ABSTRACTS

Hexagonal MoO3 as a multi-functional material for energy storage, optoelectronics and photocatalytic applications

Paloma Almodóvar Losada

Molybdenum oxides are considered exceptionally functional and adaptable optical and electronic oxides due to their unique physical properties [1-2]. In particular, molybdenum trioxide (MoO3) is a polymorphic material. The thermodynamically stable orthorhombic α-phase is a well-known semiconductor with important applications in catalysis, sensors, solar cells technology, electrochromic systems and field emission devices. Known for almost one century and still a source of findings, hexagonal MoO3 is a metastable material which structure and physicochemical properties are still not well known [3]. In this work, undoped, Ag and Eu-doped h-MoO3 and h-MoO3 composites with graphene oxide (GO) and have been synthesized by a scalable soft chemistry method based on the precipitation of ammonium heptamolybdate. In addition, h-MoO3 nanoparticles were obtained by ball-milling of the as-grown microstructures. All the obtained samples were thoroughly characterized by a wide set of complementary techniques including monochromatic X-ray diffraction (XRD), scanning electron microscopy (SEM), high resolution transmission electron microscopy (HRTEM), micro-Raman, micro-photoluminescence and X-ray photoemission spectroscopy (XPS). h-MoO3 microrods appear wrapped by graphene and GO layers in the composite materials. This coating increases the specific capacity (compared to the reference h-MoO3 electrode) and the stability, exceeding a value of 650 mA h /g at a current density of 1 A/g after more than 130 cycles. These excellent storage properties are attributed to the effect of graphene and GO layers, which are interspersed between the h-MoO3 rods preventing both their aggregation and the electrode from being sprayed as a result of the large volume changes that occur during Li insertion-deinsertion cycles. The photocatalytic behavior of the Ag-doped samples for the degradation of trichloroethylene in gas phase under visible light irradiation was studied as a function of the Ag content and gas flow. Increased anode stability as well as a significantly improved photocatalytic activity were found when h-MoO3 nanoparticles were used instead of the as-grown microrods. Finally, we achieved effective optical activation of Eu ions in implanted h-MoO3 microrods at a desired position and with high precision by laser irradiation in a confocal microscope, spanning potential applications of this material towards optoelectronics.

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Astrophysical parameters of M dwarfs with Exoplanets

Carlos Cifuentes San Román

CARMENES is a very high resolution spectrograph that observes M dwarfs in the visible and in the IR for the search of earth-mass planets using the radial velocity method. Carmencita is the name of its catalog, containing hundreds of tabulated parameters for 2182 M dwarfs. It includes a comprehensive collection photometric data obtained in terrestrial and space missions, with wavelengths ranging from the far ultraviolet to the medium infrared. Determining the fluxes in such a wide range allows us to build the Spectral Energy Distribution (SED), and derive the luminosity and effective temperature using model fitting. From these empirical variables it is possible to obtain fundamental parameters, such as surface gravity or metallicity. The latter is known to play an essential role in the formation of planetary systems. Since the M dwarfs in Carmencita are main sequence objects, it is very convenient to analyse their colours, which are independent of the distances, and thus study their multiplicity and intrinsic characteristics. One of them is the emission in the ultraviolet, directly linked with the magnetic activity, which is highly frequent in M dwarfs, especially in later types. This and other phenomena can easily mask the radial velocity jitter produced by planetary companions, and in the case of stars that harbour planets, it can seriously compromise their habitability conditions. Defining stellar properties is an essential requirement for the study of the formation, detection and characterisation of planets.

Magnetic properties of the cave sediments at Gran Dolina in Sierra de Atapuerca (Burgos, Spain)

Serena D'Arcangelo

This study is being carried out at the Sierra de Atapuerca, near the city of Burgos (north of Spain), that represents one of the most important archaeological and paleontological sites of the Middle and Early Pleistocene in Europe. Magnetostratigraphic work in the Atapuerca site has provided a paleomagnetic age as it reveals the Matuyama-Brunhes boundary, the latest major geomagnetic reversal (0.78 Ma). Now, the goal of the current work is to analyse the environmental conditions to further understand the human development in the occupational period. Our samples are taken at the cave entrance and cave interior sediments of Gran Dolina Cave, a cavity infilled by 25m of Pleistocene sediments from which was discovered around 170 hominin bones that allowed the definition of a new species, Homo Antecessor. This work has two intimately related goals, i) univocally identifying the ultimate magnetic carriers in already well accepted paleomagnetic studies and ii) further exploring the environmental coupling between of the magnetic properties and paleoclimatic framework. Rock magnetic experiments include: initial bulk susceptibility and its frequency dependence to estimate the concentration of ferromagnetic grains near the SD/SP boundary, Day plot in order to distinguish the behavior domain particles and the thermomagnetic curves to individuate the type of minerals presents. Finally, also representation of the King plot, which provides a means of assessing grain sizes. Preliminary results indicate that the samples contain two main magnetic minerals: magnetite and hematite. Its concentrations change within facies and also between the cave entrance and cave interior sediments.

It seems that the upper level of the cave entrance is characterized by a high concentration of magnetic minerals while the cave interior presents a variation of concentration, due to the different facies contained in that cave. Results summarized in the also called Day plot suggest that our samples are PSD (pseudo-single-domain) particle range. In a grain-size framework, results show that the cave entrance is dominated by smaller magnetic grains, while in the cave interior includes also larger magnetic particles. Our study will help us better understanding the paleoenvironment at the time the first Europeans began to migrate into Europe.

Magnetic microwires for contact-less sensing application

Diego Archilla Sanz

Amorphous magnetic microwires presents unique magnetic properties, in particular, the giant magneto-impedance effect present in this type of microwires allows to detect the interaction of the sample with microwaves. The changes of this interaction due to variation of the physical properties of the microwire makes them useful as elements for contact-less sensing application. In this work microwires with nominal composition Fe2.25Co72.75B15Si10, and nucleus and total diameter of 32,9 μm and 49,4 μm respectively, were used in order to measure changes in the GMI effect produced by temperature and to detect AC current passing through the microwire.

Interplay between two type II superconductors at the nanoscale

Víctor Rollano García

We have fabricated a superconducting nano-composite made up of two different type II superconductors in order to study the interplay between them. The hybrid sample comprises an array of Niobium (Nb) nanotriangles embedded in a Vanadium (V) thin film. First, the array of Nb nanotriangles is defined on a Si substrate by electron beam lithography and grown by magnetron sputtering. Then, the V thin film is deposited by magnetron sputtering on top of the Nb array. Optical lithography and etching techniques are used to define a cross-shaped bridge which allows carrying out transport measurements. A study of superconducting vortex dynamics is performed below the superconducting temperature of both materials (4.84 K for Nb nanotriangles and 4.3 K for the V thin film) by means of magneto-transport measurements. In the mixed state, we have measured and analyzed the superconducting critical magnetic field, (I,V) curves, magnetoresistance and ratchet effect. We have also studied the influence of the angle between the magnetic field and the hybrid sample.

Extinction thresholds of spatially extended population with Allee effect

Rodrigo Crespo Miguel

Many species are unsustainable at small population densities (Allee Effect). This implies that for population densities below a threshold, named Allee threshold, the population decreases instead of growing. Here, we have studied how a ecosystem with a stable population density (close to carrying capacity) can become extinct due to large environmental fluctuations, which lead the population below the Allee threshold.

Background-independent measurement of θ13 in the Double Chooz experiment

Diana Navas Nicolás

Reactor experiments have successfully measured the θ13 mixing angle by studying the neutrino deficit as a function of the prompt visible energy. Among these, Double Chooz is unique due to the experimental configuration that features only two reactors. Taking advantage of this fact, the Reactor Rate Modulation (RRM) analysis classifies the neutrino interactions according to three reactor configurations: both reactors are running, only one reactor is on or both reactors are off. This last scenario allows for a direct and independent measurement of the total background rate of the experiment. A global fit to both θ13 and the total background is performed by analyzing the neutrino candidates rate for different reactor power states. The results yield a competitive measurement of θ13 and an independent estimation of the total background rate, consistent within one sigma with the background model used as an input for the Rate+Shape fit.

Effect of Doping on the growth and properties of NiO

María Taeño González

Nickel oxide (NiO) is a wide band gap p-type semiconductor with good electrical, optical and magnetic properties, as well as excellent chemical and thermal stability. This material has recently demonstrated potential applicability in electrochemical capacitors, alkaline batteries, smarts windows and gas sensing, among others. Morphology engineering can lead to optimize most of these applications by reducing the size and selecting proper shapes. Alternatively, doping is an additional parameter, which can induce property improvments and originate new applications. In this work, NiO/SnO2 micro- and nanostructures have been fabricated using different amounts of Sn or SnO2 in the initial mixture, following a catalysis free vapor-solid process. These method, avoids the use of catalyst or external substrates. Thermal treatments were performed at 800 ˚C and 1400 ˚C during 10 hours under a controlled argon flow, obtaining a great variety of morphologies. Studies of the morphology and characterization of the as grown micro and nanostructures with Scanning Electron Microscopy (SEM), X-Ray Diffraction (XRD), Energy-Dispersive X-ray spectroscopy (EDS), Raman spectroscopy, Cathodoluminescence (CL) and Photoluminescence (PL) were performed. XPS results measured at the ESCA microscopy beamline at the Elettra synchrotron (Trieste,Italy) will be also discussed. Sn/SnO2 doping not only induces the growing of nanostructures, but also induces changes in morphology, size and Raman and XPS signals.

Nanostructuring of conducting polymer thin films by laser and its influence on its electrical properties

Edgar Gutiérrez Fernández

At the beginning of the second half of 20th century, the discovery and optimization of industrial techniques to fabricate polymeric materials started a new era. Polymers can be cheaper, lighter and more durable than many traditional materials. They can be used in almost every aspect of everyday life and industry processes, from packaging, textile, household to construction, motor and aeronautic industry. From the beginning of polymer industry, it was found that polymers were electrical insulators, so they were largely used as well to fabricate protection coatings for cables, plugs or every kind electronic device. However, in the 1970s, the discovery of intrinsic conducting polymers opened infinite lines of investigation that resulted, for instance, in the creation of Polymeric Solar Cells (PSCs), Organic Light-Emitting Diodes (OLEDs) or Organic Field-Effect Transistors (OFETs). Nowadays this field is more active than ever due to its close relation with the field of nanoscience. The possibility of fabricating nanostructures that, through influencing over its electrical or optical properties, may lead to an improvement in the organic electronic devices previously mentioned. Among the different conducting polymers in the market, poly(3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PEDOT:PSS) has reached an special position due to the broad range of potential applications that rise from the merge of its electrical conductivity, visible transparency, stability and solubility. It can be processed at room temperature from an aqueous dispersion into thin films and incorporated into organic solar cells as a hole transport layer. PEDOT:PSS can also be used as a transparent conductive electrode as an alternative to the expensive indium tin oxide (ITO) electrode. The increasing interest in nanostructuring leads to seek alternative ways of producing nanostructures: more economic, quicker and reproducible, avoiding the necessity of stringent environmental conditions like those implied in using clean rooms, high vacuum or complex mask fabrication. In particular, laser induced patterning of organic surfaces is a versatile strategy in order to produce functional nanostructures.

Controlling topologically protected states by external fields and doping

Álvaro Díaz Fernández

Topological materials often display topologically protected surface states with Dirac-like dispersions. Controlling their properties is desirable for their foreseen applications and a number of proposals have been put forward to this respect (e.g. [1,2,3,4]). In this contribution, the system I will consider is a topological boundary. I will discuss how applying uniform electric and magnetic fields that preserve the symmetries lead to an anisotropic reduction of the Fermi velocity as the fields are increased. [5,6]. I will also show how a δ-layer of donor atoms at the boundary can lead to a coexistence of a two-dimensional electron gas with the topological surface states. Moreover, the linear optical response is markedly reshaped by the presence of the topological state [7].

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Influence of Water Models on AQP1

Alberto Zaragoza de Lorite

Membrane proteins are vital for the correct functioning of cells, being responsible for cell- cell communication and both active and passive transport of molecules across the membrane[1]. The latter include protein channels and pores, and constitute a large family whose members have different features depending on the nature of the transported molecules. Aquaporins (AQP) are protein pores enabling the passage of water [2] across the membrane, characterised by high selectivity and rates of permeability. Although they have been widely studied, key aspects of the mechanisms relevant for their function remain unclear. Molecular dynamics (MD) is powerful numerical tool for investigating the features of a membrane protein, simulating a full complex system consisting of the membrane protein, the bilayer lipid membrane, water molecules, and ions. In such a system, water plays a key role in the lipid-protein interaction, given that the lipid membrane structure is governed by hydrophobic-hydrophilic forces (as well as the protein structure). Hence, it is essential to properly describe both the water-protein and water-membrane interactions. However, so far in biological simulations, water models have been selected for their ability to reproduce the behaviour of biological molecules, for example how lipids assemble into a membrane or the dynamics of a protein [5]. In our work, we propose a different point of view: the choice of the water model might influence the predicted transport properties of aquaporins [6]). We will be focusing on newer water models, such as TIP4P/2005 [7] and OPC [8], known to reproduce and to predict the values of a huge range of thermodynamics properties [6]. We have carried out several simulations for AQP1 in combination with TIP3P [9], TIP4P/2005 and OPC as the water potential. We have calculated the water flux through the channel, the water molecule orientation into the channel and the water dipole moment for the three systems. Our preliminary results for all systems reproduce the molecular mechanism described by Tajkhorshid et al. [10]. However, the number of water molecules crossing the channel depends on the water model. The thermodynamic properties of the water potential in bulk are extremely different, thus modifying the protein behaviour.

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Influence of Sn doping in Zn2GeO4 structure, surface and optical properties

Jaime Dolado Fernández

Germanates have emerged as a new family of transparent conducting oxides (TCOs), which are materials with a high electrical conductivity and a high optical transparency in visible light, due to their wide band gap. Some of the proposed germanates have been bismuth, strontium or zinc germanates. Their properties make them of interest in applications like nanoelectronics, optical nanodevices, sensing or catalysis, which has made the activity on nanostructured germanates increases in the last few years. On the other hand, the role of dopants is of paramount importance in the design of materials at the nanoscale, because impurities may influence both morphology, architecture and physical properties. In addition, surface properties are key in understanding the physical behaviour of nanomaterials due to the increase of the surface to volume ratio. In this work, we will tackle the doping challenge in zinc germanates micro and nanowires. We have chosen Sn as dopant for several reasons: i) tin often acts as a catalyst during the thermal growth process and would modify the final morphology of the nanostructures. ii) Impurities often tend to out-diffusion in nanowires, hence surface properties could be affected as well. iii) Tin may locally modify the crystal lattice and the native defects structure, which would add electronic levels in the band gap and/or alter oxygen vacancies related states. In this work, we have characterized the chemical, microstructural, surface and optical properties of Zn2GeO4: Sn nanostructures and studied the influence of the Sn concentration in the precursor and thermal treatment duration on the morphology and physical properties of the products.

Spin-glass magnetic behavior on nanostructured zinc ferrite

Miguel Ángel Cobos Fernández

Spin-Glass is a magnetic order where individual spins moments of the magnetic atoms reach a random distribution that leads to a magnetic frustration. This behavior has been observed in materials with another magnetic state like ferro/ferrimagnetism or paramagnetism as the temperature is decreased below a glassy temperature transition, when the spins can be frozen in random orientations. At present, the spin glass behavior is, for analogy, a model for other complex systems beyond materials science, like cancer cells or neural works. We present here a systematic study to understand the relationship between the structural order present on Zn-ferrite with the spin-glass behaviour induced at low temperatures. Massive Zn ferrite has a normal spinel structure (with all Zn+2 cations in the tetrahedral (A) sites, while Fe+3 ions occupy the octahedral (B)ones), and it behaves paramagnetic at room temperature. Stoichiometric ZnFe2O4 was synthesized from a powder mixture of pure ZnO and Fe2O3 by high energy mechanical milling in air. Microstructural characterization of resulting material by XRD confirmed the presence only of zinc ferrite after 150h milling and the Rietveld refinement of this spectrum showed a cation inversion close to 0.60, which was associate to a random distribution of Zn2+ and Fe3+ cations over tetrahedral and octahedral sites. Starting from the maximum inversion associated to the random cationic distribution, the inversion parameter was tuned by annealing for 1 h at temperatures ranging from 300 to 600ºC. Magnetic measurements of ZFC-FC showed an anomalous behavior consisting of a decrease of the glass transition temperature as the nanoparticles size was increased by increasing the annealing temperature, Thus, it was concluded that in nanostructured ferrites this transition is mainly related with the cation distribution that can be monitored by the degree of cationic inversion.

Study of non thermal effects of ultrasound in a fibroblasts monolayer culture in vitro

Silvia Ronda Peñacoba

Background: Since the knowledge of ultrasound (US) induced bioeffects, numerous studies are interested in the study of biophysical effects of therapeutic US in vitro culture cells. These results are useful in determining functionality of this type of radiation, but should be carefully interpreted to extrapolate findings to in vivo or humans treatments. Cellular effects of US group into thermal and non thermal, and may occur simultaneously. There is an actual tendency to improve non thermal effects in physiotherapy applications so treatment regimes in pulsed mode are being used to reduce the temperature rise. At low intensities, acoustic streaming is considerable, but in higher levels, acoustic cavitation is predominant. Methods: In this work, experiments with a cell line of fibroblasts grown in a polystyrene common 12 well cell culture plate are made. Using a 2 MHz piezoelectric transducer, two protocols of treatment have been designed and only one parameter is modified each time: maximum amplitude of the acoustic beam for long duration pulsed mode (200 cycles of 0.9 MPa, 0.18 MPa and 0.09 MPa) and pulse repetition frequency for short duration pulsed mode (5 cycles of 1.1 MPa each 1 kHz, 10 kHz and 100 kHz). Results: A complete characterization of the acoustic

field in the experimental conditions has been made with needle hydrophones supported with simulations with COMSOL Multiphysics ®. The results are quantified in terms of viability and number of cells after sonication. Visual modifications of the morphology of cells were observed with optical microscopy. Conclusion: This study shows a decrease in fibroblasts number in the first 24 hours in the sonicated groups respect to the control, however an increase of the individual average viability gets that after 48 h the differences are minimal and groups are similar in the 7th day. Sonoporation and mechano stimulation effects are supposed to be implicated and further experiments will be carried on to confirm these hypotheses.

Influence of ball milled pyrex free magnetic microwires on strontium ferrite, BHmax

Papa Gorgui Birame Gueye

Hybrid permanent magnets were fabricated with a high energy ball milling of hard and soft magnetic phases. Previous works developped in this field using ribbons, show an increment of BHmax for cryomilled powder of nanocrystallized ribbons. In our case we propose the use of magnetic microwires with uniaxial anisotropy presenting a biestable hysteresis loops. FeBSiCuNb amorphous magnetic microwires have been annealed at 550ºC-1H and ball-milled for several times. Pyrex has been removed by means of a magnetic method and pyrex free microwires have been ball milled with ferrite. The structure of the composite is studied by SEM pictures and the energy products BHmax by measuring their hysteresis loops.

Recubrimientos anti-hielo para componentes industriales

Francisco Carreño Puertas

La acumulación de hielo sobre distintas superficies es un problema grave en industrias como la aeronáutica o la eólica; pues el hielo puede provocar pérdidas de rendimiento, así como riesgos en la seguridad de pasajeros y operarios. Actualmente la forma de combatir este problema es con el uso de sistemas activos que quitan el hielo tras haberse formado, es decir sistemas de deshielo. Sin embargo, una aproximación más eficiente podría ser el diseño de un dispositivo que evite la formación de hielo de forma pasiva, es decir un dispositivo antihielo. A lo largo de la tesis hemos desarrollado diferentes formulaciones para la preparación de recubrimientos que reduzcan la adhesión del hielo a una superficie permitiendo su eliminación más fácilmente. Para lo cual se ha modificado una pintura comercial con diferentes siliconas, que reducen su afinidad por el agua, así como introduciendo rugosidades que permiten la fractura de la interfase hielo-sustrato. Todo ello sin perder de vista los requisitos industriales de calidad y escalabilidad de los procesos implicados.

Information can be recovered from thermal equilibrium

Carlos Morales Lóbez

We show that it is possible to recover information from the initial state of a quantum system after it has reached thermal equilibrium providing the process is done slowly enough. To do so, we perform a numerical simulation of a closed cycle, bringing the system very slowly to a chaotic region where we let it reach thermal equilibrium and where the erasure of information would be expected. Next we bring the system back to its initial condition very slowly. We obtain that the average expected value of macroscopic observables after the whole process depends on the initial conditions, therefore allowing the recovery of information about the initial state. We simulate the process using the Hamiltonian of the Dicke model through two different procedures, obtaining the same results.

Ferromagnetic resonance in superconductor/ferromagnet bilayers

David Sánchez Manzano

Ferromagnetism F and superconductivity S are antagonistic phenomena. At F/S interfaces proximity effect is suppressed due to the different density of states for majority and minority bands at the Fermi level. In the case of a half metal proximity effect is completely suppressed. In spin active interfaces F/S proximity occurs through the formation of odd triplet Cooper pairs opening the door to spin polarized phase coherent quasiparticles. We study the superconductor/ferromagnet proximity effect by using ferromagnetic resonance (FMR) [1][2]. We have prepared S/F bilayers that combine the high-temperature superconductor YBa2Cu3O7 with Permalloy (NiFe) with and without a strong spin orbit spacer layer (Au) which has been predicted to promote the creation of triplet Cooper pairs. We analyze the temperature dependence (293K-3K) of magnetic damping of 2 samples, with and without gold in between when the sample is cooled down across the superconducting transition. In absence of the gold spacer, the suppressed proximity effect causes that the spin current generated by the ferromagnetic resonance cannot relax by diffusing into the superconductor. As a result, a reduced magnetic damping is observed as compared to the case of samples with the gold spacer, where proximity induced triplet Cooper pairs provide a mechanism for the spin current to relax by penetrating the superconductor. Results will be discussed in the frame of the spin- pumping theory considering the superconductor a spin sink where part of the FMR generated angular momentum relaxes [3] . As it turns out, magnetic damping and its temperature dependence below the superconducting transition is a delicate probe of the non conventional proximity effect at our F/S interfaces.

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Determinación de emisores de radiación gamma en población con exposición interna en emergencia nuclear

Begoña Pérez López

En un accidente o un incidente nuclear o radiológico, existe el riesgo de que se liberen al exterior radioisotopos que puedan afectar al público incorporándolos al organismo, con comportamientos variados. Los radioyodos son muy volátiles, se incorporan fácil y rápidamente dentro del cuerpo, normalmente vía inhalación y se retienen en su órgano diana, el tiroides. Los isótopos del cobalto y del cesio se distribuyen por todo el organismo quedando retenidos principalmente en músculos y sangre. Las técnicas "in-vivo" son adecuadas para medir la actividad retenida de contaminantes emisores γ tras una exposición interna. Los equipos del Contador de Radiactividad Corporal del CIEMAT son un contador Fastscan (100-2000 keV), con detectores de centelleo tipo NaI(Tl) y un sistema de detectores de semiconductor LEGe (Low Energy Germanium) (10-2000 keV) en el interior de una cámara blindada. Las calibraciones, hasta ahora, están configuradas para trabajadores expuestos (adultos-hombres), en caso de contaminación interna en población, permiten identificar los contaminantes incorporados pero la cuantificación es mejorable, puesto que la diferencia de tamaños con los niños más pequeños provoca más incertidumbres en la actividad medida. En este trabajo se han diseñado maniquíes de calibración para medir a la población expuesta con edades de 1, 5, 10, 15 años y mujer. Cada patrón de cuello-tiroides consiste en un maniquí de cuello de metacrilato [1] con dimensiones adecuadas para cada edad [2], con una oquedad en la que se introduce el vial de 131I. La simulación de la contaminación de todo el organismo es un maniquí BOMAB (Bottle Absortion Phamtom) [3] para el hombre-adulto, consistente en 10 piezas de polietileno huecas en las que se introduce agua destilada acidificada con 57Co, 113Sn, 137Cs, 60Co y 88Y, a partir de las cuales se configuraron los patrones de las diferentes edades [2]. Las curvas de calibración en eficiencia mejoran la actividad de radionucleidos desconocidos retenidos en una contaminación real de miembros del público. El Fastscan es más eficiente y de peor resolución que el sistema LEGe, pero muy adecuado para medir en emergencias como cribado de población potencialmente expuesta, mientras que el sistema LEGe es conveniente para medir la actividad retenida en contaminaciones complejas.

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Carrier-doping control of metal-insulator transition in SrIrO3 ultrathin films

Fernando Gallego Toledo

Quantum materials include a vast collection of different compounds such transition metal oxides, high Tc superconductors, topological insulators or two-dimensional van der Waals crystals [1]. Their study is not just providing the discoveries of new states of matter, which stimulate disruptive advances in physics, but bring us the possibility of exploit their anomalously strong response to weak stimuli, creating new device concepts for the next-generation quantum-technologies [1,2]. The 5d transition metal oxide SrIrO3 (SIO) is a good candidate to explore these new emergent phenomena, because it combines electron correlations and strong Spin Orbit Coupling. This system is also generating a considerable interest in terms of its proximity to a Mott transition [3] and a ferromagnetic instability [4]. In this work we have explored metal-insulator-transition in SIO ultrathin-layers by using Electric Double Layer techniques. This technique is used to modify the carrier up to extremely high concentrations, at the level of an electron per formula unit, what can stabilize novel phases in strongly-correlated systems. We have simultaneously measured longitudinal (magneto) resistance and Hall effect across this transition. Increasing the doping, we are not only able to modify the transition temperature, but also to reach an insulating state which exhibits hysteretic-magnetoresistance and anomalous Hall effect at low temperature, suggesting ferromagnetic order.

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The relevance of fluorescence radiation in Cherenkov telescopes

Daniel Morcuende Parrilla

Cherenkov telescopes, one of the main techniques used in very-high-energy gamma-ray Astrophysics, are also sensitive to atmospheric fluorescence produced by extensive air showers. However, this contribution is currently not considered in the reconstruction and analysis chains of imaging air Cherenkov telescopes (IACTs) and wide-angle Cherenkov detectors (WACDs). The emission and tracking of atmospheric fluorescence photons have been implemented in the CORSIKA code, a program for detailed simulation of extensive air showers, aiming to evaluate the fluorescence contamination to both types of telescopes. Our results show that fluorescence contribution to the signal recorded by these telescopes at distances of about 1000 m of the shower impact point could be around 5% for IACTs and around 45% for WACDs in the PeV region, whereas the contamination is negligible up to a few hundreds of meters in both cases. Therefore, atmospheric fluorescence radiation will not be always negligible for the new generation of Cherenkov telescopes, although further studies including the simulation of the telescopes are needed. We are also exploring the attractive possibility of using these same telescopes to detect fluorescence radiation. This technique would be complementary to the detection of Cherenkov light and it would allow us to reach even higher energies, out of the scope of any current technique.

Effect of incomplete acquisitions on the image of high resolution preclinical scanners

Pablo Galve Lahoz

Positron Emission Tomography (PET) scanners are commonly made of many detector blocks that sample the field-of-view (FOV) with millions of lines-of-response (LOR). Sometimes some of the detector blocks may fail, or they could be intentionally removed to provide easier access to the animal or patient. In these situations, images obtained with basic reconstruction methods, like Filtered Back Projection (FBP) which assumes a complete sampling, will contain important artifacts. On the other hand, iterative methods such as the Maximum Likelihood Expectation Maximization (MLEM) are more flexible and the impact of some missing detector blocks on the image quality obtained with them will be low. We have extensively studied with phantoms in the Super Argus four-ring preclinical PET/CT scanner, the impact on the image quality of eliminating randomly up to half of its 96 detector blocks, or removing a whole section of the scanner, i.e. a pair of contiguous detectors in all the rings. Results based on the NEMA NU 4-2018 protocol show no significant negative image impact using the MLEM method when less than 10 randomly detector blocks are removed (10.4% of the detectors for this scanner). On average, only a 3% reduction in the recovery coefficient (RC) for the 1 mm rod and 1.6% noise increase was obtained. On the other hand, the removal of a section of the scanner does not significantly affect the image quality (less than 1% loss in RC for the 1 mm rod and 4% noise increase), but the images may contain artifacts depending on the location of the section removed relative to the phantom. Some regularization methods are being considered to improve this. In conclusion, the results show the robustness of MLEM respect to the failure or removal of detector blocks. This could be used to design new PET scanner geometries that allow interacting with the patient (inject additional radiotracer, guide a catheter, etc.) while the data are being acquired, and new real-time imaging applications.

Hierarchies in SU(2)_L x SU(2)_R x U(1)_X effective potential models

Clara Álvarez Luna

In the present work we study a model with an SU(2)_L x SU(2)_R x U(1)_X symmetry, with two scalar doublets. We start from a massless lagrangian, but by using the Coleman-Weinberg mechanism we obtain masses for both the gauge bosons and the scalars. We also calculate the renormalized effective potential, depending on the masses and couplings of the model. With this formalism we obtain two sets of gauge bosons, corresponding to the L and R sectors, in addition to the two scalars. We analyse the mass ratio of these sectors in order to obtain a hyerarchy between them. With an appropriate choice of parameters we can have the L particles in the SM range, while the R particles have much higher masses.

Crecimiento y caracterización de micro y nanoestructuras de ZnO codopado con Er y Li

Fernando Pavón Martínez

El ZnO es un semiconductor del grupo II-VI extensamente estudiado durante las últimas décadas. Su ancho de banda de energía prohibida (3,37 eV), unido a su alta energía excitónica (60 meV) hacen de él un material con excelentes propiedades para aplicaciones optoelectrónicas a temperatura ambiente. Así pues, dadas sus propiedades el ZnO puede utilizarse para dispositivos de emisión de luz LED o láseres ultravioletas a temperatura ambiente, para aplicaciones de guía de luz, puede actuar como nanodetector de gases o como transductor debido a sus propiedades piezoeléctricas. Además es biocompatible, biodegradable y no tóxico, ideal para aplicaciones en biomedicina. A pesar de sus excelentes propiedades, estas se pueden mejorar con la adición de diferentes dopantes. El dopado con alcalinos, por ejemplo, varía su conductividad eléctrica y su ancho de banda. La adición de lantánidos mejora sus propiedades luminiscentes debido a que sus transiciones dentro de los niveles 4f dan lugar a emisiones muy intensas centradas en longitudes de onda muy concretas: azul (Tm+3, Ce+3), verde (Er+3, Tb+3), rojo (Eu+3, Pr+3, Sm+3) y en el infrarrojo cercano (Nd+3, Er+3). Los estudios relativos a la adición de una tierra rara como el Er en matrices de ZnO ponen de manifiesto mejoras interesantes, fundamentalmente debido a la conversión de luz infrarroja en visible mediante transiciones entre niveles energéticos y a la emisión de 0,8 eV (1,54 μm), ideal para su uso en telecomunicaciones (longitud de onda de menor pérdida para la transferencia en fibra de vidrio). No obstante, el dopado con Er de matrices de ZnO presenta también una serie de obstáculos pues la diferencia de carga de los iones Zn+2 y Er+3 y sus diferentes radios iónicos hace necesario que el ajuste se realice mediante defectos locales y/o deformaciones en la estructura del cristal. Esta compensación de carga necesaria para la formación de un compuesto estable puede realizarse con un alcalino como el litio, cuyas características hacen de este elemento un candidato perfecto para tal cometido. Además, la adición de litio mejora la eficiencia de la emisión en sistemas ZnO:Er+3 por lo que parece más que interesante trabajar con estos dos codopantes.

Exploring Galaxy Clustering with the Dark Energy Survey Dataset

Martín Rodríguez Monroy

The Dark Energy Survey is an international collaboration whose main goal is to understand the nature of the dark energy. To achieve this, it is performing a 5-year photometric survey from Cerro Tololo (Chile), covering around 5000 square degrees of the southern sky up to magnitude i =23.7 or redshifts of about 1.2. One of the main cosmological probes used by DES is the angular galaxy clustering in photometric redshift shells. When studying galaxy clustering, the impact of systematics and observing conditions must be taken into account, since they can introduce an artificial clustering. In order to mitigate the influence of these conditions, Survey Property maps (SPs) are created, allowing to characterize their magnitude. The aim of this contribution is to showcase how the influence of these SPs on the clustering is identified and to explain the procedure that is followed to reduce their impact.

Búsqueda en tiempo mínimo en entornos dinámicos con incertidumbre

Sara Pérez Carabaza

The thesis research line is the Minimum Time Search (MTS) problem, where a target with uncertain position and dynamics needs to be found as soon as possible by a fleet of Unmanned Aerial Vehicles (UAVs) equipped with sensors. One of the main objectives of the thesis is developing new and more efficient MTS algorithms, which return optimized UAVs search trajectories taking into account the available uncertain information about the search scenario. We have proposed several bioinspired MTS algorithms, based on Genetic Algorithms and Ant Colony Optimization techniques, and incorporated several heuristics that allow the algorithms to reach better solutions (search trajectories) in less computational time. The reduction of the computational time is a key factor in a high complexity problem like MTS, where the number of possible solutions increases rapidly with the problem variables (number of UAVs, length of the trajectories, etc). Besides, we have been working on more realistic modelling of the problem by considering more accurate UAV dynamic models (dynamic restrictions) and sensor models (radars and cameras). Furthermore, other of the main objectives of the thesis was to integrate and test the thesis contributions into the Airbus simulator of the Ground Control Station (GCS) of the ATLANTE (UAV). We have developed a MTS planner that communicates with Airbus GCS and is able to return optimized search trajectories considering the search scenario information sent by Airbus GCS.

Caracterización del afloramiento del Noroeste de África mediante el uso de modelos acoplados del CMIP5

Antonio Castaño Tierno

Las zonas de afloramiento costero marino son regiones adyacentes a las costas continentales en las que la incidencia del viento produce el ascenso de agua rica en nutrientes del fondo del mar. Estas áreas tienen una gran importancia desde el punto de vista biológico, cultural y económico. Aunque solo ocupan el uno por ciento de los mares, casi la mitad de la pesca mundial se obtiene en esas regiones. La zona de afloramiento más importante en nuestro entorno geográfico es la del Noroeste de África, de la que depende tanto la subsistencia de gran parte de la población costera de Senegal y Mauritania como el suministro de pescado en Europa. El estudio de los sistemas de afloramiento desde el punto de vista climático es de gran interés, ya que su comportamiento depende de la interacción de variables atmosféricas (principalmente el viento meridional) con el océano en su región más próxima a la costa. Comprender esta dinámica y su variación en el tiempo es esencial para poder predecir su evolución, tanto a corto como a medio plazo. En este trabajo se ha caracterizado el comportamiento medio y la variabilidad del afloramiento del Noroeste de África en veinte modelos climáticos acoplados, pertenecientes al Coupled Model Intercomparison Project 5 (CMIP5), y se ha estudiado la relación entre viento meridional, temperatura de la superficie del mar y profundidad de la termoclina oceánica. También se ha estudiado cómo la resolución horizontal de los modelos climáticos puede influir en la representación de los afloramientos.

New membranes for water treatment: towards circular economy to increase water resources

Paula Arribas Fernández

The development of efficient membrane filtration technologies is especially important as water shortage has become a growing global problem. Low cost operation, high energy efficiency and high throughput enable membrane separation processes to compete successfully with conventional separation processes. Membranes are a highly utilized, environmentally-friendly method in wastewater treatment, in water purification and in clarification and concentration processes. However, the fabrication of adequately designed membranes for a specific application is challenging. The main objective of this research is the preparation, characterization and optimization of different types of membranes that could be competitive with the ones available in the industry for the treatment, clearance and disinfection of different types of contaminated waters throughout different filtration processes. The fabrication conditions of new polysulfone electrospun nanofibrous membranes (PSU ENMs) were optimized and a heat post-treatment approach was applied to modify their structural and morphological properties and improve their filtration performance, obtaining membranes suitable for wastewater treatment. These membranes showed a high performance in humic acid (HA) removal by microfiltration (MF). To reduce the organic fouling tendency of PSU ENMs and consequently to increase their lifetime while reducing the operation and maintenance costs of the filtration process, different surface modification techniques such as interfacial polymerization (IP) and TiO2 coating were conducted on the membranes. Particularly, thin-film composite (TFC) polyester-PSU based ENMs were prepared by IP of bisphenol A and trimesoyl chloride and the reaction time was optimized for best antifouling performance of the membranes. To develop the first approach to recycle disposed reverse osmosis (RO) membranes as support in forward osmosis (FO) wastewater treatment, different polyamide-IP approaches were, in a preliminary study, tested on commercial polyethersulfone membranes and their FO-filtration performance was evaluated with HA. In addition, new antibacterial membranes were developed by modifying their surface with interlaced carbon nanotubes electrodes. The electrodes effectively reduced the biofouling during the treatment of water contaminated with bacteria and viruses by electrochemical MF. Finally, new graphene oxide membranes were manufactured using different types of graphene oxides available in the market. They were evaluated for their intrinsic antifouling performance, dye absorption capacity and membrane permeability.

Quantum fields and gravitation

José Manuel Sánchez Velázquez

In this work, we investigate the effects that appear when one considers that quantum fields interact with gravitation. In a cosmological scenario, we study the particle production of a scalar field due to the expansion of the universe and the dynamics of the Ricci scalar of curvature. On the other hand, we consider the Alcubierre solution of the Einstein equations and take into account the semiclassical regime in which the fluctuations of a scalar field is considered in the energy-momentum tensor and how it affects to the stability of this solution.

Reconstrucción ultra rápida de imagen PET tomográfica mediante la pseudoinversa de la matriz de respuesta del sistema

Alejandro López Montes

Las imágenes médicas obtenidas mediante tomografía por emisión de positrones (PET) permiten obtener información funcional del cuerpo del paciente. Los algoritmos de reconstrucción de imagen PET se suelen clasificar en métodos analíticos, rápidos en general pero que suelen proporcionar menor resolución espacial y métodos iterativos que modelizan la respuesta del sistema de adquisición mediante una matriz de respuesta del sistema y permiten obtener una mayor recuperación de resolución en la imagen. Se propone utilizar la pseudoinversa de esa matriz para obtener imágenes PET de manera rápida y obteniendo mejores resultados que con los métodos analíticos.

Twinkle, twinkle, little star: Unravelling the stellar atmospheric parameters of CARMENES GTO M dwarfs using the spectral synthesis technique

Emilio Gómez Marfil

We focus on our very first results in connection with the stellar atmospheric parameter determinations (Teff, log g, [M/H]) of M-type dwarfs observed with CARMENES under its GTO programme by means of the spectral synthesis technique. We also describe our three-step approach to the problem: first, the careful selection of spectral ranges around iron and titanium atomic lines and molecular bands in three reference M-type stars: GX And (M1.0 V), Luyten's star (M3.5 V), and Teegarden's star (M7.0 V); second, the use of BT-Settl stellar model atmospheres, the radiative transfer code Turbospectrum and line data from the VALD3 database to obtain a grid of synthetic spectra to be compared with the CARMENES spectra; and finally, the Markov Chain Monte Carlo process implemented in SteParSyn code designed to derive the probability distribution functions of the stellar atmospheric parameters.

Curved laser traps for optical manipulation of micro/nano-particles and micro-robotics

Mercedes Angulo Curto

Las pinzas ópticas son un instrumento que permite manipular micro y nano-partículas solo con luz, es decir ópticamente sin contacto mecánico. Éstas consisten en un haz láser altamente enfocado en forma de punto, capaz de ejercer una fuerza óptica de confinamiento que atrapa a la partícula y que es proporcional al gradiente de intensidad del haz. Este hecho fue descubierto por A. Ashkin en 1970, valiéndole el nobel de física en este 2018 por las importantes implicaciones que ha supuesto para la ciencia. Por ejemplo, en biofísica, ha dado acceso a conocer el funcionamiento de motores moleculares del tamaño de pocos nanómetros usando las llamadas “single-molecule techniques”, que aprovechan la capacidad que tienen las pinzas ópticas de poder ejercer fuerzas sobre sistemas macromoleculares y medir sus respuestas. Las pinzas ópticas

son un tipo particular de trampa láser en forma de punto, por lo que para mover la partícula atrapada es necesario mover este haz láser puntual. Este mecanismo hace inviable atrapar y mover ópticamente numerosas partículas a la vez de forma práctica. Recientemente, hemos desarrollado una tecnología holográfica que da respuesta a este problema ya que permite generar trampas láser dinámicas en forma de curvas 3d arbitrarias capaces de confinar y transportar ópticamente las partículas a lo largo de la curva de forma programable. En este caso, además de la fuerza de confinamiento activa a lo largo de toda la curva, hemos logrado explotar la presión de radiación para ejercer sobre las partículas una fuerza de propulsión a lo largo de la curva. Esta fuerza óptica de propulsión se controla de forma independiente a la geometría y tamaño de la curva, permitiendo así realizar por primera vez operaciones complejas de transporte óptico programables que son cruciales en el desarrollo de micro-robótica óptica. En este trabajo demostramos experimentalmente esta innovadora herramienta de manipulación óptica, con ejemplos que ilustran funciones micro-robóticas como el transporte óptico reconfigurable de numerosas micro/nano-partículas evitando obstáculos y gestionando el tráfico en circuitos de transporte.