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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **BOSCH RAMON, VALENTI** **Referencia:** RYC-2011-07731

Area: Física y Ciencias del Espacio

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Titulo:

Estudio de la radiación no térmica de fuentes astrofisicas de rayos gamma con chorros de plasma

Resumen de la Memoria:

In the last years, data obtained at all wavelengths, and in particular with the present satellite-borne and ground-based high-energy and very high-energy instruments (Fermi, AGILE, HESS, MAGIC I-II, VERITAS), have unveiled astrophysical outflows as very luminous and sometimes rapidly varying sources. The very high luminosities, and particle energies, involved in the emission from galactic microquasars and binary systems with pulsar are a serious challenge for the present models. Massive young stellar objects (MYSO) are turning out to be particle accelerators with potentialities at high energies that start to be considered. Active galactic nuclei (AGN) jets present very fast and efficient radiation even when their jets do not point towards us, against the common belief that only blazars can be powerful and fast varying sources. Finally, the termination regions of galactic and extragalactic outflows can be detected not only in radio, but also in X-rays and even in gamma-rays. In this context, theoretical studies, including semi-analytical modelling and numerical calculations (Monte-Carlo and magnetohydrodynamical simulations), are more important than ever to unequivocally determine, not done so far, the (magneto)hydrodynamical properties of outflows/jets, the nature of the acceleration processes and emitting particles, and the emission mechanisms behind the observed non-thermal radiation. The fact that more powerful instrumentation (e.g. HESS II, CTA) is planned for the near future makes this kind of research even more necessary. My main research consists on the theoretical study of non-thermal emission from astrophysical outflows from radio to gamma-rays, accounting for the available multiwavelength data (and if available also neutrino data), i.e. in close contact with observations. The subfields included in my research are quite multidisciplinary and consist of semi-analytical model of radiation processes and flow dynamics in jets and jet/medium interactions, analysis of particle acceleration constraints in outflows and compact sources, numerical simulations of the (magneto)hydrodynamics of outflows and their interaction with their environment, Numerical calculations (Monte-Carlo) of radiation transfer (e.g. electromagnetic cascading) in compact gamma-ray sources, interpretation of multiwavelength observations, and identification of counterparts, of gamma-ray sources, and reduction and analysis of X-ray data of spectral, temporal and morphological behavior. My research embraces galactic and extragalactic outflow sources. The first group includes microquasars and other gamma-ray binaries, which are well established gamma-ray sources but their nature has not been properly characterized yet. Also in the same group lie MYSO, which are non-thermal sources and particle accelerators, and may be as well high energy emitters. In the extragalactic arena, I have been working in non-thermal gamma-ray and broadband production mechanisms of jets of non-blazar AGN, at small scales through the interaction with inhomogeneities like clouds or stars, and at large scales via interacting with the environment. As RyC researcher I plan to follow/deepen the described research. As future prospects, I plan also to apply the know-how acquired in other sources to work on massive star binary systems, another type of gamma-ray binary, and gamma-ray bursts.

Resumen del Curriculum Vitae:

I did my PhD (1.7.02) on Broadband leptonic emission from microquasars with Prof. J. M. Paredes in Universitat de Barcelona (UB), getting it (27.4.06) with European mention and excellent cum laude (extraordinary prize of the UB; 1 of the best 5 thesis SEA 2006-2007). During the PhD, I published 16 refereed papers (1 in Science), mostly theoretical but some also observational. During my career I have worked on the astrophysical jet radiation: modelling of gamma-ray and multiwavelength emission from galactic jet sources, mainly on microquasars but also in young stellar objects, particle acceleration in jets, hydrodynamics of microquasar jet/medium interactions and subsequent radiation, secondary emission and electromagnetic cascades in gamma-ray binaries, X-ray observations of X-ray binaries, multiwavelength interpretation of gamma-ray sources, and gamma-ray emission from small and large scale jets of AGN. At present, I have 68 (43 in journals in first quartile JCR) refereed publications, 23 as 1st author; 11 of them (1 in Science) are MAGIC collaboration papers in which I had a significant or very significant contribution. My first publication appeared in 2004. The number of citations for these 68 refereed papers is ~1200 (normalized ~235 -ADS-); Hirsch-number=20 (ADS). Beside these refereed papers, I have 45 more with MAGIC with a non-significant contribution. I have also 41 unrefereed conference proceedings. A non-negligible part of my publications are devoted to observations, and I have taken part in observational campaigns in radio, X-rays, GeV and TeV. I have done 14 research stays in int. research centres plus numerous ~1 week stays in UB, giving 24 seminars. I have attended to 48 (mostly international) conferences and schools, giving 30 talks (20 review/invited; forthcoming inv. review and talk in the Frascati Workshop 2011 and HEPROIII in Barcelona). I have been referee of several scientific journals (MNRAS, A Heidelberg). I have provided theoretical tutoring in the PhD thesis of Dr. P. Bordas (dir. J. M. Paredes), Dr. A. T. Araudo (dir. G. E. Romero), and V. Zabalza (dir. J. M. Paredes). I have been member of the PhD tribunal of Dr. P. Bordas (UB) and Dr. M. Reynoso (UNMdP). I was in the short list for a Max Planck Research Group position (2010). I have the habilitation to obtain a permanent contract in university (professor agregat by AQU-Catalunya). I have been professor in an international school of astrophysics, and invited professor (two lectures on jets) in La Plata University. I have given 2 divulgative talks on jet emission and black-holes, and I am writing a divulgative book on black-holes. I have the habilitation to teach in high schools (CAP) by UB.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **GIANLUCA , CALCAGNI** **Referencia:** RYC-2011-09009

Area: Física y Ciencias del Espacio

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Titulo:

Fundaciones, cosmología y evidencias experimentales de modelos de gravedad cuántica

Resumen de la Memoria:

La observación de huellas de teorías gravitacionales cuánticas y su discriminación del cuadro general-relativista estándar son problemas calientes pronto que se enfrentarán con los experimentos más recientes o más próximos, especialmente ésos que implican la observación del fondo cósmico de microondas (WMAP y Planck), ondas gravitacionales primordiales (LIGO), supernovas extragalácticas, estructuras en escala grande, y física de partículas (LHC). El objetivo principal de esta propuesta de investigación es responder a las siguientes preguntas: ¿Qué pueden decirnos los experimentos cosmológicos y los colisionadores de partículas sobre la física de altas energías? ¿Podremos comprobar teorías de cuerdas o de gravedad cuántica en un futuro próximo? Evidencias físicas inequívocas de fenómenos más allá del modelo estándar evolverían nuestra opinión moderna de la estructura geométrica del espacio-tiempo y promoverían la investigación teórica para una teoría viable y completamente coherente. Por lo tanto el candidato cree que será importante capitalizar sus esfuerzos en la inspección de modelos que dan predicciones verificables en un futuro próximo.Nos concentraremos en desarrollar una teoría de gravedad cuántica, tal como la gravedad cuántica de loops y modelos fenomenológicos de ¿flujo dimensional¿ (teoria de campos en fractales) para aclarar cuestiones fundamentales que podrían dar lugar directamente a modelos verificables en escala grande (cosmológica) y/o microscopica (partículas). Comenzaremos tratando de formular la teoría y ubicarla dentro de modelos concretos de inflación (o de energía oscura), y después realizaremos un análisis dinámico (clásico y cuántico) completo. Después de la extracción de observables cosmológicos, compararemos el modelo con datos cosmológicos disponibles.

Resumen del Curriculum Vitae:

La evolución de mi carrera investigadora y académica a través de posiciones en centros investigadores de reconocido nivel en el Reino Unido (U. of Sussex), Estados Unidos (Penn State University) y Alemania (Max Planck Institute), y estancias breves en más de treinta instituciones en Europa, Estados Unidos, Canada, India y Japón me ha permitido establecer una vasta red de colaboraciones, de intercambios de conocimientos y de contactos profesionales. El suceso de los workshops que he organizado en los EstadosUnidos y en Alemania, la frecuencia de invitaciones a instituciones de excelencia científica para colaboraciones, seminarios o contribuciones a conferencias internacionales, y la relevancia de las becas de investigación hasta ahora conseguidas confirman la calidad de mis actividades de investigación y difusión de ideas. Actualmente, estoy desarrollando un programa de investigación y enseñanza en el Albert-Einstein-Institut en Potsdam (Max-Planck-Institut für Gravitationsphysik) dentro de un contrato postdoctoral avanzado de cuatro años. Parte de mis tareas es la creación y desarrollo de un nuevo subgrupo de investigación en cosmología y de una red de colaboraciones europeas con otros grupos de gravedad cuántica y cosmología, con los cuales ya he establecido amplios contactos durante mi carrera.He desarrollado varias líneas independientes y complementarias de investigación en física teórica, gravedad cuántica y cosmología. Mis investigaciones comprenden: a) la cosmología de branas y no-conmutativa, b)teorías gravitatorias efectivas de Gauss-Bonnet, c) el taquión en cosmología y teoría de campos de cuerdas abiertas, d) nuevos métodos para la interpretación y solución de teorías no-locales a nivel no-perturbativo, e)gravedad canónica, a nivel clásico y cuántico, y f) la cosmología cuántica de bucles (loop quantum cosmology), donde por primera vez hemos computado los observables inflacionarios que permiten establecer cotas observacionales sobre el modelo, g) modelos de gravedad y teorías de campos fractales. En cada sector, contribuí a profundizar la comprensión de aspectos o problemas que merecían o necesitaban aclaraciones, promoviendo un incremento notable del interés en ellos y un avance de la frontera deinvestigación. Todos los resultados fueron publicados en revistas especializadas de prestigio internacional, incluyendo un artículo en Phys. Rev. Lett., dos en Nucl. Phys. B, trece en Phys. Rev. D, cinco en Phys. Lett. B, cinco en JHEP, entre otros.Actividades de enseñanza regulares en matemática y física son un complemento esencial a la investigación. Doy un valor ético importante a los deberes del docente, puesto que los estudiantes de hoy continuarán lainvestigación de mañana. Por eso, he dedicado mucho tiempo a la enseñanza (que casi nunca es un requisito obligatorio por contrato para un postdoc) y al cuidado de mis estudiantes. La confección de un volumen de notas de curso está convirtiendose en un proyecto editorial.La convergencia de las trayectorias académica, investigadora, de enseñanza y profesional en general hasta este punto de madurez de mi carrera desemboca naturalmente en la actual búsqueda de una posición académica superior.

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CONVOCATORIA 2011

Nombre: **TIERNO , PIETRO** **Referencia:** RYC-2011-07605

Area: Física y Ciencias del Espacio

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Titulo:

Motion, assembly and collective dynamics of paramagnetic colloids

Resumen de la Memoria:

Colloidal microspheres are the subject of intense research due to their ubiquitous technological nature and to thevast playground for basic Soft Matter Physics they constitute. Colloidal particles display Brownian motion, havesize in the visible wavelength (~microns) and their dynamics is characterized by experimentally accessible timeframes(ms¿s). Use of external fields allows the precise control of the inter-particle interactions, motions andassembly of colloidal material. The proposed research will focuses on the dynamics, and collective properties ofspecially prepared colloidal dispersions consisting of spherical or anisotropic paramagnetic particles subjected toexternal magnetic fields. Three main directions will be pursued: (i) Collective ratchet transport. I discovered amethod to transport paramagnetic colloids above epitaxially grown uniaxial garnet films (PRE 07, PRL 07, JPCB07, JPCB 08, PRL 10). Here I will exploit the full potentiality of this method, extending it to large collection ofparticles, realizing particle sorting in case of bi- or poly-disperse suspensions and transporting chemical orbiological micro-/nanoscale cargoes previously attached to the colloidal carriers.(ii) Combination of magnetic and optical forces. I will build up a novel experimental platform capable to combineoptical forces (fast scanning laser tweezers) with magnetic forces (uniaxial garnet films). This platform will be usedto explore the mechanical and rheological properties of non-magnetic colloidal crystals optically assembled abovea garnet film. Paramagnetic particles will be driven through these crystals via the magnetic ratchet effect and thusused as active microrheological probes to explore the linear and non-linear viscoelastic properties of theassembled crystals.(iii) Colloidal micro-swimmers. I demonstrated that elongated DNA-linked paramagnetic colloids subjected toexternal precessing fields are capable to propel in a controlled way in viscous fluids (PRL 09, JPCB 09, PRE 10).Here I will study how these micro-swimmers interact between each other and the role played by the hydrodynamicinteractions. I will implement optical forces to test the swimmers performance and their constrained motion intomicroscopic pores or microfluidic networks.

Resumen del Curriculum Vitae:

My scientific background is quite wide since I graduated in Physics at University ¿Federico II¿ of Naples (Italy) and received a PhD in Natural Sciences at University of Ulm (Germany). Later on, I spent 2 Post Doctoral years at Florida State University (USA) and 3 more years at University of Barcelona (Spain). My main research interests focus on Soft Matter systems under non equilibrium conditions and, in particular, manipulation, transport and assembly of colloidal particles. I discovered new methods to move microscale particles via a magnetic ratchet effect; I fabricated anisotropic paramagnetic colloids and janus catalytic motors, and I designed micro-swimmers based on DNA linked colloidal particles and capable to deliver chemicals or biological cargoes in small pores and microfluidics devices. To reach these goals, I used both experimental and theoretical approaches. I have a total of 30 publications in high impact factor journals with 4 more under review process. These includes 5 PRL (one Editor Suggestion, one PRL Focus, one highlighted VJ), 1 JACS, 1 APL (highlighted in VJ), 1 Small, 7 JPCB (one cover-art, another highlighted in Nature Chemistry), 5 PRE (1 Rapid Comm.), 1 Langmuir and 1 EPL. I also recently published a review article in PCCP which describes some of my discoveries during these years of research. In most of these articles I¿m first author (22) and mainly contributor. My work received a total of 180 citations (h factor 8). I have participated in 10 research projects in Germany, USA and Spain including one NSF grant and I have been PI of 2 grants from the European Science Foundation. My previous proposal ¿DynaMO¿ passed the two evaluation thresholds during the highly competitive ERC starting grant 2010 but was not funded due to unavailable budget. I have submitted a new proposal for the ERC starting grant 2011. I have presented my scientific results in more than 20 International conferences being invited to give talks in various prestigious international groups. I also hold two patents, one in USA and another in Spain. I have established a solid network of international and Spanish collaborators which I visit regularly to perform joint projects. My teaching experience includes the development of lectures and classes in various countries such as Germany, USA and Spain and, in these countries, I supervised and direct the scientific work of various undergraduates and PhD students. I hold the accreditations from the ANECA for ¿Profesor Contratado Doctor¿ and from AQU of ¿Professor Lector¿ and the research accreditation for permanent position. I¿m regularly called as referee for various scientific journals including, among others, Physical Review Letters, Small and Nanoletters.

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CONVOCATORIA 2011

Nombre: **GIAMMANCO , ANDREA** **Referencia:** RYC-2011-08545

Area: Física y Ciencias del Espacio

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Titulo:

Top quark studies and the hunt for a fourth quark generation

Resumen de la Memoria:

For the next five years this project foresees three main streams of investigations: direct search for signatures of t' and b' quarks at LHC; model-independent measurement of the modulus of the CKM element Vtb through the single top cross-section and other precision measurements in the top quark sector at LHC; R&D and simulations for new or upgraded detectors.The LHC delivered 47/pb in 2010 during its first pp run at a center-of-mass energy of 7 TeV. The current plans foresee several inverse femtobarns to be delivered at the same energy during 2011 and 2012, then after a long technical stop LHC is scheduled to restart in 2014 or 2015 with pp collisions at 13-14 TeV. This amount of data would provide an unprecedented precision in the measurements of the properties of the top quark, and it would allow a sensitivity to new quarks up to TeV masses.The possible discovery of new quarks at the sub-TeV scale, long believed to be disfavoured by electroweak precision data, would have a revolutionary impact on particle physics by potentially solving some of the open issues in the Standard Model, e.g., the origin of the baryon asymmetry of the Universe, the Higgs mass naturalness, the fermion mass hierarchy, the nature of Dark Matter.The existing projects for new facilities or upgrades (ILC, CLIC, SLHC) would receive new emphasis, and several aspects of these projects would be adjusted as to give the best possible sensitivity to the study of the properties of the new quarks.A participation to the preparation of new experiments is foreseen.

Resumen del Curriculum Vitae:

PhD in Scuola Normale Superiore, Pisa (Italy), 2000-2003.Grant for one year at CERN in 2003.Post-doc in Scuola Normale Superiore, Pisa (Italy), 2004-2005.Post-doc in UCL, Louvain-la-Neuve (Belgium), 2005-2007.Researcher at FNRS, Belgium (based at UCL Louvain-la-Neuve), 2007-present, after ranking 1st in a national competition open to particle physicists, nuclear physicists, cosmologists, and theorists of the same fields.*** Main research activities ***Convener of the CMS Fast Simulation since Jan.2011 (until Dec.2012).Single top analysis in CMS (convener of the working group since 2008, for two mandates until Dec.2011), development of original strategies and first cross section measurement at 7 TeV.Convener of the CMS Tracker Simulation in 2010.Phenomenology: re-examination of the limits on |Vtb|, proposal for model-independent extraction (2006).First ttbar cross section measurement at 7 TeV, with the first 3/pb (2010); proponent of the track-jets method, applied to the dileptonic channels.Tests of the CMS Silicon Strip Tracker modules.Participation to CMS Physics Technical Design Report (3 sections: single top, tW, top FCNC decays) in 2006.Development of dE/dx-based particle-id with the CMS Silicon Strip Tracker.Commissioning of the CMS Silicon Strip Tracker with cosmics and early collisions.Hadron-id development and validation.Application of dE/dx to Heavy Stable Charged Particle search.Measurement of the g->cc rate at the Z peak in ALEPH.*** Other achievements ***Editor / main author of 17 articles and notes.Organizer of two international conferences (TOP2008 and TOP2010).Editor of one book of proceedings (TOP2010 proceedings).Co-advisor of 2 PhD theses, 2 MSc theses, 1 BSc thesis; supervisor of 1 summer student at CERN."Most Valued Reviewer 2010" for Physics Letters B.Participated to the "Lindau Nobel Laureate Meeting 2008" in the cathegory "young researchers": proposed by FNRS as only HEP representative from Belgium, selected by the organizers on the basis of CV.Invited 13 times to give academic seminars in other institutes in Europe.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **ALAVERDYAN , YURY** **Referencia:** RYC-2011-08471

Area: Física y Ciencias del Espacio

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Titulo:

Active nano-plasmonic devices for amplifying and directing light

Resumen de la Memoria:

The aim of the project is to introduce new physical mechanisms to develop novel nanophotonic devices for the efficient manipulation of light, either free-propagating or emitted by single-photon sources, such as quantum dots, molecules or optically active impurities in diamond. Reliable operations of single-photon-based devices rely purely on relatively fast and stable manipulation of emitter¿s state, and the key to implementing this goal is the emitter-cavity coupling for controlling electromagnetic fields in the emitter¿s environment. Such manipulation of light is based on the ability to amplify, control the directionality (beaming), efficiently couple in/out and tune the wavelength of emission. These abilities are of vital importance for various applications, including bio/chemo-molecular sensing and secure quantum/tele communication, as well as for the fundamental research, from quantum optics to biophysics. The novelty of this project lies in bringing together the fields of surface plasmons, magneto-optics and surface acoustic waves to boost the performance and capabilities of future sensors and photonic devices. Such combination will allow extraordinary possibilities, such as amplifying, collimating and directing weak intensity light, multiplexing, modulating and switching between different channels with a GHz rate with all the components integrated on the same chip. Surface plasmons offer a unique control of the electromagnetic field, being able to amplify it thousands of times, squeeze it into a nanometer-scale volume and transmit it hundreds of microns on a femtosecond time-scale. Within the project, plasmonic technology will allow engineering near/far-fields and spectra with a nanometer precision, designing optical antennas and super-lenses to collimate, diffract and focus light, as well as building integrated optical cavities for making multiplexers and interference-based on-chip sensors. On the other hand, magneto-optics brings in the optically-induced generation and control of magnetic fields. The goal is to achieve magneto-optic activity with bare plasmonic nanostructures of a sub-micron size and couple the magnetic field generated by this ¿nano-magnet¿ to the electronic transitions of single quantum emitters. Electron state manipulations will require ultra-fast electro-optical modulation to access the relevant transitions. Controlling the strength of the local plasmonic magnet via optical power will allow controlling both the spin state and level splitting of the emitters, and therefore the transition wavelength. Finally, piezo-electric materials used as an active component of the device¿s structure will permit the generation of surface acoustic waves (SAWs) by pre-fabricated on-chip microwave sources. SAWs will offer ultra-fast modulation of material and plasmonic structure dispersions and, correspondingly, efficiency of coupling and controlled angular profile of scattered/emitted light.Nanofabrication and numerical simulation methods, in which the applicant has a extensive experience, will be used to optimize and fabricate the nanostructures. Active plasmonic components based on the ideas of this proposal will find practical applications in sensing and photonic integrated circuitry for secure quantum communication, as well as in fundamental research.

Resumen del Curriculum Vitae:

During his scientific career, Y. Alaverdyan has acquired a highly multi-disciplinary experience. His research activities started in the last year of his studies at the Special Faculty of Physics (Moscow Engineering Physics Institute). Y. Alaverdyan was involved in a research project on ¿leaky¿-wave semiconductor lasers as a Master student at the Quantum Optics Lab, Lebedev Physics Institute (1998-1999), whose results were published in the journal of Quantum Optics in 1999.In 1999 he continued along the academic path as a Ph.D. student at the Institute of Bioorganic Chemistry (2000-2004). This change of direction allowed him to acquire new complementary experience in experimental organic chemistry and various optical spectroscopy techniques. The project was related to the photo-chromic behavior of organic ionophores able to change their structure and optical properties in presence of metal ions. Y. Alaverdyan developed the optimization method for activating silver surfaces and preparing them for molecular absorption and surface-enhanced Raman scattering (SERS) measurements. The work resulted in 9 publications in mostly international journals. After completing his Ph.D. in 2003, Y. Alaverdyan was invited for a post-doc at the Bio-nano-photonics group at Chalmers University of Technology (Gothenburg, Sweden), led by Prof. Mikael Käll. He received extensive cleanroom training in micro/nano-fabrication techniques such as electron-beam lithography, focused ion-beam lithography, photo-lithography, various dry etching, thin-film deposition and sputtering methods, as well as atomic-force, scanning electron and optical microscopy. He also participated in the development of novel self-assembled fabrication techniques. Y. Alaverdyan focused his research efforts on developing new sensing platforms based on plasmonic nanostructures. He pioneered the fabrication and study short chains of nanoholes in thin gold films, and discovered that they exhibited scattering amplification and light beaming. This work was published and highlighted in Nature Physics (2007). In addition, his work throughout this period gave rise to a total of 14 publications with mean impact factor of 5 and more than 300 cites. He was also involved in a commercial project related to development of a SERS-based optical sensor of explosives. In September 2007, Y. Alaverdyan was invited to join a brand new group at Cavendish laboratory, University of Cambridge as Research Associate. He participated in building the optics labs from the scratch. He designed and constructed several home-built microscopes, participated in the installation of a cryogenic system and time-resolved single-photon experimental setups with CW and pulsed laser excitation. His personal responsibility was also to set up, maintain and manage the cleanroom facility. The research project aimed at engineering plasmonic cavities for shaping and directing light from color centers in diamond, being a part of a quantum cavity electrodynamics project. Y. Alaverdyan developed a methodology for fabricating hybrid plasmon/diamond structures using electron-beam lithography and atomic-force microscope for manipulating single photons from optically active impurities in diamond. The results of this period have produced 4 publications so far.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **LAUSSY , FABRICE** **Referencia:** RYC-2011-08826

Area: Física y Ciencias del Espacio

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Titulo:

Nanostructures as components for quantum optical information

Resumen de la Memoria:

Quantum dots (QDs) attract considerable interest as components for quantum information processing (QIP), with prospects for scalable on-chip implementation to bring quantum cryptography and quantum computing to widespread technological use.Embedding QDs in a microcavity unleashes the quantum regime as light (the photons of the cavity) and matter (the exciton of the QD) enter the so-called strong-coupling regime that gives rise to a quantum superposition of the states. Particular aspects of this important system, realized experimentally in 2004, have been considered in great details (such as anticrossing of the states in the photoluminescence emission, which demonstrated an excellent agreement between theory and experiment). However these studies have only scratched the surface and a complete theoretical model is still far from sight.I aim to develop in the coming years the full microscopic theory of light-matter interactions of QDs in microcavities, extending on my previous work, which was seminal in the quantitative description of experimental data. I will include i) the degrees of freedom essential for QIP applications, namely, spin and the various excited states of the QD (s-shell, p-shell, etc.), ii) up to the nonlinear regime of excitation, to access the dynamics of exciton complexes in a self-consistent and accurate way. By considering Coulomb interaction between the carriers, such a model also provides a realistic description of the semiconductor system, otherwise restricted to uncontrollable approximations. As one starting point, Coulomb interaction leads to a binding of two excitons into a bi-exciton, which recombination may generate entangled photons. This popular scheme has never been analysed in its full complexity in a microcavity for the lack of a complete theory such as the one I offer to develop.Characterization of QDs in microcavities is usually done with incoherent excitation. A powerful alternative is to excite coherently, matching the energy of the exciting source (a laser) to the resonances of the system. I will consider in parallel these two types of excitation. This will allow the design of crucial processes such as photon blockade, micro-lasing and quantum gates.In the wake of my scientific trajectory, I will focus on establishing a tight collaboration with on-site experimentalists, fostering a synergy between theory and experiments.

Resumen del Curriculum Vitae:

Ph. D.: 2005 with Summa Cum LaudePost. Doc experience in Sheffield, Madrid and Southampton.Current position: Marie Curie fellow at the Technische Universität München,Munich, Germany.Topic: Light-matter interaction in microcavities.Research output: Over 50 publications in peer-reviewed journals, 24 as first author (more than half if including those where I am corresponding author, supervising a student's work), 21 in journals with impact factor higher than 2, including 6 Phys. Rev. Lett. (3 as first author), 1 Nature and 1 Nature Physics. My h-index is 10, with over 370 citations (133 in 2010). I co-authored a popular textbook "Microcavities" (2007) in the prestigious Oxford University Press, which 2nd edition is to appear in April 2011.I had seminal publications in Bose-Einstein condensation of polaritons, their superfluidity and recently, their superconductivity (using them as binding agent), predicting record breaking critical temperatures (as high as room temperature in nitride systems). With QDs in microcavities, I developped a particular technique of correlator expansion to compute self-consistently any observable of experimental interest. Revisiting the weak and strong coupling in dissipative systems under incoherent pumping, I have shown the importance of the so-called cavity feeding mechanism, which alters the effective quantum state realized in the system, with important consequences for experimentalists. I was the first to provide a quantitative description of strong-coupling between a quantum dot in a microcavity. The work gathered over 65 quotations in a series of three related publications and sparked various follow-ups by other groups.The recognition of my work in the two fields of polaritons in planar cavities and quantum dots in microcavities has been recognized by two invited contributions to a book chapter in collective volumes gathering experts in the field, for both of which I am first author.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **LOPEZ MORALES, MERCEDES** **Referencia:** RYC-2011-07778

Area: Física y Ciencias del Espacio

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Titulo:

Detection and Characterization of Exoplanetary Atmospheres and Discovery of Earth-like Planets via Transit Timing Techniques

Resumen de la Memoria:

Extrasolar planet studies is a highly dynamic field. Within the past five years, the field has expanded from just detecting new planets and estimating their masses and radii, to the first attempts to measure more detailed physical properties, in particular of their atmospheres. The main future goals in this field are 1) the detailed characterization of the atmospheric properties of the planets, and 2) the detection of the first Earth analogs.Transiting planets (planets which cross in front and behind their host star once every orbit) currently provide the best tool to characterize exoplanet atmospheres. Over 100 transiting exoplanets have been discovered to date, most of them gas giants like Jupiter, although some Neptune-size transiting planets have also already been found. Via transiting planets we can now measure the atmospheric temperature of the planets, the chemical composition of those atmospheres, and the presence or absence of clouds (albedo) and longitudinal winds (energy redistribution coefficient). About a dozen planets have been already detected, the majority gas giants. Explanet transits are also used to track periodic variations in the mid-time of a transit, which can reveal the presence of additional planets in the system as small as Earth.My research in the past four years has focused on several of these topics, therefore, the main objectives of the project I propose here are to continue my work on this field and produce new results on: 1) the detection and characterization of exoplanet atmospheres, with emphasis on improving our techniques to characterize the atmospheres of the first discovered Earth-mass planets, and 2) to search for Earth-mass planets around stars hosting transiting planets via the transit timing variations technique.

Resumen del Curriculum Vitae:

Degree in Physics from the University of La Laguna, Tenerife, Spain in 1996. 1997-1998 worked in Public Science Outreach as a staff member at the OAAD in Lanzarote, Spain. In 1998 started Ph.D. studies at the University of North Carolina, USA, obtaining a Masters degree in 2001, and a Ph. D. in Astrophysics in 2004. In 2004, started working at the Carnegie Institution of Washington, first as a ¿Carnegie and NASA Astrobiology Institute Postdoctoral Fellow¿ (2004-2007), and then as a ¿Hubble Fellow¿ (2007-2010), funded by NASA. I am the first and so far only Spanish citizen to have been awarded a Hubble Fellowship, considered the most prestigious fellowship awarded to early career scientists in astrophysics. Between 2005-2008 also worked as Project Scientist in the construction of the APT-South; three 0.8-m robotic telescopes now operating at Las Campanas Observatory in Chile, as part of the California-Carnegie Exoplanet Search Group. In October 2010 started appointment as JAE-Doc at the Institut de Ciències de L¿Espai (CSIC-IEEC) in Barcelona, Spain, while keeping affiliations as Visiting Investigador at the Carnegie Institution of Washington and as Research Associate at the American Museum for Natural History in New York City. I have thus far 34 refereed papers in internationally recognized scientific journals in Observational and Theoretical Astrophysics and Instrumentation. I am first author in 12 of those papers (of which 4 are single author, including a Nature publication), and second author in another 12. Several science results highlighted by international news media such as ¿BBC News¿, ¿Time Magazine¿, ¿Europa Press¿ and ¿United Press International¿, among others. Work also covered in the Spanish National Television programs ¿Mujeres en las Estrellas¿ and ¿Tres14¿. Have more than 30 contributions to international meetings. To this date, my publications have been referenced over 500 times, with a Hirsh index h=11. I am / have been Principal Investigator in 3 international collaboration projects funded by NASA, NSF, APS and CIW and co-investigator in another 10 projects. Also have a pending proposal to join the Science Team of the NASA Kepler Mission to search for Earth-like planets as Participating Scientist. Over 40 professional talks at international meetings and research institutions as invited speaker and 8 public outreach talks. Currently organizing the 17th Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun in Barcelona in June 25-29 of 2012, as Chair of both the Science and Local Organizing Committees. I have supervised 4 Ph.D. theses, one defended in 2010, and another scheduled for this year. I have served (or been invited to serve) in international evaluation committees, among them the ¿Advanced Technologies and Instrumentation Program¿ of the American National Science Foundation, and NASA¿s ¿Hubble Telescope Time Assignation Committee¿ and ¿Kepler Mission Guest Observer¿s Program¿. Member of the Science Working Group for the proposed high resolution near-IR spectrograph NAHUAL-NIRINTS for the 10-m GTC. Member of the Science Core Team and coordinator of the ¿Synergy with other telescopes¿ Working Group for the mission project EChO (Exoplanet Characterization Observatory) currently being evaluated by ESA as one of the candidates for M3 type mission.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **DR. , MICHELE DELLA MORTE** **Referencia:** RYC-2011-08557

Area: Física y Ciencias del Espacio

Correo electrónico: morte@kph.uni-mainz.de

Titulo:

QCD on the lattice as a tool for precision tests of the Standard Model and New Physics search

Resumen de la Memoria:

The Standard Model (SM) of particle interactions describes with great accuracy all experimental results on particle physics, in the explored energy region up to the electroweak scale of O(M_W). It is clear however that the SM can only be seen as an effective theory valid up to some energy cut-off, as it for example does not contain a candidate for dark matter an it does not account for gravitational interactions. New Physics (NP) is expected to be found ``around the corner''. With the advent of the LHC experiment, scales one order of magnitude larger than it has been possible with present accelerator facilities will be probed. The direct search of new particles will be the main approach to establish NP at the LHC, however indirect searches will provide important complementary informations. In particular, precision measurements and computations in the flavour physics field will play a key role in constraining any NP model. As these indirect NP effects are expected to be small it is absolutely necessary to perform at the same time precision tests of the SM. In my research project I propose to use lattice QCD in order to compute the hadronic parameters entering the SM predictions for some experimentally well measured quantities (such as the anomalous magnetic moment of the muon or the nucleon axial charge) and for processes with expected large sensitivity to NP, especially in the heavy flavour sector (such as rare B decays). In addition I plan to pursue a precise computation of the glueball spectrum in QCD. The existence of glueball states is a distinctive property of a quantum Non-Abelian gauge theory, but these states have not yet been reliably identified in experiments as JLAB, BES or FAIR. Finally I am interested in using the lattice to explore non-perturbative features of strongly interacting theories different from QCD. The search for infrared fixed points is essential in the construction of a class of possible extensions of the SM, such as walking technicolor. Whether such fixed points exist or not depending on the specific theory, can be established by studying the non-perturbative running of the strong coupling in the same way as I did for the coupling alpha_s in QCD.

Resumen del Curriculum Vitae:

PERSONAL DATAName: Michele Della MortePlace of Birth: Tirano (Italy)Date of Birth: 7th of August, 1974Citizenship: ItalianMarital status: marriedHome Address: Emmeransstrasse 36, 55116 Mainz, GermanyTel. +49 6131 5542806Current position: Research associate at the Institut fuer Kernphysik in Mainz.Institution Address: Institut fuer Kernphysik, Johannes Gutenberg-Universitaet Mainz,Becher-Weg 45, 55099, GermanyTel.: +49 6131 39-26876Fax: +49 6131 39-25474E-mail: morte@kph.uni-mainz.deWORKING EXPERIENCENov. 2008 - today: Research associate at the Institut fuer Kernphysikat the Gutenberg University in Mainz.Oct. 2006 - Oct. 2008: Fellow position at CERN in the Theory Unit.Oct. 2003 - Sept. 2006: Research associate in the ¿ Sonderforschungsbereich¿at the Humboldt University in Berlin in the Computational Physics Institute.Oct. 2001 - Sept. 2003: Research associate in the ¿EU IHP Network onHadron Phenomenology from Lattice QCD¿ at the DESY Zeuthen node.EDUCATION10th of December 2001: PhD degree in Physics at the University ofMilan Bicocca, discussing a thesis on ¿Light pions on the lattice with Wilson¿like fermions¿, supervisors Prof. G. Marchesini and Dr. R. Frezzotti.Nov. 1998 - Sep. 2001: PhD studies in Physics at the University of Milan Bicocca.21st of May 1998: Laurea degree in Physics at the University of Milan,with 110/110 cum laude, discussing a thesis on ¿The fields transformation method in lattice theories¿, supervisors Prof. G. Marchesini, Dr. P. Butera and Dr. B. All¿es Salom.October 1993 - May 1998: Diploma course in Physics at the University of Milan.July 1993: Italian Diploma (60/60) after five¿year secondary school courses at the Liceo scientifico C. Donegani in Tirano, Italy.TEACHING EXPERIENCESep. 2009 - Oct. 2010. Co-supervision of Benjamin Jaeger, Diploma student at the GutenbergUniversity, Mainz.Nov. 2008 - today. Co-supervision of Bastian Knippschild, PhD student at the Gutenberg University, Mainz.Oct. 2004 - Dec. 2005. Supervision of Magdalena Luz, Diploma student at the Humboldt University, Berlin. Oct. 2003 - Oct. 2005. Co-supervision of Roland Hoffmann, PhD student at the HumboldtUniversity, Berlin. OTHER ACTIVITIESReferee for Nuclear Physics B, Physical Review D, Physics Letters B and Computer Physics Communications.Organizer of the ¿Lattice seminar¿ series in the Theory Division at CERN from September 2007 to November 2008.INVITED TALKS AT CONFERENCES¿An exponentially improved technique to compute the glueball spectrum on the lattice¿, invitedtalk at the IX Quark Confinement and the Hadron Spectrum Conference, Universidad Complutense de Madrid, August 30 - September 3, 2010.¿Recent results from heavy flavour physics on the lattice¿, invited talk at the 35th InternationalConference on High Energy Physics - ICHEP2010, Palais des Congres, Paris, July 22-28, 2010.¿Heavy flavors on the lattice. Challenges and (some) new results¿, invited talk at the IV AnnualWorkshop of the FlaviAnet European Network, INFN and University of Bari, November 9-11, 2009.¿Heavy quarks phenomenology from the lattice¿, invited talk at the Theory Institute ¿Flavour asa Window to New Physics at the LHC¿, CERN, May 5 - June 13, 2008.¿Standard Model parameters and heavy quarks on the lattice¿, invited plenary talk at LATTICE 2007, University of Regensburg July 30 - August 4, 2007.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **DE ONA WILHELMI, EMMA** **Referencia:** RYC-2011-08254

Area: Física y Ciencias del Espacio

Correo electrónico: emma@mpi-hd.mpg.de

Titulo:

Unveiling the origin and physics mechanisms of the Highest-Energy Astro-particles in our Galaxy through Gamma-ray observations

Resumen de la Memoria:

My research interest is focused in the understanding of CR (electrons and protons) acceleration and production of extremely high energy radiation in galactic sources, and find unambiguous evidence of the origin of galactic cosmic-rays with energies up to the cosmic-ray knee.For that I will use current and future instruments to carry on comprehensive studies of these mechanisms through gamma-ray emission.The new generation of Cherenkov telescopes, mainly MAGIC and HESS and CTA in the near future, together with the Fermi LAT satellite (from 100 MeV to 100 TeV) have uncovered a large number of extreme-energy sources in the Galaxy. Still nowadays basic questions, such as whether the emission originates in hadronic or leptonic processes, diffusion and interaction of cosmic rays, residual leptonic emission and processes of particle acceleration remain unanswered.The advent of MAGIC-II and HESS-II, and specially CTA promises a new time of fast development on the field. The study I propose here will build upon my early work on hardware, analysis and interpretation of gamma-ray emission from VHE sources:- Continue the studies of CTA design and get involved in its construction, with special emphasis at low energy where Spain is largely involved. I will apply my experience in the field and the R&D of Cherenkov telescopes working in the development and construction of the prototypes of the camera of the large telescopes for low energy studies and the construction of the astronomical observatory. I will also be involved in the construction of the physics case especially for Galactic sources- Understanding the origin of high-energy cosmic rays by characterising and modelling the energy spectrum of SNR from radio to TeV energies, analysing data from different VHE (MAGIC II and CTA), HE (Fermi) and multi-wavelength facilities.- Constraining models for pulsar wind energetics and transport by comparing the energy released by pulsars at GeV wavelengths with the ultra relativistic particle component accelerated by the pulsar wind and unveiling the nature of so-far unidentified gamma-ray sources and investigating new types of gamma-ray sources.

Resumen del Curriculum Vitae:

Master Degree at GAE-UCM, Madrid (2 years). PhD with O. de Jager at the North-West University, South Africa (3 years). Post-doctoral contract at GAE-UCM, Madrid (10 months). Post-doctoral contract at IFAE, Barcelona (2 years and 3 months). LEA Post-doctoral contract at APC-CNRS, Paris, France (2 years). Post-doctoral contract at Max-Planck Institut für Kernphysic (duration: 5 years). 19 papers in refereed journals (all them within 25% highest IF) as main author, two of them published in Science (and 65 additional ones as member of different collaborations). 49 contributions to international congresses. Contribution to a book chapter (HEEP). 12 invited seminars since 2008. Invited Speaker in the International School for Ph.D. students in Nagoya, 2009. Master Degree Supervisor of Roger Firpo at IFAE, Barcelona, Spain (2005-2006). Ph.D. Degree supervisor of Ignasi Reichardt (2010-2013). Principal Investigator of a coordinated DAAD (German Academic Exchange Service) and MICINN project (2010-2011). Principal Investigator of several XMM, Chandra and Suzaku proposals. Member of (former) HEGRA, MAGIC, HESS and CTA Collaborations. MAGIC Camera Coordinator (2004-2007). Convener of the SNR, PWN and Pulsar Working Group of the HESS Collaboration. Task Leader of the Diffuse Galactic Working Group of the CTA project. Task Leader of the Pulsar Wind Nebula Working Group of the CTA project.External Reviewer for JSPS (Japan Society for the Promotion of Science). Scientific Reviewer of ApJ since 2009 and Astrophysics and Space Sciences Transactions. Organization of workshop: Pulsar Physics I and II, IFAE, 2006. Member of the Local Organization Committee (LOC) of 2nd workshop on Supernova Remnants and Microquasars held at IFAE, Barcelona, Spain, 2006 and Texas Symposium, Heidelberg 2010. Member of the international team on ¿Multi-wavelength Study of Very High Energy Gamma-ray". Member of Red Nacional de Altas Energias (RENATA) & Sociedad Española de Astronomia. Supervisor for the outreach programs ¿Relyc Project¿ (Paris, APC, 2007-2008) and ¿ARGO¿ (IFAE, Barcelona, 2006).

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **CENARRO LAGUNAS, ANDRES JAVIER** **Referencia:** RYC-2011-08529

Area: Física y Ciencias del Espacio

Correo electrónico: cenarro@cefca.es

Titulo:

Investigando la Evolución de Galaxias a partir de Grandes Cartografiados Astronómicos Multi-Filtro

Resumen de la Memoria:

Los cartografiados fotométricos multi-filtro, destinados a determinar con suficiente precisión el redshift de cientos de miles de fuentes (ej. SDSS, COMBO-17, COSMOS, ALHAMBRA), han abierto nuevos horizontes para analizar las poblaciones estelares de enormes volúmenes de galaxias, permitiendo abordar aspectos claves de la Evolución de Galaxias y de la Cosmología.En los próximos años, los telescopios del Observatorio Astrofisico de Javalambre (OAJ) -diseñados específicamente para realizar grandes cartografiados astronómicos- van a marcar un hito en este campo. Durante 2013-2017, el telescopio T250 (2.55m; 3deg FoV; 0.2¿/pix) llevará a cabo el Javalambre-PAU Astrophysycal Survey (J-PAS), un cartografiado de 8000deg2 con 42 filtros estrechos (~120Å) en el rango 3500-8500Å hasta AB 5), el cuál permitirá estudiar la ecuación de estado de la Energía Oscura a través de la medida de Oscilaciones Acústicas de Bariones. De 2012 a 2014, el telescopio T80 (84cm; 2deg FoV; 0.5¿/pix) se dedicará a completar el Javalambre Photometric Local Universe Survey (J-PLUS), un cartografiado previo de calibración en la misma región del cielo que J-PAS con 12 filtros: 10 filtros anchos e intermedios diseñados específicamente para la calibración fotométrica estelar de J-PAS y estudios de poblaciones estelares (SDSS-griz y 6 filtros de 200-300Å centrados en líneas de absorción claves como Hdelta, la banda-G, líneas de Mgb/Fe y el triplete de Ca, alcanzando AB5) y 2 filtros estrechos en común con el sistema de J-PAS centrados en las líneas de emisión [OII]/3727 y Ha/6563, para anclar la calibración de J-PAS y, a su vez, cartografiar la formación estelar en galaxias cercanas (0 10^11Msun) a diferentes épocas cósmicas, con el fin de comprender desde una nueva perspectiva sin precedente los mecanismos que han dado lugar a la drástica evolución de sus tamaños (un factor 4-5) desde alto redshift hasta hoy. Asimismo, se pretende investigar la evolución de galaxias elípticas del Universo Local a través del análisis de sus gradientes 2D de edad y metalicidad hasta grandes distancias galactocéntricas, donde las predicciones de los modelos difieren unos de otros. Todo ello previo el desarrollo de técnicas de análisis e indicadores específicos (pseudo-índices) para la determinación automática de edades y metalicidades promedio, contenido de polvo y tasas de formación estelar local usando los datos multi-filtro de ALHAMBRA, J-PLUS y J-PAS.

Resumen del Curriculum Vitae:

CV multidisciplinar, con amplia experiencia en 5 pilares básicos de la Ciencia moderna: Investigación, Gestión, Instrumentación, Docencia, y Difusión1) INVESTIGACIÓNPublicaciones (ADS Feb. 2011)- Número H = 19- Total: 62 entradas en ADS, 1062 citas.- En revistas internacionales con referee: 31 publicaciones (12 de 1er autor) con 1052 citas (388 de 1er autor).- Artículo más citado de 1er autor: Cenarro et al. (2001, MNRAS, 326, 959), 112 citas- Letter de 1er autor con mayor ritmo de citas: Cenarro Sobresaliente Cum Laude)- Participación en 17 proyectos nacionales e internacionales, 11 visitas de investigación al extranjero, organización de 5 reuniones científicasSupervisión y Arbitraje Científico- Árbitro de 10 artículos en ApJ, MNRAS y A Director J. Gorgas). Becarios de verano: Sol Molina (IAC, 2008), Jorge Rivero (IAC, 2007). Becario colaboración: Jorge Rivero (ULL-IAC, 2007-2008) 2) GESTIÓN- Project Manager del proyecto OAJ (16.780.000 EUR; Fondo Inversiones de Teruel). Definición y supervisión del equipo técnico OAJ: 1 doctor, 4 ingenieros, 2 técnicos (+ 4 incorporaciones en 2011)- Miembro del Comité de Gestión de J-PAS-IP del proyecto DESEOAJ, solicitado al MICINN en Ene 2011 (por resolver)- Responsable de la ICTS-2009-143) INSTRUMENTACIÓN- Miembro del equipo CEFCA-BRASIL de diseño conceptual de las cámaras panorámicas J-PAS- Miembro de Comité de PDR (Chair: S. Eikenberry) y FDR del telescopio T250- Charla Invitada en SPIE 2010, San Diego, EEUU (Cenarro et al. 2010, SPIE, 7738E, 26)- Miembro del Comité Técnico Evaluador de los Proyectos Finales de la licitación OAJ- Master ¿International School of Advanced Instrumentation (IScAI-2008)¿. Estancia de 3 meses en la Universidad de Florida (Gainesville) con S. Eikenberry, sobre CIRCE/GTC4) DOCENCIA- ACREDITACIÓN por la ANECA y ACAP para Profesor Contratado Doctor y figuras inferiores- Profesor visitante en el Master de Astrofísica de la UCM- 2002-2006. Como Profesor Ayudante UCM: Laboratorio de Física (100h/año), Estadística (120h/año), Técnicas Experimentales en Astrofísica (60h/año), Poblaciones Estelares (20h/año)5) DIFUSIÓN- Programa Ciencia Viva (http://www.catedu.es/ciencia, Gobierno de Aragón). Charlas en IES Medina Albaida, Zaragoza, Nov 2010; IES Vega del Turia, Teruel, Abr 2010. Publicación en Clepsidra, Nov 2010- Publicaciones: Revista AstronomíA (www.astronomia-e.com) núm. Mar 2011- Otros Eventos y Charlas. Ej. Clausura del AIA en Aragón 2009, Semana de la Ciencia de Aragón 2009, etc

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **DIAS CAMPOS, OSCAR** **Referencia:** RYC-2011-09216

Area: Física y Ciencias del Espacio

Correo electrónico: O.Dias@damtp.cam.ac.uk

Titulo:

Black holes and aspects of the gauge/gravity duality

Resumen de la Memoria:

The emergence of gauge/gravity duality is introducing powerful holographic techniques to explore the dynamics of strongly coupled quantum field theories (QFTs) and guiding the search for a theory of quantum gravity (QG). These dualities provide a concrete realization of the holographic principle of QG: the information of a gravitational theory defined on a spacetime volume is encoded in a dual gauge theory that lives on its asymptotic boundary (i.e. with one less dimension). This is a strong/weak coupling duality: we can study strongly coupled phenomena in 4-dimensional gauge theories using computations in the classical limit of the (higher-dimensional) gravitational system, ie using general relativity as a non-perturbative technical tool. The exploration of gauge/gravity duality has led to fascinating corollaries. Field theory has for a long time been a standard tool in a condensed matter theorist's toolbox. Adding the gauge/gravity duality ingredient naturally leads to the existence of a condensed matter/gravity correspondence whereby holographic superconductors and their phase transitions are modeled by black holes and associated phase transitions. In addition, a QFT often has a hydrodynamic limit: for near-equilibrium phenomena with wavelengths much larger than the thermal mean-free path, the QFT has an effective fluid dynamic description. We can then formulate a fluid/gravity correspondence.In the reverse direction, QFTs can help understanding the regime where classical gravity breaks down and quantum effects must be introduced. Indeed, the gauge/gravity duality describes QG in a QFT language. Improving the dictionary between the two dual sides, we will be able to reformulate and address long-standing quantum gravitational puzzles. Open questions include understanding the statistical description of black hole (BH) thermodynamics. BHs can probe the merging between quantum and gravitational physics, and play a crucial role in the above duality programs. For example, a BH describes a thermal state in the boundary QFT, BH formation corresponds to heating the QFT, and the oscillation of a perturbed BH back to equilibrium describes thermalisation of the QFT.In the forthcoming years I want to improve our understanding of BH physics (in Einstein gravity and string theory) and to use it to develop further the gauge/gravity duality. My research proposal is divided into three main topics: "1. Black hole instabilities and thermodynamics. Their holographic QFT interpretation", "2. Holographic superconductors: gravity/condensed matter correspondence", and "3. The fluid/gravity correspondence". In topic 1, I want to: study the ultraspinning, bar-mode, and superradiant instabilities in BHs; their associated bifurcation to new BH families (aiming at a final classification of BH solutions); their holographic interpretation in the dual gauge theory; and to understand the statistical origin of BH thermodynamics. In topic 2, I want to study gravitational systems with a scalar condensation instability which are dual to a holographic superconductor that undergoes a holographic normal/superconducting phase transition. Finally, in topic 3 I will keep developing the hydrodynamic description of the gauge/gravity duality. The proposed work builds on my previous research but introduces new lines of research with several concrete objectives.

Resumen del Curriculum Vitae:

I have been managing my career development to attain my current position of scientific maturity, and to perfect my skills as a team leader and team work stimulator. I have proved that I am an ambitious and self-driven researcher who has made decisions towards excellence. As a post-doctoral researcher, I have worked in some of the best scientific institutions of Canada (2 years at Perimeter Institute for Theoretical Physics), USA (3 months at Kavli Institute for Theoretical Physics, California), and Spain (2 years at Univ. of Barcelona). Currently, I am a Marie Curie researcher at the Dept. of Applied and Mathematical Physics (DAMTP), Cambridge (UK) (since Feb. 2009). I have experienced and incorporated the route to success followed by the researchers of these institutions and I have been earning the recognition of my peers. Having finished my Ph.D. in December 2003 (at Instituto Superior Técnico-IST, Lisbon), I have up to the present moment published 39 papers (mainly in Phys. Rev. D, JHEP). These papers have received more than 950 citations (average of 23 citations per paper). My publication record singles out three important features: (i) the path-breaking ability to go beyond the state-of-the-art in some cases, (ii) the diversity of collaborations, and (iii) the interdisciplinary nature of some works. I have been invited as a speaker in many workshops: over the last 2 years I have given a total of 15 invited presentations.I have been promoting the diversification of my scientific knowledge/skills/competencies, embodied in a life-long learning spirit. My main research interest is general relativity, but I recognize the benefits of interdisciplinary research. My published projects and my research proposal establish bridges between general relativity, gravitational aspects of string theory, numerical relativity, holographic aspects of condensed matter physics/hydrodynamics/plasma physics, astrophysics, high-energy physics.My ability for scientific/personnel interaction are recognized. I have established a solid network of collaborations (including in all the institutions I worked). I have publications with 18 collaborators, many of whom are world leaders on their area. A partial list includes Vitor Cardoso (IST and 2 years at Cambridge with Harvey Reall) with a funding total value of 280.000 ¿. I am also a task leader member of three scientific projects funded by the National Science Foundation of Portugal (some using CERN funds) with a total value of ~175.000 ¿. In the event that I am appointed a Ramón y Cajal position, I will apply to an European Research Council (ERC) Starting Grant.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **GOY LOPEZ, SILVIA** **Referencia:** RYC-2011-08630

Area: Física y Ciencias del Espacio

Correo electrónico: silvia.goy.lopez@cern.ch

Titulo:

Study of events detected at the CMS experiment in the CERN-LHC presenting muons in the final state and search for New Physics.

Resumen de la Memoria:

The research project presented here is based on the study of events detected in the CMS detector at the LHC, having muons in the final state. These events can be used for understanding the performance of both, the detector and the reconstruction programs, and for extracting the relevant physical information about the processes leading to their production.Previous experience on general muon performance in CMS, on the measurement of the W boson production cross section and on the search for the W prime particle in the muonic channel constitute the basis for an analysis research line that extends to the general search for New Physics through the study of events with muons recorded in CMS. This expands from the first phases of data taking, focusing on electroweak measurements and exotica searches, to later stages, when an even deeper understanding of the performance of the detector, trigger and reconstruction algorithms will be required for precision measurements. For example, in case super-symmetry (SUSY) is discovered, and with enough statistics, the muon momentum distribution can be used to evaluate the level of compatibility of the predictions from different theoretical models with the actual observations. In addition to its own physical interest, this kind of research line, based on a robust understanding of generic muon performance at CMS, creates solid ground for any contribution to future projects like the Super LHC.Another interesting research line could be envisaged starting from the study of the W prime decay to top and bottom quarks and leading later to studies related to top physics.

Resumen del Curriculum Vitae:

I am specialized in the area of High Energy Physics. My primary field of interest at the moment is the study of events taken with the CMS (Compact Muon Solenoid) detector, situated in the LHC (Large Hadron Collider) accelerator, at CERN (European Organization for Nuclear Research) that are characterized by the presence of muons in the final state. This kind of events can be used first for understanding the detector and reconstruction software performances and second, to extract information about the physical processes involved in their production. I started working at CERN in 1999, when I got a Technical Student contract to work on the prototypes of the LHC dipole magnets. After I decided to move into the Particle Physics domain, joining Northwestern University (USA), where I worked as Teaching Assistant and Research Assistant. I got the Master of Science degree in 2002. From that moment I started working on the NA48 experiment, at CERN. NA48 uses protons from the SPS impinging on a beryllium target, so that kaons are produced and their decays can be studied. In NA48 I was in charge of the calibration of the electromagnetic calorimeter, contributing as well to the reconstruction software of the kaon spectrometer and to its calibration.In 2004 I joined University of Turin and became responsible and expert on-call for the trigger supervisor system of the experiment. In 2005 I joined the Dapnia/SPP-CEA (Saclay) group, and in 2006 I got my PhD in Physics with Turin and Paris Sud XI universities for the analysis of the radiative decay K±-> pi+-pi0 gamma. The paper with the final analysis results has been published in EPJC. In 2007 I was run coordinator during two weeks of data taking.My first postdoctoral contract was a Research Fellow at CERN, from February 2007 to March 2009, mainly within CMS.During last years I have worked in the high level trigger (HLT), developing algorithms to increase the efficiency for collection of muons from decays of the top quark, and contributing as well to the planning for evolving the trigger tables through varying luminosity and beam conditions. I am also the main developer of the system used for promptly monitor the quality of the reconstructed muons (Muon-DQM), being also the project coordinator. Since beginning 2011 I am co-head of the group studying the performance of the drift tubes (DT), expanding multiple areas, like timing synchronization, calibration, efficiency of local reconstruction, etc. My research has been focused in the measurement of the Standard Model W boson production cross section through its decay to muons, were I have studied data-driven methods for background estimation, and in the search for the W prime (W¿) particle, also in the muonic channel, for which I have studied the performance for momentum assignment of different muon reconstruction algorithms, developing also methods to extract the mis-reconstruction probability directly from the data. In this area I am also supervising the work of a PhD student. Both W and W¿ analyses have been published, using the 2010 CMS data sample. In addition, I have been recently appointed as chief editor of the paper summarizing the measurements on muon reconstruction performance at CMS on last year¿s data, to be published in early spring.I think my experience shows my capability to accomplish the objectives of the proposed research line.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **ASCASIBAR SEQUEIROS, YAGO** **Referencia:** RYC-2011-09461

Area: Física y Ciencias del Espacio

Correo electrónico: yago.ascasibar@uam.es

Titulo:

Formación de galaxias y evolución química en distintos entornos

Resumen de la Memoria:

Galaxy formation is still one of the main open problems of modern Astrophysics. However, thanks to the recent advances on both the observational and the theoretical side, we are now closer to obtaining a complete picture of star formation on galactic scales. A fundamental piece of this puzzle is the balance between hydrogen phases. More precisely, there is mounting evidence that the star formation rate, averaged over scales of the order of kpc, is roughly proportional to the abundance of molecular hydrogen. This, in turn, depends on several factors, such as the ambient gas density, pressure, chemical composition and the intensity of the ionizing radiation from the stars.The aim of the proposed research is to develop a self-consistent model of galaxy assembly and chemical evolution, paying special attention to the self-regulation of the star formation activity through photoionization and photodissociation of the surrounding hydrogen reservoir. Accretion of gas and dark matter will be fully determined by the cosmological context, while stars form according to a simple phenomenological prescription. The spectral energy distribution of the stellar radiation, as well as the chemical yields, will be computed by state-of-the-art population synthesis models, and the radiative transfer problem may be solved by a plasma physics code, assuming that the gas is in hydrostatic equilibrium.Comparison with observational data is a key part of the project. In particular, the relative abundance of molecular, neutral, and ionized hydrogen as a function of the current star formation rate will be investigated in great detail, considering also the effect of an external radiation field (e.g. in the vicinity of a galaxy cluster). It is expected that the amounts of neutral and molecular hydrogen decrease in favour of the ionized phase, and thus the star formation activity of the object becomes suddenly quenched. On the other hand,the model will predict correlations between the star formation history of the object and the abundance ratios of certain elements (e.g. nitrogen and oxygen), making possible to constrain the evolutionary scenarios for several types of galaxies in different environments.

Resumen del Curriculum Vitae:

Ph.D. in Astrophysics and Cosmology at the U. Autónoma de Madrid (Spain, January 2003).Postdoctoral contracts at the U. Oxford (UK, 15 months), the Harvard-Smithsonian Center for Astrophysics (USA, 18 months) and the Astrophysikalisches Institut Potsdam (Germany, 31 months).42 publications, 25 of them (16 as first author) in refereed journals.421 citations according to the NASA ADS (160 normalized citations, Hirsh index h=11).Involvement in 14 research projects (2 as principal investigator).Development of 4 open-source programs.15 stays (3 doctoral, 3 postdoctoral, 9 short visits) in internationally-recognized centres.29 contributions to conferences (3 invited, 23 oral, 3 poster).297 teaching hours in several institutions.Supervision of 1 M.Sc. thesis (UAM, 2010) and 1 Ph.D. thesis (U. Potsdam, scheduled for 2011).

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **LOPEZ ALBACETE, JAVIER** **Referencia:** RYC-2011-09010

Area: Física y Ciencias del Espacio

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Titulo:

QCD in the LHC era

Resumen de la Memoria:

My research activity spreads over different theoretical and phenomenological aspects of Quantum Chromodynamics (QCD) both at weak and strong coupling. One main aspect covered by my research work is the study of high-energy QCD scattering and QCD at high parton densities. Such domain of strong interactions is governed by unitarity and non-linear coherent phenomena, effects accounted for by perturbative non-linear pQCD evolution equations for hadronic wavefunctions (equivalently, parton distribution functions). Their study, solution and extension beyond their current degree of accuracy is one of my research lines. I also work in the study of factorization theorems for particle (heavy and light quarks, gluons..) production in the high energy/density environment. Phenomenologically, these studies are relevant for the analysis of data from electron-proton (Deep Inelastic Scattering), proton-proton and ultra-relativistic heavy ion collisions carried out at HERA, RHIC, and the LHC. They also play an important role in the study of physics opportunities and prospects in future colliders, such as the Electron Ion Collider or the LHeC, initiatives with which I cooperate frequently.Other aspect of my research work is the study and thermodynamic characterization of the Quark Gluon Plasma formed in heavy ion collisions and, more generally, in the study of the phase diagram of QCD. In particular, I am interested in the early stages of such collisions: early gluon production, high multiplicity events, initial and final state interactions etc, and in the dynamics that might drive the initially formed system towards thermalization. An important aspect of these studies is the matching with other formalisms employed to describe later dynamic stages of the collision such as hydrodynamics, kinetic transport theory or the perturbative treatment of hard diagnosis probes. Another topic comprised in my research work is the study of the gauge-gravity or Anti de Sitter-Conformal Field Theory (AdS/CFT) correspondence. This connection between string theory and quantum field theory provides access to the strong coupling, non-perturbative regime of certain gauge theories. I work in the study of formal aspects of the correspondence and its possible extensions to QCD or Condensed matter systems and in its applications to the study of gauge theories at finite temperature and its phenomenological connection with the study of Quark Gluon Plasma and high energy scattering at strong coupling.

Resumen del Curriculum Vitae:

Personal data:-Born in Madrid on December 9th 1977-DNI: 44354830CEducation: -Degree in Physics at Universidad de Córdoba (July 2001).-PhD in Physics at Universidad de Granada (July 2005). Qualification: Sobresaliente cum laude with European Mention. During the 4 years of my PhD I profited from a FPU grant (ref AP-3333-2001) as well as from 2 complementary mobility grants to go to the CERN TH Unit (Geneva, Switzerland), where I spent 18 months in total.Professional experience:-Oct 2005 to Sep 2008: Postdoctoral position at the Department of Physics of the Ohio State University, Columbus (OH), USA.- Oct 2008 to May 2009: Postdoctoral position at the ECT*, TRento, Italy.- June 2009 ON: IntraEuropean Marie Curie fellowship at the Institut de Physique Theorique CEA/Saclay, France.Publications:- I have 35 published works, some of them corresponding to contributions to conference proceedings. Most of my articles have been published in high impact factor journals, including 3 Phys Rev Lett., 4 JHEP and 4 Phys Rev D.Talks:- I have given 27 talks in international conferences and workshops, including several invited plenary talks.- I have given 26 invited seminars in different US and EU-based research institutions.Collaborations with experimental groups:- I am a member of the steering group for a Large electron-Hadron Collider (LHeC). I shall be a co-author of the Conceptual Design Report.- Member of the Electron Ion Collider (EIC) working group. - Member of the Retequarkonii network.Others:-Referee for the journals Physical Review Letters, Physical Review D, Physics Letters B, Nuclear Physica A and Journal of Physics G.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **LAZIC , SNEZANA** **Referencia:** RYC-2011-09528

Area: Física y Ciencias del Espacio

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Titulo:

Semiconductor nanostructures as components for quantum information processing: ¿On demand¿ emission of entangled photon pairs

Resumen de la Memoria:

Entanglement of quantum objects is one of the key issues in the quantum treatment of information. It is a direct consequence of the correlation between two or more quantum objects, which manifest itself in the formal description as a nonseparability of the subsystem's states. This nonseparability is in the heart of quantum information science and its rapidly emerging technologies. Pairs of photons are the usual candidates for supporting and transmitting quantum information encoded in photonic entangled states. Polarization-entangled photon pairs, in particular, are at the basis of long distance communication, quantum key distribution and quantum logic operations. The production of such photon pairs is a very active field of research and will be the main objective of this investigation. The emission of entangled photon pairs (EPPs) has been demonstrated in several material systems including atoms, non-linear crystals and semiconductor quantum dots (QDs). The later has received much attention due to its potential for scalability and integration in microelectronic circuits. With this in mind, the primary focus of this study would be to employ semiconductor QDs to realize a reliable way to operate sources of entangled photons that can be delivered efficiently ¿on demand¿. While much emphasis will be placed on the use of such sources in the fast-growing research areas of quantum information processing, the fundamental aspects will also be investigated to improve our understanding of the nature of quantum information. From the applications point of view, EPP sources working in the visible range at relatively high temperatures are strongly desirable. The use of QDs in III-V material system is promising in this respect and will be investigated here. To the best of the applicant¿s knowledge, this would be among the first experimental attempts on EPP emission in Spain.

Resumen del Curriculum Vitae:

The applicant started her scientific activity as a Ph.D. Fellow at the Department of Physics of Materials of the Universidad Autónoma de Madrid (Spain), where she was working in the field of Solid State Physics. Her research was focused on the investigation of optical, structural and electronic properties of group-III nitride semiconductor nanostructures (such as quantum wells, wires and dots). She was responsible for planning, setting up and performing experiments using optical microscopy and spectroscopy, ultra-high vacuum systems and ultra-low temperature cryogenics, including photoluminescence (PL), PL-excitation and Raman scattering. During her Ph.D., the applicant has made several short stays in internationally recognized research centers and has actively participated in seven national (Spanish) and two European research projects. Throughout this work, she has gained considerable experience in both theoretical and experimental solid-state physics as well as the subsequent data processing and analysis. Within the scope of this research, she made a valuable contribution to the field by covered both fundamental and technological aspects of group-III nitride semiconductor nanostructures, with much emphasis on their applications in optoelectronic devices. After defending her Doctoral Dissertation with highest qualification (sobresaliente ¿cum laude¿), she joined the Paul Drude Institute for Solid-State Electronics in Berlin (Germany), where she is currently employed as a Postdoctoral Researcher working in the field of Acoustics in Solid State at the Department of Semiconductor Spectroscopy. She is actively participating in two research projects founded by the German Government. The main focus of her research is to investigate the interaction of the dynamic fields induced by the surface acoustic waves (SAWs) with the optical properties of semiconductor nanostructures in III-arsenide material systems. Central to this work has been the use of SAWs as a tool for controllable transport and manipulation of elementary excitations, such as charge carriers, spins and excitons. During this period, the applicant was in charge of setting up experiments in optical spectroscopy and low-temperature physic for photon correlation measurements using Hanbury-Brown and Twiss approach as well as spatial, time- and polarization-resolved micro-PL measurements of acoustic transport dynamics of charge carriers, excitons and spins. As a result of these activities, she has demonstrated the first realization of acoustically-driven high-repetition single-photon sources with tunable emission energies. These results have opened the door to a range of different quantum information experiments using SAWs, such as secure optical communication using quantum cryptography protocols. In the course of this research, the applicant has gained considerable experience in designing the semiconductor heterostructures as well as in semiconductor device fabrication using photolithography and chemical etching processes.During her career, she has demonstrated capability to develop novel ideas and perform independent research lines in different scientific areas, which is directly reflected in her publications (including 1 Nature Photonics, 3 Applied Physics Letters and 2 Physical Review B publications) covering all of the aforementioned topics.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **GARCIA MUNOZ, MANUEL** **Referencia:** RYC-2011-09152

Area: Física y Ciencias del Espacio

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Titulo:

Fusion Technology. Use of low-energy particle accelerators at CNA to develop and calibrate detectors of energetic particle losses for magnetically confined fusion devices.

Resumen de la Memoria:

On the road to ITER, a basic understanding of burning plasmas represents a primary scientific and technological challenge towards the demonstration of fusion as a commercial source of energy. In contrast to actual plasmas, burning plasmas will be mainly heated by the 3.5 MeV alpha-particles born in the fusion reactions themselves. Moreover, external heating systems such as Neutral Beam Injection and Ion Cyclotron Heating will allow a better control of the plasma through suprathermal particles with anisotropic distribution functions. In nowadays fusion plasmas, energetic particles constitute a source of particles, momentum and free energy that under certain conditions drive unstable some magnetohydrodynamic (MHD) instabilities such as Alfven waves. The interplay between MHD fluctuations and energetic particles may cause dramatic losses of those energetic particles, affecting considerably the fusion performance as well as the safety of the vacuum vessel. This is of particular importance in burning plasmas such as ITER with a large population of supra-alfvenic particles. The research lines that I plan to pursue over the next years aim to gain a better understanding of the energetic particle loss mechanisms induced by MHD fluctuations through innovative diagnosis techniques developed at CNA (Centro Nacional de Aceleradores) and employed in different fusion devices. I plan to exploit the CNA low-energy particle accelerator capabilities to develop and calibrate fusion-relevant charged particle detectors. A natural result of this activity will be a flexible IBA chamber for Fusion technology installed at the CNA Tandem and Cyclotron with equipment suited for general material/photonic studies. This research line is aimed at the development, calibration and operation of fast-ion loss detectors for nowadays magnetically confined fusion devices with the ultimate goal of fulfilling the requirements of fast-ion loss detection in ITER. The workhorse for fast-ion loss detection will be a combined system based on thin scintillator screens and faraday collectors built and calibrated at the CNA. The system consists of a thin scintillator coating deposited on a conducting substrate. Different scintillator materials and coating thicknesses will be considered. The ionoluminescense of several scintillator materials when irradiated with fusion relevant charged particle fluxes at different operation temperatures will be determined in order to identify the most reliable material for charged particle detection. The Faraday collectors based on conducting substrates will be built using the scintillator material with the highest efficiency to the target charged particles, fastest afterglow and highest scintillator quenching temperature and saturation levels.Using the system develop along this research line, dedicated experiments will be performed in large fusion devices in order to estimate and to better understand the redistribution and loss of energetic particles in the presence of MHD instabilities of diverse nature such as Alfven waves, Sawtooth, Energetic Particle Modes, Neoclassical Tearing Modes and Edge Localized Modes. As a mid/long term project I propose to study the impact that the results obtained in tokamak plasmas may have on similar low collisionality and beta (plasma pressure over magnetic pressure) astrophysical plasmas such as Solar flares.

Resumen del Curriculum Vitae:

In March 2002 I started my scientific career at the Max-Planck Institute for Plasma Physics and the Ludwig-Maximilians-Universitaet of Munich. I was hired in the group of Prof. H. Zohm to calculate fast-particle trajectories in tokamak plasmas in the presence of MHD instabilities during my Master thesis. In April 2003 I continued with my PhD which was aimed at the design and construction of a scintillator based detector for MHD induced fast-ion losses in the ASDEX Upgrade (AUG) tokamak. The use of a novel scintillator material never used so far in fusion plasmas allowed the identification of new wave-particle interactions in AUG plasmas. The main result obtained during the PhD was the assessment of the strong impact that magnetic islands, Alfven, and Alfven-acoustic modes may have on the fast-ion confinement in tokamak plasmas. Furthermore, the detector design and characterization studies of different scintillator materials performed at CNA (Spain) in collaboration with Ciemat has led to various technical publication. After my PhD defense, I was offered a 3 years PostDoc position at the Max-Planck Institute for Plasma Physics as responsible officer for the fast-ion loss detectors and the neutral particle analyzers of the AUG tokamak. During this time, I had the opportunity to build a broad net of strong collaborations with outstanding experts from different associations such as General Atomic (USA), the University of California, Irvine (USA), Massachusetts Institute of Technology (MIT, USA), the University of Padua (Italy), University of Cork (Ireland), Technical University of Helsinki (Finland) and the Culham Plasma Research Centre (UK). Emphasis was placed on the theoretical understanding of the measurements obtained with the fast-ion loss detector at the AUG tokamak. A recent observation, M. Garcia-Munoz et al, PRL 2010, has highlighted the impact that shear Alfven waves may have on the anomalous particle and energy transport observed in the Solar corona. As of January 2011, I have more than 30 peer-reviewed publications in high impact journals (Physical Review Letters, Journal of Applied Physics, Physics of Plasmas, Nuclear Fusion, Fusion Science and Technology, Review of Scientific Instruments and Journal of Instrumentation). I am the first author of 2 Physical Review Letters, 4 Nuclear Fusion, 1 Review of Scientific Instruments and 1 Journal of Instrumentation. I also have contributed to more than 40 international conferences such as the International Atomic Energy Agency (IAEA), the American Physical Society (APS), the European Physical Society and the High Temperature Plasma Diagnostic (HTPD) Conference. As a result of my research activities at the Max-Planck Institute for Plasma Physics I have published two technical reports of the Max-Planck Institute for Plasma Physics. I am an active referee for the Department of Energy (DOE) of the USA as well as for several peer-reviewed journals such as Nuclear Fusion, Plasma Physics and Controlled Fusion, Review of Scientific Instruments and Fusion Science and Technology. I have been elected as European member of the board of experts of the International Tokamak Physics Activity (ITPA) Energetic Particle Physics Topical Group.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **SANCHEZ SANCHEZ, SEBASTIAN FRANCISCO** **Referencia:** RYC-2011-07590

Area: Física y Ciencias del Espacio

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Titulo:

The role of the AGN activity in the evolution of Galaxies: A case for Integral Field Spectroscopy

Resumen de la Memoria:

One of the most fundamental challenges in astrophysics is to understand the origin for the observed diversity of galaxies, and the physical mechanisms, that are responsible for the differences as well as similarities between them. An old but still unanswered question is the problem of ¿nature vs. nurture", i.e. the relative importance of environmental processes such as merging and accretion, relative to intrinsic secular processes that inevitably occur in an evolving complex dynamical system. A more recently posed puzzle is the bimodality of the galaxy population, observed both in the Local Universe and during the last~8Gyrs of cosmic evolution (eg., Wolf et al. 2005, ApJ, 630, 771; López-Sanjuan et al. 2010,Apj,210,1170), which has opened new questions: Why do galaxies tend to be either ¿red and dead" or blue and star forming (eg., Blanton et al. 2003, ApJ, 592,819), and in particular, what is happening to galaxies in the intermediate ¿green valley" of the color-magnitude diagram (eg., Smolcic, 2009, ApJ, 699, 43)? Why the massive galaxies forms earlier in cosmological times and in shorter burst, and latetype galaxies forms latter and the starformation processes are less intense and span over longer time periods (eg., Cowie et al. 1996, AJ, 112, 829; Pérez-González et al. 2008, ApJ, 687, 50)?The results by Magorrian et al. (1998, AJ, 115, 2285), and subsequent confirmations (eg., Merloni et al, 2010, ApJ, 708, 137), showing a tight relation between the mass of the central black-hole and the bulge of galaxies, and the need to invoke a highlyenergetic process, like the AGN feedback, to supress the starformation activity in massive galaxies in order to reconciliate the observed (eg, Norberg et al. 2002, MNRAS, 332, 827; Concalves et al. 2010, IAU, 262, 261) and predicted mass distributions,by semianalytical models (eg, Springel et al 2009, Nature, 435, 629), have given support to the hyphotesis that AGN activity is a key process that regulates somehow the evolution of galaxies within the Color-Magnitude diagram. The location of the hostgalaxies of AGNs at the transition "green valley" within this diagram gives additional support to this hyphotesis (eg, Kauffmann et al. 2003, 346, 1055; Sánchez et al. 2004, ApJ, 614, 586; Pierce et al, 2010, MNRAS, 408,139).My main research line is focused on the study of role of AGNs in the evolution of galaxies by the analysis of the morphological, kinematical and spectroscopic properties of both active and inactive galaxies, using both large scale surveys (like GEMS, STAGES), and detailed Integral Field Spectroscopic datasets. Both approaches has joined in the CALIFA survey,the largest IFS survey ever performed in nearby galaxies, recently granted with 210 dark nights at the 3.5m telescope of Calar Alto, which involves a large international collaboration (~70 astronomers of ~10 different countries) leaded by me. Using CALIFA, and data obtained previously, we will analyze in detail de similarities and differences in the spectroscopic properties of active and inactive galaxies, taken the advantage of the large statistical sample and the unique spectroscopic coverage provided by this survey.

Resumen del Curriculum Vitae:

1) Professional Career: ¿ August 2010: CAHA Resident Astronomer. Spain; ¿ May 2009- July 2010: ARAID Researcher. Spain¿ July 2008 ¿ April 2009: CAHA Resident Astronomer. Spain.¿ October 2004-June 2008: CAHA Support Astronomer. Spain.¿ August 2002- September 2004: Euro3D-RTN Postdoc, Astrophysical Institute Potsdam (AIP), Germany Instituto de Astrofísica de Potsdam (2002-2004).¿ December 2000- June 2002: System Manager, Eremas Interactiva S.A., Spain. ¿ May 1999 ¿ November 2000: Astronomical Adm. Support, ING (Isaac Newton Group of Telescopes), PPARC, Spain.2) Academic Background:a. PhD in Physics, Cantabria University, June 2001. ¿Cum Laude ¿ Qualification (Honors).b. Physics Degree, Salamanca University (1990-95; High qualifications: 3.2 over 4). 3) Science Activities: 176 publications, with 2359 citations, H=27 (ADS). 110 in International peer-reviewed journals; Several oral and poster presentations in International conferences and Workshops; Different collaborations in Academic and Public Understanding of Science Publications; Member of different international collaborations: Euro3D, GEMS, STAGES; PI of CALIFA.4) Students Training and Supervising experience: Co-supervisor of one PhD Thesis (Dr. J. Aceituno). The PhD under supervision: B. Husseman (AIP), T. Bartacova (ASCR), and R. Marino (UCM). Lecturer at different International schools in astronomy: IAC Winter School(2005), and NEON school (2006 and 2010).5) Instrumental and Technical developments: PI of CAFE - Calar Alto Fiber-fed Echelle spectrograph -; Member of the Instrumental Group at the AIP (2002-2004). Collaborator in the development of instrumentation for the night-sky characterization: EXCALIBUR, ASTMON. Member of the MEGARA collaboration;Developer of different software tools for the reduction, analysis and visualization of IFS data: Euro3D, FIT3D o R3D.6) Collaboration in different peer-review processes: ANEP reviewer, with 26 projects reviewed since 2007. Member of the ESO-OPC, Galaxies Panel (2008,2009). Referee in international journals: PASP, AN and A FPI PhD Fellowship (1996-99); MEC Science introduction Scholarship (1994-95); Scholarship of the RSEF (1990-1994); Winner of the 1ª Spanish Physics Olympic Games (Spain, 1990); Winner of the regional phase of the Mathematics Olympic Games (Córdoba, 1990).8) Main Funding Awards as PI: The Anchor Point of the Evolution of Galaxies, 30.000 Euro. AYA-2010-22111-C03-02; CALIFA: Calar Alto Legacy Ifs Area survey 181.000 Euros. ICTS-2009-10; Calar Alto Instrumental Development, 716.568 Euros. ICTS-2009-32; Characterization of the astronomical properties of the night-sky at Calar Alto. 100.000 Euros. P08-FQM-0360; Calar Alto Instrumental Development. (Nov. 2008- Dec. 2009). 149.831 Euros. ICTS-2008-24.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **PALOMARES RUIZ, SERGIO** **Referencia:** RYC-2011-08649

Area: Física y Ciencias del Espacio

Correo electrónico: sergio.palomares.ruiz@ist.utl.pt

Titulo:

Neutrino and Astroparticle Physics and Cosmology

Resumen de la Memoria:

Mis intereses principales de investigación se encuentran en la física de astropartículas: la interfaz de la física de partículas, la astrofísica y la cosmología. Durante los últimos años, estos campos están experimentando un gran crecimiento e interés, con grandes esfuerzos dirigidos a la construcción de nuevos experimentos y a una mejor comprensión teórica. En la actualidad estoy trabajando en asuntos que abordan desde problemas relacionados con neutrinos de altísima energía y astrofísica de rayos gamma, a estudios sobre materia oscura y diferentes aspectos de cosmología. En particular, el estudio de la materia oscura es unos de los campos en los que más interesado estoy últimamente. Igualmente, una parte importante de mi investigación se ha basado en el estudio de la fenomenología de neutrinos intentando proporcionar ideas teóricas para una posible mejora en la determinación de parámetros relacionados con el sector de los neutrinos.Vivimos en un momento de la historia de la ciencia en el que la cosmología de precisión ha dejado de ser un sueño y podemos incluso pensar en hacer física de partículas con observaciones cosmológicas. De hecho, a pesar de degeneraciones en la determinación de parámetros, los datos de LSS, CMB, Lyman-α forest y BBN están permitiendo obtener límites más restrictivos que los que se obtienen en experimentos de laboratorio en la suma de las masas de los neutrinos. Es pues, un momento realmente excitante el cual estamos viviendo, en el que la relación entre la física de partículas y la astrofísica y la cosmología es mayor que nunca y como consecuencia estamos siendo testigos del desarrollo del nuevo campo de la física de astropartículas. Entre otros logros, estos tiempos verán la primera generación de experimentos de neutrinos de muy altas energías que nos permitirán acceder a energías imposibles con experimentos de aceleradores, ni en funcionamiento ni en proyecto.Durante los próximos años, estoy muy interesado en continuar mis estudios de astropartículas y en particular, sobre diferentes temas relacionados con la materia oscura. También estoy interesado en continuar mis estudios en física de neutrinos y sus posibles aplicaciones en contextos astrofísicos y cosmológicos. Desde 2005 estoy colaborando activamente con estudiantes de doctorado de diferentes centros internacionales y desde este año soy el director de tesis de una estudiante, dedicada al estudio de diversos problemas en relación con la materia oscura. Asimismo, estoy interesado en todos los aspectos de la física de neutrinos, desde baja energía (MeV) al extremo de muy altas energías del espectro (alrededor de la supresión GZK). El hecho de tener un rango en energías tan amplio es una posibilidad auténticamente motivadora que nos fuerza a estudiar la relación entre los diferentes campos. La ventana a nuevos descubrimientos, que los neutrinos empezaron a abrir hace solamente unos años con la confirmación de las oscilaciones de neutrinos atmosféricos, necesita del último empujón para mostrarnos posiblemente el nuevo marco de la física, que podría provenir de la misma física de neutrinos. Además de toda esta motivación, deseo continuar mi trabajo y explorar en mayor detalle campos como el de los rayos cósmicos, la astronomía de rayos gamma, y también la física del Universo Temprano (en relación o no con los neutrinos).

Resumen del Curriculum Vitae:

Tras disfrutar en 1998 de una beca de verano en el IAC y en 1999 de una beca de colaboración en el Dept. Astronomía y Astrofísica de la U. Valencia, me licencié en Ciencias Físicas en 1999 por la U. Valencia y ese año obtuve una beca FPU para comenzar el doctorado en el Dept. Física Teórica de esta universidad, sobre la fenomenología de neutrinos atmosféricos. Hasta la finalización del doctorado en 2003, realicé 5 estancias en el extranjero (2 en SISSA, 2 en Fermilab y 1 en UCLA). En este tiempo publiqué 4 artículos en revistas de gran factor de impacto, asistí a 12 congresos internacionales (1 contribución oral y 3 escritas) y fui invitado a ofrecer 5 seminarios. Al finalizar el doctorado me desplacé a UCLA, donde realicé el primer año de mi estancia postdoctoral, uniéndome a un proyecto de la NASA obtenido en conjunto por UCLA y Vanderbilt U. Allí trabajé en cuestiones de neutrinos en cosmología y astrofísica. Los últimos dos años de mi contrato estuve en Vanderbilt U. donde trabajé en neutrinos de muy altas energías, así como en cuestiones más puramente astrofísicas. En estos tres años de mi primera estancia postdoctoral publiqué 8 artículos, realicé 12 visitas a centros internacionales (Fermilab, CERN, U. Valencia, UCLA, U. Hawaii, Durham U.), asistí a 21 congresos (17 contribuciones orales y 6 escritas), y fui invitado a dar 9 seminarios en diferentes instituciones. En septiembre de 2006 comencé mi segunda estancia postdoctoral en el IPPP de la Durham U. hasta septiembre de 2008. En este período publiqué 8 artículos, atendí a 14 congresos internacionales (10 contribuciones orales y 7 escritas), visité 9 centros (HRI Institute, UCLA, Penn State, Vanderbilt U., CERN, MPI-Heidelberg, Dortmund U., CFTP y U. Valencia), coorganicé un congreso en enero de 2007 en el IPPP, formé parte de la Red Europea de Física Teórica de Astropartículas (ENTApP ILIAS/N6) y fui invitado a dar 9 seminarios. En septiembre de 2008 comencé un contrato de Investigador Auxiliar (plaza postdoctoral avanzada) en el CFTP de Lisboa. En los dos años desde que llegué, he acabado 8 artículos (5 ya publicados), he asistido a 20 congresos (9 contribuciones orales y 4 escritas), he visitado 3 centros (CCAPP, U. Valencia y Durham U.), he sido invitado a dar 3 seminarios, fui miembro del comité científico de un congreso internacional, propuse la incorporación del CFTP a la red EUROν, fui miembro de un comité de tesis y soy el organizador del Journal Club del CFTP. En resumen, desde que empecé mi doctorado, he publicado 27 trabajos de gran relevancia en el campo de la física de neutrinos, la astrofísica y la cosmología con más de 700 citas, he realizado 37 estancias en centros de reconocido prestigio internacional, he atendido a 67 congresos (37 contribuciones orales y 20 escritas), he pertenecido a 10 proyectos de investigación, he sido invitado a dar 26 seminarios en centros de todo el mundo, he impartido docencia 4 años (licenciatura y doctorado) y he contribuido de diversas formas al campo de la física de neutrinos y las astropartículas, así como en la organización de 2 congresos internacionales. A destacar mi colaboración desde 2005 con estudiantes de doctorado y en particular el hecho de ser el director oficial de tesis de una estudiante desde principios de 2011. Me hallo también implicado en numerosos estudios científicos con colaboradores de todo el mundo.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **TONELLI , DIEGO** **Referencia:** RYC-2011-09147

Area: Física y Ciencias del Espacio

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Titulo:

Non-standard model and Higgs searches using muons with the ATLAS detector

Resumen de la Memoria:

The search for particles or interactions not described by the current theory (standard model) is the chief motivation for the Large Hadronic Collider program, which started a few months ago and is expected to operate for many years to come. The ATLAS experiment has alreadyshown, with its first data, a strong potential in leading this challenge. If I will be offered the Ramon Y Cajal research position, I will join the ATLAS collaboration to pursue a synergic and consistent program of physics measurements aimed at making significant contributions tothis effort. The common thread will be the exploration of final states containing muons: particles that exhibit striking experimental signatures and are present in many interesting standard model processes and a large variety of beyond-the-standard-model scenarios. Building upon my strong background in physics analysis in hadron collisions, specifically in the heavy quark sector, I plan to develop analysis tools for fitting the composition of inclusive dimuon samples in terms of prompt sources (which generate muons in the pp collision point), long-lived sources (whose muons are displaced from the pp collision) and instrumental effects. In parallel, a careful tuning of the simulation will allow reproducing in detail the features of standard model and instrumental sources of dimuon candidates. This will be developed and refined during the first year, by measuring standard model processes as the correlated production cross-section of b-bbar quarks pairs, or the time-integrated mixing probability of neutral B mesons. These first measurements will also help me in familiarizing with the new experiment and establishing my role and exposure in the collaboration. In the medium term (2nd-3rd year) the focus will move toward new physics searches. Using the full 2011-2012 sample, refined strategies to infer inclusive muon sample compositions will be used for measurements of semileptonic dimuon decay asymmetry (A_sl), a quantity extremely sensitive to the presence of new physics in the loop amplitude ofstrange-bottom oscillations, which shows today a tantalazing discrepancy with predictions. In addition, techniques will be developed for efficient identification of clusters of collimated, displaced muons (muon-jets). This will allow extending the reach towards a broad class of¿Hidden Sector¿ new physics models, where large portions of the space of parameters can be potentially constrained with a limited number of signature-based analises that search for muon-jets final states. Finally, in the longer term (4th-5th years), the focus will center on theoptimal use of muons to identify hadronic jets containing b-quarks that undergo semileptonic decays. Two energetic b-quark jets contribute the most abundant final states in decays of Higgs bosons that have mass in the range currently favored by indirect constraints. Despite the purity of a H->b-bbar signal is extremely unfavorable a priori, reconstruction of this decay mode is considered crucial for recognizing and classifying, in terms of standard model or else, whatever Higgs-like candidate may be observed in other modes. My research line will thusprovide, in the longer term, the expertise and tools to make a significant impact in Higgs searches at low-mass, and will establish a prominent leadership role for myself and my group in the ATLAS program.

Resumen del Curriculum Vitae:

I am an experimental high energy physicist. After a limited initial experience with instrumentation, my research has centered on the physics of quark-flavor in hadron collisions. I have been pursuing my research entirely in the Collider Detector at Fermilab (CDF) experiment, near Chicago. A collaboration of about 600 physicists from more than 50 institutions in 12 countries operates a large multipurpose detector that measures the features of a broad range of final states produced in 1.96 TeV proton-antiproton collisions. In year 2000 I got my laurea degree in Physics (approximately equivalent to bachelor+master) from the University of Pisa with full marks and highest honors. I participated in the construction and test of part of the silicon detector and my specific project was to set up a laser test stand with which I tested the silicon sensors (NIM A 461, 216 (2001) and NIM A 485, 6(2002)).In year 2011 I started my PhD in Physics at the Scuola Normale Superiore of Pisa. I focused on the analysis of charmless hadronic B decays, accomplishing the first such measurement in hadron collisions. The final results of my thesis are published in PRL 97 211802 (2006), and include the first observation of the B0s->K+K- decay, world-leading upper limits on the unobserved B0s->K- π+ and B0s-> π-π + modes, and the first measurement in hadron collisions of direct charge-parity (CP) violation in B decays. I also contributed in adapting the approach and tools used in my thesis to other similar measurements (PRD 72 051104 (2005) and PRD 81 031105 (2010)). During my PhD work I was also supported through a Della Riccia Fellowship and an INFN postdoctoral contract. I got my Phd In 2006 with full marks and highest honors. I am now a Lederman Fellow at Fermilab, In 2007-2009 I improved and extended the analysis of charmless B decays obtaining the first observation of the decay B0s->K-π+, the first measurement of direct CP violation in B0s decays, the first observation of charmless b-baryon decays, and the first measurement of CP violation in b-baryons.These are published in PRL 103 031801 (2009). I also contributed to the measurement of the phase of bottom-strange meson mixing by proposing and implementing an original statistical treatment of the results that appropriately correct for non-gaussian uncertainties and effect of systematic nuisances. The results are published in PRL 100 161802 (2008) and PRL 100 121803 (2008) of which I was also CDF internal reviewer. More recently I have completed a measurement on CP violation in charm decays with per-mille accuracy, which is the most precise result from a single experiment. I have leadership responsibilities in CDF as a current leader of the B physics group (50 active people + 100), former leader on one of its subgroups, and as coordinator of the dE/dx calibrations team. I gave more than ten talks at international conferences and a similar number of departmental seminars. Owing to my contributions to flavor physics I have been invited to join the Heavy Flavor Averaging Group, an international team of experts that periodically compiles and averages experimental results (arxiv:0808.1297(hep-ex) and 1010.1589(hep-ex)). I am also routinely invited to chair or convene working groups and sessions in various international conferences. I supervised directly one Phd and three Master's students.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **HERNANDEZ MONTEAGUDO, CARLOS** **Referencia:** RYC-2011-08262

Area: Física y Ciencias del Espacio

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Titulo:

The CMB as a Probe of the First Stars, Dark Energy and the Missing Baryons

Resumen de la Memoria:

La Radiación de Fondo Cósmico ("CMB" de sus iniciales en inglés) cruza todo el universo visible desde la época de recombinación hasta el presente, y por ello constituye un testigo excepcional de cada uno de los episodios cosmológicos acaecidos en su trayecto hacia el observador. Observaciones proporcionadas por experimentos como WMAP, PLANCK y ACT están haciendo de la Cosmología una ciencia de precisión:(1)- El candidato co-lidera el proyecto sobre Efecto Sachs-Wolfe integrado (que describe la influencia de Energía Oscura sobre el CMB) dentro de la misión europea PLANCK. Los métodos propuestos por el candidato para la separación del efecto Sachs-Wolfe han demostrado la viabilidad de PLANCK para distinguir este efecto de la señal dominante proveniente de épocas más tempranas y no relacionadas con la Energía Oscura, y serán implementados en datos reales de PLANCK durante su análisis en los próximos dos o tres años. Asimismo el candidato liderará la aplicación de dichos sobre los datos públicos de WMAP y los catálogos de densidad proporcionados por la colaboración BOSS.(2)- El estudio estadístico del CMB y su interacción con la estructura a gran escala hacen del estudio conjunto del CMB y la distribución de materia en el universo una poderosa herramienta de investigación cosmológica. Con ella el candidato va a abordar problemas de índole diversa, como la influencia de la Energía Oscura en las velocidades peculiares y en la correlación angular de las galaxias, la energía térmica del universo, el censo de cúmulos y grupos de galaxias o la búsqueda de los "bariones ausentes". Para ello el candidato está involucrado en cartografiados ópticos como BOSS y EUCLID, y co-liderará el análisis cosmólogico de J-PAS y J-PLUS (a desarrollar en el Observatorio Astronómico de Javalambre en los próximos años).(3)- El candidato, en compañía del Prof.Sunyaev, ha abierto un nuevo campo en el estudio de las anisotropías secundarias en el CMB relacionado con el impacto de la generación de los primeros metales en la radiación de Fondo Cósmico. Cuando las primeras estrellas se forman, contaminan a su vez el medio interestelar con los primeros metales e iones por ellas sintetizados, que interaccionan con el CMB por medio de la absorción resonante, la emisión colisional y la emisión inducida por el campo local de radiación Ultra Violeta. El candidato ha realizado las primeras estimaciones teóricas de la amplitud de estos efectos en el campo de anisotropías del CMB, y usará esos resultados en los datos de los experimentos ACT y PLANCK para establecer las primeras cotas a la historia de reionización temprana y enriquecimiento del medio interestelar. Asimismo el candidato ha sido invitado a participar en el experimento español QUIJOTE sobre polarización de CMB sobre el problema de campos magnéticos primordiales.

Resumen del Curriculum Vitae:

El candidato terminó la licenciatura de Cc.Físicas en Junio de 1997 en la Universidad de Salamanca, y a las pocas semanas le fue otorgada una beca predoctoral (Astrofísico Residente) en el Instituto de Astrofísica de Canarias (IAC). No obstante, a los pocos meses recibió otra beca de Formación de Personal Investigador con la que volvió a la Universidad de Salamanca para comenzar una tesis en Cosmología. Allí desarrolló lo que sería la primera tesis doctoral en el campo de Cosmología, en particular sobre el análisis de mapas de Radiación de Fondo Cósmico de Microondas (CMB de sus iniciales en inglés). Ésta fue también la primera tesis doctoral dirigida por el prof. Atrio-Barandela (único astrófisico en esa universidad), y dió lugar a cuatro publicaciones repartidas entre ApJ y A&A. Antes de su defensa en Febrero de 2002, el candidato estaba trabajando en el Instituto Max Planck de Astrofísica (MPA) de Munich, donde permaneció tres años como postdoc. Durante ese tiempo, el candidato amplió su campo de intereses, estudiando las anisotropías generadas durante reionización, por cúmulos de galaxias, y se introdujo en el análisis de los datos de CMB del satélite WMAP. Durante ese tiempo, el candidato co-dirigió con el Prof.Sunyaev una tesis doctoral, organizó el congreso "CMB and Cosmology: Where Are We?"y se involucró en la colaboración de la misión de la ESA "PLANCK", de la que tiene el status de "Scientist" y de cuyo "HFI Core Team" forma parte. En Febrero de 2005 el candidato comenzó su segunda estancia postdoctoral en la Universidad de Pensilvania, invitado por la colaboración del "Atacama Cosmology Telescope" (ACT). ACT es un experimento pionero en la medida de las anisotropías de CMB en pequeñas escalas, liderado por la Universidad de Princeton, y cuyos resultados han salido a la luz en 2010. El candidato lideró el problema de modelado de la contaminación por fuentes infrarrojas correladas. Durante su tiempo en Filadelfia, e independientemente de su trabajo para ACT, el candidato amplió sus intereses en el campo de reionización, Energía Oscura, velocidades peculiares y bariones ausentes, liderando colaboraciones con la Universidad de Princeton y la Universidad de Columbia en Nueva York. Desde Octubre de 2007, el candidato es de nuevo postdoc en el instituto MPA de Munich. Durante esta estancia, el candidato ha co-dirigido su segunda tesis doctoral en el campo de CMB y reionización, y espera ahora a su tercer estudiante de doctorado. Ha co-organizado el Workshop "The Physics of Cosmological Recombination", y actualmente co-lidera el proyecto de Efecto Sachs-Wolfe integrado en el Grupo de Trabajo 5 de la colaboración PLANCK, así como la tarea de velocidades peculiares, y participa en otros proyectos de PLANCK relacionados con bariones ausentes y campos magnéticos primordiales. El candidato lidera el proyecto de correlación CMB - LRGs dentro de la colaboración BOSS de SLOAN III, y liderará tareas de índole cosmológica en los cartografiados J-PAS/J-PLUS a desarrollar en los próximos años en el Observatorio Astronómico de Javalambre. De 53 publicaciones con árbitro, 18 están bajo examen arbitral y 35 en prensa. De estas 35 últimas, el candidato lidera 17, y de las 31 que son fuera de grandes colaboraciones, el número de autores promedio es 3.33 y la posición promedio del candidato es 1.73. Ésta es la última solicitud del candidato a la RyC.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **RADICCHI , FILIPPO** **Referencia:** RYC-2011-08411

Area: Física y Ciencias del Espacio

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Titulo:

ScienceScale: Analysis and evaluation of scientific research with tools and concepts of statistical physics

Resumen de la Memoria:

Scientific knowledge is a fundamental pillar of modern society. The development of science is continuously accelerating and scientific research involves nowadays millions of people and huge investments worldwide. The increment of scientific production gives big advantages but, on the other hand, creates two main problems. The first concerns the understanding of the structure and evolution of the systems of production and dissemination of scientific knowledge. These systems are very complex: both depend on a priori decisions (funding, organization of research institutions, etc.), but also on spontaneous and self-organizing interactions among single agents (scientists, departments, etc.). Macroscopic phenomena, such as the emergence of new disciplines, the success of research projects and the development of areas of excellence, are the results of a complex interplay between global planning and microscopic dynamics of agents. Understanding the mechanisms at the basis of these systems is particularly interesting not only from a conceptual point of view, but also because the knowledge of these mechanisms may be useful for improving the efficiency and the productivity of scientific research activities. The second problem is the growing difficulty to properly evaluate the results of scientific research. Due to its huge growth and hyper-specialization, nowadays even scientists cannot have a global understanding of science. In particularly active sectors, scientists can hardly follow all the developments in their own field of expertise. This is somehow a paradox, since information technology offers today communication possibilities which did not exist only few years ago. The over-abundance of information makes very difficult to objectively evaluate the impact of a scientific result, the productivity of a scientist or a scientific institution. In order to alleviate this kind of difficulties, there is an increasing trend toward the use of quantitative measures, obtained from the study of large bibliographic data sets containing information about scientific publications. Finding objective measures and numerical indicators for scientific evaluation, able to quantify (ex post evaluation) and predict (ex ante evaluation) the impact of a particular scientific research activity, is therefore fundamental for scientific policy making and assuring the future correct development in science. In spite of their relevance, the investigation of these topics is still largely unexplored. By using the tools and concepts of the statistical physics of complex systems, which are suited for the analysis of complex phenomena such as the production and the dissemination of scientific knowledge, it is possible to provide a novel understanding of science from a different point of view.

Resumen del Curriculum Vitae:

My research activity has always focused on topics related to the statistical physics of complex systems. I am author of more than twenty scientific publications in international peer reviewed journals. In the majority of them, I am the first author meaning that I have performed the main part of the scientific activity. I have also published two single author papers demonstrating the independence to produce alone scientific articles. Some of my papers were published in very important journals: I have published 2 papers in the Proceedings of the National Academy of Sciences USA, 2 articles in Physical Review Letters, 1 paper in PloS ONE and more 12 publications in Physical Review E. I have received 433 total citations according to Web of Science and over 700 according to Google Scholar. Some of my publications have been highlighted by featuring articles appeared in Nature News , Nature Nanotechnology and Physics spotlighting exceptional research, and featured by relevant web sites such as physicsworld.com.I have worked in seven different places [University ¿Tor Vergata¿ (Rome, Italy), ISTC-CNR (Rome, Italy), University ¿La Sapienza¿ (Rome, Italy), Jacobs University (Bremen, Germany), ISI Foundation (Turin, Italy), Northwestern University (Evanston, USA) and Howard Hughes Medical Institute (HHMI, Evanston, USA)]. I have international and interdisciplinary (with physicists, computer scientists, social scientists and psychologists) collaborations. I have been guest of and still collaborating with important groups of research in complex system science at Indiana University (USA), University of Palermo (Italy) , University of Aveiro (Portugal), Universitat Politècnica de Catalunya (Spain), University of Rome ¿La Sapienza¿ (Italy) and Univesity of Calgary (Canada). I have some teaching experiences. During my M.Sc. studies, I have been teaching assistant at the didactic laboratory of general physics (in 2000). I have co-organized, together with Dr. F.Cecconi, a short course for psychologists with title ¿Dynamics of Non-linear Systems: Applications for Social and Biological Problems¿ at the Institute of Cognitive Sciences and Technology (CNR) in 2004. During my Ph.D. studies, I have been teaching assistant in two courses for graduated students, both organized by my Ph.D. supervisor Prof. H.Meyer-Ortmanns, at Jacobs University Bremen (in 2005 and 2006).

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **RODRIGUEZ GOMEZ, DIEGO** **Referencia:** RYC-2011-07593

Area: Física y Ciencias del Espacio

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Titulo:

Lessons from the extra dimension: strong coupling gauge dynamics from holography

Resumen de la Memoria:

String theory contains deep relations to quantum field theory Being string theory a theory of gravity, these relations represent a geometrization of the latter. Over the last decades, this fruitful interplay has led to remarkable progress in both. One of the most outstanding such connections is the AdS/CFT duality. This duality is holographic in nature, in that the field theory lives in one less dimension that the field theory. Furthermore, it is a strong/weak coupling duality. This remarkable fact allows us to understand strong coupling gauge dynamics through a classical, thus weakly coupled, gravity theory.Over the last few years we have seen big progress towards the understanding of the AdS_4/CFT_3 duality. The field theory side involves Chern-Simons theories whose quantum properties remain yet to be investigated. Following up on previous work, I plan to study aspects of AdS_4/CFT_3 with a twofold interest, both purely theoretical (in particular the role of global symmetries, as well as the actual nature of the fixed point, characterized by the minimization of the partition function); but also more applied; as Chern-Simons theories arise naturally in condensed matter systems such as the description of the quantum Hall effect. Only very recently we have started to realize that condensed matter provides a whole ¿landscape¿ of field theories, some of them involving strong correlations and thus not easily accesible by standard tools. While the case of the fractional quantum Hall effect is one such situations, one can imagine a wide variety of them. In turn, AdS/CFT emerges as a powerful new tool which can be used to face these problems. Following on previous work, I plan to investigate the potential applications of holography to condensed matter systems. While much better understood, the AdS_5/CFT_4 duality still hides jewels to be further studied. One of them is the remarkable connection between certain statistical mechanics models called dimers and CFT's describing D3 branes probing certain (toric) singularities. In fact, in view of the Belyi/Grothendieck theory of Dessins d'Enfants ¿a state-of-the-art area of mathematical research¿, this connection appears even deeper as thought. While in previous work we have set out for the understanding of this connection, a number of key questions remain to be answered in future work.

Resumen del Curriculum Vitae:

My field of research is string theory and its interplay with gauge theories. String theory naturally contains gravity, and thus its many relations with field theory represent, in a sense, a geometrization of the latter. This connection between geometry and physics, and its implications for QCD or condensed matter systems, is what drives my research interests.I took my PhD under the supervision of Prof. Yolanda Lozano at the University of Oviedo, from where I graduated (Sobresaliente cum Laudem) in 2005 after three years of studies. During that period, I held an F.P.U. (awarded by the spanish Ministry of Science) predoctoral grant. After short stays at the Universities of Santiago de Compostela and Granada, I took an Assistant Professor position at UAM (Madrid). On fall 2006 I moved to Princeton University, first as a Fullbright scholar (Spanish Ministry of Science/U.S. Department of State) and subsequently as a Marie Curie fellow (European Comision fellowship). I spent the last year of my Marie Curie OIF at Queen Mary College, U. of London (U.K). Very recently I moved to the Technion, Israel Institute of Technology for a postdoctoral position (joint with Haifa U.). I have co-authored more more than 30 scientific publications on different aspects of string theory and its interrelations with quantum field theory. I am particularly interested in the applications of the AdS/CFT duality as a tool to learn valuable lessons for realistic cases such as QCD or condensed matter systems. Besides, I I have given over 30 research talks at internationally recognised research institutions, and attended numerous workshops, schools and conferences all over the world. I am a regular referee for JHEP, the most spread scientific journal in my field.I served as Assistant Professor at UAM (Madrid) during a semester. I had also participated in outreach activities, such as colloquium talks and science fairs.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **PAREDES ARIZA, MARIA BELEN** **Referencia:** RYC-2011-08406

Area: Física y Ciencias del Espacio

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Titulo:

Topological Quantum Computation

Resumen de la Memoria:

To control and manipulate a physical system to be able to use it as a quantum computer is one of the big challenges of modern quantum physics. A crucial issue is how to avoid errors, which arise due to the interaction with the ambient environment. In the last few years a novel way how to perform quantum computation has been envisioned: the so-called Topological Quantum Computation (TQC). In TQC, information is encoded in topological excitations dubbed anyons, quasiparticles that are neither bosons nor fermions, but exhibit fractional statistics. A topological quantum computation is carried out by braiding these anyons around each other, creating knots that the environment is unable to undo. Anyons are known to appear as elementary excitations of exotic states of quantum matter in which particles are organized in an unconventional manner that is not related to the breaking of any symmetry: the so called topological order. The possibility of TQC has recently brought together international leaders of quantum information, quantum optics and condensed matter physics, with the common goal of finding realistic physical systems that might serve as quantum hardware for a topologial quantum computer. My principal line of research will focus on the theoretical investigation of topologically ordered states of matter, the study of new theoretical routes towards their realization in quantum optical and solid state physical systems, and the development of theoretical schemes to create, manipulate and detect anyons in actual experiments, with the long term objective of paving the way towards the realization of a topological quantum computer. In a project that will combine condensed matter physics, quantum optics and cold atomic gases theory, I will attempt to shed light on fundamental open questions in the theory of topological order. To this aim, I will propose novel models for many-body systems and investigate the development of topological order depending on the type of interaction between the particles. At the same time I will explore novel easy-to-use ways to characterize and detect topological phases. On the other hand, I will develop ideas and theoretical schemes to realize topological order and anyons with quantum optical and solid state physical systems. Particular attention will be given to a special kind of topological matter, dubbed non-Abelian, which has never been observed in nature. Its defects, non-Abelian anyons, obey non-Abelian braiding statistics and are known to be the route towards topological quantum computation. I am especially interested in exploring the potential of ultracold atomic gases in optical lattices as quantum simulators of topologically ordered many-particles phases and anyons. The extraordinary degree of controllability achieved experimentally in the last few years makes them ideal candidates for the realization of a topological quantum computation based on anyons. This interdisciplinary line of research at the interface between condensed matter physics, quantum optics and quantum information and computation would mean a novel avenue of research in the spanish research environment. I plan to use my expertise in these three fields acquired along the last ten years of collaboration with Prof. Ignacio Cirac, Prof. Peter Zoller, and Prof. Immanuel Bloch to advance this line of research.

Resumen del Curriculum Vitae:

1996-2000. PhD on topological spin textures of fractional quantum Hall systems in the Condensed Matter Theory Department of the University Autónoma of Madrid, under the supervision of Prof. Carlos Tejedor, becoming an experienced researcher in fractional quantum Hall effect, quantum Hall ferromagnets and topological spin textures, anyons and fractional statistics. My work on a novel topological excitation (Phys. Rev. Lett. 1999) captured the attention of Prof. Ignacio Cirac and Prof. Peter Zoller at the University of Innsbruck, who invited me to join their group as a postdoctoral researcher. 2000-2002. Marie-Curie Fellow at the University of Innsbruck with Prof. Ignacio Cirac and Prof. Peter Zoller. I developed a project to realize fractional quantum Hall states and anyons with ultracold atomic gases. This work (Phys. Rev. Lett. 2001) was one of the first pioneering works at the interface between quantum optics and condensed matter physics, constituting one of the very first proposals to observe strongly correlated phenomena with ultracold atomic gases. Furthermore, it was the first theoretical proposal to test fractional statistics in an actual experiment. It has received more than 100 citations and has triggered a lot of experimental and theoretical research.2002-2006. Research assistant of Prof. Ignacio Cirac at the Max-Planck Institute of Quantum Optics. Leader of many different research projects at the interface between quantum optics, quantum information and ultracold atomic gases. One of my mayor achievements was the development of a novel idea to realize a Tonks-Girardeau gas of bosonic atoms in an optical lattice, a periodic potential made of laser light. Following my original idea I coordinated a joint theoretical and experimental project with the experimental group of Prof. Immanuel Bloch, which succeeded in the experimental realization of such novel state of matter. This work (Nature 2004) has made me an internationally recognized expert in fermionization and strongly correlated effects with ultracold bosonic gases. It has more than 500 citations. Another highlight was the discovery of a new quantum algorithm in quantum computation for the simulation of quantum random systems.Co-supervision with Prof. Cirac of two diploma students and four PhD students in different projects regarding quantum information and ultracold atomic gases.2006-2009. Senior researcher at the University of Mainz.Leader of many different research projects in joint collaboration with the experimental group of Prof. Immanuel Bloch. A major achievement in this period was the discovery of a novel anomalous effect in the thermodynamics of fermionic atoms in an optical lattice. Following my original theoretical idea I led and coordinated a joint theoretical and experimental collaboration involving senior scientists and PhD students from Mainz and Harvard universities. This work deserved publication in Science.Oct 2010-now. Senior researcher and lecturer at the Ludwig-Maximilians University in Munich. Teaching Master course on Quantum Information Theory and Quantum Simulation.Research in numbers: About 30 Publications: 2 x Nature, 1 x Science, 4 x Phys. Rev. Lett., 10 x Phys. Rev. More than 40 Invited talks in international conferences. Graduate and undergraduate courses on quantum computation, strongly correlated phenomena and ultracold atomic gases. Invited lecturer in more than 10 summer schools and workshops.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **MEEUS , GWENDOLYN** **Referencia:** RYC-2011-07920

Area: Física y Ciencias del Espacio

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Titulo:

The nursery of planets. Gas and dust evolution in protoplanetary discs.

Resumen de la Memoria:

The planets orbiting the Sun originated from a disc of gas and dust during the earliest stages of our Solar System. In order to understand how those planets formed, and in how far planets are present around other stars, it is necessary to understand protoplanetary disc evolution. My research is mainly situated within this framework. The main goal is to create a better understanding of the processes dictating disc evolution - hence the early stages of planet formation. I do this by comparing the characteristics of a large sample of young objects with a protoplanetary disc and a wide range of stellar properties, and through detailed modelling of a few selected objects.I designed a classification for protoplanetary discs, based on their appearance in the infrared, and proposed that this could be related to the geometry (flaring angle) of the disc. This classification is still widely used. Furthermore, I used IR spectroscopy to study the properties of the dust grains with a spectral decomposition method. I related these properties to the geometry of the disc, and found that grain growth and dust settling cause the disc to flare less. I also found that the dust properties in discs around stars with a wide range in luminosity are rather similar, but that dust and disc evolution appears to go faster in lower-mass objects. To further constrain the most recent disc models, my IR analysis is complimented by multi-wavelength data. The study of the cold, outer disc through mm observations can reveal disc size, mass, structure and inclination. On the other hand, the determination of the properties of the inner disc is also of great importance: as protoplanetary discs evolve in time, the inner region is expected to clear out first, creating an inner (opacity) hole, devoid of dust particles. Hence, spatially resolved observations, that can be obtained by adaptive optics, spectro-astrometry or interferometry, are important tools that I plan to fully exploit in my research. As part of the disc team of CanariCam Guaranteed Time (GranTeCan) I will further constrain the disc structure through mid-IR imaging and polarimetry.Gas is an important component of protoplanetary discs, as it contains up to 99% of the disc mass. Its dissipation as the disc evolves limits the formation period of giant planets. With the Space Observatory Herschel, it is possible to study gas lines in the far-IR. I am involved in several Herschel Key Projects and Open Time proposals to study protoplanetary discs. In particular, I am leading the analysis of a large sample of Herbig Ae stars, and I am the principal investigator of a new study on Herbig Be stars. As it is important to consider all parameters (e.g. age, effective temperature, accretion rate, disc flaring) in these studies, I am collecting multi-wavelength data for the whole sample. I also plan to obtain high spatial resolution mm images with ALMA to unravel the disc structure, and the properties of the (molecular) gas present in the disc through emission lines.I also plan to use future facilities, in particular the James Webb Space Telescope for sensitive IR surveys, enabling the routine study of brown dwarf discs, and further ahead, ESO's Extremely Large Telescope, that will allow us to study discs in even more detail, given its superior spatial resolution.

Resumen del Curriculum Vitae:

I studied Physics at the Catholic University of Leuven, with a specialisation in Astrophysics. My third year I studied at the University of Pavia, Italy. I started my PhD with a research grant from the IWT in Flanders, for the proposal "A multi-wavelength study of the circumstellar environment of isolated Herbig Ae/Be stars", that I wrote and defended after my Physics studies. Most of the work was done at the Catholic University of Leuven (supervisor Prof. C. Waelkens), with regular visits to the University of Amsterdam (advisor Prof. L.B.F.M. Waters), to work in a team with a lot of expertise in disc and dust studies. After my PhD, I took up a position as post-doctoral researcher in the European Research Training Network "The formation and evolution of young stellar clusters" at the Astrophysical Institute Potsdam (AIP), with Prof. M.J. McCaughrean. Next I obtained a post-doctoral grant for the project "A comparative study of the discs of young objects" from the German Fund for Research (DFG) for initially 2 years. I got a 1 year extension after reporting my results. During these years, I had regular working visits to the MPIA in Heidelberg, and the University of Toronto, to discuss with disc experts and gain more modelling experience. My last year at the AIP I was involved in developping data reduction software for the cryogenic testing of the spectrograph NIRSpec that is to be incorperated in the James Webb Space Telescope, in collaboration with EADS Astrium, gaining ample experience in the domain of pipeline development, validation and documentation. Since mid 2009, I am working at the Universidad Autonoma de Madrid, with Prof. C. Eiroa, where I am in co-charge of the UAM contribution to the Herschel Key Project GASPS (Gas in Protoplanetary Discs, PI Dent). In particular, I am responsible for the HAEBE data reduction, interpretation and coordination with other groups in GASPS. I now also lead an international effort (including teams from the MPIA, UVA and KUL) to study Herbig Be stars for the first time with Herschel, for which I got 33 hours observing time. I am also actively participating in the Herschel Open Time Key Programmes DIGIT (Dust, Ice, Gas in Time, PI Evans) and DUNES (Dust around Nearby Stars, PI Eiroa), as well as Open Time proposals to study brown dwarfs and transitional discs.My papers have been cited 1113 times, the most cited paper has 260 citations and I have an H index of 15. I am a referee for A&A, MNRAS, AJ, ApJ(S) and AN. I wrote a book chapter with Prof. Th. Henning on 'Dust processing and mineralogy in protoplanetary accretion discs', 33 pages, to appear in 'Physical processes in circumstellar disks around young stars', Garcia P.J.V., Ed., Chicago University Press. I regularily give talks in international meetings/conferences. Furthermore, I am panel member of the ESO's OPC, deciding upon the fate of observing proposals, and part of the Herschel User's group, that advices the Herschel Science Center. I obtained time at several international observatories, including some of the largest telescopes on earth: LBT, VLT, VLTI, SUBARU, GEMINI N and Keck. I have been teaching for 5 years at the Catholic University of Leuven, and I was the thesis advisor of 2 undergraduate students. At the AIP, I was the practical advisor of a PhD student. Currently, I am involved in advising a PhD student at the UAM.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **COSTACHE , MARIUS VASILE** **Referencia:** RYC-2011-08319

Area: Física y Ciencias del Espacio

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Titulo:

Spin transport and magnetization dynamics in nanostructures

Resumen de la Memoria:

Spintronics, which is based on spin orientation and spin coupling, promises much higher speeds, low power demands, non-volatility and higher integration densities. There are however many fundamental problems that are currently not fully understood that hinder the progress of the field.The main focus of this RyC project is to take advantage of the extraordinary sensitivity that can be achieved with all electronic transport methods to attain a deeper understanding of spin physics in the solid state. Three principal research lines will be explored by the RyC candidate:1) Magnetization dynamics and spin currents: Spin torque, spin pumping and spin ratchet.By properly designing new devices and methods, we expect to gain information on a number of spin related phenomena, including spin torque and pumping, spin transport through interfaces, scattering mechanisms and the magnitude and nature of the spin-orbit coupling in semiconductors. For example, single electron transistors spin ratchets allows one to probe spins at the single electron level and can be used to study fundamental quantum problems in the solid state. 2) Spin transport in bulk materials and through interfaces: Spin-resolved spectroscopy and spin injection and detection in semiconductors. Here, we propose to go beyond the state-of-the-art in sample fabrication to study various spin related properties that are of critical importance for any spintronic device: Spin transport through interfaces and spin relaxation mechanisms in relevant materials. Spins in semiconductors open additional paths, including spin-based quantum computation and cryptography.3) Spintronics devices for thermoelectric energy harvesting.The candidate will also explore thermoelectric devices based on metallic and semiconducting ferromagnetic nanostructures, where the thermoelectricity would result from the conversion of a spin electrochemical potential (Spin Seebeck effect) to a voltage.The proposed research lines are innovative ways for exploring and testing fundamental ideas on spin transport in the nanoscale. As a whole, the project pursues a series of inter-related objectives that would have a clear impact in present spintronics and lay the foundations for future directions in the field.

Resumen del Curriculum Vitae:

The candidate obtained his PhD in physics from the University of Groningen, working on high frequency spin-dynamics in the group of Prof. BJ van Wees. His PhD thesis describes a series of experiments aimed at the understanding of the physics of magnetization and spin dynamics in the GHz frequencies range in hybrid submicron ferromagnet/normal-metal devices. The main results are: i) The first demonstration of electrical detection of the spin pumping effect due to the precessing magnetization of a single ferromagnet. ii) Development of new methods to induce and detect on-chip ferromagnetic resonance in an individual, submicron permalloy strip. Seven articles, five as first author, were published from the work done during this PhD, all of them in top journals. After his PhD, the candidate went for a postdoctoral training at the Massachusetts Institute of Technology, in the group of Nanospintronics and Superconductivity lead by Dr. JS Moodera. There, the candidate was responsible for a molecular beam epitaxy system, which he used to grow magnesium diboride epitaxial thin films that later he used to fabricate and measure of all-magnesium diboride Josephson junctions. In 2009, the candidate joined the Valenzuela Group at the Catalan Institute of Nanotechnology because of the great fit in research interests. Since then the candidate has been deeply involved in developing new research lines in the young research group. Recently, the candidate and his supervisor presented the first experimental demonstration of a Spin Ratchet. Spin ratchets are a fundamentally new approach to transport spins and generate spin currents in the nanoscale. Their demonstration is thus a deep conceptual progress in the field of spintronics. In parallel to the basic research, the candidate interest is focused also on developing spintronics devices for novel thermoelectric devices for energy harvesting.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **BLANCO PILLADO, JOSE JUAN** **Referencia:** RYC-2011-07997

Area: Física y Ciencias del Espacio

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Titulo:

Connecting Fundamental Physics and Cosmology

Resumen de la Memoria:

Cosmology has emerged in the last few years as one of the most effective tools to probe fundamental physics. This proposal aims to explore the cosmological implications of some of the novel ideas about the evolution of our early universe with the ultimate goal of computing its observational signatures. In particular, we will investigate, using large numerical simulations, the evolution of a network of cosmic (super) strings. The main objective of this approach is to obtain a clear understanding of the statistical properties of the strings in the so called scaling regime so that we can extrapolate these quantities from the small simulated region of spacetime all the way to the scales relevant for observations. Our current code allows us to run the largest simulations ever performed hence we should be getting closer to the scaling solution. This should give us a better description of the observational signatures in these models like, for example, the imprint of cosmic strings in the cosmic microwave background data, the expected gravity wave signal, etc. Furthermore, I will also explore the consequences of a multidimensional landscape of vacua that is suggested in many higher dimensional theories discussed in the literature today. Transitions between different vacua occur through tunneling with regions of different vacua nucleating and expanding in the never-ending process of eternal inflation. As a result, the entire landscape of vacua is explored. Most of the studies of the cosmological consequences of the string landscape have focused on effectively (3+1)-dimensional vacua. However it is reasonable to suppose that the string landscape contains compactifications to vacua with fewer or more large spatial dimensions. Clearly we do not live within such a vacuum; however our universe may reside in a bubble that nucleated within or collided with such vacua, and such processes might leave distinct observational signatures. Our aim is to explore such signatures focusing in particular in their imprint on the cosmic microwave background.

Resumen del Curriculum Vitae:

I obtained my B.Sc. in Physics from the University of Santiago de Compostela in 1995 obtaining the First National Physics Undergraduate Award (Primer Premio Nacional de Terminacion de Estudios de Fisica) from the Ministry of Science and Education. I defended my undergraduate thesis (tesina) in Santiago under the supervision of Prof. Enrique Zas in June 1997 obtaining as well the Outsanding Undergraduate Award (Premio Extraordinario de Licenciatura). In 1997 I move to Tufts University to complete my Ph.D. under the supervision of Prof. Alexander Vilenkin in May of 2001. In 2001 I obtained a Research Associate position at the DAMTP at Cambridge University where I worked for 2 years before moving to NYU where I became a James Arthur Postdoctoral Fellow at the Center for Cosmological and Particle Physics. In 2006 I started my current position at Tufts University as a tenure track Assistant Professor at the Institute of Cosmology. During my research career I have worked on several aspects of topological defects, ultrahigh energy cosmic rays, braneworld models, inflation, cosmic (super) string dynamics and recently I have focused on the cosmological evolution of cosmic string networks as well as the implications of a multidimensional string theory landscape. I am currently supervising 2 graduate student theses on these topics at Tufts. I have published over 33 papers in some of the leading peer-reviewed journals in theoretical physics. I have been invited numerous times to give seminars in several physics departments and I currently serve as referee for several scientific journals.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **PREZADO ALONSO, YOLANDA** **Referencia:** RYC-2011-08452

Area: Física y Ciencias del Espacio

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Titulo:

Applications of physics to medicine: improvement of the therapeutic index in radiotherapy.

Resumen de la Memoria:

The main objective of radiotherapy (RT) is to deposit a therapeutic dose of ionising radiation in the tumour without exceeding the tolerances of the surrounding healthy tissues. For some radioresistant tumours, radiotherapy is only palliative: to reach a curative radiation dose, the risk of serious damage to normal tissues would be unacceptable. This limitation is particularly severe for brain tumours and especially important in children. One possible solution is the development of new radiotherapy techniques that exploit what it is called dose-volume effect: the smaller the field size is, the higher the tolerances of the healthy tissues are. At the European Synchrotron Radiation Facility (ESRF) two new techniques, based on this principle, are under development: Microbeam radiation therapy (MRT) and Minibeam radiation therapy (MBRT). Extremely high doses (> 100 Gy) are delivered in one fraction by using arrays of parallel thin beams (25 μm to 600 μm). The first preclinical studies indicate a remarkable healthy tissue sparing capability and the ablation of highly aggressive tumours. The scientific objectives of this project include an in depth investigation on the radioresistance of the different healthy tissues to this new type of irradiation, its effectiveness for the treatment of brain tumours, central nervous system, tumours close to an organ at risk and some illness like epilepsy. In addition, as opposite to MRT, MBRT does not require high dose rates. Therefore it is possible to extend this promising technique outside synchrotron sources towards hospitals by using modified conventional x-rays equipment. A part of this project is the modeling of this new equipment. This could lead to an industrial collaboration. A further improvement in the outcome of RT can be achieved by using molecular imaging. Voxel-based prescriptions of deliberately non-uniform dose distributions based on molecular imaging of the tumour could significantly improve the outcome of the treatment. In this line, work on the optimization of the equipment for research with small animals as well as of the reconstruction imaging algorithms with the aim of searching for new/different molecular pocesses to be be used for molecular targeting in RT is desirable.

Resumen del Curriculum Vitae:

I received my Master¿s Degree in Physics from University of Santiago de Compostela in 1999. My Ph.D. thesis entitled ¿Multiple particle emission in 12C and in the mirror transitions of the isobar A=9¿ was defended as an European Thesis at the University of Santiago de Compostela in 2003, obtaining a ¿Sobresaliente Cum Laude¿. The results of my Ph.D. work have been reported in several publications with impact factors higher than 4 (Physics Letters B, Physics Review Letters, Nature, etc). In 2004 after a competition at national level, I enrolled the Spanish training program to become an accredited Medical Physicist. This program consists of a three-years practical and theoretical training on the applications of Physics to Medicine. This takes place at a hospital. During that period I acquired a strong background in clinical assistance in radiotherapy and radiology departments, skills to work within a multidisciplinary team (medical doctors, biologists, physicists, etc) and I explored new research lines on the medical applications of ionising radiation. Since 2007 I work as the second scientific responsible at the Biomedical Beamline at European Synchrotron Radiation Facility (ESRF) on the development of new radiotherapy techniques by using synchrotron radiation. Besides working on the existing research lines, I have implemented a new radiotherapy technique at the ESRF, called minibeam radiation therapy. This new method has the potential to be extended outside synchrotron sources towards hospitals with a cost ¿effective equipment. I am the coordinator of the studies involving that technique, managing several multidisciplinary collaborations. In addition, I have been the spokesperson of several official proposals at the ESRF, experiments that have obtained an outstanding rank from the international evaluation panel. I led the experimental campaigns and the data analysis. I am the responsible person of the experimental dosimetry as well as Monte Carlo studies coordinator for the Biomedical Beamline. In addition, I am one of the main participants in the preparation of the clinical trials at the ESRF. Since my arrival at the ESRF, I have acted as local contact in different experiments of external users at the ESRF, providing help and advice in administrative, technical and scientific issues. My work on radiotherapy has been published in some prestigious journals specialized in Medical Physics. Some of the papers have received mentions as featured paper or highlights of the year. My research activities has included the supervision of two master thesis students and two Ph.D. students. I have been one of the main proponents of a Biomedical Beamline at the new Spanish synchrotron ALBA. I have been part of the organizing committee of one international workshop. I am peer reviewer in different specialized journals. I was able to present my research work in 23 congresses, 3 of them by invitation, and in several invited seminars at different institutions. I am author/co-author of 47 papers, including two invited reviews. My H-index is 8.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **BADENES MONTOLIU, CARLOS** **Referencia:** RYC-2011-09187

Area: Física y Ciencias del Espacio

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Titulo:

New Views of Type Ia Supernova Progenitors

Resumen de la Memoria:

My research addresses key observational and theoretical aspects of Type Ia Supernovae (Ia SNe), from the identity of their progenitor systems to the physics of their explosion mechanisms. These issues have a direct impact on the role of SN Ia as sources of heavy elements in the Universe and as distance indicators in cosmology. To break new ground in this field, I propose to shift the focus from the hundreds of distant SNe routinely discovered every year by optical telescopes to nearby objects that provide a much more detailed view of the SN Ia phenomenon: supernova remnants (SNRs) and binary white dwarfs (WDs). I describe three research lines to be conducted in parallel: * Studies of individual young SNRs in the X-rays to explore the details of the ejecta structure and the relationship between the SN Ia explosion mechanism and the environment.* Studies of complete SNR samples and resolved stellar populations in nearby galaxies to measure the SN Ia rate and the delay time distribution of SN Ia progenitors (i.e., SN rate as a function of age).* A survey of short-period binary WDs discovered by mining the spectroscopic data base of the Sloan Digital Sky Survey (SDSS) to discover potential SN Ia progenitors and measure the rate of WD mergers in the Milky Way. Although these lines involve very diverse astronomical methods and techniques, they share a unified scientific goal to improve our knowledge of SN Ia progenitors. They also share a common drive to develop innovative data analysis and data mining techniques that can take the maximum advantage of public data. The next decades in astronomy are going to be dominated by large surveys that wil trigger an exponential growth in the quantity and quality of public data. In this context, I think my proposed research plan will contribute to the development of the strategic skills of data management and data mining within Spanish astronomy.

Resumen del Curriculum Vitae:

Career: I got my B.S. and M.S. in Electrical Engineering at the Universitat Politècnica de Catalunya (UPC) in Barcelona between 1993 and 1999 (Ingeniería Superior de Telecomunicaciones). I did my Masters Thesis under Dr. Eduardo Bravo, designing a detection simulator for a scientific mini-satellite for astrophysical observations in the X-rays (SIXE). In 1999, I decided to switch from engineering to astrophysics, enrolling in the graduate program at the UPC, with Dr. Bravo as my thesis advisor. During my graduate studies, I was a teaching assistant at the School of Mechanical Engineering of Barcelona. I also visited several international research centers: the Centre d'Étude Spatiale des Rayonnements (Toulouse, France; 3 months in 2001), North Carolina State University (Raleigh, North Carolina, USA; 3 months in 2002), and the NASA Goddard Space Flight Center (Greenbelt, Maryland, USA; 1.5 months in 2003). I obtained my Ph.D. in 2004 and shortly thereafter I was hired as a postdoctoral researcher at Rutgers, the State University of New Jersey, by Dr. John P. Hughes. In 2006 I was awarded a Chandra Fellowship by NASA, which I split between Rutgers University (one year, 2006-2007) and the Department of Astrophysical Sciences of Princeton University (two years, 2007-2009). In 2009, I was awarded a Senior Research Fellowship jointly by the Benoziyo Center for Astrophysics at the Weizmann Institute of Science and the Department of Astrophysics at Tel-Aviv University (Israel), where I conduct independent research within the groups of Prof. Avishay Gal-Yam (WIS) and Dan Maoz (TAU). In December 2010, I was awarded an European Union IRG grant to fund my research in Israel. During my postdoc years, I have visited several research centers in the USA and Europe. The most relevant stays have been at the Kavli Institute for Theoretical Physics (Santa Barbara, California, USA; 1 month in 2007 invited by Dr. Lars Bildsten), the Astronomy Department at the University of California Berkeley (Berkeley, California, USA; 1 month and a half in 2008, invited by Dr. Alexei Filippenko). Publication record and other achievements: I have published 28 papers in refereed journals (13 of them as first author, including one invited review), and 10 conference proceedings. My publications have received more than 590 citations as of February 10, 2011, with an H parameter of 12. I have attended 30 international meetings, where I presented 6 invited reviews, 8 invited talks, 10 contributed talks, and 8 posters. I have given 44 colloquia and seminars in universities and research centers around the world. I have served in several NASA committees, including time allocation committees (Chandra, Swift and Suzaku) and committees to define scientific objectives for upcoming missions (IXO and Constellation-X).

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **BONCIANI , ROBERTO** **Referencia:** RYC-2011-07816

Area: Física y Ciencias del Espacio

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Titulo:

Precise predictions for top-quark physics at LHC

Resumen de la Memoria:

Thanks to the start of activity of the CERN Large Hadron proton-proton Collider (LHC), in the next few years it will be possible to study physics at the TeV energy scale, with an experimental accuracy never reached before. The understanding of the electroweak symmetry breaking, the validity range of the Standard Model and the possible discovery of new physics beyond it, will push particle physics towards a better understanding of the laws that govern the Universe. The search program of LHC rely on a good control of the experimental setup as well as on a good understanding and control of the theory, i.e. Quantum Field Theory in the perturbative regime, with QCD that will play a crucial role. LHC will be a factory of heavy quarks: in the high-luminosity high-energy phase (~100/fb/year at 14 TeV), a pair of top-antitop will be produced approximately every second, with 5x10^5 pairs of bottom-antibottom and 8x10^6 pairs of charme-anticharme. This huge amount of data, collected already in the first years of run, will make in such a way that the statistical error of the experimental measurements will be immediately negligible, and top physics will become soon ¿precision physics¿. Many observables are planned to be measured at the LHC with a ¿few percents¿ accuracy. Theoretical perturbative calculations will have to match this accuracy. At the moment, many LHC processes are known at the level of next-to-leading order radiative corrections and the Monte Carlo event generators are systematically including them. Nevertheless, for key processes, as for instance top-antitop production and decay, the control of the NNLO corrections will be mandatory to match the experimental accuracy. The goal of the research project here presented is to calculate the NNLO corrections (mainly QCD corrections) to the most important observables concerning top-quark physics at the LHC: the production cross section, including the decay products for a description of the process closer to the experimental requirements; the invariant mass and more exclusive distributions; the spin correlations; the asymmetries. Moreover, top quark is very important in many models of physics beyond the SM, in which it plays a direct role in the mechanism for the electroweak symmetry breaking or it has enhanced interactions with new gauge bosons coming, for instance, from the breaking of grand unified symmetry groups. This aspect deserves a detailed study in which accurate theoretical results concerning the possible effects of new physics could be compared with equally accurate predictions within the SM of fundamental interactions. The expertise to achieve these goals is there. In the last few years a big improvement in the calculation of Feynman diagrams was done, and many results were found, also in the heavy-quark sector. The techniques used (reduction to the master integrals, differential equations, Mellin-Barnes transformations, dipole or antennae formalisms, etc.) are by now well established and they can be applied as well to this new challenge. This will be an optimal testing ground, and it will be also the occasion for the development of new techniques and new ideas for the evaluation of higher-order corrections in quantum field theory.

Resumen del Curriculum Vitae:

I graduated in Physics at the University of Florence, Italy, working with Prof. S. Catani on the resummation of threshold-enhanced next-to-leading logarithmic contributions to the production of heavy quarks at hadronic colliders. I got the PhD in Physics at the University of Bologna, working with Prof. E. Remiddi at the development of new techniques for the calculation of Feynman diagrams. During the PhD, I presented in the frame of ¿Progetto Giovani Ricercatori¿ of the University of Bologna, my own project concerning the application, to massive three- and four-point Feynman diagrams, of the techniques based on the reduction to the master integrals, that were just starting to be introduced in the mass-less case; the project got funding. Within my project I had collaborations with the Karlsruhe University, Germany, were I spent also some months. After the PhD, I was ¿Fondazione A. Della Riccia¿ (Italian Fundation) fellow at the Theory Division of CERN, Switzerland. Then, I was Marie Curie fellow of the European Network ¿Particle Physics Phenomenology of High Energy Colliders¿ at the University of Freiburg, Germany, and DFG postdoctoral researcher in the same University; Marie Curie fellow of the European Network ¿EURIDICE¿ and postdoctoral researcher of the MEC at the IFIC (Istituto de Física Corpuscular) in Valencia, Spain. In September 2007 I got an I3P postdoc position at the IFIC. Then, I spent one year as a postdoctoral researcher in the Institute for Theoretical Physics of the University of Zuerich, Switzerland and, since the beginning of 2009, I am a 3+3 years senior CNRS researcher at the LPSC of Grenoble. I participated to many research projects, funded by Universities and/or Research Institutions, five of them in quality of Principal Investigator.My research interests concern mainly the phenomenology of the Standard Model (in particular QCD) and its extensions, at lepton and hadron colliders. In particular, my current work is devoted to the physics of the CERN LHC. I am involved in several collaborations working on the study of radiative corrections at the level of next-to-leading and next-to-next-to-leading order in perturbative quantum field theory, for observables that will play a crucial role in the LHC programme.I published 32 papers that were taken in a very good consideration by the international high-energy physics community. Among the most important results achieved, I would like to mention the calculation of the heavy-quark hadro-production cross section up to, and including, next-to-leading threshold-enhanced logarithms, that since a decade is a reference work for the accurate determination of the top-antitop total cross section at Tevatron, and the calculation of the two-loop light-fermion contribution to the Higgs production cross section and two-photons decay width at hadron colliders. Recently, I started to work on the calculation of the NNLO QCD corrections to top-antitop observables at LHC, a long-term project that will be able to face the incredible improvements in the experimental accuracy coming from the LHC data.In the last years I was instructor of Advanced Quantum Mechanics in Freiburg University and of Analytical Mechanics in Grenoble University. I teached a course in quantum field theory for the PhD school in Grenoble; I co-supervised a degree and a PhD thesis and I am supervising a PhD student.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **DAFNI , THEOPISTI** **Referencia:** RYC-2011-07661

Area: Física y Ciencias del Espacio

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Titulo:

Gas Time Projection Chambers for Rare-Event Searches

Resumen de la Memoria:

The present Project falls in the lines of the research in Rare-Event Searches (axions, neutrinos, dark matter). It proposes the exploration of the new available technologies for the development of gaseous Time Projection Chambers (TPCs) in order to prove their viability through the strict requirements of the field of rare event searches: low backgrounds, low energy thresholds, spatial and energy resolution, stability of operation, scaling-up, etc. More specifically, the main idea is to investigate the merging of the technology of the micropattern detectors ¿in particular the MICROMEGAS- with low background techniques and study the possibility to push the spatial resolution (for WIMPs or axions) and energy resolution (for double beta decay) to a maximum, to achieve very good event topology information and background discrimination, without compromising the good scaling- up potential offered by the technology. The ERC-funded T-REX project of the Zaragoza group offers the appropriate framework for the work here proposed. It is a transversal R ββ decay of 136Xe in the Canfranc Underground Laboratory. The ultimate goal of NEXT is to jump to a 1-ton device able to probe the entire inverse hierarchy neutrino mass model band. NEXT is currently going through a very active prototyping stage, and faces the start of activities underground in the coming months. In addition, low background TPCs optimized for x-ray detection are a key ingredient of axion helioscopes like CAST, the world-leading experiment in axion searches at CERN. CAST has been indeed a pioneer in some of the considerations above, being a test bench for the last state-of-the-art low background Micromegas detectors. The studies here proposed would have a direct impact on the future new generation axion helioscope, currently under conception.The proposed research is drawn along these, already approved and active, projects. The objective is two-fold: a) the contribution to the generic development of TPCs for rare events, pushing aspects like radiopurity, low energy thresholds or very high spatial resolutions (for WIMPs or axions), discrimination techniques, energy resolution (for ββ), shielding techniques, stability of operation, scaling-up, etc. and b) the contribution to the construction, installation and operation of NEXT prototypes at LSC, which should greatly benefit the first point. The methodology towards the proposed goal would be developed in two fronts: on one hand the study of the phenomenology of the physics involved as well as of the working principles of the detectors based on simulation/calculation work; on the other, the design and building of prototypes (readout planes, electronics and eventually a full prototype) in order to prove the feasibility ¿ and the limitations- of this technology and experimentally test the aforementioned studies.

Resumen del Curriculum Vitae:

I have a long track record in Rare Events in Astroparticle Physics (dark matter, axion, double beta decay) and instrumentation of Time Projection Chambers, especially with Micromegas readouts. I obtained my PhD degree from the University of Technische Universitaet Darmstadt, Germany in 2005, under the supervision of Prof. Dr H.H.H. Hoffmann. During my doctoral studies I worked at CERN in the CERN Axion Solar Telescope (CAST) experiment lead by Prof. K. Zioutas. I was deeply involved in aspects like the operation, data taking and analysis of the experiment. I was responsible of the CAST Micromegas detector, whose data I analyzed to extract a limit of the properties of the axion. This result was part of the first physics paper of the collaboration (Phys. Rev. Lett. 94 121301, 2005), nowadays the most cited experimental paper on axion physics. I later performed a 2-year post-doctoral stay at the SPhN group at CEA Saclay, lead by Dr F. Kunne, for the nuclear physics experiment COMPASS at CERN. There I had to supervise/organize the studies campaign for technical improvements of the Micromegas detectors planned for the second phase of the experiment, apart from the running and maintenance of the 12 Micromegas already installed. After that, I obtained a Juan de la Cierva grant awarded by the Spanish Ministry, to join the group of the Zaragoza University, and its physics program in the Canfranc Underground Laboratory and CERN. Here I got involved in the search for double beta decay (experiments SuperNEMO and NEXT), as well as in the RD-51 collaboration at CERN, devoted to developments of micro-pattern detectors. I have been active in the tasks of development of Micromegas readouts for double beta decay, with relevant results regarding their potential energy resolution and radiopurity. Throughout these years, I have been working in close collaboration with Dr. I. Giomataris, creator of the Micromegas concept, and his group at Saclay. I am deputy Team Leader for the Zaragoza group for the CAST and RD-51 Collaborations and a member of the Steering Committee of the former. Within the NEXT collaboration, I share the responsibility of the important NEXT-10 project consisting in the first activities underground and the gas system design and construction. I have presented my work in many international conferences. I currently have 28 publications of which approx. 65% is in the 25% highest impact factor of its area, as well as 40 proceedings of international conferences a good part of which have been refereed. I am co-author of two review articles (¿The case for a directional dark matter detector and the status of current experimental efforts¿, Int. J. Mod. Phys. A 25: 1-51, 2010 and ¿Axion searches with helioscopes and astrophysical signatures for axion(-like) particles¿, New J. Phys. 11 125020, 2009), and I have participated in the organization of an international school and an international workshop. I have had teaching responsibilities at graduate and undergraduate level, including the supervision of a doctoral student.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **RAMASCO SUKIA, JOSE JAVIER** **Referencia:** RYC-2011-08510

Area: Física y Ciencias del Espacio

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Titulo:

Networks as a tool to study Complex Systems: structural description and applications to real-world systems

Resumen de la Memoria:

Las líneas de esta propuesta representan investigación original en el área de conocimiento en el área de Sistemas Complejos. El uso de redes para caracterizar las interacciones entre los elementos que componen un sistema complejo tiene una larga tradición en disciplinas como Economía, Sociología y Matemáticas. Sin embargo, esta idea no se ha generalizado a otros campos hasta hace poco años. Las actuales tecnologías en red como la Internet, la Web o las redes sociales online han contribuido notablemente a este éxito. Su existencia ha portado también un buen número de oportunidades para la investigación ya que han facilitado substancialmente el acceso a grandes bases de datos relativas a la actividad de sistemas complejos. Hoy, gracias a Internet, es fácil poder delinear redes representando las interacciones de los elementos al interno de sistemas sociales, ecológicos, biológicos o incluso económicos, son comunes las redes de interacciones entre usuarios de las redes sociales, de interacción de proteínas al interno de una célula, entre compañías, de regulación de genes, etc., ... así como datos sobre su evolución temporal. Dada esta situación, algunas cuestiones que surgen inmediatamente son, por ejemplo, ¿cuál es el mejor método para recuperar tanta información como sea posible sobre el sistema complejo original desde la representación en forma de red? ¿Hay algún límite a la información recuperable? ¿Se pueden clasificar los elementos del sistemas de acuerdo con su papel en la red de interacciones? La búsqueda de respuestas a estas preguntas se puede encuadrar dentro del área que estudia la estructura de las redes complejas, uno de las tres líneas en esta propuesta. La idea es usar herramientas de la Teoría de la Información y herramientas estadísticas como la inferencia Bayesiana para buscar respuestas bien fundamentas desde el punto de vista matemático a estas cuestiones y también aplicar las nuevas herramientas creadas a las redes representado sistemas complejos reales. Será también necesario la comparación de los resultados con los actuales métodos de carácter heurístico y se buscará llegar hasta las consecuencias de estos resultados en el contexto de origen de las redes analizadas (sociología, ecología, etc). Ésta es la primera de las tres líneas de investigación propuestas, en las cuales como se puede ver en mi CV tengo cierta experiencia además de haber desarrollado ya un buen número de colaboraciones internacionales. Mi intención es usar el contrato Ramón y Cajal como una plataforma para lanzar un programa de investigación independiente en esta área al mismo tiempo competitivo y bien integrado a nivel internacional.

Resumen del Curriculum Vitae:

Mi actividad en la investigación comenzó en el área de Física Estadística, en el análisis del crecimiento de interfases, y la he orientado después hacia el estudio de sistemas complejos y más particularmente de redes complejas junto a sus aplicaciones a sistemas reales en diversas disciplinas . Mi experiencia, a parte del doctorado en el Instituto de Física de Cantabria en Santander, incluye dos postdocs de dos años cada uno: el primero en el Centro de Fisica do Porto, en la Universidad de Oporto, Portugal, y el segundo en el Physics Department de la Emory University en Atlanta, EE.UU., un periodo de cuatro años como investigador en la ISI Foundation en Turín, Italia, y de vuelta a España como Jae-doc en el IFISC de Palma de Mallorca. Mi campo de investigación es el estudio de los sistemas complejos mediante el uso de redes. Esto conlleva una orientación teórica pero también incluye aplicaciones prácticas como el proyecto GLEaM, un simulador global de propagación de epidemias, o la herramienta de detección de estructura en redes OSLOM. Durante estos años he escrito 37 artículos publicados en revistas con buena visibilidad, incluyendo 1 PNAS y 5 PRL, trabajos que han recibido más de 300 citas. He realizado también presentaciones en un buen número de congresos internacionales de las cuales 9 charlas invitadas. Recientemente he recibido también financiación por parte del proyecto SESAR de la UE y Eurocontrol para un proyecto de estudio y optimización de las redes de transporte aéreo. El proyecto incluye un estudiante de doctorado cuya tesis codirigiré a partir de marzo.

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SUBPROGRAMA RAMON Y CAJAL

CONVOCATORIA 2011

Nombre: **CROCCE , HECTOR MARTIN** **Referencia:** RYC-2011-09173

Area: Física y Ciencias del Espacio

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Titulo:

Challenges and Opportunities for the 21st century Cosmology

Resumen de la Memoria:

The striking discovery that the Universe expansion is not slowing down but in fact accelerating has become one of the main puzzles in the whole of Physics today, setting the programme for the 21st century Cosmology and making this by far the most exciting time to be studying the origin and evolution of the large scale structure of the Universe.The ultimate way to tackle this challenge is by implementing large astronomical surveys probing a significant fraction of the observable Universe, and scanning the way millions of galaxies and other structures distribute. Some such surveys have been successfully completed and others, much larger, are planned to yield a wealth of new data in the near future (2012-2013) such as the international Dark Energy Survey (DES) and the Spanish Physics of the Accelerating Universe (PAU), culminating in the ESA Euclid mission for Cosmic Vision 2015-2025.However, the exquisite statistical precision at which they will render the large scale structure distribution needs an unprecedented level of accuracy in our theoretical models and numerical simulations to provide the interpretative framework that will maximize the scientific return. This level of accomplishment has not been reach yet, despite efforts taken in this direction. Contributing with multiple approaches towards this new standard is the ultimate goal of this proposal.I will follow three solid lines of research where I have a strong background and expertise, further developing each of them and their interplay. Novel research in theoretical models of large-scale structure and clustering following successful ideas that I partially pioneered. Implementation and analysis of some of the largest cosmological simulations of structure formation, in collaboration with top-ranked groups in this field. This will be done in the context of the MICE project, an active collaboration that have already completed several different simulations including a record 70 billion particle one within a cosmological volume of 30 cubic Gpc.Merging and cross-validation of results developing essential tools to interpret the wealth of information from upcoming astronomical surveys of which I am an active member already leading activities within their working groups, DES, PAU and the ESA/Euclid mission.We are witnessing a very exciting time in which our understanding of the Universe can dramatically change, and we need to be up to it. I believe that only the precise interplay of theoretical, numerical and observational cosmology will allow us to solve the most intriguing puzzles in this field.

Resumen del Curriculum Vitae:

I obtained my PhD at NEW YORK UNIVERSITY (USA) in 2007, after developing an innovative formalism that merged Field Theory techniques into Cosmology to describe the growth of structure at cosmological scale and solve some long-standing problems in the area. Soon after my graduation I was awarded a Juan de la Cierva fellowship to conduct postdoctoral research at the Institute for Space Science (ICE) at Barcelona. At ICE I am actively involved in some of the largest astronomical surveys that will take place in the inmediate future (2012-2017), the international Dark Energy Survey and the Spanish PAU Survey, as well as ESA/Euclid in the longer term (2018).My main lines of work lay in the rich interphase of theoretical and numerical cosmology and their interplay to interpret observational data.I had led several projects in the field of large-scale structure and theoretical cosmology. In particular a series of 3 papers that showed for the first time that it was possible to model the large-scale matter clustering in simulations with a precision of ~ 1 percent. They reached 200 citations over 3 years. Our work constitutes a solid starting point to an accurate description of baryon acoustic oscillations and redshift space distortions, two of the most promising observational probes of dark-energy.I also gained a deep expertise in the field of computational cosmology that allowed me form part of the core-team at ICE developing and analyzing some of the largest cosmological simulations of structure formation to date (e.g. 70 billion particles with 30 cubic Gpc). I have full responsability for finding the virialized structure, or halos, from these runs. My papers in this area includes a more accurate way of imposing initial conditions in simulations, that have become a common practice in the field. More recently, I led a project that calibrated the expected abundance of the most massive clusters in Universe using N-body simulations.In addition I have an established background in the interpretation of observational data, with relevant papers based on clustering analysis of the Luminous Red Galaxies in the Sloan Survey, both at low (using spectroscopic data) and high redshift (using photometric one, as will be done in DES, PAU and Euclid) Throughout my carrer I had contributed several first author papers in refereed journals with an average of ~ 50 citations per paper. Their scientific impact granted me invited talks to 9 conferences and 13 seminars in well-known departments throughout Europe, USA and Japan. Most importantly, some of my publications had ignited new and innovative lines of research within the field of large-scale structure. I had maintained, and keep, successful interactions with leading scientists in top regarded groups at Spain (UAM, CIEMAT, IFAE) and abroad (e.g. Durham U., Ohio State U., Fermilab, Saclay, Zurich U., MPA and NYU) some of which consider me a regular visitor today.