tabarés, *CIEMAT*
Nerea Bordel, *Universidad de Oviedo*
José Muñoz, *Universidad de Córdoba*

ID: 03850, 15/07/2019 15:00 - 15/07/2019 15:30, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Invited Symposio)

Low Temperature Plasmas for the Tailored Fabrication of Nanostructured Thin Film Materials

Aurelio García-Valenzuela[1] , Rafael Alvarez[1] , Carmen López-Santos[1] , Victor Rico[1] , Ana Borrás[1] , Jose Cotrino[1] , Alberto Palmero[1] , Agustín R. González-Elipe[1]

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Los temperature plasmas are the basis for a large variety of material processing technologies, including thin film deposition techniques or surface functionalization methodologies. Although, in general, the energetic species of the plasmas contribute to the densification of the deposited layers, there are ways to use plasmas for the synthesis of nanostructured and porous thin films. This work illustrates various possibilities for the fabrication of this type of materials, provided that some key parameters of plasmas are modified during the deposition process. Among the various possibilities, the present talk illustrates the effect of the deposition geometry and the use patterned substrates and template structures to tailor the thin film nanostructure. Basic concepts involved in the nanostructuration mechanisms such as shadowing effects of deposited particles, the occurrence of scattering events in the plasma gas or the preferential impingement of ion species along given directions [1] will be discussed within the frame of two classical thin film growth methodologies, magnetron sputtering and plasma enhanced chemical vapour deposition [2]. For these two techniques, it will be shown how the modification of experimental conditions and working parameters enable a precise control at the nanoscale of the nanostructure and even the chemistry of the films. Some of these nanostructuration processes will be accounted for by the employ of Monte Carlo techniques to simulate the film growth. The possibilities of the cold plasma technique to tailor the nanostructure of materials will be illustrated with various application examples in the fields of sensors, electrodes and fuel cells.

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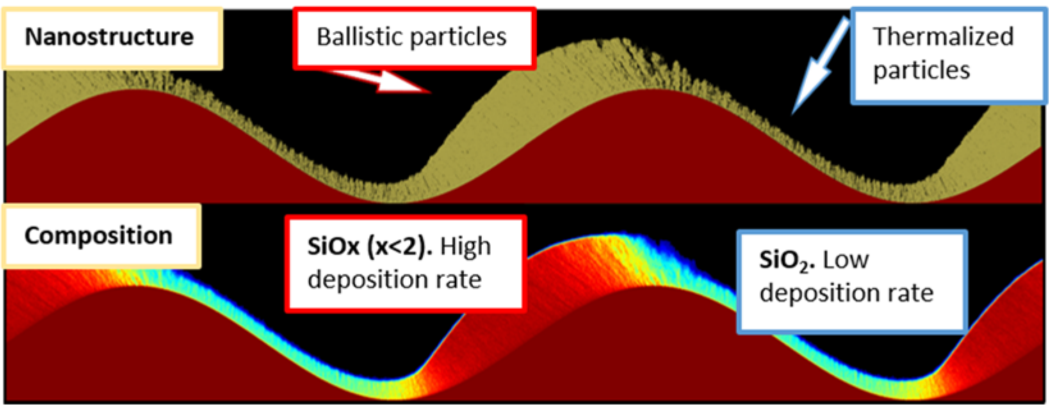

ID: 03763, 15/07/2019 15:30 - 15/07/2019 15:50, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

Corroboración de modelos de frenado de iones en plasmas altamente ionizados

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La pérdida de energía de iones al penetrar en materia se ha investigado durante más de un siglo [1-3], siendo de gran utilidad e interés en muchos campos científicos, como el tratamiento de tumores [4]. Se han realizado aproximaciones para predecir el comportamiento con altos estados de carga a bajas velocidades. Hoy en día el poder de frenado de iones en sólidos se comprende bien, al contrario que en plasmas; debido a la escasez de datos experimentales y a retos teórico-experimentales. Sin embargo, el uso de iones para calentar plasmas y la caracterización de plasmas con iones hacen necesario entender las interacciones entre haces de partículas y plasmas.

El poder de frenado de iones en plasmas de alta densidad es crucial en la fusión por confinamiento inercial (ICF), puesto que para calentar el plasma con iones se necesita una descripción precisa de la deposición energética, en las fases de ignición y combustión del combustible de deuterio-tritio.

Actualmente se investiga la deposición de energía de iones en plasmas de alta densidad, especialmente en proyectiles de baja-media energía [5-7], franja donde aparece un mayor poder de frenado. En esta región aún hay grandes discrepancias entre los modelos teóricos existentes sin poder corroborar dado que no se disponen de suficientes datos experimentales. Se presentan distintas simulaciones sobre la pérdida de energía de iones en un plasma de carbón altamente ionizado generado por láser. Los parámetros del plasma se han obtenido con simulaciones hidrodinámicas en dos dimensiones. Se muestran las diferencias en la predicción de la pérdida de energía entre los distintos modelos teóricos.

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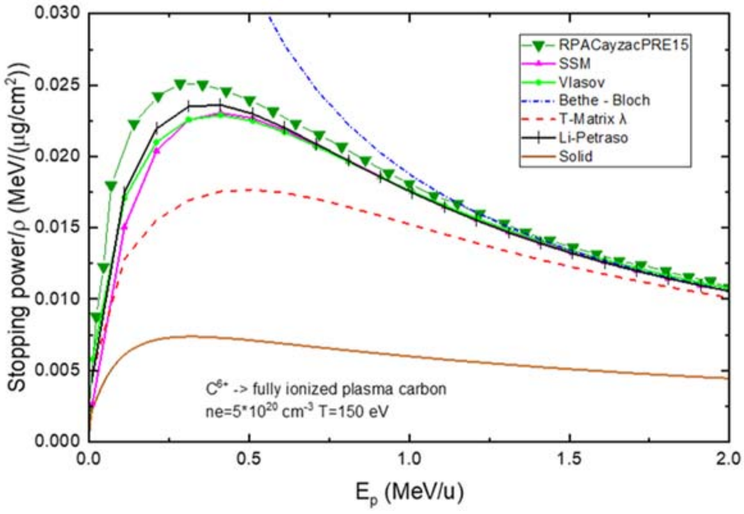

RPACayzacPRE15
SSM
Vlasov
Bethe - Bloch
T-Matrix λ
Li-Petraso
Solid
C^{6+} -> fully ionized plasma carbon
ne=5*10^20 cm^-3 T=150 eV
Stopping power/ρ (MeV/(μg/cm^2))
E_p (MeV/u)
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.0
0.5
1.0
1.5
2.0

ID: 04074, 15/07/2019 15:50 - 15/07/2019 16:10, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

Shock wave from exploding wire time evolution after energy deposition ending

Gonzalo Rodríguez Prieto[1] , Luis Bilbao Dates[2]

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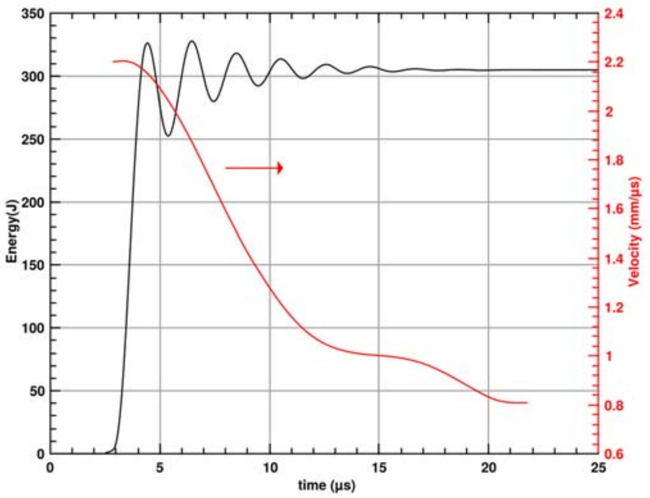
Shock waves can be created by means of explosive techniques to explore its properties in a controlled manner with different systems. One of them is the exploding wire system, where through a metallic cylinder with a very large length/radius ratio, typically on the order of 1~000, a very large electrical current passes. Typical currents are on the order of 100~000 amperes, and energy delivery time reaches microseconds. Due to Joule effect, the wire increases its temperature until in a final stage, reaches the plasma state. During the plasma and previous gaseous wire expansion, a shock is formed when the explosions take place in a suitable medium, like atmospheric air.

In the present work, the expansion velocities of shock wavers under diverse experimental conditions are measured, compared, and interpreted.



ID: 04004, 15/07/2019 16:10 - 15/07/2019 16:30, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

Estudio de plasmas LIBS con resolución espacial y temporal: distribución de la emisión atómica y molecular.

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La espectroscopía de plasmas inducidos por láser o LIBS (*Laser Induced Breakdown Spectroscopy*) es una técnica que permite generar plasmas sobre todo tipo de materiales. Al enfocar un pulso láser del orden de nanosegundos y de alta fluencia sobre una región reducida de la superficie de un material, se alcanzan altos valores de irradiancia (10^{12} W/cm^2). De esta manera se transmite energía para vaporizar y excitar el material, creando un plasma con un tamaño de milímetros. Analizando espectroscópicamente la luz emitida por dicho plasma se pueden detectar las especies atómicas y moleculares contenidas en el mismo, aplicándose esta técnica para obtener la composición química de los materiales [1]. Una dificultad de la espectroscopía de emisión es la baja sensibilidad de detección de halógenos, debido a sus elevadas energías tanto de excitación como de ionización (> 10 eV). Existen alternativas para solventar este inconveniente como la generación de los plasmas en una atmósfera rica en gases nobles (He o Ar), o la detección mediante espectroscopía de emisión molecular.

El objetivo de este trabajo es el estudio de la emisión de la molécula CaF como fuente espectroscópica para la detección y cuantificación de flúor [2] en materiales sólidos. Como fuente de excitación se ha utilizado un láser pulsado de Nd:YAG. La luz del plasma ha sido analizada mediante un espectrómetro Czerny-Turner con un detector CCD. En este estudio se han empleado dos muestras en polvo, CaF_2 y una mezcla de 55% $CaCO_3$ y 45% de NaF. La detección simultánea de las emisiones de Ca y CaF con resolución temporal y espacial revela la diferente evolución de la emisión atómica y molecular. La primera se distribuye a lo largo de la pluma del plasma, mientras que la segunda permanece en las proximidades de la muestra.

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ID: 04082, 15/07/2019 17:30 - 15/07/2019 17:50, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

Tracer-filled pellets for performing impurity transport studies in magnetically-confined plasmas of stellarators

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Magnetically confined plasmas are studied in order to understand the underlying physics and to identify pathways towards achieving controlled self-sustaining nuclear fusion. A critical issue on the way to the development of the stellarator concept is the identification of operation scenarios that avoid impurity accumulation in the plasma core as this can lead to discharge termination by radiation collapse. Here, impurities are all non-fuel elements, their origin being atoms ejected from vacuum-vessel walls or from in-vacuum components. Several methods are used to measure diffusion and convection coefficients as well as confinement times of their ions. Among these is the Tracer Encapsulated Solid Pellet (TESPEL) technqiue developed at the National Institute for Fusion Science, Japan. Its involves injecting a small spherical (300 to 900 um diam.) polystyrene capsule filled with a tracer impurity. Such systems are now operated on the stellarators LHD (NIFS). TJ-II (Ciemat) and morst recently W7-X (IPP-Greifswald). W7-X is an advanced superconducting helical-axis type with major radius of 5.5 m, typical minor radius of 0.5 m, and plasma volume of 30 m^3 which beagn operation in 2015. TESPEL systems are equipped with an injector mechanism consisting of a rotating magazine with 30 to 90 chambers, each one loaded with a TESPEL capsule. Prior to experiments, polystyrene balls are drilled out and filled with a known quantity of a selected element before being plugged. In order to fulfil the expected demand for capsules on TJ-II and W7-X, a dedicated laboratory is being set-up at Ciemat to prepare TESPEL capsules for the European machines. It is expected to produce between 200 and 300 filled capsules per year, the majority for W7-X. In order to guarantee quality, test injections will be made on TJ-II using it TESPEL injector.

This work is partially financed by the Spanish Minesterio de Economia y Competividad (FIS 2017-89326-R)

ID: 04097, 15/07/2019 17:50 - 15/07/2019 18:10, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

Dynamics of the edge transport during edge localized mode cycles

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Recent advances in the diagnostic capabilities at ASDEX Upgrade (AUG) allow us to measure the edge profiles on a sub-ms timescale and with a spatial resolution of less than 5 mm. This makes it ideal to study the profile recovery during fast transient events. Here, we present the dynamic behaviour of the energy, particle and momentum transport during edge localized mode cycles at the plasma edge of AUG by combining a comprehensive set of pedestal measurements with interpretive and predictive modelling.

The dynamics of the ion and electron kinetic profiles were measured in deuterium and helium plasmas with unprecedented time resolution down to 100 ms. At the ELM onset, the separatrix T_i increases, leading to a reduced gradient in the pedestal [1]. Shortly after the initial separatrix increase, the whole profile drops and then the pedestal starts to build up again. The pre-ELM profile is fully recovered 3-4 ms after the ELM crash. Comparing the ion to the electron temperature profile revealed that the ion temperature gradient reaches its pre-ELM value after the ELM crash on a faster timescale than the electron temperature gradient. The ion temperature and electron density gradient recover to their pre-ELM values on similar timescales, while the electron temperature gradient recovers only 7-8 ms after the ELM onset. The saturation of ∇T_i and ∇n_e is correlated with the onset of medium-frequency fluctuations (f~50 kHz) [2], while high-frequency fluctuations (f~200 kHz) appear when ∇T_e recovers [3], indicating a different clamping mechanism for the ion and electron energy and particle transport.

The edge toroidal rotation recovers on a similar timescale as ∇T_i. This was observed in both deuterium and helium plasmas, the latter enabling measurements of the main ion species. Compared to the impurity toroidal rotation, which exhibits a local minimum at the plasma edge during the inter-ELM phase, the edge main ion toroidal rotation has a much less pronounced dip and is rather flat. During the ELM the main ion toroidal rotation in the pedestal drops by about 5-10 km/s. This is in contrast to the behaviour of the impurity toroidal rotation, which shows a flattening of the toroidal dip feature.

Integrated modelling of the various transport channels allows us to shed light on the dynamic behaviour of the transport coefficients during the ELM cycle. The analyses reveal that the ion heat transport is at the neoclassical level before the ELM crash in the region where the edge ion temperature gradient is maximal [4]. Further inwards, the ion heat transport is about a factor of 4-5 above the neoclassical level. Two possible mechanisms for the additional energy transport in the electron channel (electron temperature gradient modes and neutral ionization) that could cause the delay in the ∇T_e recovery, were studied. The energy loss due to ionization of neutrals was found to be insignificant, while ETGs cannot be excluded. The dominant effect comes from the depletion of energy caused by the ELM. The local sources and sinks for the electron channel in the steep gradient region are much smaller compared to the energy flux arriving from the pedestal top, indicating that the core plasma may dictate the local dynamics of the ∇T_e recovery during the ELM cycle.

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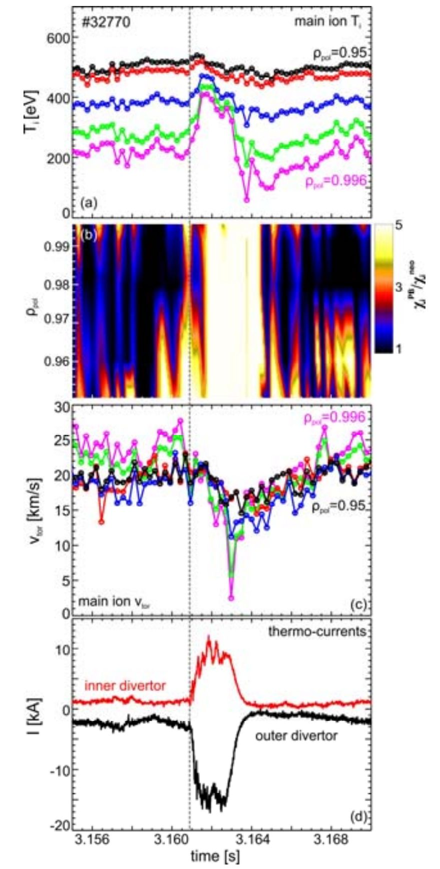

ID: 04093, 15/07/2019 18:10 - 15/07/2019 18:30, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

The IFMIF-DONES Project and the IFMIF Validation Activities

Beatriz Brañas[1] , IFMIF-DONES Team[1]

1) CIEMAT

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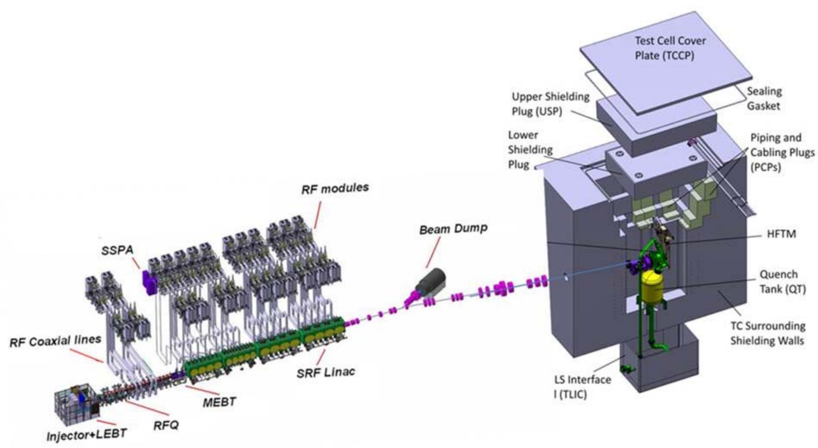
IFMIF-DONES - a powerful neutron irradiation facility for studies and qualification of materials is planned as part of the European roadmap to fusion-generated electricity. Its main goal will be to study properties of materials under severe irradiation in a neutron field similar to the one in a fusion reactor first wall. In particular, DEMO in-vessel materials will be exposed to neutron fluxes in the order of 10^{18} neutrons·$m^{-2}s^{-1}$ with peak energy of 14.1 MeV which will produce a displacement damage greater than 10 dpa per year and a He production inside the metal of 10-13 appm/dpa.

IFMIF-DONES neutron source is based on an accelerator producing a high current (125 mA) of 40 MeV deuterons which are focused on a fast flowing liquid lithium target to produce neutrons via D-Li stripping reactions. The beam footprint at the lithium target has a rectangular shape with dimensions ranging from 100 mm x 50 mm up to 200 mm x 50 mm. A prototype of the accelerator, called LIPAc, is currently being tested at Rokkasho (Japan).

The large number of neutrons generated by stripping reactions interact with the material samples enclosed in the Test Module located immediately behind the lithium target that houses around 1000 specimens with a temperature controlled in the range foreseen in the reactor (250-550ºC).

EUROfusion and Fusion for Energy started in 2015 a process to develop the engineering design of DONES and to identify possible EU sites to host the facility. F4E positively evaluated the joint Spain-Croatia proposal to site DONES in Granada. In 2018 DONES was included in the ESFRI roadmap. The activities to prepare the teams and the site will start very soon. A strong international collaboration is sought in the design and construction of the facility which will benefit from the experience acquired in the validation activities performed under the Broader Approach Agreement between Europe and Japan. In this work the present status of the project will be presented.



ID: 03769, 15/07/2019 18:30 - 15/07/2019 18:50, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

Estudio de las propiedades espacio-temporales de flujos zonales presentes en el borde del plasma del dispositivo de confinamiento magnético TJ-II

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El control del transporte turbulento en los plasmas de fusión nuclear confinados magnéticamente es uno de los campos de estudio más importantes para la comunidad de fusión por confinamiento magnético [1]. Los resultados experimentales obtenidos en el dispositivo de tipo stellarator TJ-II han mostrado evidencias robustas de que el desarrollo de estructuras globales fluctuantes estacionarias y/o de bajas frecuencias en el borde del plasma, conocidas como Flujos Zonales, y que están estrechamente relacionadas con el campo eléctrico radial, constituyen un mecanismo probado de control de la turbulencia en dispositivos de tipo stellarator [2, 3]. En este trabajo se muestran resultados experimentales que relacionan las características espaciotemporales de los Flujos Zonales con el tipo de calentamiento de plasma y la masa isotópica del mismo.

Los experimentos han sido llevados a cabo en el stellarator TJ-II, en plasmas calentados mediante procesos resonantes a la frecuencia ciclotrónica de los electrones (53,2 GHz / ECRH), con una potencias en el rango de 300 - 600 kW y/o mediante la inyección de partículas neutras energéticas (E ≈ 30 kV / NBI) con una potencia de 0.5 - 1 MW. El radio mayor y menor de TJ-II son R = 1.5 m y respectivamente y el campo magnético B = 1 T. Los resultados se obtienen de dos sistemas compuestos de sondas de Langmuir dispuestas radialmente y que están situados en dos puntos de las superficies magnéticas del TJ-II con coordenadas toroidal/poloidal diferentes (Figura).

La extensión radial de los Flujos Zonales depende de la frecuencia de las fluctuaciones [4] y del esquema de calentamiento. En plasmas NBI el perfil radial de los mismos se incrementa en un factor en plasmas dominados por Deuterio con respecto a los plasmas de Hidrógeno y se desplaza ligeramente hacia el interior.

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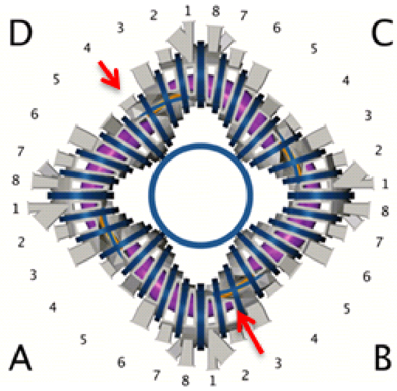

Figura 1: Vista en planta de TJ-II en la que se pueden apreciar las posiciones, en rojo, de los dos sistemas de sondas de Langmuir.

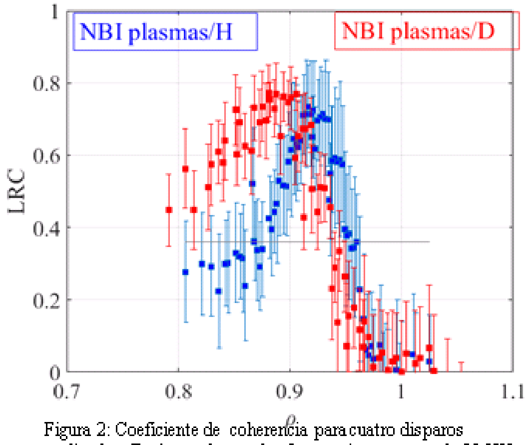

Figura 2: Coeficiente de coherencia para cuatro disparos analizados. Está tomado para las frecuencias menores de 20 KHz, que dominan el espectro. Se aprecia como la coherencia aumenta hasta valores cercanos a 1 cuando el campo eléctrico global supera 1-2 KV/m

ID: 03824, 16/07/2019 15:00 - 16/07/2019 15:30, Room 1.4 (first floor)

S18. Plasma Physics (GEFP)

(Invited Symposio)

The cool plasma eruptions in the solar atmosphere

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The Sun is known for its ubiquitous eruptive activity. The largest instances of eruptions, flares and coronal mass ejections, are well known among the general public, even if the physical processes involved are still not fully understood. Going to smaller sizes and energies, jets and mini-filament eruptions have received much research attention in the past decades. Those are all explosive phenomena with temperatures above one million Kelvin. Much less well known, and more intricate to decipher, are the cool ejections in the solar chromosphere: like other phenomena in that solar layer, they are not simple to investigate, since the chromosphere is a highly dynamic region with a low ionization degree, important non-equilibrium and radiative phenomena and conditions intermediate between high and low plasma beta. The availability of powerful computer codes that can combine realistic atomic and radiative modeling in the very different solar atmospheric layers has given an important boost to the research in this field. In this lecture, a brief review of the history of the subject is provided. After that, a number of results obtained in the past few years are presented, especially those achieved through multidimensional numerical modeling with (radiation-) MHD numerical codes. Special emphasis will be given to results that combine the numerical models with chromospheric and transition region observations obtained with space and ground based telescopes, ane which open the way to forward-modeling in this field.

ID: 03962, 16/07/2019 15:30 - 16/07/2019 15:50, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

Synergies between space plasma propulsion and magnetic confinement plasma fusion: PROMETEO project

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The Plasmas and Space propulsion team (EP2) at UC3M and the National Fusion Laboratory (LNF) at CIEMAT participate in the PROMETEO project, funded by the Community of Madrid. In this project we address the fundamental challenges of plasmas in electric space propulsion (ESP) and magnetic-confinement plasma fusion (MCPF) by exploiting the synergies between the two groups. Both groups aim at confining and manipulating plasmas efficiently, but the regimes, objectives, techniques, approach and knowledge are largely different. The project, while solving common problems transversal to the two fields, is focused on developing a next-generation space plasma thruster incorporating techniques and methods from the fusion community. Specifically, the project is structured around five large objectives: (1). Understand and improve turbulence and anomalous transport; (2) Analyze Plasmawall interaction, materials, and propellants; (3) Improve the deposition of energy by electromagnetic waveplasma interaction and model wave-plasma kinetic effects; (4) Develop a versatile numerical simulation platform for plasma thrusters, incorporating the physics learned in previous objectives; (5) Design, develop and test a electrodeless, wave-heated, space plasma thruster prototype. The natural continuation of this project will focus on the design of thrusters based on fusion plasmas, much hotter than the ESP and with more impulsive capacity, but with a much larger scientific and technological complexity. This paper covers the major physical challenges faced by PROMETEO in each of the objectives above, and presents the first results of the research carried out in the first 4 of them.

ID: 03647, 16/07/2019 16:10 - 16/07/2019 16:30, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

Radio-astronomy emission techniques and cold plasmas to study molecular species and processes of astrophysical interest

Isabel Tanarro[1] , Celina Bermúdez[2] , Carlos Cabezas[2] , Ramón Javier Peláez[1] , José Luis Doménech[1] , Víctor José Herrero[1] , Pablo de Vicente[3] , Juan Daniel Gallego[3] , Francisco Beltrán[3] , José Manuel Hernández[3] , Sandra Ignacia Ramírez[4] , Elena Moreno[5] , Gonzalo Santoro[5] , José Ángel Martín Gago[5] , José Cernicharo[2]

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3) CNTRAG-IGN, Observatorio Astronómico de Yebes, Spain
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In this work we present an original experimental setup in which mm-wave astronomical receivers and spectrometers are coupled to a reaction chamber to study the spectroscopy and chemical evolution of molecular species of astrophysical interest, via their rotational emission lines.

In a first proof of concept, a small prototype reactor was placed in the beam path of the 40 m radio-telescope of Yebes (Spain), facing its Q-band receiver (41-49 GHz). The signal received by the antenna, or that emitted by a liquid N_2 trap, were used as cold background. Experiments with cold plasmas generated by an inductively coupled RF glow discharge were performed successfully [1].

In a second phase, new receivers have been designed and built and are now coupled to a larger reaction chamber, which provides longer optical paths and allows to operate at lower plasma pressures (~ 0.1 Pa), in a dedicated laboratory. The receivers cover the Q (31.5-50 GHz) and W (72-116 GHz) bands with 38 kHz resolution. A cryogenic cold load operates as background reference at 17 K. Mass spectrometry and optical emission spectroscopy are used as complementary diagnostic techniques. Plasmas produced in gas mixtures containing light carbon bearing species and other gases are employed to study the precursors, which dissociate in the plasma, and the products generated in gas phase or by heterogeneous reactions [2].

The mm-wave emission technique provides large sensitivity, instantaneous bandwidth and spectral purity, so that it is perfectly suited for high resolution spectroscopy of molecular species of astrophysical interest. High accuracy measurements of the frequencies and intensities can be determined.

Acknowledgments: We acknowledge funding from the U. E. Sinergy Grant (ERC-2013-Syg 610256, NANOCOSMOS) and the Spanish Research Agency through projects FIS2016-77726-C3-1-P and MAT2017-85089-c2-1R.

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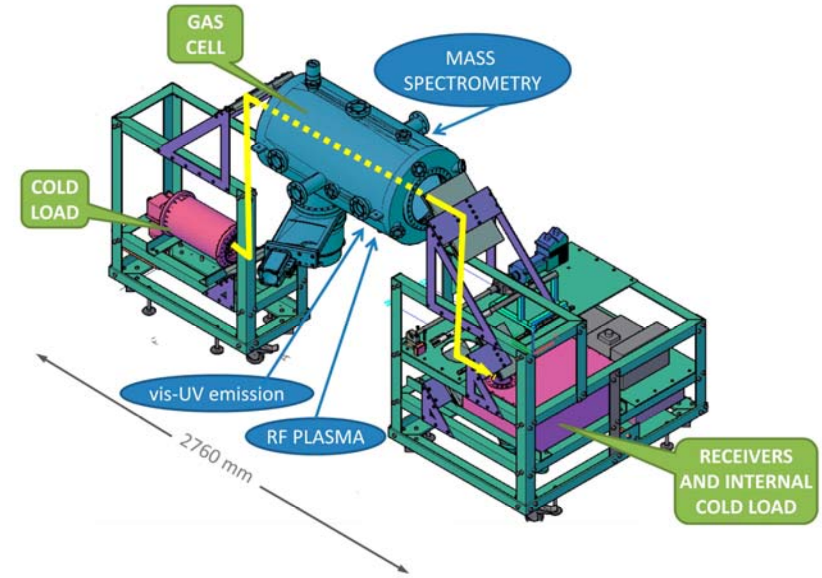
GAS
CELL
MASS
SPECTROMETRY
COLD
LOAD
vis-UV emission
RF PLASMA
2760 mm
RECEIVERS
AND INTERNAL
COLD LOAD

ID: 03727, 16/07/2019 17:30 - 16/07/2019 17:50, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

Density jump as a function of magnetic field strength for parallel collisionless shocks in pair plasmas

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2) Harvard University

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Collisionless shocks follow the Rankine–Hugoniot jump conditions to a good approximation. However, for a shock propagating parallel to a magnetic field, magnetohydrodynamics states that the shock properties are independent of the field strength, whereas recent particle-in-cell simulations reveal a significant departure from magnetohydrodynamics behavior for such shocks in the collisionless regime. This departure is found to be caused by a field-driven anisotropy in the downstream pressure, but the functional dependence of this anisotropy on the field strength is yet to be determined.

Here, we present a non-relativistic model of the plasma evolution through the shock front, allowing for a derivation of the downstream anisotropy in terms of the field strength. Our scenario assumes double adiabatic evolution of a pair plasma through the shock front. As a result, the perpendicular temperature is conserved. If the resulting downstream is firehose stable, then the plasma remains in this state. If unstable, it migrates towards the firehose stability threshold. In both cases, the conservation equations, together with the relevant hypothesis made on the temperature, allows a full determination of the downstream anisotropy in terms of the field strength.

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ID: 03805, 16/07/2019 17:50 - 16/07/2019 18:10, Room 1.4 (first floor)
S18. Plasma Physics (GEFP)
(Oral)

Characterization of interstellar carbonaceous dust analogs produced in RF capacitively coupled discharges

Miguel Jiménez-Redondo[1] , Lidia Diaz-Perez[1] , Ramón J. Peláez[1] , Belén Maté[1] , Isabel Tanarro[1] , Víctor J. Herrero[1]

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** Miguel Jiménez-Redondo, m.jimenez@csic.es*

A significant fraction of cosmic dust is made of carbonaceous material [1]. Carbonaceous grains originate characteristic IR absorption bands revealing the presence of aliphatic and aromatic functional groups in variable proportions. At present, the most likely carrier of the observed IR bands is believed to be some sort of hydrogenated amorphous carbon (HAC), but the detailed composition and structure of the grains are still not clear and under intensive investigation.

In the present work we use capacitively coupled radio frequency (CCRF) plasmas of C_2H_2/He and C_2H_2/Ar to induce the gas-phase formation of HAC particles as analogs of interstellar (IS) dust in a process expected to be close to the actual conditions of IS dust formation [2]. We have characterized both the gas phase and the dust with various diagnostic techniques.

Dust is typically formed in cycles of several minutes. The time evolution of dust aggregation in the discharge is observed using laser light scattering recorded with a CCD camera. Information about the evolution of gas-phase species during particle formation is derived from optical emission spectroscopy and from quadrupole mass spectrometry of neutrals and ions. Finally, the dust produced in the plasma is collected and analyzed ex-situ with infrared (IR) spectroscopy. The IR spectra of the collected HAC samples show variations that depend on the precursors and discharge conditions.

In the analysis of the measurements we try to relate the data from the gas-phase diagnostics and the process of particle formation. The results are discussed in the light of astronomical observations and, whenever possible, compared with previous work.

Acknowledgments: We acknowledge funding from ERC-2013-Syg 610256 (NANOCOSMOS) and FIS2016-77726-C3-1-P

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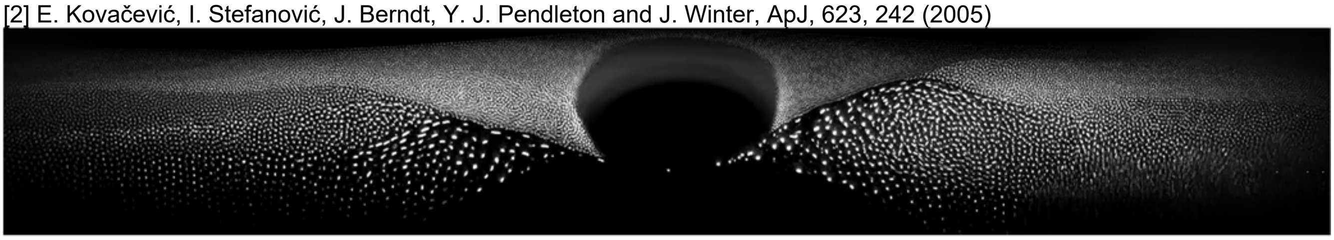

Dust particles in a He+C_2H_2 plasma

ID: 03774, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S18. Plasma Physics (GEFP)
(Poster)

The influence of edge sheared radial electric fields on edge-SOL coupling in the TJ-II stellarator

Gustavo Grenfell[2] , Boudewijn van Milligen[1] , Ulises Losada[1] , Álvaro Cappa[1] , Teresa Estrada[1] , Monica Spolaore[2] , Carlos Hidalgo[1]

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** Carlos Hidalgo, carlos.hidalgo@ciemat.es*

In this work, we study the impact of the radial electric field (E_r) on radial transport in the edge and Scrape-Off Layer (SOL) of the TJ-II stellarator. The edge radial electric field was modified by applying external biasing and/or by inducing a spontaneous transition by raising the electron density [1].

Langmuir probes are used to measure the floating potential and ion saturation current simultaneously at various points in the edge or SOL. Recently, in Neutral Beam heated plasmas with biasing, we showed that sheared flows do not merely suppress turbulence locally, but also affect the radial propagation or spreading of turbulence [2]. (See Figure.)

We will present new results obtained in Electron Cyclotron Resonance Heated plasmas, in which we induced a spontaneous confinement transition. Correspondingly, the radial electric field was modified gradually, allowing a detailed study of its effect on turbulence.

We found that the increased edge $E \times B$ shear reduced the radial characteristic size of the turbulent structures, as reflected in a correlation analysis, while the propagation of turbulence into the SOL was reduced. This was confirmed by the variation of the 'propagation of information' between radially spaced pins detected using the Transfer Entropy technique [3]: in the SOL, blobs arriving from the edge region were largely suppressed during the existence of the edge sheared flow layer associated with the ion root regime. This novel observation may have consequences for the understanding of the mechanisms that set the SOL width [4].

Figure: a) Biasing voltage and its effect on b) the radial profile of floating potential, c) ion saturation current, d) turbulent particle flux and e) turbulence phase velocity.

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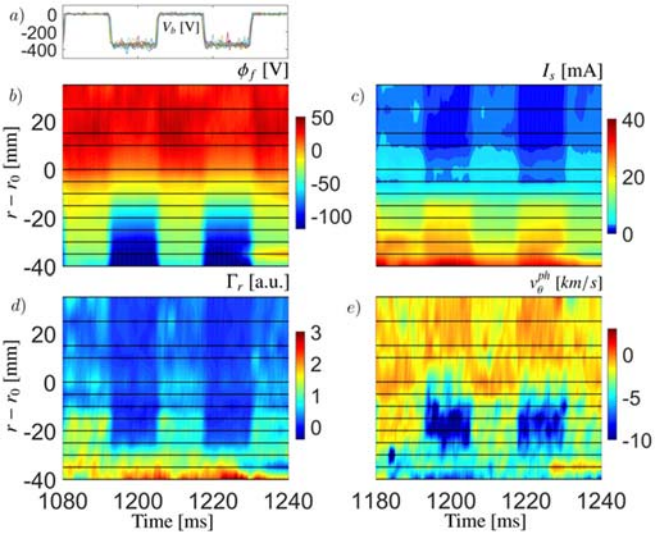
a)
0
-200
-400
V_b [V]
b)
ϕ_f [V]
c)
I_s [mA]
d)
Γ_r [a.u.]
e)
v_θ^{ph} [km/s]
$r - r_0$ [mm]
Time [ms]

ID: 03968, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S18. Plasma Physics (GEFP)
(Poster)

Simple and analytical function for the Stark profile of the H_α and H_β lines and its application to plasma characterization

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In recent years, Atomic Emission Spectroscopy techniques have been shown to be an excellent tool to determine plasma characteristic magnitudes. Among atomic emission lines, Hydrogen Balmer series lines are the most used. These lines are the result of the internal processes contributing to the total width of a spectral line in an independent manner. While most of these processes can be described in terms of analytical functions, this is not the case of the Stark broadening of Hydrogen lines, because of joint action of electrons and ions which influence differently due to large difference in masses. To date, analytical functions have been proposed for the Stark profiles of the H_α line and for the H_β line. These functions are convoluted with those of the other internal processes in order to compare with the experimental profile, what allows improving the determination of characteristic parameters of plasma with respect to the methods traditionally used.

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ID: 03758, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S18. Plasma Physics (GEFP)
(Poster)

Modelling of ICRF heating for JET T and D-T plasmas

Dani Gallart[1] , Mervi Mantsinen[2] , Philippe Jacquet[3] , Krassimir Kirov[3] , Ernesto Lerche[4] , John Wright[5] , JET Contributors[6]

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4) LPP-ERM-KMS, Association EUROFUSION-Belgian State, TEC partner, Brussels, Belgium
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6) EUROfusion C

** Dani Gallart Escolà, daniel.gallart@bsc.es*

A tritium (T) campaign is planned in preparation for the forthcoming deuterium-tritium (D-T) campaign [1] at the Joint European Torus (JET). These experiments will be the first experiments involving T with the ITER-like plasma-wall facing components materials. They will give a unique opportunity to test one of the most promising ion cyclotron resonance frequency (ICRF) heating schemes for ITER plasmas: the 2nd tritium (T) harmonic resonance ($w = 2w_T$). As a continuation to the work carried out in [2-4], this paper provides two key contributions related to modelling of the performance of this scheme at JET. First, we assess the heating performance of the 2nd T harmonic resonance and, second, we model different ICRF schemes for the T campaign in support for the D-T campaign, i.e., identify differences and similarities from the heating point of view between T and D-T plasmas in order to predict the performance of $w = 2w_T$in the D-T scenario. For this study, the ICRF and NBI heating are modelled with the ICRF code PION [5] and the beam code PENCIL which take into account the ICRF+NBI synergy.

The analysis of the T velocity distribution function shows that a stronger tail is formed in those plasmas with lower tritium density. This fact has an important impact on the slowing-down process of fast tritons with the background species. On the other hand, the use of ^{3}He as a minority makes the fast ion T energy considerably lower due to strong ^{3}He absorption. Fast ion average energies reached at the plasma centre are similar in all species mixture cases.

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**See the author list of E. Joffrin et al. [1]*

ID: 03924, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S18. Plasma Physics (GEFP)
(Poster)

Influence of D_2 (v) excitation on the OH + D_2 → HOD((v_{HO}',v_{HOD}',v_{OD}'), J') + D reaction dynamics. Vibro-Rotational Energy in HOD vs. Chemical Laser.

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Analysis of the OH + D_2 → HOD((v_{HO}',v_{HOD}',v_{OD}'), J') + D benchmark reaction from Quasi Classical Trajectory Gaussian Binning (QCT-GB) method, in a quantum spirit, provides a significant information about gas/chemical lasers of similar characteristics.

A large sample is necessary employ to obtain product energies (translational, vibrational and rotational) state distributions for the title reaction, using Quasi-Classical Trajectory (QCT) calculations and the Gaussian Binning (GB) methodology on Wu-Schatz-Lendvay-Fang-Harding (WSLFH) [1] potential energy surface (PES). The reason why only this PES is used is because of its better behaviour in the last research carried out by the author [2] than another more recent PES.

It has been observed that, depending on a first selection, Vibrational-Gaussian Binning, a second selection, Rotational-Gaussian Binning, induces a preference for odd or even values in the Total Angular Momentum of de HOD product molecule (Figure) [2]. It is interesting to remember that a similar phenomenon is observed in the CO_2 triatomic molecule, utilized in the correspondent gas laser. The dynamics and kinetics of polyatomic chemical reactions (e.g., OH + D_2 → HOD* + D and its isotopic variants), of relevance in the excitation/emission processes of current and future chemical lasers, could be studied theoretically from the results obtained in this article.

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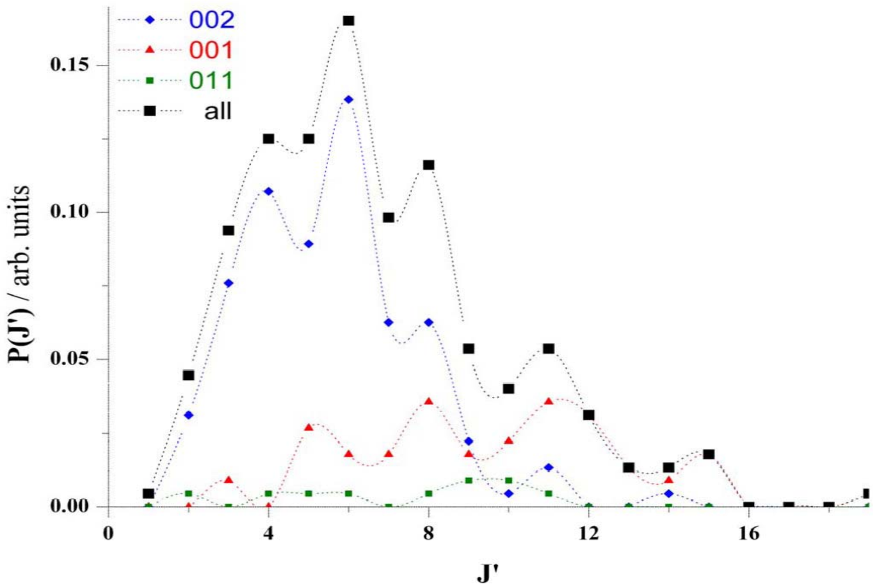

Figure. QCT-(R-GB) rotational angular momentum distributions, P(J') after a second selection (R-GB). P(J')(002, 001, 011 and all) distributions are divided in 19 bin's (J'= 1,…, 19) and normalized to the unity the sum of the set of all probability distributions. The P(J')(all) distribution is the sum of all possible QCT-(R-GB) distributions, P(J')(002, 001, 011, 010, 020, 021, 040, 030, ... 012,...). Results for WSLFH PES.

ID: 04005, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S18. Plasma Physics (GEFP)
(Poster)

Adsorption energies of CH4, CO, N2 and CO2 on plasma generated interstellar carbonaceous dust analogs

Belén Maté[1] , Isabel Tanarro[1] , Miguel Jiménez-Redondo[1] , Lidia Díaz-Pérez[1] , Ramón Peláez[1] , Victor J Herrero[1]

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The interaction of volatile molecules with the surface of dust grains is crucial for the physics and chemistry of interstellar clouds. The degree of chemical complexity attainable in hot cores or protoplanetary systems is largely dependent on the binding, diffusion and reaction of these molecules on grain surfaces. A significant fraction of cosmic dust is made of carbonaceous material, and surface chemistry will be strongly affected by their particular composition and morphology.

In the present work we have generated hydrogenated amorphous carbon (HAC) dust analogs in two different plasma reactors. We use inductive coupled CH4/He plasma to generate HAC films that grow on an Al plate placed inside the reactor. Alternatively, we use capacitive coupled radio frequency plasmas of C2H2/He and C2H2/Ar to induce the gas-phase formation of HAC dust particles, that is collected in an Al plate. We have characterized both HAC samples with various diagnostic techniques [1].

In a second step we transfer the Al plates with HAC deposits to a ultra-high-vacuum chamber and place them in the cold head of He cryostat. We then introduce the volatile species into the chamber trough multichannel arrays and deposit them on the HAC samples at selected temperatures down to 15 K. We apply reflection absorption IR spectroscopy (RAIRS) and line-of-sight thermal programmed desorption (TPD) to determine binding energies and HAC specific surface areas by application of simple theoretical models [1,2,3].

Acknowledgments: We acknowledge funding from ERC-2013-Syg 610256 (NANOCOSMOS) and FIS2016-77726-C3-1-P.

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ID: 03970, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S18. Plasma Physics (GEFP)
(Poster)

Activation of seed germination processes by plasma treatment

Encarna Arroyo[1] , Paula Navascués[1] , Carmen López-Sánchez[1] , Ana Gómez-Ramírez[1] , José Cotrino[1] , José Luis García[1] , Manuel Cantos[1] , Agustín R. González-Elipe[1]

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Plasma-agriculture is an emerging research and technological topic with much prospects of applications to improve the quality and efficiency of many agriculture-related activities. In this communication we show that plasma treatment of seeds may significantly contribute to enhance their germination capacity (i.e. reduce failure percentages and increase germination rates) and to remove fungi and other microorganism contamination. Experiments are carried out using both atmospheric pressure and low pressure plasma treatments of air. Seeds subjected to plasma treatment under different conditions were also examined by a variety of techniques including XPS, SEM, FT-IR and other characterization tools [1, 2]. This analysis revealed changes in chemical composition, surface diffusion of elements, wetting behaviour and moist absorption capacity after plasma treatments. Results are shown for quinoa and cotton seeds where chemical and morphological changes in the surface state of seeds after plasma treatment have been related with their distinct germination capacity depending on plasma treatments.

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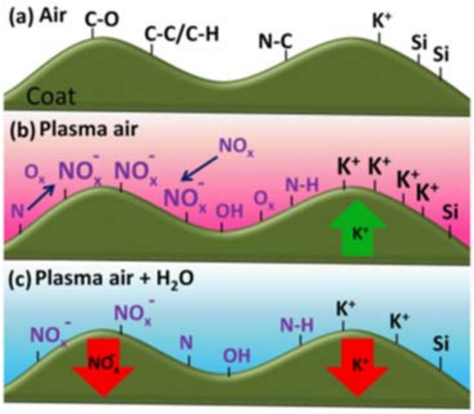

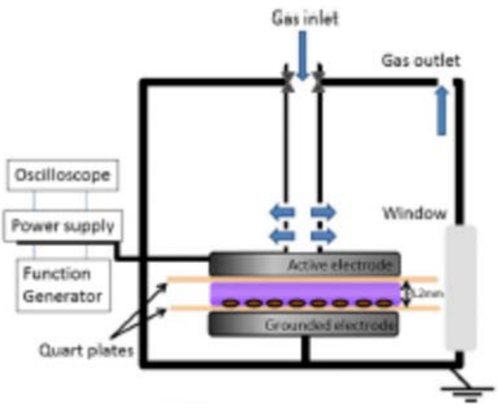

ID: 03837, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S18. Plasma Physics (GEFP)
(Poster)

A collisional-radiative model for lithium

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Experiments on several fusion tokamaks have shown that wall coating with lithium leads to a significant improvement of reactor performance (see [1] and references therein). Wall conditioning with Li has been also employed in the stellarator TJ-II [2], where an important increase of the energy time confinement, and an enlargement of the density operational range have been obtained [3]. On the other hand, although in the ITER design, tungsten is the plasma facing material in the divertor, other alternatives are currently explored for the demonstration reactor DEMO, including the use of liquid Li [4]. These applications have motivated a large interest in atomic processes involving Li and Li ions, and a complete database exists for electron collisions [5]. However, only a few works have studied heavy particle collisions. Charge exchange processes in H^+ + Li and Li^+ + H collisions can be relevant in determining the population of Li and Li^+ in H plasmas. The goal of the present work is to discuss the relevance of the above-mentioned heavy-particle collisions, and, in particular, to study the importance of the isotope dependence of the Li^+ + H (D,T) cross sections found in ref. [6]. We have developed a collisional-radiative model that includes ionization and excitation by electron impact together with charge exchange processes and spontaneous emission.

This work has been partially supported by the project FIS2017-84684-R of Ministerio de Ciencia, Innovación y Universidades.

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S19. Mujeres en Física (GEMF)

El simposio del GEMF tendrá como objetivos debatir temas que tengan que ver con estrategias para aumentar la presencia de mujeres en física, visibilizar los logros de éstas y defender los intereses y la igualdad de derechos y oportunidades de las físicas. El simposio incluirá una charla invitada de Dra. María Villaroya Gaudó, profesora de la Universidad de Zaragoza.

Organizadores:
Pascuala García Martínez, *Universitat de València*
Pilar López Sancho, *ICMM-CSIC*
Ana Xesús López Díaz, *Universidade A Coruña*
Máriam Tórtola Baxauli, *Instituto Física Corpuscular (IFIC)-UV*
Carmen Carreras Béjas, *UNED*
Leonor Chico Gómez, *ICMM-CSIC*
Carmen Ocal García, *ICMAB-CSIC*

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S19. Women in Physics (GEMF)

The GEMF symposium will have as objectives to discuss topics that have to do with strategies to increase the presence of women in Physics, to visualize their achievements and to defend the interests and equal rights and opportunities of women in Physics. It will also include an invited talk by Dr. María Villaroya Gaudó, professor at the Universidad de Zaragoza.

Organizers:

Pascuala García Martínez, *Universitat de València*
Pilar López Sancho, *ICMM-CSIC*
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Carmen Carreras Béjas, *UNED*
Leonor Chico Gómez, *ICMM-CSIC*
Carmen Ocal García, *ICMAB-CSIC*

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ID: 04198, 16/07/2019 15:00 - 16/07/2019 15:18, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Invited Symposio)

Work against bias and for meritocracy

Tomas Brage[1]

1) Lund University

** Tomas Brage, tomas.brage@fysik.lu.se*

There is a strong belief in a meritocratic system for academia, but the existence of implicit bias threaten it. At the same time, bias exists in a social and organisational context. In this talk I will discuss some recent trends in the anti-bias work, to defend the meritocracy and refer to evidence-based toolboxes and actions.

ID: 04046, 16/07/2019 15:18 - 16/07/2019 15:30, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Gender Perspective in Physics, a guide

Encina Calvo Iglesias[1]

1) Universidade Santiago de Compostela

** Encina Calvo Iglesias, encina.calvo@usc.es*

This paper presents the Guide for the Incorporation of Gender Perspective in the Teaching of University Physics [1], which is part of a collection of eleven guides from the Luis Vives Network of Universities for university teaching with a gender perspective. This guide covers the sections of objectives, contents, evaluation, organizational modalities, teaching methods and didactic resources with the aim of making women scientists visible in the discipline and eliminating the androcentric vision that predominates in science and, in particular, in the field of physics [2]. To this end, the guide offers a multitude of examples, presents good practices both nationally and internationally and suggests concrete activities (in the classroom, in virtual classroom forums or through social networks) with which to include gender perspective in Physics.

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ID: 04041, 16/07/2019 15:30 - 16/07/2019 15:42, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Presencia de la mujer en los estudios de Física (1998-2017)

Milagros F. Morcillo Arencibia[1] , Antonio J. Sarsa Rubio[1] , Cristina Yubero Serrano[1] , José Manuel Alcaraz Pelegrina[1]

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** Milagros F. Morcillo Arencibia, f22moarm@uco.es*

La evolución de la presencia de la mujer en los estudios universitarios de Física desde el curso 1998/1999 hasta el curso 2016/2017, tanto a nivel nacional como en la Universidad de Córdoba, revela que a lo largo de este periodo el porcentaje de mujeres es inferior al de hombres manteniéndose constante en torno al 20-30%. Por otra parte, la relación entre el porcentaje de egresadas y el de matriculadas es superior a la unidad, lo cual rebate el prejuicio de que las mujeres están menos capacitadas que los hombres para este campo. Se presentan algunas propuestas para lograr un mayor interés de las alumnas en la Física y que su presencia en los estudios universitarios aumente.

ID: 04168, 16/07/2019 15:42 - 16/07/2019 15:54, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Gender Equity in the optics+photonics workplace

Pascuala García-Martínez[1] , Krisinda Plenkovich[2]

1) Universitat de València 2) SPIE Director, Education and Community Services

** Pascuala García-Martínez, pascuala.garcia@uv.es*

Since 1998, SPIE Women in Optics promotes personal and professional growth for women through community building, networking opportunities, and encouraging young women to choose optics as a career. We present a gender equity survey was conducted as part of the SPIE Global Salary Survey Nearly 10,000 responses 21% of respondents were female.

ID: 04031, 16/07/2019 15:54 - 16/07/2019 16:06, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Despertando vocaciones femeninas en física desde el IFIC

Mariam Tórtola[1]

1) IFIC (CSIC/Universitat de València)

** Florencia Castillo, casflo@ific.uv.es*

En esta charla contaremos las actividades que se realizan desde el Instituto de Física Corpuscular (CSIC/Universitat de València) para estimular el interés de las niñas y las chicas en física en general y en particular en las áreas de la física objeto de investigación en el IFIC, como son la física de partículas y nuclear o la cosmología.

ID: 03809, 16/07/2019 16:06 - 16/07/2019 16:18, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Mecánica: femenino, singular

Ana Jesus López[1]

1) Universidade da Coruña

** Ana Jesús López, ana.xesus.lopez@udc.es*

La integración de la perspectiva de género en la docencia de materias de carácter científico o tecnológico suele resultar complicada dado que se tratan contenidos de gran abstracción o muy técnicos. Es el caso la Mecánica que se imparte en los títulos de grado como el de Ingeniería Naval y Oceánica o Ingeniería Mecánica de la Universidade da Coruña. En esta materia de segundo curso se trabaja sobre sistemas idealizados (masa puntual, sólido rígido...) y objetos matemáticos como vectores, tensores... Se trata de una materia "clásica", con un corpus cerrado ya en el siglo XIX, donde destacan los nombres de grandes científicos como Galileo, Newton, Lagrange o Euler; todos ellos varones. La realidad es que no se puede entender el avance de esta disciplina sin la contribución de mujeres como Madame du Châtelet, Sophie Germain o Sonia Kowalevskaya; o la de grandes astrónomas que llevaron a cabo un trabajo minucioso y muchas veces escondido tras la sombra de maridos o hermanos. Todas ellas fueron mujeres singulares (de ahí el título de la comunicación) que tuvieron que luchar con fuerza para abrirse camino en un ámbito, el científico, hasta hace muy poco restringido a los hombres.

En este trabajo se propone visibilizar el trabajo de algunas de estas mujeres, largamente ocultadas en los ámbitos académicos, bajo el discurso de la supuesta neutralidad de la ciencia. Se ha seleccionado para ello casi una veintena de científicas que a lo largo de la historia han tenido relación con los contenidos habituales de un curso de mecánica y se ha elaborado una breve reseña biográfica que pueda dar pie a muchas y muchos docentes para seguir indagando sobre ellas y sobre otras mujeres de distintos ámbitos de la física.

ID: 03994, 16/07/2019 16:18 - 16/07/2019 16:30, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Early instrumental observations in Equatorial Guinea by the Urquiola sisters

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Some of the first systematic meteorological observations in Africa were made by two Spanish women, Isabel and Juliana Urquiola, in Equatorial Guinea at 1875.

Isabel was married to the Spanish Explorer Manuel Iradier in November 1874. One month later Iradier traveled to explore the Spanish possessions at the Muni Country (Equatorial Guinea) and his wife and sister-in-law joined him. Without any financial support nor previous experience in Africa, he studied the Spanish possessions in many aspects (geographical, meteorological, geological, zoological, botanical, social), thanks to his persistent passion for Africa.

Little Elobey Island was their expeditionary base. Here, they built a meteorological observatory (0º 59\' 46\'\' N, 9º 32\' 14\'\' E), and from 1st June to 31st December of 1875 they collected sub-daily readings (6h, 12h, 15h and 18h) of humidity, temperature, precipitation and wind direction. These measurements and other wide range of non-meteorological observations were published at 1887 in the Iradier´s book “Africa: Viajes y Trabajos de la Asociación Eúskara La Exploradora”, attributing all of them to him and without naming the two sisters. Later, he will recognize the observations were made by the sisters Urquiola. To evaluate the quality of these observations we have compared them with Cocobeach series (the modern meteorological station nearest to Little Elobey) and with other observations of the 19th century made in Equatorial Guinea by Pellón y Rodríguez (1859-1863, monthly) and Iglesias y Pardo (1873-1874, daily).

In this contribution, authors would like to recognize the sisters Urquiola effort in the collection of meteorological data in precarious conditions (environmental and social) at Little Elobey in 1875, being pioneering women in this tasks reserved to men in that epoch. Moreover, their collected meteorological observations are especially interesting due to were made during the 19th century and in places with scarce coverage.

ID: 04135, 16/07/2019 16:30 - 16/07/2019 16:42, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Sassy Science: Drag and non-heteronormative self-presentation as a means of empowerment for under-represented minorities and women towards STEM

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It is evident that there is a wide gap in many fields of science, technology, engineering and maths (STEM) still to this very day. There is plenty of research that shows patent proof that there is a substantial underrepresentation of women [1-3], LGBT+ individuals [4,5], and people of colour (POC)[1,3]. This underrepresentation comes in many ways, including higher education [1-3].

The social media revolution has brought with it the creation of safe havens within the digital world. Women, POC and the LGBT+community have found safe spaces. However, this translates into the fact that viewers fall into selective exposure, watching content that has been created for their specific demographic. As a consequence, STEM-related content falls out of the exposure range for these underrepresented minorities (URM) unless it's specifically targeted at them or, in some cases, at other minorities.

On the other hand, in the last 30 years, and in a more substantial way, in the last decade, drag has integrated more and more within the mainstream, becoming especially popular among the LGBT+ community and cis-straight women.

Drag in digital platforms and non-heteronormative (non-normative LGBT+) self-presented Youtubers have something in common: They create audiovisual content that reaches a vast amount of the aforementioned URM.

With this in mind, the Sassy Science project has been created. It consists of a Youtube channel where the topics to be featured will focus on the engagement of URM in STEM through visibilisation of historical women, LGBT+ and POC in STEM. With this, the aim of this project is to empower them in order to reach a more diverse reality in STEM.

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Sassy
SCIENCE

ID: 04174, 16/07/2019 17:30 - 16/07/2019 17:48, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Invited Symposio)

Mujeres en STEM, ¿por qué no cambia la tendencia?

Maria Villarroya Gaudo[1]

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** María Villarroya, maria.villarroya@unizar.es*

Las mujeres en ciencia y tecnología han sido una minoría a lo largo de la historia. La situación de desigualdad cultural podría ser la explicación, cuando la igualdad social está cambiando en estudios de físicas o ingeniería la situación permanece bastante estable. Desde hace más de dos décadas se está trabajando por cambiar esta tendencia y parece que las acciones no tienen demasiado efecto. ¿Cuales son las causas? ¿Como podemos cambiar la balanza? ¿Tienen todas las niñas las mismas oportunidades?

ID: 03815, 16/07/2019 17:48 - 16/07/2019 18:00, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Mi experiencia divulgando la vida de grandes físicas

Laura Morrón Ruiz de Gordejuela[1]

1) Next Door Publishers

** Laura Morrón Ruiz de Gordejuela, lmorron@nextdooreditores.com*

En este trabajo me gustaría explicar mi experiencia divulgando la vida de grandes físicas.

Descubrí a Marie Curie en una película en blanco y negro y me quedé prendada de aquella mujer que parecía disfrutar tanto con lo que hacía. Empecé a devorar biografías sobre ella y, cuando con doce años cursé física por primera vez, supe lo que iba a estudiar. El profesor que me impartió la asignatura contribuyó a mi decisión, pero también fue muy importante contar con una heroína como modelo. Si Manya lo había conseguido en aquellas circunstancias tan desfavorables, yo sentía que también podría hacerlo. Esta mentalidad tan positiva y ambiciosa es en parte, el resultado de la educación de unos padres que siempre me han transmitido que podía conseguir todo lo que me propusiese. Pero mi entorno podía haber sido menos propicio y contar con un único referente femenino pudo haber hecho que me rindiese antes de empezar. Creer que una sola mujer lo había conseguido pudo haber anulado mis expectativas.

Cuando empecé a interesarme por la historia de la física, me entusiasmé al descubrir que había muchas otras grandes mentes femeninas que habían contribuido a su desarrollo. Grandes físicas que podrían ser referentes y fuentes de inspiración, grandes científicas injustamente invisibilizadas y olvidadas. Esta omisión distorsiona la realidad y puede llevar a las más jóvenes a seguir creyendo que la física es cosa de hombres. Por este motivo decidí aportar mi granito de arena divulgando sobre ellas.

En el simposio me gustaría exponer dónde y cómo he llevado a cabo la divulgación de estas grandes científicas (blogs, revistas y radio) y mis conclusiones acerca de la respuesta recibida. Pienso que relatar mis vivencias puede animar a más personas a hacerlo.

ID: 04007, 16/07/2019 18:00 - 16/07/2019 18:12, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Science Outreach and Gender Perspective at IFCA

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The Institute of Physics of Cantabria (IFCA) has an intense program of science communication activities, giving a special emphasis on gender perspective and women in scientific careers. Our institute has an area dedicated to Outreach, Communication and Education led by the Institute's Vicedirector.
We report on the structure of the work, talks and events carried out by the team: target population, activities, media and platforms. We organize, on average, a hundred events, reaching over 5000 students per academic year. Our main objectives are Primary, Secondary, and High School students. A similar number of events is arranged to reach general public as well as executive and legislative local and national managers.
The institute encompasses a rich range of activities, making special emphasis on inclusivity and gender equality in science. We will present a selected list of events such as: Expanding Science, Scientific Coffee, European Night of Researchers, Conferences at the Ateneo, Week of Science, Open Doors Days and Nighttime observations at the IFCA dome; focusing on those developed for the special dates around February 11th (International Day of Women and Girls in Science) and March 8th, which pay particular attention on the promotion of STEM studies for girls and the presence and visibility of (contemporary) women in science.
On top of the traditional communication resources and IFCA's website, press releases, etc., we make use of all kind of available media tools such as Facebook, Twitter or Youtube to reach a wide variety of citizens. To understand our presence in society we continuously monitor and analyze the data obtained from these platforms.

ID: 04035, 16/07/2019 18:12 - 16/07/2019 18:24, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Los enigmas del tiempo y del clima.

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Según la Organización para la Cooperación y el Desarrollo Económicos (OCDE) en España solo el 7% de las niñas de 15 años se inclinan por estudios relacionados con profesiones técnicas. Este hecho se refleja posteriormente en la elección de los estudios universitarios. Aunque las alumnas obtienen más del 50% de los títulos universitario, su presencia en carreras como Física apenas alcanza el 30% y en las carreras relacionadas con las TICs o con la ingeniería se encuentra en un porcentaje inferior al 20%. Lo peor es que a medida que se avanza en la jerarquía universitaria, el número de mujeres disminuye.

Para mitigar esta desigualdad, las Naciones Unidas declararon el 11 de febrero "Día Internacional de la Mujer y la Niña en la Ciencia", con el objetivo despertar las vocaciones por las disciplinas STEM (del inglés Science Technology Engineering and Mathematics) en el alumnado femenino. En España, se lanzó en 2016 la iniciativa "11 de Febrero" para fomentar la organización de actividades y materiales que contribuyan a cerrar la brecha de género que actualmente existe en el ámbito científico. Dentro de esta iniciativa, el campus de Ourense de la Universidad de Vigo organiza desde 2018 una feria científica en la que investigadoras y tecnólogas muestran sus investigaciones a estudiantes de secundaria y bachillerato bajo el lema "eXXperimenta en feminino".

En el caso particular del grupo "Ephyslab", grupo de referencia en el estudio del cambio climático, se participó en dicha feria con el taller "Resolver el rompecabezas del clima". En este taller, a través de experimentos y actividades de carácter visual y manipulativo, se abordó el tema del cambio climático y algunos de los conceptos básicos de meteorología y oceanografía. Los alumnos pudieron crear su propia nube, descubrir el funcionamiento de las corrientes oceánicas o entender los mecanismos que provocan la formación de un tornado. También pudieron observar el efecto del calentamiento global sobre el nivel del mar o los mecanismos que se esconden detrás del fenómeno del NIÑO.

ID: 04109, 16/07/2019 18:24 - 16/07/2019 18:36, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Jornadas "La Ciencia tiene nombre de Mujer" de la Universidad Miguel Hernández de Elche

María del Mar Sánchez-López[1] , Ángela Sastre-Santos[1] , Purificación Heras[2] , Mª José Alarcón[3]

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Desde que la Asamblea General de las Naciones Unidas proclamara todos los 11 de febrero *Día Internacional de la Mujer y la Niña en la Ciencia*, son muchas las actividades realizadas desde el año 2016 para celebrarlo. La Universidad Miguel Hernández de Elche se ha sumado a esta celebración impulsando sucesivas ediciones de la jornada "La Ciencia tiene nombre de Mujer" en las que participaron más de doscientos chicas y chicos de Institutos y de la propia universidad, y una centena de profesores. Con una primera edición centrada en las ciencias básicas [1], una segunda edición orientada a las ingenierías [2], y una reciente tercera edición centrada en visualizar a mujeres de las STEM [3], el programa de estas jornadas incluye conferencias divulgativas de científicas y profesionales de las STEM, relato personal de trayectorias profesionales, talleres de experimentos y teatro científico. Todo ello con los objetivos de visibilizar las aportaciones de mujeres relevantes en estas áreas, y alentar que las chicas y chicos se acerquen a estas disciplinas sin estereotipos. En esta comunicación se presentará la programación de estas jornadas, y se describirán los aspectos organizativos, la planificación de tiempos y las estrategias de difusión que hemos realizado. Cabe señalar la implicación de la RSEF en estas jornadas, estando entre sus impulsoras y organizadoras la Presidenta de la Sección Local de Alicante (Prof. M.M. Sánchez-López) y la Presidenta del grupo especializado de Nanociencia y Materiales Moleculares (Prof. Á. Sastre-Santos); y la inauguración de la 1ª edición con la ponencia de la Prof. Mª Josefa Yzuel (Premio RSEF-FBBVA 2014).

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II JORNADA
"LA CIENCIA TIENE
NOMBRE DE MUJER"

ID: 04009, 16/07/2019 18:36 - 16/07/2019 18:48, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Iniciativa 11 de Febrero. Fomentar la presencia de mujeres en física a través de la acción colectiva.

Julia Herrero Albillos[1] , María José Calderón[2] , Leni Bascones [2]

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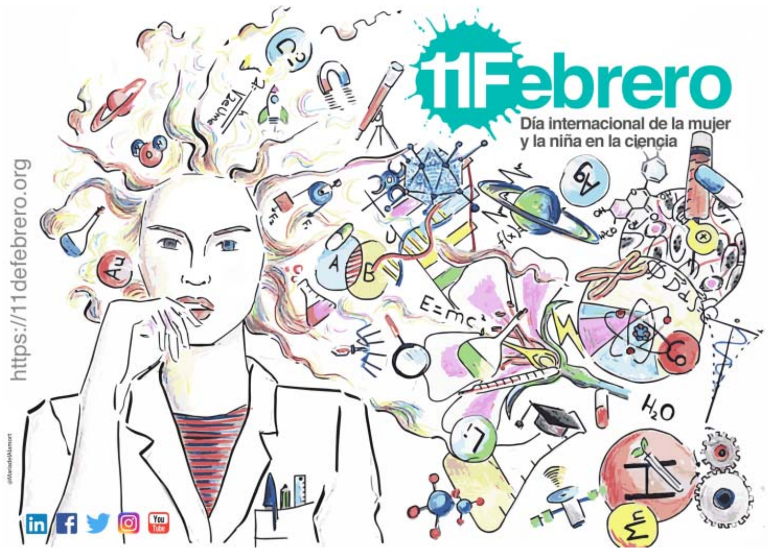
La desigualdad de género en ciencia y la baja presencia de mujeres en las carreras técnicas y en particular en física es un problema global que requiere de una actuación a gran escala que sea capaz de llegar a un amplio sector de la sociedad.

Para ello es importante la movilización de diferentes actores sociales y muy especialmente de las comunidades científica, tecnológica y educativa.

Desde septiembre de 2016 la iniciativa 11 de Febrero impulsa y facilita la realización de actividades que conmemorando el día internacional de la mujer y la niña en la ciencia ayuden a cerrar la brecha de género en ciencia y fomenten las vocaciones en las niñas. Ya se han celebrado tres ediciones de la iniciativa en las que se han implicado miles de personas. Esta movilización tan importante está ayudando a sensibilizar a la sociedad en la importancia de lograr la igualdad de género en el ámbito científico.



ID: 04054, 16/07/2019 18:48 - 16/07/2019 19:00, Room 1.6 (first floor)
S19. Women in Physics (GEMF)
(Oral)

Divulgar la física a través de los escaparates de la ciudad. Iniciativa 11 de febrero.

Juana Moya[1] , María Hernández[2] , Milagros Arrébola[3] , Julia Herrero Albillos[4]

1) Hospital Clínico Universitario Miguel Servet
2) Consultora Formadora Facilitadora.
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La iniciativa 11 de Febrero (11defebrero.org) conmemora en España el Día Internacional de la Mujer y la Niña en la Ciencia desde hace tres años. La ciudadanía de Zaragoza ha sido especialmente activa en la organización de actividades, proponiendo algunas de las más originales. Una de esas actividades es la denominada #Escaparates11F.

Durante la primera quincena de febrero tiendas de toda la ciudad, la mayoría de ellas de la red de economía creativa Made in Zaragoza, decoraron sus escaparates con la vida y los logros de mujeres científicas. En 2018 se sumaron más de 20 establecimientos, duplicándose la cifra para esta ultima edición de 2019.

Entre las 48 científicas seleccionadas en 2019, diversas tanto en sus disciplinas como en su procedencia geográfica y época, se encontraban las físicas Jocelyn Bell (astrofísica, Irlanda), Vera Rubín (astrónoma, EEUU), Sally Ride (física y astronauta, EEUU), Wanda Diez (astrofísica, Puerto Rico), He Zuhei (física nuclear, China) así como dos físicas españolas pertenecientes al Grupo Especializado de Mujeres en Física Josefa Yuzuel (óptica, España), Carmen Magallón (filosofía de la Ciencia, España).

Los escaparates de las calles de la ciudad ofrecían la posibilidad de aprender sobre estas mujeres inspiradoras tanto con la información expuesta en los escaparates (diseñados por las propias tiendas) como entrando en las tiendas y preguntando a las tenderas y tenderos.

Para completar la actividad, se programaron diversas rutas guiadas, en las cuales se convocó al público general a pasear con las organizadoras y otras voluntarias y escuchar de ellas las historias de algunas de las científicas. “Mujeres Intrépidas”, “Mujeres Inclusivas” o “Mujeres Estelares” fueron los títulos de algunas de esas rutas en las que se contó con el apoyo de Made in Zaragoza y de otros servicios municipales zaragozanos como Juventud o Cultura. Durante los paseos además se pudo escuchar poesía, música, observar las estrellas o disfrutar de la danza.

ID: 04015, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S19. Women in Physics (GEMF)
(Poster)

Mi física favorita

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La presencia de la mujer en el ámbito de la Física es muy reducida, siendo la rama de Ciencias la que menos porcentaje de mujeres estudiantes presenta. A fin de visibilizar el trabajo de las mujeres dentro del ámbito de la Física, se planteó durante el curso 2017/18 la realización de una elección de la física o científica relacionada con este ámbito que, en opinión de los alumnos del Grado de Física y del personal de la Universidad de Córdoba relacionado con dicho Grado, haya tenido un papel relevante en el desarrollo de alguna disciplina de la Física o que pueda motivar a que las jóvenes estudiantes se decanten por este campo. De manera paralela, también se propuso esta elección a través de redes sociales, permitiendo una mayor difusión de la actividad y una mayor participación.

ID: 04177, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S19. Women in Physics (GEMF)
(Poster)

El teatro como herramienta para dar visibilidad a las mujeres sabias de la historia de la ciencia.

Núria Aliaga[1] , M. Isabel Alonso[1] , Esther Barrena[1] , Mariona Coll[1] , Arántzazu González[1] , Mariana Köber[1] , Anna Laromaine[1] , Ana M. López-Periago[1] , Joana Martínez[1] , Anna May Masnou[1] , Rosario Núñez[1] , Carmen Ocal[1] , M. Rosa Palacín[1] , Imma Ratera[1] , Susagna Ricart[1] , Anna Roig[1] , Pietat Sierra[1] , Marta Vendrell[1]

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Con el objetivo de estimular y promover el interés por la carrera investigadora, y conscientes de la falta de referencia de mujeres científicas para jóvenes en el momento de elegir su futuro profesional, desde el Instituto de Ciencia de Materiales de Barcelona (ICMAB-CSIC) llevamos a los centros educativos y sociales una lectura teatralizada*, interpretada por mujeres del propio ICMAB, que da a conocer la historia de mujeres científicas de épocas diferentes.

Se ha optado por un relato en “primera persona”, utilizando el papel de salonière de Émilie du Châtelet para, saltando las barreras del tiempo, reunir en su salón a mujeres sabias de todos los tiempos: Hipatia de Alejandría, Trota de Salerno, Beatriu de Pinós, Maria Sibylla Merian, Ada Lovelace, Nettie Stevens, Rosalind Franklin, Vera Rubin y Margarita Salas. De una manera amena y entretenida, pero rigurosa, cada una de ellas da a conocer sus contribuciones, en el entorno histórico en que se produjeron, provocando curiosidad en el público sobre la ciencia y su papel en la sociedad. Hildegarda von Bingen ameniza la sesión al piano, con una selección de temas musicales escogidos para cada una de las protagonistas. La lectura incorpora una proyección realizada con imágenes de las propias sabias, su trabajo y su época, proporcionando así el ambiente temporal del relato.

* Fundación General del CSIC (ref. FGCC-2019-0014) ayuda para actividades orientadas a favorecer la cultura científica e incrementar el valor social de la ciencia en su II Edición.

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S20. Física Nuclear (GEFN)

Organizadores:
Dolores Cortina, *Universidade de Santiago de Compostela*

Patrocinado por

GE Física Nuclear

S20. Nuclear Physics (GEFN)

Organizers:

Dolores Cortina, *Universidade de Santiago de Compostela*

Sponsored by:

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ID: 04224, 15/07/2019 15:00 - 15/07/2019 15:30, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Invited Symposio)

Introduction to hadrontherapy: physics, biology, qualy.

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Accelerated protons (eg. 250 MeV), Carbon (eg 450 MeV/n) and other charged particles are used at present as optimized weapons in radiation therapy against cancer.

The physical properties of energy deposition, in particular (a) the Bragg peak (produced by a high stopping power before the end of range of the particles) and (b) no significative residual energy deposition behind the peak, makes them a tool of choice to conform the radiation deposited dose to a tumour target and to reduce the integral dose deposited in critical and healthy tissues. Additionally, a biological enhanced effect exists compared to photon beams, related to the high concentration of ionisation around the particle track, in the order of 10% for protons but of higher importance with Carbon.

The pioneer work in the field has been done in experimental accelerators since the 50', and at the end of the 90' specific accelerators (cyclotrons and synchrotrons) have been conceived and built for external radiation therapy, including sophisticated methods of beam transport and shaping (isocentric gantries, passive and scanning methods to delivered the beam to a patient). The main clinical applications are for paediatric patients, base of the skull and ophtalmic tumors, as well as many others clinical sites being under study.

In this talk, the principles, the status and the applications of protontherapy will be presented, with some considerations on Carbon beams.

Concepts like the importance of workflow, cost benefit and quality of life will be shown as determinant for the operation of these facilities. Research in the field includes the development of new accelerators, investigate new beams, use of minibeams, high dose rate beams, conversion of Hounsfield Units from CT scanners to stopping power, uncertainties, nanoparticles, biological effects and, of course, clinical protocols.

ID: 04223, 15/07/2019 15:30 - 15/07/2019 15:45, Room 0.7 (ground floor)

S20. Nuclear Physics (GEFN)

(Invited Symposio)

VISIÓN DE LA IMAGEN MÉDICA PARA LA PRÓXIMA DÉCADA

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1) UPV

** José María Benlloch Baviera, benlloch@i3m.upv.es*

En esta charla proporcionamos nuestra visión de cómo evolucionarán durante la próxima década las diferentes técnicas de imagen médica tradicionales (Rayos X, Medicina Nuclear, Resonancia Magnética, Ultrasonidos) y describiremos otras nuevas que pueden ir apareciendo en la clínica, para su aplicación en el diagnóstico y tratamiento del cáncer, de las enfermedades neurológicas y en cardiología.

Comenzaremos describiendo el estado del arte en imagen híbrida PET/MRI y especularemos sobre la evolución de esta técnica en los próximos años. Seguidamente, explicaremos las diferentes alternativas para aumentar de forma significativa la sensibilidad de los sistemas PET. Estas tecnologías innovadoras de Imagen Molecular, junto con la difusión de radiofármacos más específicos, permitirán realizar diagnósticos más precisos basados en la biología y en algunos casos al mismo tiempo en el que se realiza una terapia dirigida (“theranostics”).

Nuestra perspectiva de la MRI es muy diferente ya que esperamos la aparición de sistemas de bajo coste trabajando a bajo campo y que permitirán la obtención de imágenes en las consultas de los especialistas (cardiólogos, urólogos, traumatólogos). Por otro lado, nuevas secuencias de pulsos abrirán la visualización simultánea del tejido duro y del tejido blando.

En el área del cribado en cáncer de mama, el siguiente paso después de la mamografía digital y de la tomosíntesis será obviamente el TAC de mama a baja radiación, probablemente espectral. La técnica de rayos X también superará su limitación para la visualización de calidad de los tejidos blandos mediante la introducción del contraste de fase.

Finalmente, en ultrasonidos se están produciendo importantes avances que se trasladarán a la clínica tanto para el diagnóstico como para la terapia. En particular, la foto-acústica será relevante a nuestro entender en el diagnóstico del melanoma, así como nuevas técnicas permitirán la detección y evolución del cáncer de próstata, hígado y páncreas midiendo la visco-elasticidad de los tejidos.

ID: 04019, 15/07/2019 16:00 - 15/07/2019 16:15, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

PET Imaging and Dose correlation from Proton Activation.

Victor Valladolid Onecha[1] , Pablo Galve[1] , Fernando Arias Valcayo[1] , Paula Ibáñez[2] , Daniel Sanchez Parcerisa[2] , Samuel España[3] , Joaquin L. Herraiz[2] , Luis M. Fraile[2] , Jose M. Udías[2]

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Range verification techniques for protontherapy include positron-emission tomography (PET) and prompt-gamma (PG) imaging. The main challenges preventing their clinical implementation are, in case of PET, the relatively long half-lives of the isotopes of interest and the large energy needed to activate PET-decaying nuclei [1].

We have investigated the use of certain isotopes as contrast agents for PET, increasing their activation rates and shifting the activity peaks towards the Bragg peak. For this purpose we have developed an activation calculation tool in different software packages such as TOPAS and PenH, and we have compared both. The results show an increased PET activation at the distal end of a 150 MeV proton beam, within 1 mm from the Bragg peak (BP), using Water-18O (H_2O^{18}) as a contrast agent.

The activation maps of ^{18}F ($T_{1/2}\approx$110 min) and ^{15}O ($T_{1/2}\approx$122 s) obtained from TOPAS and the SuperArgus 4R preclinical PET scanner [2] have been simulated with PeneloPET [3], in order to obtain 5-minute-long acquisitions right after irradiation and 15 minutes later. Results show the dominance of the ^{15}O signal in a delocalized region far from BP in the first 5 minutes, but the BP distal end is perfectly identified for the 15 minutes delayed acquisition due to the ^{18}F signal arising from the proton activation of ^{18}O. The H_2O^{18} is perfect for validation and verification with phantoms, and *in vivo* patients, provided if it could be biologically fixed in area of maximum dose deposition.

References

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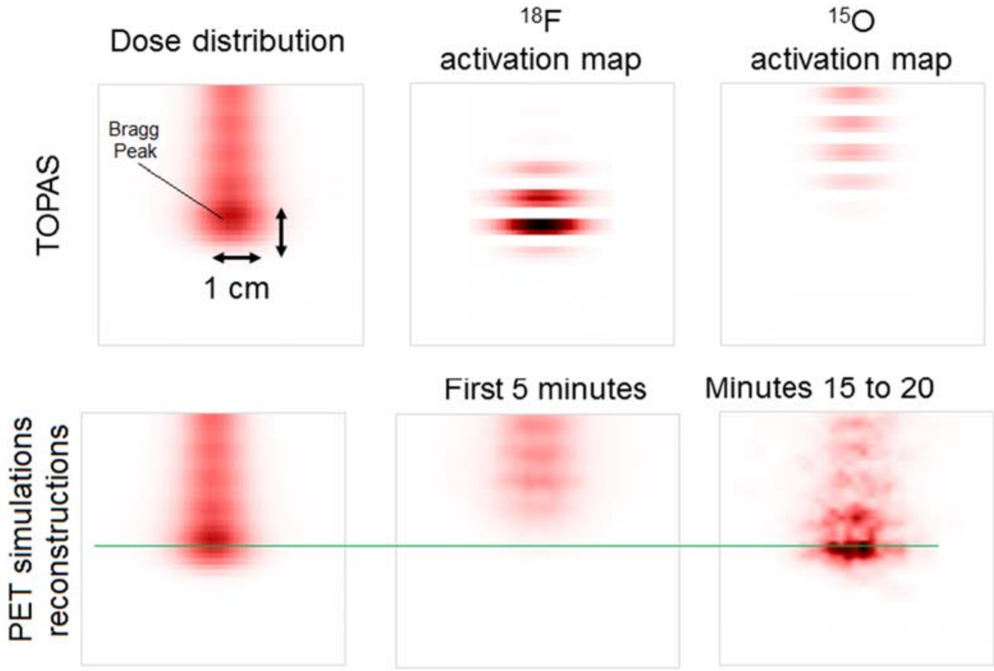
Dose distribution
^{18}F activation map
^{15}O activation map
TOPAS
Bragg Peak
1 cm
First 5 minutes
Minutes 15 to 20
PET simulations reconstructions

ID: 03864, 15/07/2019 16:15 - 15/07/2019 16:30, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

Measurement of the production cross section of the short-lived β^+ emitters of interest in range verification in proton therapy

Teresa Rodríguez González[1] , Carlos Guerrero Sánchez[1] , Peter Dendooven[2] , Luis Mario Fraile[3] , M. del Carmen Jiménez Ramos[4] , Jorge Lerendegui Marco[5] , M. de los Ángeles Millán Callado[1] , Ikechi Ozoemelan[2] , Jose Manuel Quesada[5]

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** M. Teresa Rodríguez González, mrodriguezg@us.es*

In proton therapy there is an intensive research program aiming at *in-vivo* range verification. *In-vivo* PET range verification requires a comparison of the measured and expected β^+ activity distribution produced by the proton beam by means of nuclear reactions on the most abundant elements in the body: C, O, N and, to a lesser extent, P and Ca. The accuracy of the expected activity distributions depends on the accuracy of the MC simulations, dominated by that of the underlying cross sections [1]. However, a review of the experimental data indicates that they are not available in the full energy range of interest (up to 230 MeV) and, when they are, there are sizable discrepancies between them. Indeed, several studies [2] confirm the need for more measurements, especially for the short-lived nuclides, for which there are no data above 55 MeV [3].

In this context, we intend to improve the knowledge of the production yields of the long- and short-lived isotopes of interest. Focusing on the short-lived nuclides (half-life shorter than the 19s of ^{10}C), the most copiously produced isotopes are ^{12}N ($t_{1/2}$=11ms) on C, ^{29}P ($t_{1/2}$=4.14s) on P and ^{38m}K ($t_{1/2}$=924ms) on Ca [3], which will be measured at KVI-CART in 2019. The set-up is designed to minimize the number of irradiations placing thin target films between converter/degrader Al foils with an array of $LaBr_3$ detectors pointing at the targets and measuring in coincidence (fig. 1). In this way, a single irradiation provides the production yield at several energies, one for each target. A series of Geant4 simulations have been performed to optimize the set of beam energies and detector/target configurations that will allow studying the full energy range (20 to 200 MeV.) The experimental setup, simulations and preliminary results of the production yields of ^{12}C(p,n)^{12}N, ^{31}P(p,p2n)^{29}P and ^{40}Ca(p,2pn)^{38m}K below 190 MeV will be presented.

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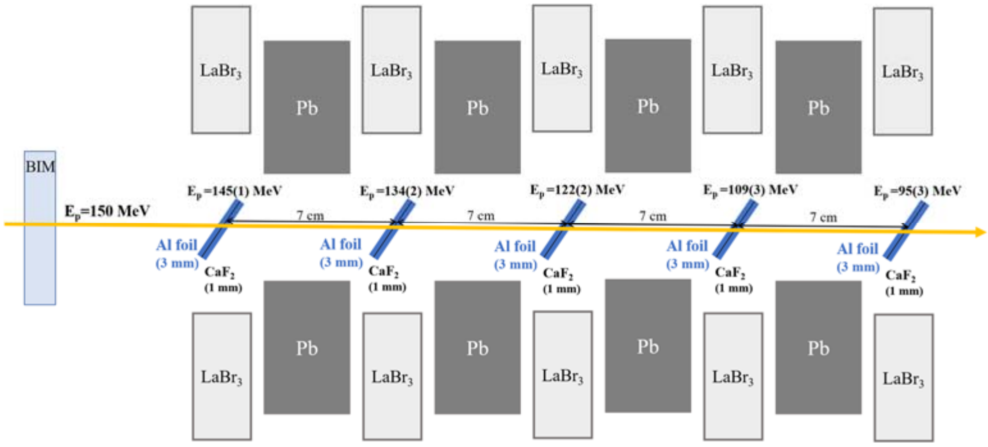

LaBr3
Pb
BIM
E_p=150 MeV
E_p=145(1) MeV
E_p=134(2) MeV
E_p=122(2) MeV
E_p=109(3) MeV
E_p=95(3) MeV
7 cm
Al foil
(3 mm)
CaF2
(1 mm)

ID: 03922, 15/07/2019 17:30 - 15/07/2019 17:45, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

GHMCp – GPU-based Hybrid Monte Carlo for Proton therapy

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Introduction. Proton beams allow for higher conformity of dose distributions and less dose to the healthy tissue. However, uncertainties in dose distribution can affect strongly the clinical outcome. The most accurate dose predictions are obtained with Monte Carlo (MC) simulations, but they are not suitable for real-time dose planning. This work presents a calculation tool based in the full physics content and particle tracking of realistic MC simulations, able of computing dose distributions, proton fluencies, phase spaces and nuclear activations from proton beams within seconds.

Material and Methods. The GPU-based Hybrid Monte Carlo for protons (GHMCp) incorporates a precalculated database of the transport of protons, photons and electrons in different materials, obtained from a MC code. This way all the physics of the primary and secondary particles are included. The database can be easily calculated from any MC code, and thus predictions from different MC packages can be tested with the same code. Other quantities such as nuclear activation or neutron production can also be calculated. A GPU implementation has been made to further increase the speed. Benchmark MC simulations with PENH-NUCL [1,2] and TOPAS [3] were used to compare with GHMCp.

Results. GHMCp dose predictions agreed with the calculations in homogeneous and heterogeneous media. Figure 1 shows a comparison of Bragg peaks for a 150 MeV proton beam in water. The performance study showed a 5000 acceleration factor for the GHMCp compared to the MC codes.

Conclusion. The GHMCp is fast and versatile. It employs precalculated particle transport quantities easily derived from any MC code. It computes dose distributions and activation maps 5000 times faster than a regular MC, making possible near real time calculations and inverse dose planning.

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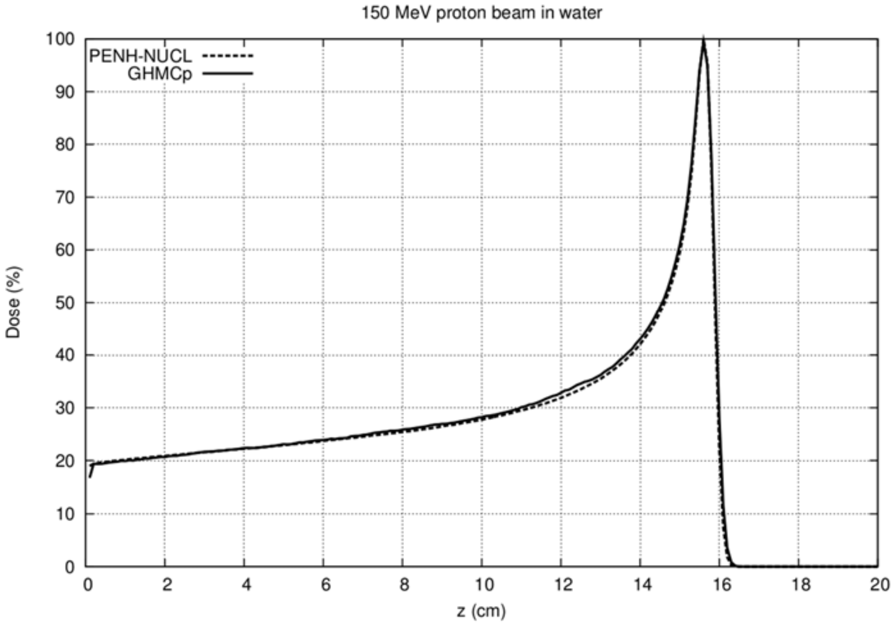
150 MeV proton beam in water
PENH-NUCL
GHMCp
Dose (%)
z (cm)
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
10
12
14
16
18
20

ID: 04017, 15/07/2019 17:45 - 15/07/2019 18:00, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

Awake Preclinical Brain PET Imaging based on Point Sources

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The presence of motion during the relatively long PET acquisitions is a very common problem, especially with awake animals [1, 2], infants and patients with neurological disorders. External motion can be detected based on the optical tracking of markers placed on the skin of the patient, but it needs additional hardware and a somehow complex integration with the PET data. The possibility of motion detection directly from the acquired PET data would overcome these limitations. In this work, we propose the use of the centroid of lines of response to identify long motion free frames (more than 2.5 seconds). Then, thanks to the high sensitivity of PET detectors [3], we can split these no-notion frames into smaller frames, in order to identify the motion with higher precision. In these frames we identify in real-time the location of 18F markers placed on the head of the rat with the radiotracer labeled with 18F. We evaluated the performance of the proposed method in a preclinical PET/CT scanner with an awake rat injected with 600 µCi and four 18F sources attached in its head. After solid rigid motion compensation, we reconstruct an image that use 70% events of the acquisition, and the resolution is comparable with the motion-free frames.

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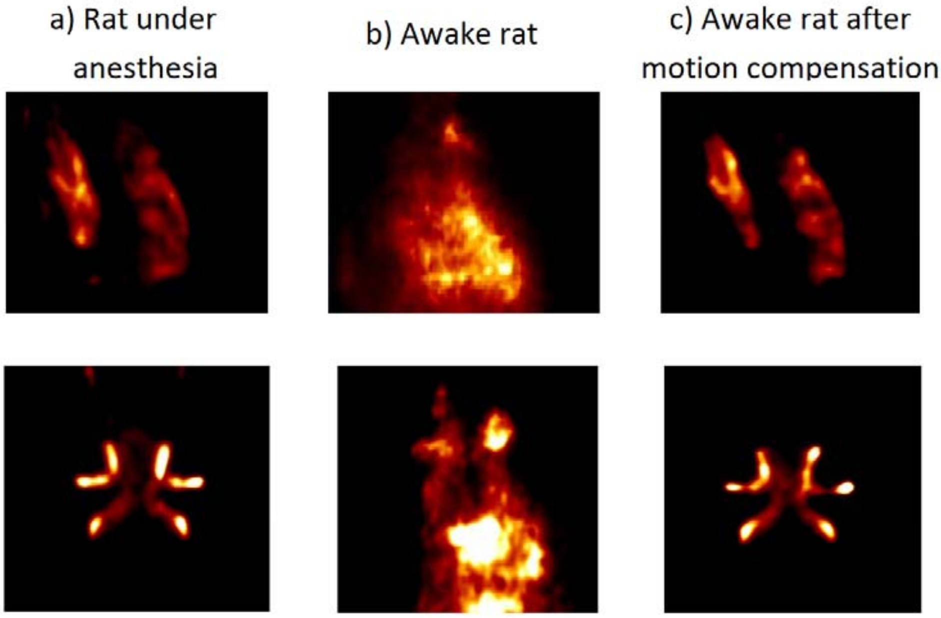
a) Rat under anesthesia
b) Awake rat
c) Awake rat after motion compensation

ID: 04061, 15/07/2019 18:00 - 15/07/2019 18:15, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

Activation of contrast agents for range verification in proton therapy

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We explore the suitability of several activable radioisotopes to monitor proton range in proton therapy treatments, either from prompt γ or PET imaging. For this purpose we have developed an experimental setup to measure the production cross sections and explore possible materials that could be used as contrast agents to enhance the capability of direct imaging of proton range. This further develops on our previous proof-of-concept experiment where the production of ^{68}Ga and ^{66}Ga radioisotopes through (p,n) reactions, after irradiation of a natural Zn target using the 9-MeV proton beam at the 5-MV CMAM tandetron accelerator, was used to produce PET images. We have used Zn as reference for our measurements in this work.

A promising candidate for proton range verification is iodine. Several iodinated radio contrasts have already been used in angiography and X-ray computed tomography (CT) applied to brain, thorax and abdomen, with concentrations up to 370 mg/ml. It is thus a good candidate for activation from the point of view of feasibility, but also because the irradiation of stable ^{127}I produces the γ-ray emitter ^{127m}Xe, with 69.2(9) s half-life, which decays by γ emissions of 124.6 keV (69% branching) and 172.5 keV (38%). Further motivation for our study is that virtually no data exists for irradiations of ^{127}I with proton energies above 100 MeV.

The irradiation was made with a proton beam of energies between 15 and 220 MeV in the West Germany Proton Therapy Centre (WPE) in Essen, Germany. The setup consisted of 4 $LaBr_3$(Ce) detectors specially designed to enhance the time resolution and the packing factor while keeping a good energy resolution. The detectors have high rate and coincidence capabilities and are read out with the DRS4 evaluation board by Paul Scherrer Institute.

The contribution presents preliminary values of the measured cross sections for the ^{127}I(p,n)^{127m}Xe reactions, as well as other reactions of interest for range verification in proton therapy.

ID: 04063, 16/07/2019 15:00 - 16/07/2019 15:15, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

A high repetition laser-plasma proton accelerator for radioisotope production

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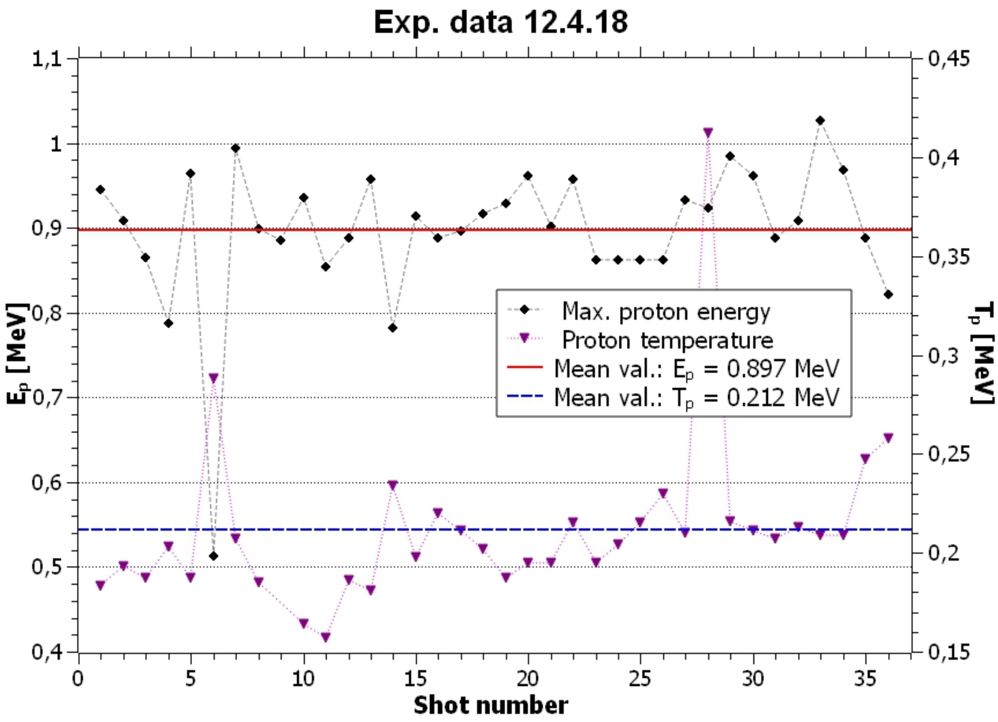
Radioisotope for medical imaging and treatment are produced in conventional accelerators. More recently, the use of ultraintense lasers has been proposed as an alternative in terms of availability an size. These compact systems can accelerate, via laser-plasma interaction, charged particles like protons, ions or electrons, as well as neutrons and x-ray generation, which can induce radioisotope production through nuclear reactions.

At the Laser Laboratory for Acceleration and Applications (L2A2) of the Universidad de Santiago de Compostela a high repetition rate laser of 45 TW is used for proton acceleration. It can deliver pulses of 1.2 J and 25 fs at 10 Hz, which are then focused on a few micron achieving intensities of 10^{19} W/cm^2. The high repetition rate of the laser requires a positioning mechanical assembly that maintains the same focal incidence conditions while refreshing the target material at each shot. A wheel-like holder containing target sheets of few micron thickness is placed on a three mechanical stages assembly (two linear and a rotational one) to perform the positioning. A map of the target surface is generated by measuring the deviation of each shot point from the focal reference position with a laser-position sensor. The map is then programmed into the stages which automatically correct the laser focal position on the target shot-by-shot with micron resolution. This procedure allows to perform series of hundreds of shots in a row in the same focal conditions.

Proton pulses of few MeV have been measured using a time-of-flight detector, with an stability both in maximum energy and spectra temperature of about 3%. We expect to increase the proton maximum energy in future campains by optimizing this correction procedure and by using thinner target sheets. Once we reach protons of enough energy, we aim to achieve the production of radioisotopes like ^{11}C for PET imaging and study its viability in relation to conventional accelerators.



Exp. data 12.4.18
Max. proton energy
Proton temperature
Mean val.: E_p = 0.897 MeV
Mean val.: T_p = 0.212 MeV
E_p [MeV]
T_p [MeV]
Shot number

ID: 03973, 16/07/2019 15:15 - 16/07/2019 15:30, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

Variational approximations to exact solutions in shell model valence spaces

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The interacting shell model (ISM) and the self-consistent mean-field (SCMF) and beyond-mean-field (BFM) approximations are the two most commonly used methods to study the structure of the atomic nucleus from a microscopic point of view.
In the ISM method, the nuclear states are found by diagonalizing an effective nuclear Hamiltonian defined in a reduced valence space. On the other hand, SCMF and BMF techniques are variational approaches to the exact solution of a many-body system where all the nucleons are active in a no-core valence space. The most successful SCCM and BMF approaches use energy density functionals such as Gogny, Skyrme or Covariant Lagrangians as the underlying interaction between the particles. The range of applicability of SCMF and BFM methods is much larger than the ISM framework but the agreement with the experimental spectra is better with the latter. Therefore, BMF methods with increasing complexity (including symmetry restorations and configuration mixing) have been developed in the last fifteen years. However, the quality of these variational approaches with respect to the exact solutions are rarely tested.
In this contribution we will compare different SCMF and BMF approaches with respect to the exact solutions using ISM Hamiltonians and valence spaces. In particular, the Hartree-fock-Bogoliubov method and its extensions like the symmetry conserving configuration mixing framework will be applied to compute the low-lying spectrum of several isotopic chains in the sd and pf shells.

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S20. Nuclear Physics (GEFN)
(Oral)

The TRAPSENSOR facility: towards universal Penning Trap Mass Spectrometry with single-ion sensitivity

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High-precision mass measurements using Penning traps are an invaluable tool in nuclear physics, since they can be used to obtain the nuclear binding energy. SuperHeavy Elements (SHEs) are of particular interest – the determination of their binding energy provides insight on the nuclear shell effects that are essential for their very existence.

SHEs can only be produced with extremely low yields. Thus, a technique that features single-ion sensitivity and is universal (in terms of accessible mass-to-charge ratios) is required.The Time-Of-Flight Ion-Cyclotron-Resonance and Phase-Imaging Ion-Cyclotron-Resonance techniques have provided invaluable contributions by directly measuring the masses of several transuranic elements [1,2]. However, they still require tens of ions for a mass measurement. Induced-Image-Current detection is very precise [3] and single-ion capable, but not universal; the required charge-to-mass ratio is unattainable for SHEs, given the current techniques.

In this contribution the on-going work towards a mass spectrometry technique that fulfills all the above requirements will be presented. The work is based on a proposal to use a laser-cooled ion as an extremely sensitive detector [4,5]. The target and sensor ion, stored simultaneously in a Penning trap, form a crystal after performing Doppler cooling. The eigenfrequencies of the crystal can then be very sensitively probed and measured using the photons scattered by the sensor ion. In this contribution we will present the technique in detail, underlining the outstanding features with respect to sensitivity, how this can be applied to SHEs, and the Penning trap facility where laser cooling has been carried out in a $^{40}Ca^+$ ion in the highest magnetic field [6]. The final temperature for the sensor ion greatly affects sensitivity; thus, the use of the method in the quantum regime will also be addressed.

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ID: 04080, 16/07/2019 15:45 - 16/07/2019 16:00, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

The role of Nuclear Physics in Neutrino Oscillations

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Neutrino properties have been investigated for more than 80 years. It has been firmly established that neutrinos oscillate and hence are massive particles. The oscillation parameters have been measured, but still one needs to determine the neutrino-mass hierarchy, the neutrino-mass absolute scale, and whether the neutrino is a Dirac or a Majorana particle. Also, investigation of charge-parity (CP) violation in the leptonic sector of the Standard Model is of fundamental importance for the construction of cosmological models. Today, huge efforts in both theoretical and experimental sides are made to achieve these goals.

Inevitably, this ambitious scientific program meets challenges that slow down the process. The underlying problem is that the energy of the incident neutrino, which is a necessary input for the oscillation analyses, is unknown. The neutrino energy is reconstructed using the available experimental information and theoretical models. This is a major source of systematic uncertainties in the determination of the neutrino properties. What complicates the reconstruction of the neutrino energy is that all present and future generations of neutrino-oscillation experiments use complex nuclei as target/detector material.

I will present an overview of some theoretical approaches employed for the modeling of the main reaction mechanisms involved in the neutrino-nucleus interaction at intermediate energies: low-energy excitations, quasielastic scattering, two-nucleon knockout processes, and pion production.

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S20. Nuclear Physics (GEFN)
(Oral)

Radiative neutron capture on ^{242}Pu: combining beams and techniques to improve the cross section accuracy from thermal to 500 keV

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The sustainability of nuclear energy as a key technology in a low-carbon energy future points to the use of innovative nuclear systems, such as Accelerator Driven Systems and Generation-IV reactors. The design and operation of these systems require a better knowledge of the neutron cross sections. For the case of the ^{242}Pu(n,γ) cross section, improved accuracy is required between thermal (25.3 meV) and 500 keV.

A key factor for the success of capture measurements is the quality of the targets, in particular for scarce radioactive isotopes. For this work we designed an innovative ^{242}Pu sample consisting of a stack of seven fission-like targets making a total of 95(4) mg of ^{242}Pu electrodeposited on thin (11.5 μm) aluminum backings, featuring a uniquely small neutron reaction rate in the target backings [1].

This contribution presents the final results of a new measurement of the ^{242}Pu(n,γ) cross section using complementary neutron beams (see Figure 1). The thermal point was determined at the Budapest Research Reactor, where the combination of Neutron Activation and Prompt Gamma Analysis [2] has significantly improved the accuracy, hence solving previous discrepancies. The cross section from 1 eV to 500 keV was measured by means of the time-of-flight technique at the pulsed white neutron beam of the CERN n_TOF facility. In the resolved resonance region (RRR), the high resolution of n_TOF-EAR1 has allowed analyzing 180 new resonances up to 4 keV [3]. In the unresolved resonance region (URR), the reduced backing thickness and the study of the background have enabled the extraction of capture data up to 500 keV for the first time [4].

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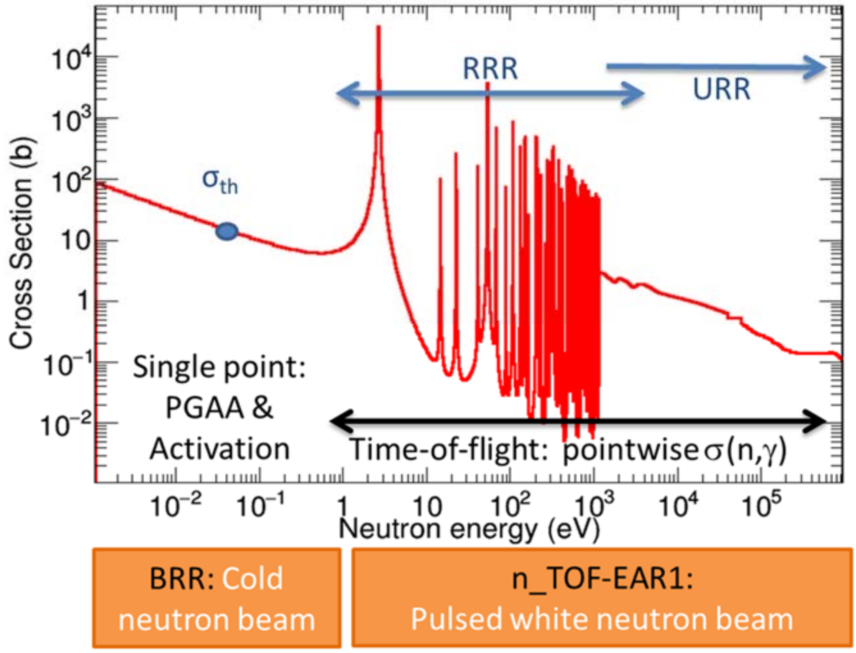
RRR
URR
σ_{th}
Cross Section (b)
Single point:
PGAA &
Activation
Time-of-flight: pointwise $\sigma(n,\gamma)$
Neutron energy (eV)
BRR: Cold neutron beam
n_TOF-EAR1:
Pulsed white neutron beam

ID: 03743, 16/07/2019 16:15 - 16/07/2019 16:30, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

On shape coexistence in zirconium region

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The shape coexistence phenomenon is related with the presence in the same energy region of eigenstates with different deformations. The lead region is considered as a paradigm for shape coexistence and several decades of experimental effort have supported this believe. In particular, long chains of the Pb, Hg, Pt and Po isotopes have been measured and a rich experimental body of data concerning, excitation energies, electromagnetic transition rates, radii, magnetic g-factors, alpha-hindrance factors and Coulomb excitation reactions, has been obtained.

The goal of this contribution is the study of the even-even Zr isotopes (from A=94 till A=110) through the use of the interacting boson model with configuration mixing. This region is known for the rapid change of the ground state deformation, with clear hints of the existence of a Quantum Phase Transition. It is also known for the presence of intruder states coming from two-particle two-hole excitations across Z=40 shell closure. We will perform a detailed analysis of the excitation energies, B(E2) transition rates, radii, and two-neutron separation energies. Moreover, we will obtain mean-field energy surfaces, quadrupole shape invariants and wave functions of selected states.

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S20. Nuclear Physics (GEFN)
(Oral)

Observation of the beta-decay of ^{135}In

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For the exotic ^{135}In only the identification and β half-life have been established [1,2], but nothing is known about its β-decay and the population of the level structures in the Sn isotopes. In this work the β-decay of the ^{135}In isotope has been investigated for the first time. The study was carried out at the ISOLDE-CERN facility where In was produced by spallation neutrons in a thick UC_x target, selectively ionized by the ISOLDE RILIS, mass separated and transported to the ISOLDE IDS. The latter was equipped with a plastic β-detector, four HPGe detectors, and a compact set-up for fast timing studies.

γ-rays arising from the decay of ^{135}In have been identified by their time distribution. The analysis yields a half-life of ^{135}In in good agreement with literature [1,2]. The decay very intensely populates ^{134}Sn. In particular, strong γ-rays at 174, 348 and 726 keV are observed, corresponding to the de-excitations of the three first excited levels in ^{134}Sn. The amount of statistics allows for a coincidence study, which reveals the presence of new γ-transitions in ^{134}Sn. We will report on these findings. In addition, the β-delayed one- and two-neutron emission probabilities will be discussed. These quantities and the β-decay half-life are also relevant because ^{135}In was recognized [2] as one of the waiting-point isotopes in the rapid neutron-capture nucleosynthesis of elements in the A~130 peak [3].

Several other short-lived γ-rays can be identified in the spectrum. Owing to the lifetime and lack of coincidences with identified ^{134}Sn transitions, some of them are good candidates for the first identification of γ-decay in ^{135}Sn. The proposed low-lying structure of ^{135}Sn will be discussed based on the experimental information and in the light of the systematics and the comparison to single-particle states in ^{133}Sn.

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S20. Nuclear Physics (GEFN)
(Oral)

Latest advances in the study of the ^{8}B nuclear structure

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The interest in the decay of ^{8}B into ^{8}Be both from nuclear physics and astrophysics has led to multitude of studies over the last decades. Especially as the ^{8}B decay is the only source of solar neutrinos with an energy higher than 2 MeV mainly coming from the most intense branch of the 8B decay to the 3 MeV state of ^{8}Be that is followed by the break up into two alphas.

From the nuclear structure point of view, 8B is the only well-established proton halo nucleus in its ground state and its decay gives us access to the interesting 2+ doublet at 16.6 and 16.9 MeV in 8Be. These states have dominant configurations as ^{7}Li+p and ^{7}Be+n respectively and constitute an attractive isospin mixed doublet as stated in the reaction study done by von Brentano [1]. Prior to this study, the 16.992 MeV state, only populated via electron capture, was hinted once in a previous experiment at JYFL [2].

In this contribution, I will describe a new experiment done at ISOLDE-CERN where the 16.9 MeV state has been observed with enough statistics to allow for an R-matrix analysis of the full α decay spectrum, testing the current knowledge of the 2+ doublet.

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S20. Nuclear Physics (GEFN)
(Oral)

HISPANoS, the neutron facility at CNA: latest upgrades, status and future plans

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Neutrons play a relevant role in a wide variety of scientific fields and applications. The first accelerator-based neutron source in Spain started its activity in 2011 in the Nuclear Physics Unit of the Centro Nacional de Aceleradores (CNA) in Seville [1].

Since the beginning, HISPANoS (Hispalis Neutron Source) has had a permanent activity and it has been used by local and external users with experiments in continuous beams with ^{7}Li(p,n) and D(d,n) as neutron production reactions. Among others, in the fields of medical physics, radiation damage, neutron imaging, and nuclear astrophysics (see e.g. [2-4]).

Since 2016, the efforts have been focused on design, setup and commissioning of a new and dedicated line to develop the neutron time-of-flight (TOF) technique. So, it was installed a chopping/bunching system at the low energy section of the accelerator. The system allows delivering both proton and deuteron beams leading to 1-2 ns width neutron bunches at a repetition rate of up to 2 MHz [5]. The neutron TOF opens the door to new and more accurate activities such as the measurement of the neutron spectra, detector tests for international TOF facilities, and differential cross section measurements, among others.

This contribution presents the commissioning of the new pulsed neutron beam, including the characterization of neutron spectra by means of the TOF technique, as well as the future plans to become a reference neutron facility for external users.

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ID: 03797, 16/07/2019 18:15 - 16/07/2019 18:30, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

Halo effects in the low-energy scattering of ^{15}C with heavy targets.

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In regions at the border of nuclear stability, the reduced binding energy can favour tunnelling of valence nucleons through the barrier, extending the nuclear density to large distances and forming the so-called “nuclear haloes” [1,2].

In high-energy scattering (≳100 MeV/u) the collision process is more sensitive to the single-particle structure, and a neutron halo will produce a narrow momentum distribution of the breakup fragments and a large value of the interaction cross section. At low collision energies around the Coulomb barrier, the dynamics is dominated by collective degrees of freedom and is characterised by the coupling between the elastic, transfer and breakup channels, and the effects of the continuum. The weakly bound isotope 15C has been investigated in several experiments at high energies and the distribution of transverse-momentum for one-neutron breakup and the reaction cross sections, suggest the presence of a halo [3]. Due to the particular ground-state configuration, 15C would be unique nuclear system in exhibiting a pure 2s1/2 single neutron halo ground state [4].

In this contribution we present the first experimental results for the 15C+208Pb scattering system at E = 65 MeV, just around the Coulomb barrier. The experiment was performed at the ISOLDE radioactive beam facility at CERN and the measurement was carried out with the GLORIA detector array [5]. Details of the experiment and the first results of the elastic cross sections will be presented and discussed in the framework of coupled reaction channels calculations [6].

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ID: 03988, 16/07/2019 18:30 - 16/07/2019 18:45, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

Fast-timing investigation of the neutron rich ^{136}Te and ^{138}Te

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Nuclei with few valence particles outside of a doubly-magic core provide valuable information about single-particle energies, nucleon-nucleon effective interactions and may give insight into the onset of collectivity. The exotic ^{136}Te isotope is of particular interest, since it arises from the coupling of two protons and two neutrons to the N=82 Z=50 ^{132}Sn, in one of the most exotic regions of the nuclear chart yet to be explored. It has been experimentally shown that ^{136}Te has an anomalously low electric quadrupole transition rate B(E2; $2^+ \rightarrow 0^+$) [1], which does not follow the trend of ^{132,134}Te and is also at variance with the neighboring Xe and Ba isotopes. Although subsequent measurements [2,3,4] have reduced the anomaly, the experimental values are not fully consistent. More importantly the measurement of the B(E2; $2^+ \rightarrow 0^+$) transition rate in next isotope, ^{138}Te, is of the utmost interest.

In this contribution, we present the direct measurement of the ^{136}Te and ^{138}Te lifetimes. Data were obtained at the Institute Laue-Langevin (ILL) in Grenoble, where prompt-fission γ-ray measurements were performed after fission induced by cold-neutrons on actinide targets. The measurements were carried out using the EXILL-FATIMA mixed HPGe/$LaBr_3$(Ce) array [5]. The fast-timing gg(t) methods using triple and quadrupole events involving two fast $LaBr_3$(Ce) scintillators were used for the analysis. New time calibration procedures were put in place to take into account the background contribution to the time distributions.

We report on a new direct measurement of the 2^+ state lifetime in ^{136}Te, which allows the derivation of the B(E2; $2^+ \rightarrow 0^+$) rate in ^{136}Te. Lifetime measurements of the 4^+ and, for the first time, 6^+ and 8^+ states are also performed. We also report on the preliminary measurement of the B(E2; $2^+ \rightarrow 0^+$) transition rate in ^{138}Te.

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ID: 03982, 17/07/2019 15:00 - 17/07/2019 15:15, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

Exploring continuum structures in reactions with three-body nuclei

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Recent advances in RIB physics and detection techniques have triggered the exploration of light nuclei at the limit of stability and beyond the driplines. Of particular interest is the case of Borromean two-neutron halo nuclei, such as ^{6}He or ^{11}Li [1]. While the correlations between the valence neutrons play a key role in shaping their properties, a proper understanding requires also constraints on the unbound binary subsystems ^{5}He or ^{10}Li. The evolution of these correlations beyond the driplines gives rise to two-neutron emitters, e.g., ^{16}Be or ^{26}O [2]. Since they have a marked core+N+N character, three-body models are a natural choice to describe their structure and reaction dynamics.

Recently, we have studied the population of unbound ^{10}Li states in ^{11}Li(p,d) transfer [3] and ^{11}Li(p,pn) knockout [4] reactions in inverse kinematics by using a novel methodology which combines a full three-body description of the projectile with reliable reaction calculations. We have also applied the method to the intepretation of recent RIBF-RIKEN data on ^{14}Be(p,pn) [5] via the analysis of the corresponding ^{13}Be relative-energy spectrum and momentum distributions.

The continuum of three-body nuclei is also a topic of recent debate, with implications for the population of resonances in two-nucleon emitters. We have recently proposed a method to characterize few-body resonances by studying the time dependence of the eigenstates of a resonant operator [6], that we have applied to the unbound ^{16}Be. The extension to study the corresponding relative-energy distributions, as well as its application to other unbound three-body systems, is ongoing.

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ID: 03713, 17/07/2019 15:15 - 17/07/2019 15:30, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

Correlación entre la humedad relativa y la concentración ^{222}Rn en aire en el Laboratorio Subterráneo de Canfranc. Seis años de mediciones (2013 a 2018).

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Se presentan los resultados de seis años de medidas de la concentración de ^{222}Rn en aire, de la humedad relativa, de la presión atmosférica y de la temperatura ambiente en el Laboratorio Subterráneo de Canfranc (LSC). Se calculan las correlaciones entre estos parámetros, observándose que entre la concentración de ^{222}Rn y la humedad relativa existe una alta correlación, además se comprueba que estas dos magnitudes presentan una periodicidad estacional que puede ajustarse a una función trigonométrica.

ID: 04021, 17/07/2019 15:30 - 17/07/2019 15:45, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

Core-crust transition in neutron stars with finite-range interactions: the dynamical method

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The modelling of neutron stars (NS) requires the determination of the point of the transition between the core and the crust of the star [1,2]. In this work, the core-crust transition is studied for finite-range forces of Gogny [3], Modified Gogny Interaction (MDI) [4] and Simple Effective Interaction (SEI) [5] types by searching for instabilities in the core using the dynamical method. The dynamical method, introduced in Ref.[6], assumes that the energy density functional can be expressed as a sum of a homogeneous bulk part, a inhomogeneous term depending on the gradients of the neutron and proton densities and the direct Coulomb energy. We analyze the correlation of the core-crust transition density and pressure with the the symmetry energy associated to the nuclear equation of state. Knowing the core-crust transition point for these finite-range forces we compute the relation between the neutron star masses and radii, as well as the prediction of the mass, thickness and moment of inertia of the neutron star crust. We also address the predictions of the considered interactions for the tidal deformability in NS mergers [7].

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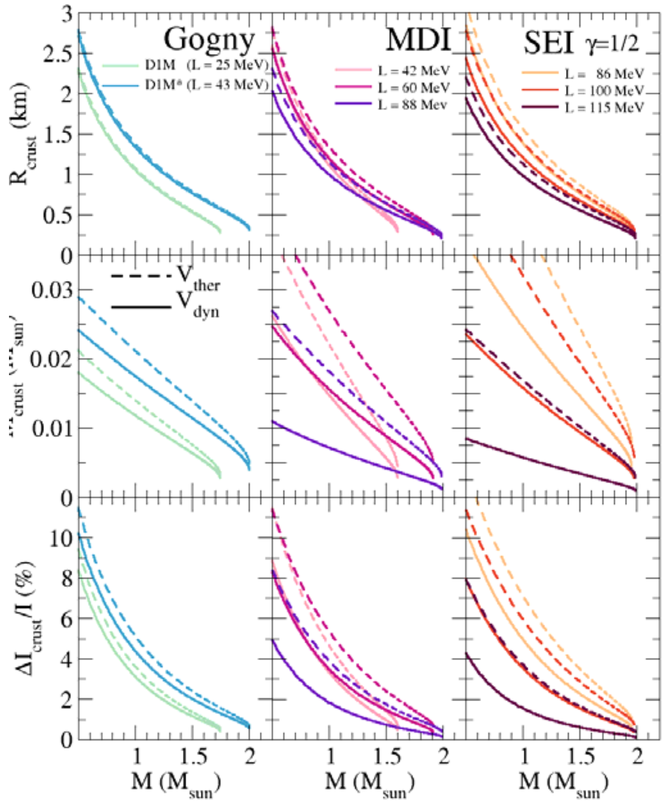

Gogny
D1M (L = 25 MeV)
D1M* (L = 43 MeV)
MDI
L = 42 MeV
L = 60 MeV
L = 88 Mev
SEI γ=1/2
L = 86 MeV
L = 100 MeV
L = 115 MeV
V_ther
V_dyn
R_crust (km)
ΔI_crust/I (%)
M (M_sun)

ID: 04066, 17/07/2019 15:45 - 17/07/2019 16:00, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

Characterization of scintillator crystals using current SiPM arrays

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In previous works we have observed that difference in shape and size of SiPM employed to read our large scintillator crystals, a considerable amount of light was lost, worsening the energy resolution. This effect can be compensated by using SiPM arrays.

In this work we have tried a commercial array from SensL, model ARRAYJ-60035-4P-BGA, a 2x2 array of 6x6 mm^2 SiPM. The main objective was to read out relatively large $LaBr_3$(Ce) cylindrical crystals, with dimensions 1,5\'\'x1,5\'\' (38,1 x 38,1 mm). In these measurements we achieved a energy resolution of 5% for the 661-keV full-energy peak of ^{137}Cs. This is an acceptable value considering the SiPM coverage of less than 30% of the surface of the scintillator crystal.

Due to the increased cost of larger arrays of SiPMs, we decided to design and build our own arrays, soldering single-pixel SiPM into PCBs, allowing for much more flexibility and reducing the electrical noise in the singal. It also makes acquisition system more compact and easy to use. We were able to make arrays of different shapes, not only square, to try and cover with SiPMs as much as possible the surface of the optical window of the scintillator.

In this work we will report the results from several of our arrays. In first place, a 3x3 array of SensL SiPMs, made of individual MicroFJ-30035 pixel. In addition, another 3x3 array of PM 332-WB pixels from Ketek. And finally an cross-shaped array of MicroFJ-60035 SiPMs by SensL. Resultas from 1,5\'\' $LaBr_3$(Ce) cylindrical crystals and other targe scintillators such as CeGAGG, LYSO or CsI are shown.

ID: 04077, 17/07/2019 16:00 - 17/07/2019 16:15, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

BRIKEN measurements of half-lives for Ce to Nd nuclei relevant for the formation of the r-process rare-earth peak (A~160)

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The Rare Earth Peak (REP) is a small, but clearly distinctive, peak around mass A~160 in the elemental solar system abundances created by the rapid neutron-capture process (r-process). In contrast to the r-process abundance peaks associated with neutron shell closures (e.g. A ~ 130, 195), which are formed during the (n, γ) ↔ (γ, n) equilibrium. The REP is formed later, after the neutron exhaustion. Thus, understanding the REP formation offers a unique probe for the study of the late times environmental conditions in the r-process site. According to theoretical models [1], half-lives (T1/2) and beta-delayed neutron emission probabilities (Pn) play an important role on the formation of the REP.

The BRIKEN project [2], launched in 2016 at RIBF in the RIKEN Nishina Center, aims to measure the decay properties (primarily T1/2 and Pn values) for a large number of isotopes on the path of the r-process, by using the BRIKEN neutron detector (the world largest beta-delayed counter), the AIDA implantation detector and two CLOVER-type HPGe detectors [3]. The NP1612-RIBF148 experiment makes use of BRIKEN for the measurement of the most relevant nuclei, the neutron rich region from Cs to Gd, linked to the REP formation [4].

The last run of this experiment was performed in 2018 with a setting centered on 165Pm.This work focuses on a preliminary analysis of half lives, in the Ce to Nd region, from the 2018 run. The results are compared with previous measurements by the EURICA collaboration [5]. Improved precision in the experimental half-lives has been achieved for 154,156-158Ce, 155-159Pr and 158- 161Nd.

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ID: 04122, 17/07/2019 16:15 - 17/07/2019 16:30, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Oral)

^{80}Se(n,γ) cross-section measurement at n_TOF (CERN)

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We have measured the ^{80}Se(n,γ) cross section with high accuracy and high resolution at CERN n_TOF, over the full energy range of astrophysical interest. These data are needed for a consistent interpretation of the temperature-sensitive s-process branching at ^{79}Se. The latter represents a key s-process branching point in the nucleosynthesis of heavy elements during core He-burning and shell C-burning in massive stars. The ^{80}Se cross section directly affects the stellar yield of the “cold” s- only branching product in this region, namely ^{82}Kr. There exist only one previous TOF measurement on ^{80}Se. However, the latter suffers of insufficient accuracy andcompleteness, owing to the 60cm flight-path used, the low energy cut-off at 3keV and a measuring set-up rather sensitive to scattered neutron backgrounds. All these aspects have been significantly improved in the present measurement. Preliminary analysis and results will be presented.

ID: 03778, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S20. Nuclear Physics (GEFN)
(Poster)

XRF spectroscopy applied to the analysis of vestiges from the archaeological site of Medellín (Badajoz, Spain)

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The magnificent strategic situation of the current village of Medellín, (Badajoz, Spain) has led to the settlement of different peoples throughout history (Figure 1). Among all of them, probably, the most prominent was a Roman colony, as evidenced by its impressive theater. The restoration works of this building carried out in the last decade were recognized with the *Europa Nostra Awards 2013,* a prestigious EU prize for cultural heritage. The excavations carried out in this archaeological site allowed to recover important prehistoric, Tartesic, Roman, Islamic and modern-contemporary material vestiges. In our research, a wide variety of these materials (objects, coins, etc.) have been characterized by energy dispersive X-ray fluorescence (EDXRF) analysis. One of the most outstanding archaeological pieces is a letter M partially gilded (Figure 2), which probably comes from the front of the theatre\'s scenic façade. The analyses carried out, not only of this piece, but also of other fragments of letters found there, show that these objects have an external significant layer of gold. In addition, coins, sculptural remains of metallic type and other materials have been analysed showing that the Roman city of Metellinum was a very important town in the Roman period, and also in other historical epochs. This work shows the importance of the application of spectroscopic techniques to the study and characterization of artworks or pieces with cultural interest, because now one can obtain important data and knowledge to characterize the materials used, which was not possible before.

ID: 04071, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S20. Nuclear Physics (GEFN)
(Poster)

Analysis of the ^{222}Rn content in the nitrogen gas purging the ANAIS experiment using a HPGe detector

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3) Universidad de Zaragoza, Laboratorio Subterráneo de Canfranc, Fundación ARAID
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The ANAIS experiment [1] aims at testing the DAMA/LIBRA positive annual modulation signal in the low energy detection rate [2,3], using the same target and technique, at the Canfranc Underground Laboratory (LSC) in Spain. The radon concentration in the Halls A, B and C of the LSC has been measured for six years (2013-2018), and a seasonal variation has been identified compatible with a yearly period having the maximum around beginning of July [4]. The ^{222}Rn upper limit presently considered in the ANAIS background model [5] is two orders of magnitude lower than outside thanks to the radon-free nitrogen gas overpressure provided by the LSC, but the variation of the possible residual ^{222}Rn could produce a modulation in the detection rate. The goal of this work is to analyze the ^{222}Rn content in the nitrogen supplied by the LSC and its possible time dependence. We have purged for two years (2017-2018) the shielding of a HPGe detector placed at LSC with the same radon-free nitrogen gas purging the ANAIS shielding. We have found an upper limit one order of magnitude lower than the one previously considered. Additionally, we have checked that the rate at the HPGe detector in the regions of the characteristic ^{222}Rn gamma lines is time independent. Therefore, we conclude residual ^{222}Rn in the purging gas is a negligible background source for ANAIS experiment.

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ID: 04224, 15/07/2019 15:00 - 15/07/2019 15:30, Room 0.7 (ground floor)
S20. Nuclear Physics (GEFN)
(Invited Symposio)

Introduction to hadrontherapy: physics, biology, qualy.

Alejandro Mazal[1]

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Accelerated protons (eg. 250 MeV), Carbon (eg 450 MeV/n) and other charged particles are used at present as optimized weapons in radiation therapy against cancer.

The physical properties of energy deposition, in particular (a) the Bragg peak (produced by a high stopping power before the end of range of the particles) and (b) no significative residual energy deposition behind the peak, makes them a tool of choice to conform the radiation deposited dose to a tumour target and to reduce the integral dose deposited in critical and healthy tissues. Additionally, a biological enhanced effect exists compared to photon beams, related to the high concentration of ionisation around the particle track, in the order of 10% for protons but of higher importance with Carbon.

The pioneer work in the field has been done in experimental accelerators since the 50’, and at the end of the 90’ specific accelerators (cyclotrons and synchrotrons) have been conceived and built for external radiation therapy, including sophisticated methods of beam transport and shaping (isocentric gantries, passive and scanning methods to delivered the beam to a patient). The main clinical applications are for paediatric patients, base of the skull and ophtalmic tumors, as well as many others clinical sites being under study.

In this talk, the principles, the status and the applications of protontherapy will be presented, with some considerations on Carbon beams.

Concepts like the importance of workflow, cost benefit and quality of life will be shown as determinant for the operation of these facilities. Research in the field includes the development of new accelerators, investigate new beams, use of minibeams, high dose rate beams, conversion of Hounsfield Units from CT scanners to stopping power, uncertainties, nanoparticles, biological effects and, of course, clinical protocols.

S21. Física Médica (GEFM)

- **Sesión 1: Diagnóstico basado en el uso de ondas electromagnéticas y acústicas** Nuevas plataformas de imagen multimodal, TAC, MRI, ecografía, elastografía de US y MRI, fotoacústica, tomografía óptica, tomografía difusa y de fluorescencia.
- **Sesión 2: Interacción de ultrasonidos e interacción radiación-materia usando nanopartículas u otros métodos para nuevas terapias focalizadas y diagnóstico** Terapias térmicas: Terapia y cirugía de ultrasonidos focalizada, hipertermia magnética de radiofrecuencia, microondas, hipertermia NIR, fotoacústica, efectos biológicos de ultrasonidos y radiación: dosimetría.
- Biosensores: biosensores basados en nanofotónica, biosensores con partículas magnéticas, biosensores electroquímicos, biosensores ópticos, plataformas analíticas múltiples y otras plataformas de sensores biológicos.Nanopartículas funcionales y multifuncionales como agentes de contraste y agentes para la liberación controlada y dirigida de fármacos.
- **Sesión 3: Terapia guiada por imágenes**:Terapias guiadas por técnicas ópticas y de resonancia magnética, avances laparoscópicos, terapia guiada por ultrasonidos, bisturís “gamma”, MRI-LINAC.
- **Sesión 4: Biofísica:** Biomecánica, mecánica celular, biofluidos y transporte.
- **Sesión 5: Radiación ionizante para nuevas terapias, dosimetría y desarrollo de algoritmos** (En colaboración con el grupo especializado de Física Nuclear).

Organizadores:
C. Sánchez-Ramos Roda, *Universidad Complutense de Madrid*
R. Ibarra, *INA-Universidad de Zaragoza*
Pablo Artal, *Universidad de Murcia*
Guillermo Rus, *Universidad de Granada*
Gabriela Llosa, *Instituto de Física Corpuscular, Valencia*

Patrocinado por:

GE Física Médica

S21. Medical Physics (GEFM)

- **Session 1: Diagnosis based in the use of electromagnetic and acoustic waves** Novel multimodal imaging platforms, TAC, MRI, ultrasound imaging, US and MRI elastography, photoacoustics, optical tomography, diffuse and fluorescence tomography.
- **Session 2: Ultrasound and radiation-matter interaction using nanoparticle or other methods for new focused therapies and diagnosis .**Thermal therapies: Focused ultrasound therapy and surgery, radiofrequency magnetic hyperthermia, microwave, NIR hyperthermia, photoacoustic, biological effects of ultrasounds and radiation: dosimetry.Biosensors: Nanophotonics based biosensors, magnetic beads biosensors, electrochemical biosensors, optical biosensors, multiple analytic platforms, others bio sensing platforms.
  Functional and multifunctional nanoparticles as contrast agents and controlled and targeted drug release agents.
- **Session 3: Imaging guided therapy Laparoscopic advances, ultrasound guided, gamma-knife, MRI-LINAC**
  Optical and MRI guided therapies. Laparoscopic advances, ultrasound guided, gamma-knife, MRI-LINAC.
- **Session 4: Biophysics**: Biomechanics, cells mechanics, biofluids and transport.
- **Session 5: Ionizing radiation for new therapies, dosimetry and algorithm development** (In collaboration with the group specialized on Nuclear Physics)

Organizers:
C. Sánchez-Ramos Roda, *Universidad Complutense de Madrid*
R. Ibarra, *INA-Universidad de Zaragoza*
Pablo Artal, *Universidad de Murcia*
Guillermo Rus, *Universidad de Granada*
Gabriela Llosa, *Universidad de Granada*

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GE Física Médica

ID: 04079, 15/07/2019 18:15 - 15/07/2019 18:30, Room 0.7 (ground floor)
S21. Medical Physics (GEFM)
(Oral)

Pseudoinverse Reconstruction for Real-Time PET Imaging

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2) Grupo de Física Nuclear e IPARCOS. Facultad de Ciencias Fisicas. Universidad Complutense de Madrid. CEI Moncloa, Health Research Institute of the Hospital Clinico San Carlos (IdISSC), Madrid, Spain

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Positron Emission Tomography (PET) is one of the main medical imaging techniques.In many applications of PET it is crucial to have images at the fastest rate possible [1, 2].Real-time PET made its way recently,thanks to PET scanners able to acquire high-coincidence rates and reconstruct multiple frames per second.Current real-time PET reconstruction methods provide images of lower quality compared to iterative methods [3].In this work, we propose an alternative real-time PET image reconstruction based on the pseudoinverse (pinv) of the System Response Matrix (SRM)[2].In a linearized model of the reconstruction problem,PET data are related to the image of the distribution of the radiotracer via the SRM,which contains the information of the geometry of the scanner and the main physical processes of the emission, transmission, and detection of the radiation [2, 3]. The pinv of this matrix can provide very fast and good quality images. Since 3D-SRMs are usually very large, and to make the process faster, we propose to separate the 3D reconstruction into two independent problems. Axial data rebinning uses the pinv of the axial part of the SRM to obtain 2D slices, which can be then reconstructed with a 2D-pinv algorithm. Pinv rebinning is as fast as standard Single Slice ReBinning (SSRB), but yields improved image quality. With regards to the in-slice reconstructions, 2D-pinv can be faster than the standard analytical Filtered Back-Projection (FBP), while achieving better images.The combination of both pinv methods is able to produce several good-quality images per second.

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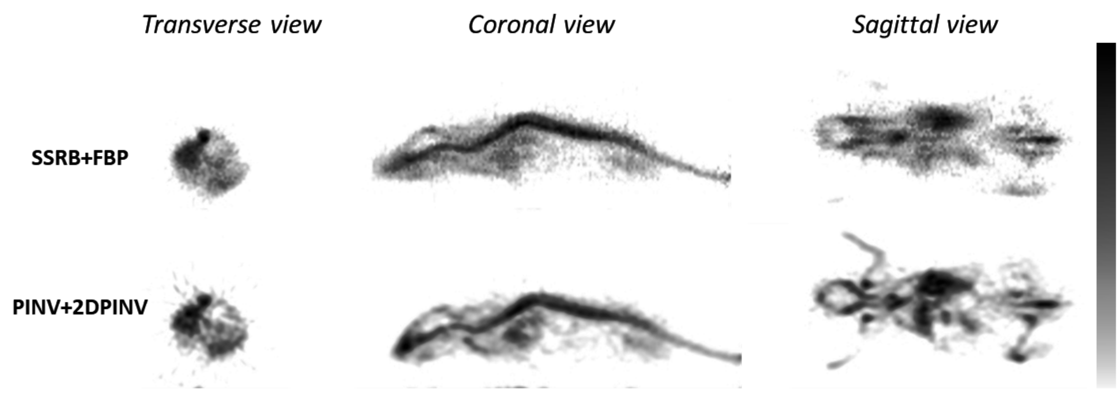

Method	SSRB + FBP	PINV + 2D PINV
Time (s)	0.75	0.35

Figure 1. (Up) Images reconstructed with standard SSRB rebinning + FBP method and with proposed PINV rebinning + 2D PINV. (Down) Computational times using multi-CPU paralelization in an Intel E5-2640 v4 @ 2.40 GHz processor.

ID: 04195, 15/07/2019 18:30 - 15/07/2019 18:45, Room 0.7 (ground floor)
S21. Medical Physics (GEFM)
(Oral)

Beam tests and upgrades of MACACO II Compton telescope

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The use of hadron therapy in cancer treatment is increasing in the world given its precise energy deposition to the tumour and the dose reduction to healthy tissue as compared to conventional photon radiotherapy. Real-time treatment monitoring is one of the main challenges addressed nowadays.

The IRIS group at IFIC-Valencia is developing a Compton telescope with this purpose. The system is made of three LaBr3 detector planes coupled to silicon photomultipliers (SiPMs). The first MACACO (Medical Applications CompAct COmpton camera) prototype demonstrated the viability of the proposed technology and served to identify its limitations. The second prototype features new detectors and image reconstruction codes, improving significantly the performance [1,2].

MACACO II has been characterized in the laboratory and in beam tests. It has been tested at CNA (Sevilla) with 18 MeV proton beams on a graphite target to produce 4.4 MeV gamma rays. Data have been taken with the system in different positions and beam intensities, and the target image has been reconstructed. Further tests have been carried out at KVI-CART (Groningen) with a 150 MeV proton beam impinging a PMMA target and the Bragg peak has been reconstructed in different positions.

In spite of the significant progress, the system does not yet reach the necessary performance for the application and thus, possible improvements are being assessed. Tests include the evaluation of SiPMs of different types and manufacturers to enhance energy resolution and the improvement of the readout electronics. The MADDAQ board currently employed is being replaced by AliVATA, that will allow to operate the three system detectors with just one board and improve the readout speed. In addition, tests are being carried out with the PETsys system, improving significantly the detector timing resolution.

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ID: 03746, 15/07/2019 18:45 - 15/07/2019 19:00, Room 0.7 (ground floor)
S21. Medical Physics (GEFM)
(Oral)

Evaluación del telescopio Compton MACACO II.

Luis Barrientos[1] , Marina Borja-Lloret[1] , Alfredo Esteban[1] , Carlos Lacasta[1] , Ricardo Marco[1] , Enrique Muñoz[1] , Josep Oliver[1] , Ana Ros[1] , Jorge Roser[1] , Cesar Senra[1] , Carles Solaz[1] , Rita Viegas[1] , Gabriela Llosá[1]

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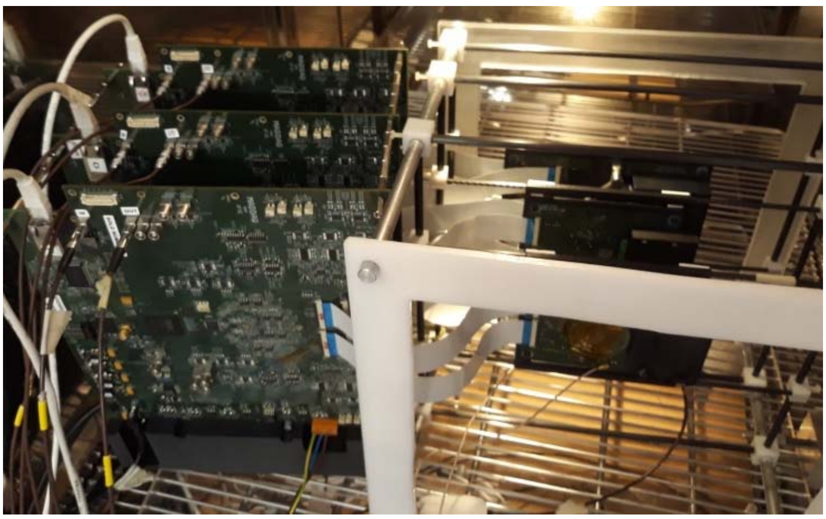
La terapia hadrónica es una técnica utilizada para el tratamiento contra el cáncer que consiste en la irradiación de tumores con iones ligeros, protones o iones de carbono. El grupo IRIS del IFIC en Valencia se encuentra desarrollando un prototipo de una cámara Compton reconfigurable (MACACO: Medical Application CompAct COmpton camera) que puede operar de manera simultánea 2 o 3 detectores basados en cristales centelleadores de $LaBr_3$ acoplados a una matriz de fotomultiplicadores de silicio (Llosá et al 2016). Un telescopio Compton es un dispositivo de obtención de imágenes que ha emergido como un posible candidato para monitorización de la terapia hadrónica, que se realiza mediante la detección de los fotones producidos en la desexcitación de los núcleos que componen el tejido tras la irradiación del paciente durante el tratamiento (Kormoll et al 2011). Los resultados prometedores obtenidos con el primer prototipo (Muñoz et al 2017) han llevado al grupo a construir un segundo prototipo (MACACO II) con nuevos detectores de dimensiones 25.8 x 25.8 x 5 mm^3 los planos 1 y 2, y 32 x 36 x 10 mm^3 el plano 3. Se han caracterizado los detectores del nuevo prototipo usando fuentes de Na-22 y Eu-152 manteniendo temperaturas constantes, obteniendo valores de resolución energética de los detectores de 6% FWHM a 511 keV, ARM de 4.6° y eficiencia de detección en coincidencias con dos planos de 1 x 10^{-3}. Para validar el funcionamiento del nuevo prototipo se han hecho simulaciones Monte Carlo con GATE v 7.0 (toolkit basado en GEANT4) obteniendo un buen acuerdo con las medidas experimentales. Por último, se han realizado pruebas en aceleradores de protones con el fin de probar el prototipo a las energías que requiere la aplicación. Mediante la detección de los fotones de 4.4 MeV emitidos al irradiar un blanco de grafito, se ha reconstruido una imagen del blanco en dos posiciones separadas 5 mm entre sí.



ID: 04205, 16/07/2019 15:00 - 16/07/2019 15:30, Room 1.3 (first floor)
S21. Medical Physics (GEFM)
(Invited Symposio)

Nanophotonic biosensor devices for the early diagnostics and therapy followup of infectious diseases

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** Laura Lechuga, Laura.lechuga@icn2.cat*

The need to monitor and detect biological elements related to human health in a fast and reliable way, is one of the challenges faced by humanity in the 21st century. Diagnostics tests done nowadays are slow (from hours to days), labour-intensive and expensive. Modern diagnostics is demanding novel analytical tools that could enable quick, accurate, sensitive, reliable and cost-effective results for implementing the appropriate treatments on time, leading to improved outcomes. Portable point-ofcare (POC) devices, able to deliver instant diagnostics, could become a reality soon thanks to the last advances in nanobiosensors, lab-on-a-chip, wireless and smart-phone technologies, which promise to surpass the existing challenges, opening the door to a global diagnostics access.

Silicon photonics based-biosensors are the most suitable candidates to achieve this ambitious objective. Photonic biosensors are systems that seize different light-based phenomena for the fast detection and quantification of biomarkers (i.e. molecules or pathogens, whose presence or quantity is an indicator of the onset of a disease). They consist of compact waveguides contained on chips that can be easily miniaturized and fabricated in arrays of identical sensors for multiplexed analysis. They present undisputed advantages such as robustness, reliability, high sensitivity and low power consumption. The driving force of our research is to achieve such ultrasensitive platforms for POC label-free analysis using nanophotonic technologies and custom-designed biofunctionalization protocols, accomplishing the requirements of disposability and portability. We are using innovative designs of nanophotonic interferometric biosensors based on silicon nitride technology and microfluidics lab-on-chip integration. We employ dedicated biofunctionalization r o ut es of the biological receptors (as proteins or genomic strands) ensuring selectivity, life-cycle, non-fouling properties and reusability.

We have demonstrated the suitability of the nanophotonic biosensors for the diagnostics of infectious diseases as Tuberculosis, Sepsis or nosocomial infections, with extremely sensitivity and selectivity. Our technology achieves a limit of detection of only a few cfu/mL and operate directly with few microliters of human fluids (blood plasma, urine). Moreover, we are able to detect the genes associated with the multidrug resistance found in Gram-negative bacteria (as E. coli) without the need of PCR amplification, helping the clinicians to implement rapidly a personalize treatment for each patient.

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ID: 04193, 16/07/2019 15:30 - 16/07/2019 16:00, Room 1.3 (First floor)
S21. Medical Physics (GEFM)
(Invited Symposio)

A photothermal lateral flow test for visual point of care detection

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The rapid development of cost-effective and efficient biosensors has had a profound worldwide socioeconomic impact. Advances in the fields of microelectronics, materials science and nanotechnology have been vital to the implementation of enhanced sensing platforms aimed at providing alternatives to traditional analytical methods. Further, current sensing platforms are often slow, unreliable and expensive; in particular, when ultralow concentration detection is required. Although progress in the biosensors field typically focuses on clinical point-of-care diagnosis, a clear demand exists in areas such as food safety regulation, environmental policy, military and the arts, where time, cost, portability and ease-of-use of the device are critical. The grand aim of our research is to develop an innovative, rapid, inexpensive, versatile and sensitive thermal transduction biosensor for the ultralow detection and quantification of relevant proteins such as tumoral markers. This novel sensing technology uses detection biomolecules linked to plasmonic gold nanoprisms which serve as thermal transducers by based on a lateral flow immunoassay and a “sandwich” recognition strategy with capture biomolecules immobilized on a dual-active nitrocellulose membrane support/thermosensitive paper that subsequently functions as photographic and tracing detection element. Although the ambitious thermal sensing device proposed here will be prototyped using simple analytes, this research goes significantly beyond the current state-of-the-art in nanoplasmonics and biosensing by proposing the development and elaboration of an almost universal paper-based thermal sensing device. This technology will be implemented and validated by applying it to a specific problem, gastrointestinal and prostate cancer diagnosis.

ID: 04214, 16/07/2019 16:00 - 16/07/2019 16:30, Room 1.3 (first floor)
S21. Medical Physics (GEFM)
(Invited Symposio)

INTERACTION BETWEEN TISSUE AND ULTRASONIC MECHANICAL WAVES FOR DIAGNOSIS: CHALLENGES FROM MODELING TO PATIENT APPLICATION

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Ulatrasonic-based elasticity quantification technologies will enable a new class of biomarkers that quantify the mechanical functionality of soft tissue, opening a new diagnostic technique to a broad range of pathologies. Towards this problem, we work on enabling new sensor technologies linked to soft tissue biomechanics, to endow a new class of biomarkers that quantify the mechanical functionality of the cervix, and indeed any soft tissue. Abnormalities in the structural architecture of soft tissues are intimately linked to a broad range of pathologies including tumors, atherosclerosis, liver fibrosis or osteoarticular syndromes. The unexplored nature and applicability span of mechanical biomarkers and torsional waves endows a foundational diagnostic technology.

Ultrasonic characterization and understanding of soft tissue has been developed as a clinical diagnostic tool over the last two decades [1] and evolved through different technologies: quasi-static, dynamic elastogra-phy, based acoustic radiation force: ARFI, vibroacous-tography or pSWE, or on direct excitation: sonoelasto-graphy and our emerging torsional wave principle [2].

Existing ultrasonic techniques are restricted to map first order tissue stiffness. In contrast, our recent advances covering (a) torsional waves (shear elastic waves that propagate in quasifluids radially and in depth in a curled geometry), (b) sensors (based on a novel arrangement of concentric sandwiches of piezo- and electro-mechanical elements), (c) propagation models and (d) patient testing, are allowing to quantify the mechanical functionality through relevant parame-ters beyond linear: dispersive and nonlinear. These higher order mechanical parameters may become key discriminating biomarkers since: (1) the physics of wave propagation is explaining how dispersion is a compound expression of the rheological, poroelastic, and microstructural scattering phenomena governed by the complex fibrous multiscale microarchitecture of the stroma, which undergoes characteristic changes during pathologies [3]; and (2) the extreme hyperelasticity that soft tissue exhibits clearly manifests as quantifiable harmonic generation, hypothesized to strongly depend on the unfolding of its collagen fibres, which again controls the tissue's mechanical functionality.

Current challenges span:

a) To understand how structural architecture of soft tissue is intimately linked and controls a broad

range of pathologies, which underpins the foundation of a new diagnostic technology.

b) To develop new sensor technologies capable of effectively sensing tissue elasticity, and yield simple and robust diagnostic tests and instruments.

c) To ground a new generation of biomarkers of physical nature based on the mechanical micro-architecture and properties of the tissue.

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Acknowledgements

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ID: 04200, 16/07/2019 18:00 - 16/07/2019 18:30, Room 1.3 (first floor)
S21. Medical Physics (GEFM)
(Invited Symposio)

Optical Coherence Tomography - Technologies and Applications in Biomedical Research

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Optical coherence tomography (OCT) belongs to optical technologies that have revolutionized both fundamental biomedical research and medical diagnostics. OCT detects light back-scattered or back-reflected from the object, and enables generation of micrometer resolution, two-dimensional (2-D) cross-sectional images and three-dimensional (3-D) volumetric data.

The generations of OCT instruments depend on the way the interferometric fringes are detected, and include: Time-domain OCT, Spectral-domain OCT and Swept-Source OCT. The advances in photonic and electronic technologies enabled impressive progress in imaging capabilities, including imaging speed, resolution, depth range, sensitivity, image contrast, and software enhancements. Nowadays, OCT technology has been applied in many fields of biomedicine. In this lecture, we will demonstrate the development of OCT systems, and will present examples of applications fundamental research and medical diagnostics. Particular attention will be paid to novel approaches enabling visualization of all ocular structures and to the methods extracting quantitative information on the geometry of the structures or the biomechanical status of ocular tissues.

ID: 03869, 16/07/2019 18:30 - 16/07/2019 18:45, Room 1.3 (first floor)
S21. Medical Physics (GEFM)
(Oral)

Local particle concentration measurement in a capillary model

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In medicine, there is an increasing interest in micro and nanoparticles used as drug carriers as they can be guided through the circulatory system, and its accumulation controlled, by an external magnetic field [1].

The local concentration of magnetic particles (MagP®-NH_2, 3µm of diameter) in a borosilicate squared-sectioned capillary (1x1x50mm^3) has been measured in this work. Series of 200 digital in-line holograms were recorded. The classical in-line holographic set-up was modified [2] by introducing a lens to image the capillary near the sensor of a camera and a knife-edge aperture in its focal plane, which allows to eliminate the twin image in the reconstruction of the hologram. A length of 7.3mm of the capillary was recorded. The liquid (a mixture of water and glycerin) was pumped at a rate of 0.02ml/min. A perpendicular magnetic field was created by a permanent magnet (1.6T).

The object wave in the capillary central plane was reconstructed using the Convolution Method. The object wave intensity was computed and added from all the holograms in a series. The local concentration was found to be proportional to this global intensity.

In absence of magnetic field, the concentration is uniform along the capillary. After three hours in presence of the magnetic field, particles have accumulated near the magnet leading edge while the lower left corner remains empty. A concentration gradient is clearly visible in the figure.

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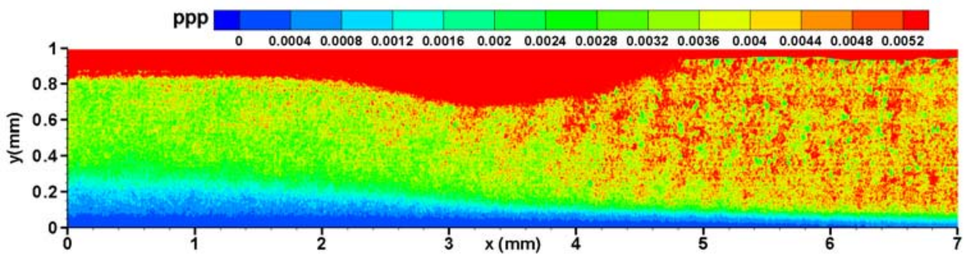

ID: 04083, 16/07/2019 18:45 - 16/07/2019 19:00, Room 1.3 (first floor)
S21. Medical Physics (GEFM)
(Oral)

Image Reconstruction of Protoacoustic Signals

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Proton-range verification is an important challenge in proton radiotherapy. Many methods have been proposed to reduce the uncertainty in the localization of the deposited dose with these treatments. The radio-induced thermoelastic effect [1,2] (i.e. the conversion of some of the deposited energy in tissue into acoustic waves) can be used to measure the penetration depth of the proton beams in real-time. This method has significant advantages compared to other alternatives, as it requires a low-cost and small equipment, but it is challenging due to the intrinsic low signal-to-noise ratio (SNR) of the measured data and the complex propagation of the acoustic waves in heterogeneous media. In this work, we present several algorithms and regularization methods for protoacoustic image reconstruction, and evaluated which one is able to provide better image quality with very noisy data. We used simulated data of the deposited dose of a proton beam in a water tank, converted into an initial pressure-wave using the dose-acoustic equation, and then propagated the acoustic wave in the medium using the software k-Wave [3]. We finally added zero-mean Gaussian noise to the resulting signal recorded by a transducer placed in the beam direction. Our results indicate that even with noisy data both gradient-descent methods and MLEM algorithm, commonly used in other medical imaging techniques such as Positron Emission Tomography, provides a good localization of the Bragg peak of the proton dose. These results are promising but they still have to be validated with real data acquired in a proton-beam facility.

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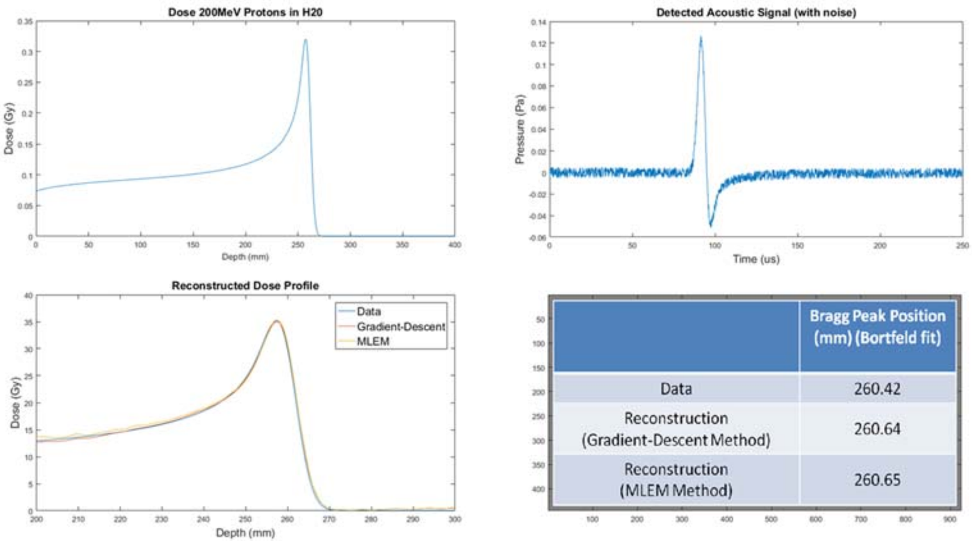

	Bragg Peak Position (mm) (Bortfeld fit)
Data	260.42
Reconstruction (Gradient-Descent Method)	260.64
Reconstruction (MLEM Method)	260.65

ID: 04001, 16/07/2019 19:00 - 16/07/2019 19:15, Room 1.3 (first floor)
S21. Medical Physics (GEFM)
(Oral)

The Normalization of Flow Mediated Dilation by the Base scaled Shear Rate

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The value of flow mediated dilation (FMD) and shear rate (SR) in brachial and radial artery as a a marker of endothelial functionwas reported in more than a few dozen of papers during the last 20 years. We have shown recently [1] the usefulness of 20 MHz imaging/Doppler system in measurements of radial artery reactive response after 5minutes of reactive hyperaemia that allows better differentiation of normal subjects from those with chronic coronary artery diseases. It was shown previously [2] that FMD was considerably dependent on vascular adaptations to extended training (handgrip) probably resulting in microvessel remodeling. This suggestion has given us the idea of checking how far the stimulation of the endothelium after ischemia is modified by normal fixed blood flow. Therefore, instead of normalizing of FMD with respect to $SR_{AUC\ 0\text{-}tpd}$(AUC calculated in time t=0-tpd, corresponding to individual time to peak dilation after releasing the pressure cuff), we attempted to normalize FMD by the base scaled shear rate (BSSR). Our modification consists in taking into account the initial shear rate of the examined patients, i.e. taking into account base shear rate, before cuff inflation. The in vivo usefulness of the new algorithm was evaluated in two groups of patients. In group I, comprising 15 healthy volunteers, FMD/SR was 0.00031±0.00014,and in group II, comprising 14 patients with chronic coronary artery disease, FMD/SR was significantly less at 0.00010±0.00076.After normalizing FMD to account for the effect of BSSR, the FMD/BSSR was equal to 28.80 ± 9.40% in group I and 6.01±3.74% in group II. The prediction of CAD patients based on the FMD/BSSR values revealed 100% sensitivity and specificity whereas the prediction of CAD patients based on FMD/SR values had a sensitivity of 83,3% and a specificity of 84.6%.

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ID: 04201, 17/07/2019 15:00 - 17/07/2019 15:30, Room 1.3 (first floor)
S21. Medical Physics (GEFM)
(Invited Symposio)

Spintronic devices for biomedical applications

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Spintronic based biosensors (static or dynamic) allow the detection of a variety of circulating or bound bioanalytes (nucleic acids, proteins, exosomes, microvesicles, CTCs, bacteria). These can be detected in body fluids (blood, serum, urine, spinal fluid, others) in analytical systems incorporating a microfluidic's sample preparation module (purification/concentration/labelling) and a detection module. Static platforms have an array of bio probes (antibodies, oligonucleotides, phages, other ligands) immobilized over magnetoresistive sensors that will selectively bind to the target (bioanalytes in solution). Some of these platforms also use magnetophoretic attraction/repulsion for sample concentration. Biological targets are labelled with magnetic nanoparticles (MNPs) through other ligands, outside or in an integrated microfluidic mixing module. Recent applications will be covered for the multiplexed detection of protein biomarkers in serum for stroke patients, allowing patient stratification for treatment, and for the detection of diseases at early stage (e.g. colorectal cancer). Dynamic platforms use integrated magnetic cytometers where circulating bioanalytes (CTCs, bacteria, others) are directly labelled with MNPs and then detected on the fly by magnetoresistive sensors on the bottom of the microfluidic channel. Hydrodynamic focusing has been used to push cells towards the bottom of the channel increasing sensitivity. The signature of a passing labelled bioanalyte is discussed in terms of amplitude, and time footprint, leading to a 2D diagram where different events are differentiated (labelled cells vs MNP non bound clusters). Examples for CTC detection will be given. These platforms are also being used in veterinary context: an example will be given for the detection of bacteria in mastitic milk, either using DNA extracted from bacteria on a fully integrated system, or by direct detection of bacteria in milk.

ID: 04194, 17/07/2019 15:30 - 17/07/2019 16:00, Room 1.3 (First floor)
S21. Medical Physics (GEFM)
(Invited Symposio)

Going the distance with heating: design of magnetic nanoparticles to increase the power absorption under physiological conditions.

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The uses of magnetic nanoparticles (MNPs) in biomedical protocols like cell sorting, detection, magneto-transfection, etc. have been expanding continuously in the last years. One of these appealing applications of MNPs is to use their capacity as nanoheaters to provoke cell death by heating cancer cells up to temperatures of 42-46ºC by a remote radiofrequency magnetic field. Although the capacity of MNPs to heat cells and tissues has been already demonstrated in clinical protocols, there is still room for further improvements in their heating efficiency, which would imply that the required doses of magnetic material to be administered can be lowered while keeping their therapeutic efficacy. It has become clear along the last years that under physiological conditions, the power absorption is hindered by different effects like agglomeration, changes in local viscosity and pH within the cell, attachment to membranes, etc. Quite a lot of effort has been applied to understand how each one of these impairments can be overcome or, alternatively (the approach from physicists and material scientists), to provide to the MNPs magnetic properties that can make them heat irrespective of their physicochemical environment. In this presentation, two main strategies to optimize the power absorption of MNPs under physiological conditions are discussed: the exploitation of complex magnetic phenomena in core-shell structured MNPs, and the use of low-dimensional arrangements of few single-domain MNPs to control magnetic relaxation through magnetic dipolar interactions. We present data on both approaches, showing that the magnetic parameters that determine the power absorption by Néel relaxation can be tuned in strongly magnetically coupled core-shell MNPs. Also, we will discuss how the formation of structures of lower dimensionality such as elongated clusters or chains can also raise the values of the specific power absorption of MNPs. In both cases, the new magnetic phenomena that are in place require more sophisticated models to be developed, in order to understand the complex magnetism of these systems.

ID: 03847, 17/07/2019 16:00 - 17/07/2019 16:15, Room 1.3 (First floor)
S21. Medical Physics (GEFM)
(Oral)

Synthesis of Fe_3O_4 nanoparticles using ultrasound irradiation: effect of precursor solution concentration in the physical properties

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One of the current challenges for the synthesis of nanostructured materials is the difficulty of controlling the final size and shape of the nanoparticles, without using surfactants or phase changes. In the case of magnetic nanoparticles (MNPs), often composed of Fe_3O_4 phase, some methods as thermal decomposition in organic solvents provide good control in size although the resulting organic layers at MNPs surface limits their biomedical applications. The sonochemical method presented in this work opens the possibility to obtain Fe_3O_4 MNPs in an easy way and reduced time (20 minutes) and tune the size using the precursor solution concentration as parameter. Using a low toxic iron salt (Iron(II) sulfate heptahydrate) we synthetized Fe_3O_4 MNPs in aqueous media adding NaOH oxidizing reactant. Five concentrations from 5.4 mM to 92.3 mM of iron salt were swept in order to observe the effectin size and physical properties of as synthetized Fe_3O_4 NPs. The application of ultrasound irradiation at 130 W improves the reaction conditions to reduce the time reaction and equipment, the reaction no need external heat of stirring. Particle sizes from 20 to 58 nm were obtained, specific absorption rate (SAR) decrease with particle size from 200 to 66 W/g. The high-resolution analysis reveals the high crystallinity of nanoparticles and electron diffraction patterns corresponds to the crystal structure of Fe_3O_4. These results show the potential of ultrasound assisted method to produce controlled nanoparticles varying the synthesis parameters, in reduced time compared with other methods. The absence of any organic layers at the particle surface provides an easy way to combine with other materials for tuning the magnetic or optical properties for biomedical applications

ID: 03895, 17/07/2019 17:30 - 17/07/2019 17:45, Room 1.3 (First floor)
S21. Medical Physics (GEFM)
(Oral)

Cálculo Monte Carlo para verificación de tratamientos de radioterapia

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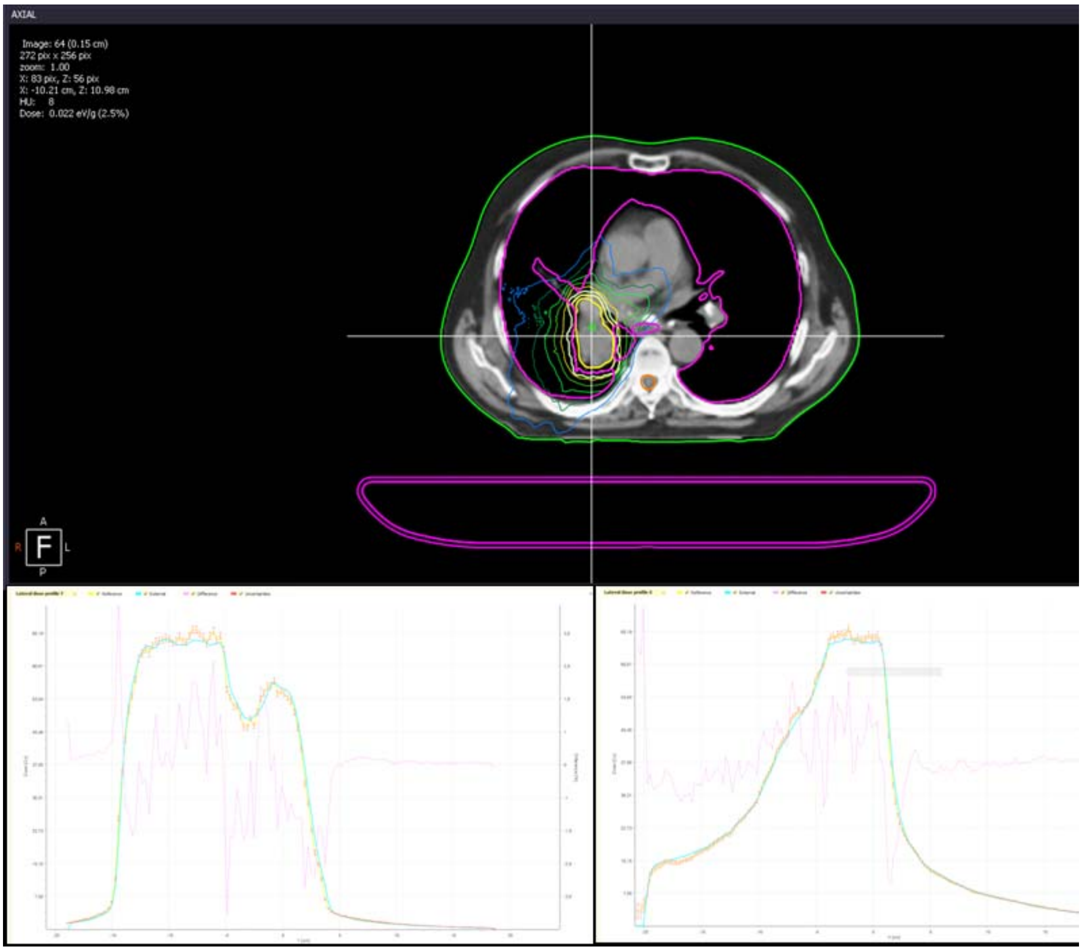
El Servicio de Física y Protección Radiológica del Hospital Clínico "Lozano Blesa" (HCLB) lleva a cabo la verificación de tratamientos de radioterapia en acelerador lineal de electrones (ALE) por varios procedimientos. Todos ellos requieren de tiempo de ALE.

La verificación de tratamientos basado en un cálculo Monte Carlo de la distribución de dosis absorbida y su comparación con la distribución producida por el planificador es una alternativa a la medida de dosis absorbida en el ALE, como indica ICRU en su informe 83, y supone un gran ahorro de tiempo de ALE que estaría disponible para otros tratamientos.

PRIMO es un sistema de cálculo Monte Carlo que simula haces clínicos de radiación producidos por varios tipos de ALEs y estima la distribución de dosis absorbida en maniquíes regulares o en estudios de tomografía computarizada (TC). PRIMO combina una interfaz gráfica con los algoritmos de transporte de radiación PENELOPE (versión 2011), y pDPM empleados respectivamente en el transporte de la radiación a través del ALE, y en la estimación de la distribución de dosis absorbida.

En la versión 0.3.1.1600 de PRIMO se ha modelado el acelerador Varian True Beam del HCLB para todas sus energías disponibles comparando con medidas experimentales sobre agua y sobre otros maniquíes específicos (CIRS), encontrando para un criterio del índice gamma 3% / 3mm en las zonas de dosis en las que se supera el 20% de la dosis máxima un acuerdo superior al 95% de los puntos en todos los casos analizados. Por tanto, PRIMO puede utilizarse como sistema de verificación de tratamientos ahorrando tiempo de ALE.

El cálculo de PRIMO sobre paciente se ha comparado con el método de verificación análogo (COMPASS) en un caso representativo de pulmón, encontrando acuerdo en el 97,47% de los puntos para un criterio de índice gamma 3%/3mm. La comparación con la distribución procedente del sistema de planificación muestra un acuerdo superior al 98% en las mismas condiciones.


AXIAL
Image: 64 (0.15 cm)
272 pix x 256 pix
zoom: 1.00
X: 83 pix, Z: 56 pix
X: -10.21 cm, Z: 10.98 cm
HU: 8
Dose: 0.022 eV/g (2.5%)
A
R
F
L
P

ID: 03896, 17/07/2019 17:45 - 17/07/2019 18:00, Room 1.3 (First floor)
S21. Medical Physics (GEFM)
(Oral)

Verificación mediante el método de Monte Carlo del blindaje de una sala de tratamiento de radioterapia

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El diseño de los recintos blindados utilizados como sala de tratamiento con radiaciones gamma o rayos X de megavoltaje tiene como objetivo reducir la exposición de los trabajadores expuestos y miembros de público por debajo de los límites legalmente establecidos.

El diseño se realiza siguiendo las recomendaciones de organizaciones como el National Council on Radiation Protection (NCRP), o la Organización Internacional de la Energía Atómica (OIEA). La metodología en ambas se basa en cálculos analíticos, fórmulas semiempíricas y tablas de datos obtenidos para casos estándar. La verificación de los blindajes se realiza a posteriori con medidas experimentales.

La verificación del diseño basado en un cálculo Monte Carlo del transporte de la radiación permite detectar posibles deficiencias en los blindajes propuestos y realizar modificaciones en el diseño antes de comenzar las obras.

En este trabajo se ha realizado la verificación Monte Carlo de una sala de tratamiento de radioterapia existente en la que se va a sustituir un linac Siemens Primus de hasta 18 MV por un Varian True Beam de hasta 10MV sin filtro con una tasa máxima de 2400 UM/min.

En primer lugar, se ha modelado la emisión del linac con PRIMO para la máxima energía sin filtro (10 MV FFF) en 3 situaciones: haz directo, campo cerrado (haz de fuga), haz sobre maniquí en condiciones de máxima dispersión. Se han obtenido 3 espacios de fase (PSF) con las partículas emergentes de cada una de las situaciones relacionadas con el número de electrones primarios incidentes en el blanco. A continuación, cada PSF se ha simulado utilizando PenEasy+PENELOPE sobre el diseño del recinto blindado, y se han recogido las partículas que atraviesan las barreras que limitan el recinto en un nuevo PSF. A partir de éstos se ha realizado la estimación de tasa de dosis en aire en las zonas exteriores al recinto blindado por unidad de monitor.

ID: 03722, 17/07/2019 18:00 - 17/07/2019 18:15, Room 1.3 (First floor)
S21. Medical Physics (GEFM)
(Oral)

Puesta en Marcha de Generadores de $^{68}Ge/^{68}Ga$. Medidas de Protección Radiológicas Asociadas.

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El generador de $^{68}Ge/^{68}Ga$ puede proporcionar de forma rutinaria y a demanda, sin depender de un acelerador o un reactor nuclear, el radionucleido ^{68}Ga.

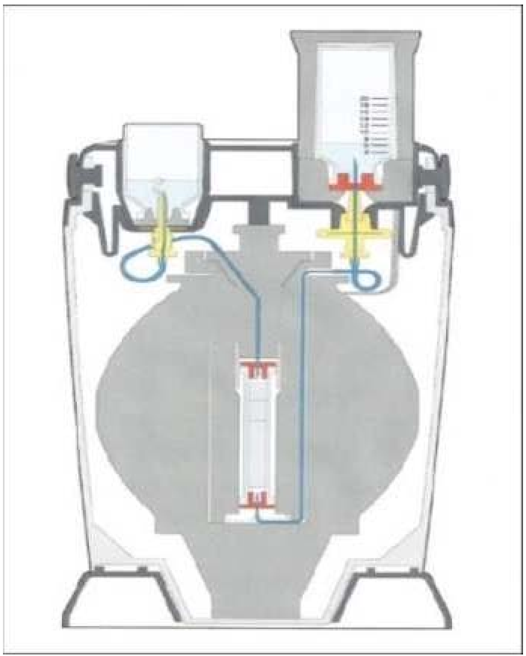
El ^{68}Ga es un emisor de positrones, que se genera en forma física líquida a partir de ^{68}Ge, y por tanto puede ser utilizado en exploraciones PET (Tomografia por Emisión de Positrones). Para este uso, generalmente se adjunta como un trazador a una molécula portadora, que da al radiofármaco resultante una especificidad de captación para diversos tejidos.

El desarrollo y disponibilidad de nuevos radiofármacos específicos para determinadas patologías es uno de los principales promotores de la expansión de la técnica PET en clínica, en este contexto el ^{68}Ga juega un papel importante.

Nuestro hospital cuenta con un Servicio de Medicina Nuclear, el cual realiza, entre otros, tratamientos de Terapia Metabólica, posee un PET/TAC Biograph 6 de SIEMENS, y una Gammacámara Irix de PHILIPS. Además cuenta con un Servicio de Protección Radiológica y Radiofísica, el cual, está preparando una memoria, para la solicitud de autorización de modificación de la instalación radiactiva de medicina nuclear, que contempla la puesta en marcha de un Generador de $^{68}Ge/^{68}Ga$.

Como resultado se presentan los cálculos de blindajes y su justificación, éstos se han realizado bajo simplificaciones que suponen criterios conservadores. Se ha estructurado el proceso de manipulación del generador y se presenta las dosis acumuladas anuales estimadas para extremidades y cuerpo entero de los trabajadores expuestos a radiaciones ionizantes de categoría A.

Se valora factible el proceso de instalación de este generador, dadas las medidas de protección radiológicas asociadas a la actividad a desarrollar.



ID: 03971, 17/07/2019 18:15 - 17/07/2019 18:30, Room 1.3 (First floor)

S21. Medical Physics (GEFM)

(Oral)

A new multichannel radiochromic film dosimetry method using Bayesian estimation techniques

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Radiochromic films are widely used as dosimeters due to its profitable characteristics [1]. The film colour changes by the action of radiation, increasing its darkness with the absorbed dose. A flatbed scanner is used to get a digital image of irradiated film in three colour (RGB) channels, and is later analysed for getting the corresponding dose map. Radiochromic film dosimetry is affected by several sources of uncertainty, some of them due to film heterogeneities.

Multichannel dosimetry [2] consists of combining the information provided by the three channels in order to mitigate the effect of uncertainties. Multichannel analysis will be of special interest in dosimetry with low energy protons used to irradiate cell cultures in specific radiobiological experiments. In these cases, Bragg peak region could be near irradiated volume and film thickness variations can introduce important changes on the absorbed dose [3].

We present a new method for multichannel dosimetry based on a net optical density model given in [2]. Together with the calibration curve, the relations between each pixel dose and the heterogeneities are established and Bayesian estimation techniques are used to combine the three channel information. This method is applied to films irradiated with standard clinical 6 MV Xray fields (Hospital Virgen Macarena) in Sevilla and compared with other multichannel methods.

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ID: 04085, 17/07/2019 18:30 - 17/07/2019 18:45, Room 1.3 (First floor)
S21. Medical Physics (GEFM)
(Oral)

Use of CR-39 nuclear track detector for ion spectroscopy in laser-plasma experiments

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The transparent polymer polyallyl-diglycol-carbonate (PADC, CR-39) is routinely used for the measurement of ambient radon levels. It allows for detection of single particles forming microscopic tracks. Its combination of high sensitivity and high specificity to protons and ions and its inertness to electromagnetic noise have made CR-39 a popular detector for energetic ions from laser-plasma interactions [1, 2].

We have developed techniques for the discrimination of different ion species and for the determination of particle energies based on the track characteristics. At the 3 MV tandem accelerator of CNA (Seville) about 300 CR-39 calibration samples have been irradiated with proton and carbon ion beams for systematic studies of the corresponding track diameters over a wide range of incident energies and under different etching conditions.

For spectroscopic purposes the requirements on track analysis are much higher than for radon alpha particles. The CR-39 plates are scanned with resolution better than 1 μm for a precise determination of the track diameters. We have compared two commercial track readers and a laboratory microscope with home-made DAQ system. Further, we have developed algorithms for the automatic identification of circular patterns [3].

In our recent calibration campaign at CNA special emphasis has been laid on the detection of carbon ions. We have observed significant differences in the response of two types of PADC plastics [4]. These techniques have been successfully applied to laser-accelerated protons with energies up to 2.2 MeV [3, 5].

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ID: 04068, 17/07/2019 18:45 - 17/07/2019 19:00, Room 1.3 (first floor)
S21. Medical Physics (GEFM)
(Oral)

Validación de algoritmos de cálculo de dosis en tratamientos de radioterapia modulados

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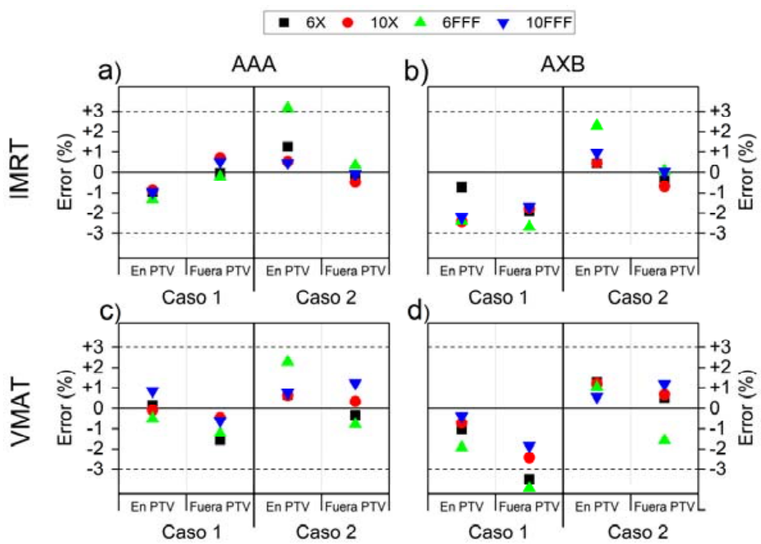
1. Introducción El objetivo de este trabajo es validar los modelos de cálculo de dosis de fotones: Analytical Anisotropic Algorithm (AAA) y Acuros® XB (AXB) del planificador Elipse™ para implementar las técnicas radioterápicas de intensidad modulada (IMRT) y de arcoterapia volumétrica modulada (VMAT). Esta labor es un proceso necesario dentro de las tareas que conlleva el comisionado de un sistema de planificación (TPS). Los haces estudiados son los de un acelerador TrueBeam® de energías de 6 y 10 MV, ambas con o sin filtro aplanador (respectivamente X o FFF).

2. Materiales y métodos Se diseñan planificaciones de IMRT y VMAT sobre un maniquí para cada energía y dos tamaños de volumen a tratar y se calculan las matrices de dosis con los algoritmos a evaluar. Se irradian esos planes midiendo la dosis en los puntos de interés. El conjunto de medida incluye el electrómetro PC Electrometer™, la cámara de ionización CC01 de Scanditronix/Wellhofer y el inserto del maniquí correspondiente al punto de medida. Los cálculos AAA y AXB se realizan con una malla cúbica de 2.5 mm de lado. El grado de concordancia entre cálculos y medidas se cuantifica según: % Error = 100 (D_{calc} - D_{med}) / $D_{med\ ref}$

3. Resultados Los resultados pueden visualizarse en la figura, según: a) Técnica IMRT calculada con AAA, b) Técnica IMRT calculada con AXB, c) Técnica VMAT calculada con AAA, d) Técnica VMAT calculada con AXB.

4. Discusión y conclusiones Para planificaciones IMRT, el 93% de los cálculos AAA y 100% AXB están dentro de tolerancias (±3%), frente al 100% de AAA y 83% de AXB en VMAT. La exactitud de cada algoritmo se ha mejorado regulando mínimamente la transmisión del MLC sin modificar el DLG, buscando un compromiso entre todas las energías y las dos modulaciones. En promedio, AXB subestima la dosis, -0.73%, mientras que AAA la sobreestima ligeramente, 0.10%, ambos dentrode tolerancias establecidas.



ID: 03798, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S21. Medical Physics (GEFM)
(Poster)

MRI magneto-stimulation thresholds for the Peripheral Nervous System

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Here we present experimental work related to a pre-clinical Magnetic Resonance Imaging (MRI) scanner we are building at i3M [1]. The system is designed for in vivo imaging with histological (single cell) resolution and is based on ultra-fast (10 us) ramping of intense (1.2 T/m) gradients [2]. In order to access this extreme regime, we have built pulsed power supplies capable of driving currents of 500 A in 10 us to the gradient coils. This system will allow for MR imaging of small mice with spatial resolutions under 50 microns.

Aside from imaging, our technology will be applied to Peripheral Nerve Stimulation studies when magnetic fields are switched in micro-second timescales, which can be used to benchmark existing models for physiological effects of electromagnetic fields in a regime thus far not accessible. The figure below shows data from the International Electrotechnical Commission which establishes requirements for magnetic resonance equipment for medical diagnosis. The three lines indicate the Spatially Extended Nonlinear Node (SENN) theoretical models used for Cardiac Stimulation (CS) thresholds, PNS thresholds, and 80 % thereof [3]. The Connectome Project is exploring long ramps, where the gap between PNS and CS thresholds decreases, but the rest of the territory is so far uncharted.

Previous experiments hint at deviations from SENN models for rapidly varying magnetic fields [4]. Still, law makers continue to use SENN for assessing the clinical safety of MR equipment, largely due to the overwhelming lack of experimental data other than in the green area. Our power supplies and gradient system open the door to charting the yellow area, which can be used to explore magneto-stimulation thresholds in an unknown regime.

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3. E.U. Saritas. IEEE Trans Med Imag. 32 (2013) 1600-1610.

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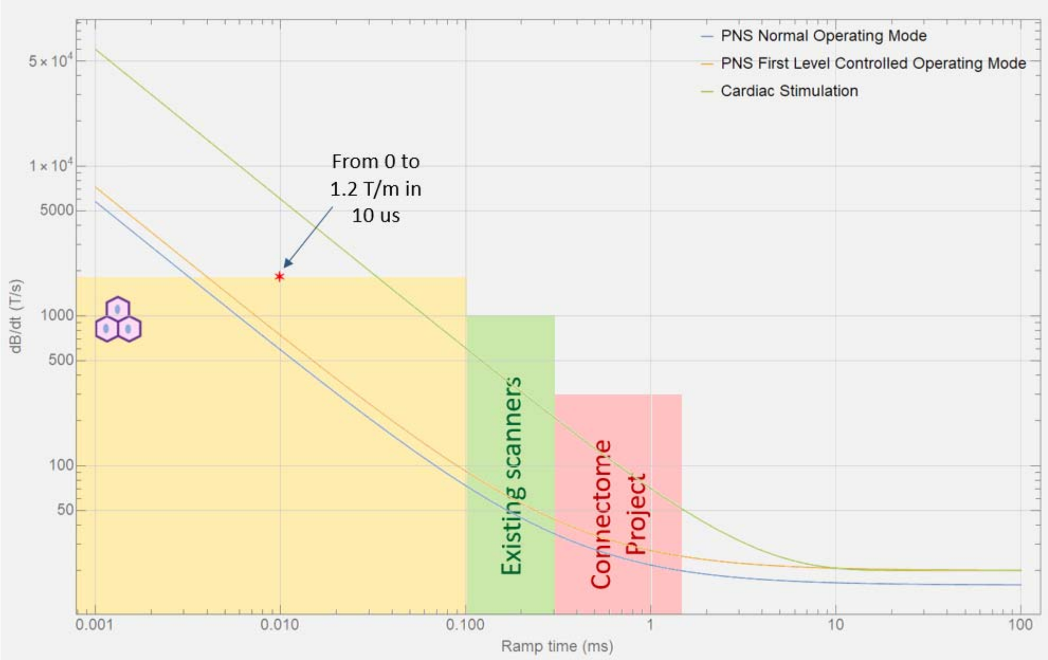
PNS Normal Operating Mode
PNS First Level Controlled Operating Mode
Cardiac Stimulation
From 0 to
1.2 T/m in
10 us
Existing scanners
Connectome
Project
dB/dt (T/s)
Ramp time (ms)
5 × 10⁴
1 × 10⁴
5000
1000
500
100
50
0.001
0.010
0.100
1
10
100

ID: 03842, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S21. Medical Physics (GEFM)
(Poster)

ANALISIS DE LA TEMPERATURA DE LA PLANTA DEL PIE EN PACIENTES DIABETICOS TRAS UN ESTRÉS MECÁNICO Y TERMICO

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Introducción. La diabetes mellituses un importante factor de riesgo cardiovascular que afecta a las arterias de las extremidades inferiores y por tanto a la vascularización periférica de la planta del pie, cuyas alteración puede ser analizada mediante imágenes termográficas.

Material y métodos. 31 pacientes diabéticos. Cámara termográfica FLIR E60. A los pacientes se les realiza una termografía basal tras 10 minutos de aclimatación en la sala a una temperatura de 23-25ºC y humedad relativa 50-70%, y otra tras caminar 500 m sobre cinta. Se analiza también el tiempo de recuperación del 90% de la temperatura basal tras situarse en bipedestación durante 10 s sobre una bolsa de gel enfriado a 0ºC.

Resultados. Se han analizado 9 zonas de interés (antepié, mediopié, retropié y zonas A1 a A6) Fig.1. Los resultados obtenidos, demuestran que tras el estrés mecánico se produce una disminución de la temperatura de todas las zonas plantares (-1,8 ± 0,3ºC). La zona con mayor variación es el antepié y el retropié es la zona con menor variación. Respecto al estrés térmico, el tiempo promedio en recuperar del 90% de la temperatura basal es de 98 ± 44 s. El talón es la zona más lenta en recuperar la temperatura basal.

Conclusión. La combinación de estrés mecánico y estrés térmico, permite analizar el comportamiento de la vascularización periférica de la planta del pie del paciente diabético y establecer las zonas de mayor interés para la cuantificación de las variaciones de temperatura asociadas con dichos estreses.

Agradecimientos: Proyecto AICO 2017-122 de la Generalitat Valenciana

ID: 03884, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S21. Medical Physics (GEFM)
(Poster)

Sonochemical synthesis of $Mn_xFe_{2-x}O_4$@SiO_2 core-shell Nanoparticles for smart drug delivery systems

Alex Alavarse[1] , Alex Alavarse[2] , Jesús Antonio Fuentes-Garcia[2] , Jesús Antonio Fuentes-Garcia[3] , Gerardo Goya[2] , Gerardo Gerardo[4] , Jean Jacques Bonvent[1]

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Nanoparticles offer a smart solution to new protocols of therapeutic drug delivery to target tissues or cells. Magnetic nanoparticles (MNPs) have been used for hyperthermia and MRI experimental techniques since many years now. Also, mesoporous silica nanoparticles (MSN) have been known to be an excellent functional platform with low cytotoxicity that can be simply bioconjugated with different ligands to carry drugs or biomolecules of therapeutic interest. Here we present a two-step synthesis method to obtain core@shell magnetic nanoparticle cores within mesosporous silica shells with large surface area. Using an ultrasonic probe (130 W) with different manganese sulfate II ($MnSO_4$) and iron sulfate II ($FeSO_4$) salts to form magnetic cores (Mag-Mn) we were able to obtain specific power absorption (SPA) values medium up to ≈ 470 W/g. Mn-doped magnetite nanoparticles with sizes of 20 nm displayed the largest SPA values (471 w/g) and were therefore chosen as magnetic cores. These magnetic cores were sonicated and mixed with Cetyl trimethylammonium bromide (CTAB), ammonium hydroxide (NH_4OH) and ethanol, adding a mixture of tetraethyl orthosilicate (TEOS) and 3-Aminopropyl)triethoxysilane (APTES) solution was dropped on to solution. This two-step sonochemical method showed to be an efficient, time saving synthesis route. The magnetite/silica core@shell system obtained in this way could be a used as multifunctional drug carrier combining magnetic hyperthermia to improve the drug release response and the interaction to biological systems.

ID: 04000, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S21. Medical Physics (GEFM)
(Poster)

Gestión de la dosis radiológica en un sistema de ámbito regional: experiencia y resultados de 4 años

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Introducción El informe UNSCEAR [1] constata que el 90% de la dosis poblacional por causas no naturales corresponde a usos médicos. La Directiva 2013/59 establece la necesidad de estimar la dosis poblacional por procedimientos diagnósticos. El Servicio Murciano de Salud, SMS, ha configurado un sistema de registro de dosis corporativo. Actualmente es uno de los mayores sistemas de escala regional a nivel europeo, con mayor número de equipos, centros y estudios registrados.

Material y métodos En 2014 se adopta el sistema de registro DoseWatch® de GE; hardware para la interconexión de equipos, el software de registro y servicios asociados. Se han interconectado equipos de 12 centros: tomografía, mamografía, radiología intervencionista y radiología convencional. Se organiza a partir de un comité de dirección de dosis de ámbito regional del que dependen 9 comités locales con representación de radiólogos, radiofísicos, enfermería, técnicos, informáticos y administración sanitaria.

Resultados y Discusión La tabla 1 da los equipos (73) conectados y el nº de estudios registrados (1.862.158) hasta final de 2018. Se han estandarizado 50 protocolos, múltiples optimizaciones y reducciones de dosis. Intercomparaciones entre equipos y hospitales. Concienciación de los profesionales. Se han incluido en el informe radiológico los parámetros dosimétricos: DLP (mGy.cm) para TC y DGM (mGy) en mamografía. La validación de los datos registrados por los diferentes equipos y la falta de homogeneidad han sido algunas de las principales dificultades encontradas.

Conclusiones La implantación de un sistema de registro de dosis a nivel corporativo supone un reto importante tanto por la variedad y cantidad de equipos, como por el elevado número de personas implicadas, que necesita un órgano director para conseguir objetivos.

Referencias

[1] UNSCEAR. Sources and effects of ionizing radiation. Volume I. Annex A y B. Medical Radiation exposures. Report to the General Assembly 2008. ISBN: 978-92-1-142274-0. United Nations, 2010.

Hospital, ciudad
HUVArrixaca, Murcia
HGSªLucia, Cartagena
HMorales Meseguer, Murcia
HRSofía, Murcia
HSMªRosell, Cartagena
HRMendez, Lorca
HVegaLGuirao, Cieza
HCNoroeste, Caravaca
VCastillo, Yecla
HLosArcos, MarMenor
Total 10
+ 2 C Especialidades

Hospital	Modalidad				
	TC	CV/IR	MG	DX/RF	TOTAL
HUVA	5	9	2	6	22
HGSL	2	6	1	6	15
HMM	2	1	1	1	5
RSOF	2	1	1	3	7
HSMR	1			3	4
RMEN	1		1		2
HVLG	1		1	2	4
CNOR	1		1	2	4
VCAS	1		1		2
HLAMM	2		1	5	8
Total equipos	18	17	10	28	73
Nº estudios	366.573	37.377	74.859	1.383.349	

Tabla 1. Equipos conectados por modalidad y centro. Número de estudios registrados a finales de 2018.

ID: 04057, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S21. Medical Physics (GEFM)
(Poster)

Diffractive corneal inlays for presbyopia compensation. Ray tracing analysis

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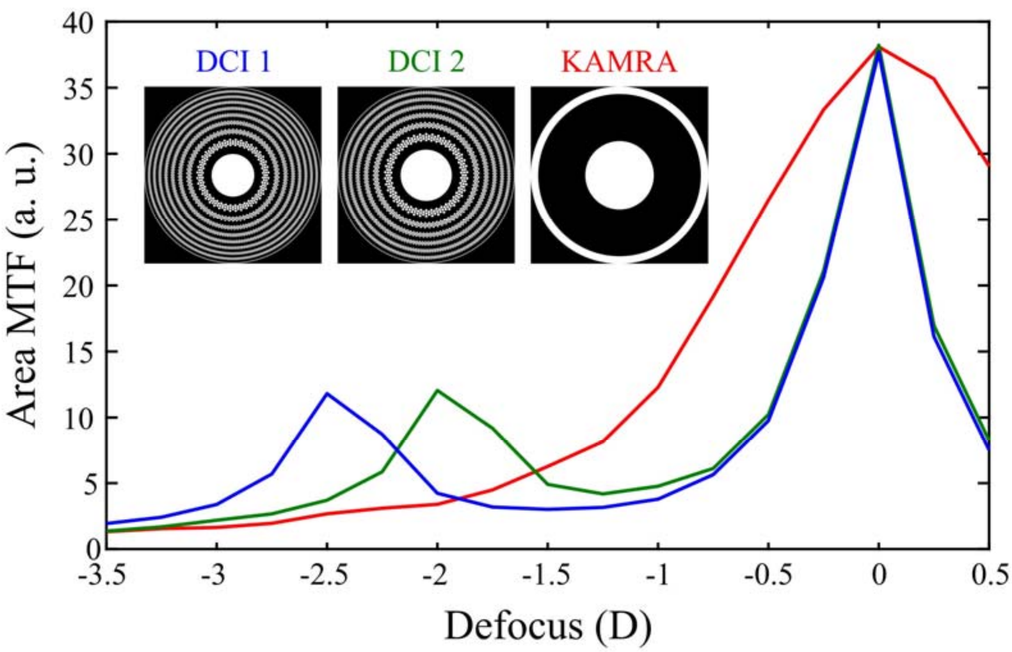
Corneal inlays are the most recent optical solutions proposed for the treatment of presbyopia. These, are artificial implants that are accurately located into 'pockets' within the corneal stroma, created by precise femtosecond lasers. Recently, we have proposed the first corneal inlay based on diffraction [1]. Our proposal, coined diffractive corneal inlay (DCI), has been designed by merging the photon sieve concept [2], and the pinhole effect. The DCI consists on a small aperture disc having an array of micro-holes distributed inside the open zones of a Fresnel zone plate (see the insets in Fig.1). The central hole of the disc lets pass the zero order diffraction and produces an extension of the depth of far focus of the eye. In this way, a DCI transforms the presbyopic eye into a bifocal optical system creating a diffractive focus to see near objects. Furthermore, the design parameters of the DCI allow customization, which is a new concept in corneal implants. In fact, DCI with different amounts of diffractive power can be designed.

The aim of this communication is to present the results of the imaging properties of different models of DCIs by means of numerical analysis of the Modulation Transfer Function (MTF) compared with those obtained for the commercial small aperture corneal inlay: Kamra ®. The image quality is evaluated by means of the area under the MTF obtained with Zemax® ray tracing software on the Liu-Brennan model eye. The bifocal nature for two DCIs of different near powers can be clearly seen in the Figure (area under the MTF computed from 0,17 cpmrad to 2,58 cpmrad which are equivalent to optotypes of decimal visual acuities from 0,1 to 1,5).



ID: 04073, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S21. Medical Physics (GEFM)
(Poster)

A new approach to radiochromic film dosimetry based on non-local means

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Introduction: Radiochromic films are frequently employed as dosimeters for advanced techniques in radiotherapy. Their pros are light element composition, low energy dependence, near biological tissue equivalence and high spatial resolution. Their cons are non-uniformities, readout noise, and scanning artifacts. The multichannel processing protocols were proposed to overcome these weaknesses. We are presenting a new protocol based on a non-local (NL) mean denoising algorithm.

Methods: The NL-means algorithm replaces the color of a pixel with the average of the colors of other pixels -not needed to be close- that resemble its color, allowing to mitigate noise and other lacks of uniformity without relying on multiple images. An implementation of the Buades algorithm has been used. The processing steps are: read out the film as a 48-bit color image just one scan, apply the NL-means algorithm, split the image into its color channels and apply the calibration curve to each split denoised image. For validation absorbed dose distributions for three open square fields were measured with ionization chamber and radiochromic film. Additionally starting out from a dose distribution of a real treatment, digital signals were simulated incluiding noise and lack of uniformity to study the behavior of the NL-means algorithm.

Results: The proposed protocol improves the standard multichannel protocol in accordance with the gamma index results.

Conclusions: The presented protocol could help radiochromic films become a handy dosimeter for quality control purpose, avoiding cumbersome and time-consuming corrections.

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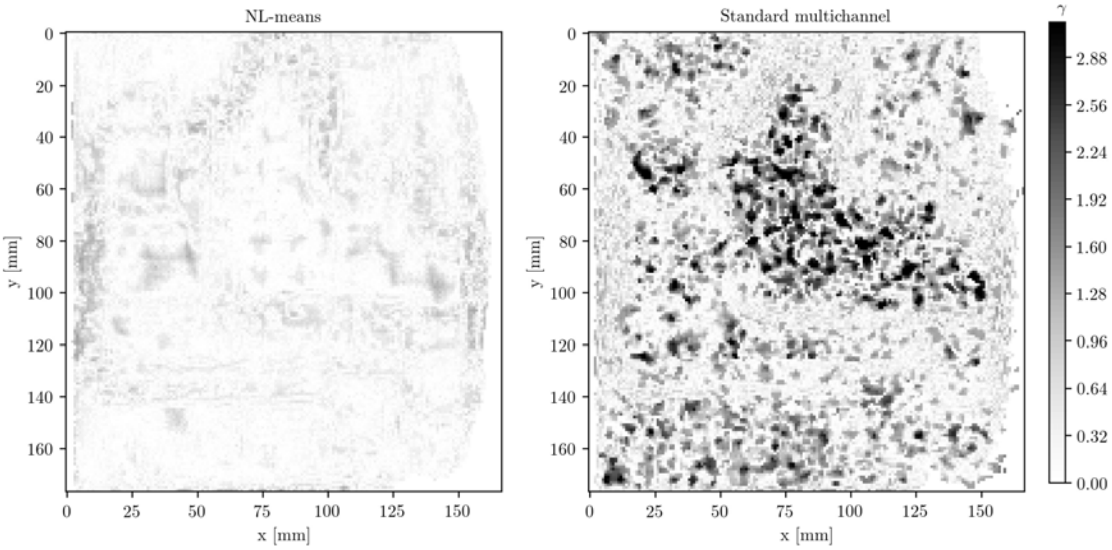
NL-means
Standard multichannel
y [mm]
x [mm]
γ
0
20
40
60
80
100
120
140
160
0
25
50
75
100
125
150
2.88
2.56
2.24
1.92
1.60
1.28
0.96
0.64
0.32
0.00

ID: 04095, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S21. Medical Physics (GEFM)
(Poster)

Sensitometry of radiochromic films based on two polymer color phases

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1) Física Médica. Departamento de Radiología. Universidad Complutense de Madrid. Servicio de Radiofísica y Protección Radiológica. Hospital Universitario de Fuenlabrada. Madrid.
2) Servicio de Radiofísica y Protección Radiológica. Hospital Universitario Doce de Octubre. Madrid.
3) Física Médica. Departamento de Radiología. Universidad Complutense de Madrid

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Introduction: Growth of polymers in radiochromic films induced by radiation alters their optical properties. Sensitometry establishes the relation between exposure to ionizing radiation and light attenuation in a film. We present a sensitometry model of radiochromic films based on radiation inducted growth of two polymer color phases.

Methods: The absorption spectrum of the film active layer was modeled and deconvolved into the contribution of each color phase. The light absorption as measured by the is a function of the integral absorption. We have investigated if a first order approximation to this function is enough to describe the sensitometry of the films. Six different production batches were analyzed according to this model.

Results: The integral absorbance follows a saturation function with dose. The linear approximation accurately describes the data coming from the six production batches. It is found that the relative abundance of the color phases is a constant, so the model depends on one free parameter. For five out of six production batches the parameter is compatible with a unique value, meaning not significant differences were found between those batches.

Conclusions: The calibration curve can be written as a linear combination of simple functions describing the dose dependence of the integral absorbance of each polymer color phase. These functions are characteristics of the active layer material, and not dependent on the model and production batch. According to the proposed model, to calibrate a batch in terms of the active layer light attenuation consists of determining just one linear coefficient.

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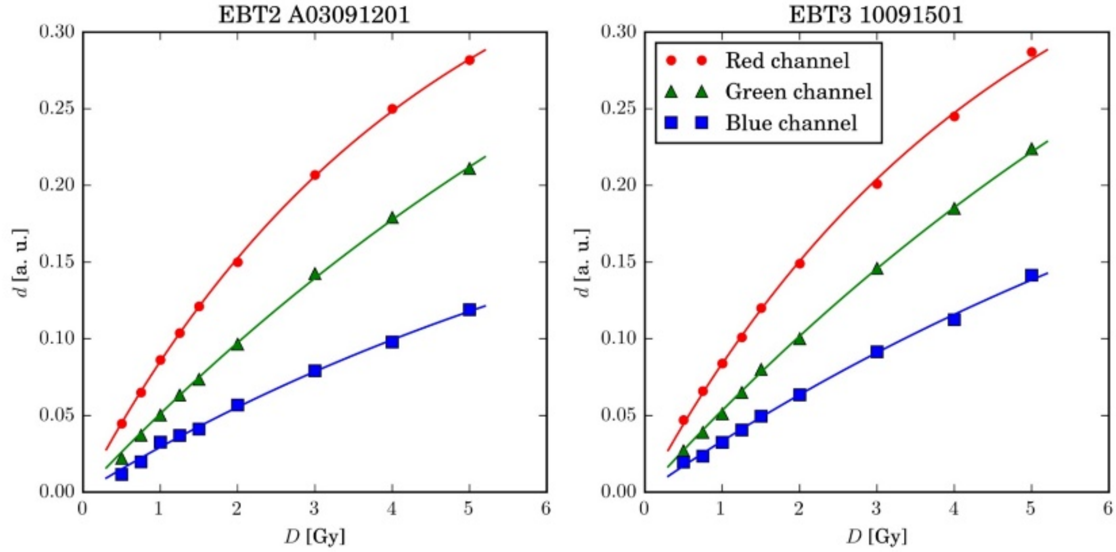
EBT2 A03091201
EBT3 10091501
Red channel
Green channel
Blue channel
d [a. u.]
D [Gy]
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0
1
2
3
4
5
6

ID: 04196, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S21. Medical Physics (GEFM)
(Poster)

Magnetic nanoparticles as inorganic components of hybrid materials for tissue regeneration

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Design of new biomaterials for tissue engineering is an important issue in modern regenerative medicine. One of the key elements in tissue regeneration are biocompatible scaffolds that closely mimic the extracellular matrix [1]. Hybrid materials are a promising class of materials tested for tissue engineering applications. The preparation of such materials is often based on the combination of organic polymers with inorganic materials, e.g. magnetic nanoparticles. Magnetic nanoparticles show great potential in biomedical applications due to their unique properties. Superparamagnetic iron oxide nanoparticles (SPIONs) and, in particular, magnetite (Fe_3O_4) and maghemite (γ-Fe_2O_3) are of special interest because of their easy preparation and non-toxicity [2]. In order to increase their biocompatibility and prevent aggregation, coating materials are often used. One of them is chitosan – a linear polysaccharide obtained by deacetylation of chitin that can be successfully used in biomedicine [3]. This work presents results concerning preparation and characterization of superparamagnetic iron oxide nanoparticles that can be potentially used as inorganic components of hybrid materials for tissue regeneration. Iron oxide nanoparticles were prepared using co-precipitation method and surface-coated with ionic derivative of chitosan. Nanoparticles obtained were characterized in regard of their physicochemical and magnetic properties. Selected batches of nanoparticles were dispersed in collagen-based hydrogels. Results of preliminary studies indicate that magnetic properties of SPION in the hydrogel matrix are preserved and no phase separation is observed.

References:

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[2] L. Mohammed, et al. Particuology 30 (2017) 1-14. [3] M. Dash, et al. Progress in Polymer Science 36 (2011) 981-1014.

Acknowledgments: S.F. acknowledges the financial support from National Science Centre, Poland (grant no. 2016/23/D/ST8/00669). A.G. has been partly supported by the EU Project POWR.03.02.00-00-I004/16.

ID: 04197, Mon-Thur 16:30 - Mon-Thur 17:30 , Hall (ground floor)
S21. Medical Physics (GEFM)
(Poster)

Magnetically Navigated Polysaccharides-based Capsules as Smart Delivery Systems

Elżbieta Gumieniczek-Chłopek[1,2] , Joanna , Odrobińska[2] , Szczepan Zapotoczny[2] , Czesław Kapusta[1]

1) AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Cracow, Poland
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** Elżbieta Gumieniczek-Chłopek, echlopek@agh.edu.pl*

Polysaccharides-based capsules with encapsulated nanoparticles of magnetic iron oxides (MNPs) may lead to novel approaches in solving biomedical problems in various nanomedicine application, including drug delivery systems, magnetic resonance imaging, hyperthermia treatment and microfluidics utilized in diagnostics.[1,2] Considerable efforts have been dedicated to fabricate and characterize magnetic iron oxides nanoparticles dispersible in oils, which were synthesized by the thermal decomposition of iron (III) oleate. [3] The research carried out is focused on core-shell nanosystems designed for smart delivery by external magnetic field navigation. For that purpose, MNPs were encapsulated in the oil core of capsules with stabilizing shell prepared of hydrophobically modified biopolymer (chitosan). [4] Physicochemical properties, as well as stability of the obtained iron oxides magnetic nanoparticles and capsules, were investigated using various techniques. The MNPs were characterized with dynamic light scattering and zeta potential measurements, infrared spectroscopy, X-ray diffraction, Mössbauer spectroscopy, magnetometry and Scanning Transmission Electron Microscopy (STEM). Fabricated capsules were examined with dynamic light scattering and zeta potential measurements and imaged by STEM.

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Acknowledgments: E.G.Ch. has been partly supported by the EU Project POWR.03.02.00-00-I004/16

Open programme: "Física para tod@s"

Monday, July the 15th

Superconductivity on stage (experiments)

Time: 20:30

Place: Plaza San Felipe

How to get there
By tram – "César Augusto" stop

Tuesday, July the 16th

El enigma Agustina (documentary and colloquium with authors)

Time: 19:30

Place: Centro cultural "El Patio de la Infanta" (San Ignacio de Loyola 11)

How to get there
By tram – "Gran Vía" stop
By bus – Line 25, 32, 51, "Constitución/Gran Vía" stop

Wednesday, July the 17th

Ordenando Elementos Químicos (a dialogue between Chemistry and Physics about Mendeleive's Table of Elements led by Luis Oro and Pablo Alonso)

Time: 19:30

Place: Centro cultural "El Patio de la Infanta" (San Ignacio de Loyola 11)

Thursday, July the 18th

Cuando teníamos las respuestas, nos cambiaron las preguntas, (Las tribulaciones de la Física Fundamental con el Universo oscuro) (open conference by Juan José Hernández Rey)

Time: 19:30

Place: Centro cultural "El Patio de la Infanta" (San Ignacio de Loyola 11)

Exhibitions

Julio Palacios y la Edad de Plata de la Física Española

Place: Facultad de Educación, sala de exposiciones (ground floor)

How to get there:
By tram – “Plaza de San Francisco” stop
By bus – Line 35, 42, Ci1: “Violante de Hungría/Escuela Idiomas” stop
Line 22, 35, 38: “San Juan Bosco 7” stop

Instrumenta

Place: Facultad de Ciencias (A), main hall (ground floor)

How to get there:
By tram – “Plaza de San Francisco” stop
By bus – Line 35, 42, Ci1: “Violante de Hungría/Escuela Idiomas” stop
Line 22, 35, 38: “San Juan Bosco 7” stop

Program design: Germán Romeo, Marisa Bonilla and Fernando Luis
Cover design: Javier Camón
Artwork: Marco Evangelisti
Zaragoza 2019

Universidad Zaragoza
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