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AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2017

Turno de acceso general

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Título:

Towards de New Standard Model with Flavor

Resumen de la Memoria:

The Standard Model (SM) is the currently accepted theory of elementary particles and their interactions. However, it is known that it fails to describe some physics (Gravity, Dark Matter, Baryon asymmetry...) and therefore it must be complemented with new degrees of freedom. Most international efforts in High-Energy physics are devoted to the search for these new degrees of freedom. My research career has focused on the intensity frontier, exploiting the potential of flavor physics in the quark sector to search for physics beyond the Standard Model.

When testing the SM with quark flavor physics, understanding QCD (the theory of strong interactions embedded in the SM) is essential, since a control of hadronic effects in low-energy processes involving quarks is necessary for a clean separation of possible New Physics contributions from the SM background.

In my research I have focused mostly on the understanding of QCD in processes that serve to test the SM and to probe New Physics, devising optimized strategies to reduce hadronic uncertainties in flavor observables, and working out the implications of experimental measurements. This requires a good control of a large sample of tools such as factorization, perturbative QCD (multi-loop) calculations or non- perturbative methods, and a deep knowledge of QCD and SM physics, Effective Field Theories and Beyond- the-SM physics. In addition, all these activities have been performed in constant interaction with the experimental particle-physics community.

In this line, I have published important work on a wide range of different topics, such as: Non-leptonic B decays, Pade unitarizations, neutral Meson mixing, angular distributions in semi-leptonic decays, radiative corrections to flavor observables, factorization in heavy-meson decays, model-independent fits, flavor physics in supersymmetry and other New Physics models, model-building for flavor anomalies, and computer tools for phenomenology. I have also participated in the elaboration of several reviews and reports on flavor physics, the last one being the Belle-II Physics Book where I have contributed two sections.

I have carried out these activities at universities in Spain (Barcelona), Italy (Rome), Germany (Siegen and Munich), France (Paris), Switzerland (Bern) and the United States (MIT). I have maintained a high rate of scientific productivity, with many highly cited papers that are having significant impact. I have collaborated with a large number of colleagues, and in a wide diversity of topics (from QCD to model-building), and have a proven record of funding generation and project management. All this highlights my scientific independence. I have co-supervised two PhD theses and supervised an undergraduate thesis, and I have experience in management and organization of scientific events.

My research is being followed up by the community, and having a significant impact and recognition.

Resumen del Currículum Vitae:

I received my PhD in Physics from Universitat Autonoma de Barcelona (UAB) in December 2007 with the thesis "Topics in Hadronic B decays" focused on the New Physics reach of two-body non-leptonic B decays. During that period I got a Master degree on Advanced Mathematics at UAB, with the thesis "On the Characterization of Polyhedra in Hyperbolic 3-space" (2008).

Since 2008 I have held postdoctoral or visiting research positions at the University of Rome (as a Marie Curie Early Stage Research fellow first, and as an INFN fellow later), at IFAE (Barcelona), the University of Siegen (Germany), the Laboratory of Theoretical Physics at the University of Paris-Sud (France), the University of Bern (Switzerland), and the Massachusetts Institute of Technology (USA).

Since July 2017 I am a research associate at the Massachusetts Institute of Technology, with a joint appointment at the Technical University of Munich. I manage my own EU-funded research project, related to the interpretation of flavor measurements at LHC and Belle-II.

I have published 33 research articles in prestigious international peer-reviewed journals (two more under review as of December 2017), many of them topcited. I have an H factor H=24 and more than 3000 citations overall (INSPIRE-HEP database). I have given 90 seminars at universities and international conferences, most of them as invited speaker. I am a regular referee for 7 of the most important journals in my field (with a distinguished referee award from The European Physical Journal C), and have been Editor for Hindawi Publishing. I have

experience convening and organizing conferences (including a grant from the Heraeus Foundation in 2016), tutoring and teaching in postgraduate schools, and supervising and undergraduate and co-supervising 2 PhD theses. I have also an extensive teaching record, with 800 hours of experience in undergraduate and graduate university courses. My current project contains six planned specified outreach activities in 2018. I also have experience in funding generation and project management.

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Título:

Exploring the Extremes of Physics with Compact Stars

Resumen de la Memoria:

My current and future plans move along a few main research lines.

1. X-ray binaries
 I want to investigate in more depth the evolutionary link between the different classes of objects (like accreting pulsars, transitional pulsars, non-pulsating LMXBs, etc). My plan is also to settle the question about the response of the magnetic field of neutron stars with accretion.
 How is accretion influenced by magnetic fields in the inner regions of the accretion disk? Some important work has been done in this area by myself and my group in Leiden. Now that the theoretical framework is developed I am
thrilled to consolidate this research area and develop observational tests to verify the predictions and the implications of the model.

2. Gravitational Waves.

 Expand my work on gravitational waves, in particular on the spin-down it generates and its measure in X-ray binaries and radio pulsars. I recently had the idea to calculate the effect of crustal mountains on the transitional pulsar PSR J1023+0038. Together with my collaborator Dr. B. Haskell we quantitatively developed the idea further and published the results in the journal Physical Review Letters. I believe it would be possible in the near future to check for similar effects in other binaries and to explore further the consequences of gravitational waves emitted
from neutron stars.
 I would like to start investigating new topics related to compact objects and gravitational waves which are very urgent at the moment: which different gravitational wave signals are expected from different neutron star systems? How can they be characterized with real observables, and distinguished from other gravitational wave emitters? How do the gravitational wave predictions depend on the equation of state and the magnetic field
configuration/evolution of neutron stars?

 In view of the upcoming LISA gravitational space observatory it is important to characterize the gravitational wave sources that fall within the LISA sensitivity band. How do tides change the structure of close double white dwarfs and how does this affect the signals emitted by these sources? Even among the so-called verification sources, i.e., those nearby binaries which are guaranteed to be detected by the LISA observatory, there are a few known white dwarf binaries (so-called AM CVn stars) whose orbital period is not evolving according to the expected angular
momentum loss via gravitational wave radiation. The reason for this is not well understood. My plan is to further investigate this effect both observationally (with multi-wavelength campaigns targeting specific objects) and
theoretically by considering the possible mechanisms behind this behavior (e.g., magnetic fields, tides, mass transfer).

3. Pulsar Planets
 I would like to also expand further on my current work on pulsar and neutron star planets. I believe there might be some potentially interesting candidates for new pulsar planetary system and I want to investigate this further both with radio observations and with numerical simulations. This effort is currently based on a collaboration with the pulsar group at Jodrell Bank. This work can potentially become very broad as I am currently also exploring the idea of detecting debris disks around pulsars with the ALMA telescope.

Resumen del Currículum Vitae:

My research centers on observational and theoretical studies of compact objects, with a particular focus on neutron stars and X-ray binaries. The use of state-of-the-art observational techniques and a good theoretical knowledge of the systems under study represent the key of my research method. A significant part of my past research has been dedicated to the study of accreting neutron stars in X-ray binaries and radio pulsars, but I have also worked on numerical simulations with binary evolution codes of black hole binaries, pulsar planets, radio jets and
accretion disks.

My main observational expertise is in the area of high energy astrophysics and I have an established leadership in the field of accreting

millisecond pulsars and X-ray binaries. I have also done some important research on gravitational waves, in particular on the emission mechanisms of continuous gravitational waves. I consider myself as an astrophysicist with a broad range of interests, able to link different research fields together and with many innovative ideas.

Fundamental and extreme physics involves many aspects of my neutron star research: what kind of particles compose the core of neutrons stars? Can neutron stars be efficient gravitational wave emitters? Why does the accreting neutron stars' gargantuan magnetic field decay over time? To answer these questions I use accretion physics as a physical setting with the aim to constrain extreme physics: for example understanding the origin of variability in accretion discs can be crucial to infer physical parameters of the compact objects. Answering these questions is not only important for the astrophysics of compact stars, but can also provide the solution to some of the most important open issues in fundamental physics and cosmology. For example, identifying the particles in the core of neutron stars can provide unique information on the behaviour of the strong force at supra-nuclear density. Understanding how neutron stars can emit continuous gravitational waves can tell us which are the best primary targets for LIGO/Virgo searches. Understanding whether intermediate mass black holes really exist can give important hints about the formation of super-massive black holes and thus on how the large scale structure of the Universe has evolved. Stellar astrophysics is also an area that I explore with great passion, in particular I am interested in the evolution of stars that are losing mass in a binary. To do this I use both observations and numerical methods, in particular binary evolution numerical codes to address questions that involve the evolution of donor stars that undergo mass loss.

I have built a small group at the Leiden University, thanks to a prestigious Vidi grant which has also allowed me to significantly broaden my international collaboration network.
I also have extensive teaching experience, both as a lecturer (four courses taught) and as a teaching assistant, collected over the past 11 years.

In summary: I am a very motivated researcher with an excellent track record both in terms of research ideas, publications, grants awarded and teaching/supervision experience. A Ramon y Cajal grant will allow me to consolidate my career and open up new exciting possibilities for my future.

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CONVOCATORIA 2017

Turno de acceso general

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Título:

Ultrafast phenomena at the nanoscale

Resumen de la Memoria:

Many phenomena in physics, chemistry and biology and a plethora of technological applications ultimately depend on processes that take place at ultrafast timescales and nanoscale length scales. My research has been focused on probing, understanding and exploiting these ultrafast, nanoscale processes.

My recent work, carried out as postdoctoral researcher and research fellow at ICFO the Institute of Photonic Sciences (Barcelona, Spain) and guest researcher at the Max Planck Institute for Polymer Research (Mainz, Germany), has been focused on optoelectronic processes in the recently discovered class of 2D layered materials. This work includes collaborations with researchers from highly prestigious institutes, including many groups belonging to the FET Flagship on Graphene; and has led to >15 publications, of which 7 in Nature family journals, and 1 patent application. The main topics:

- Probing light-induced hot-carrier effects in graphene using ultrafast nonlinear optical techniques, introducing the (later experimentally validated) concept of hot-carrier multiplication.

- Development of novel visible, infrared and THz photodetectors and following directly in time the ultrafast dynamics of photovoltage creation in 2D-material-based photodetectors.

- Demonstration of electrically tunable emitter-graphene coupling, including the first observation of graphene plasmons at the telecom wavelength of 1.5 micron.

- Initiating the field of ultrafast thermal heat flow in Van der Waals stacks.

During my Ph.D. studies, performed at AMOLF in Amsterdam (the Netherlands), and as visitor at Regensburg University (Germany), I studied ultrafast hydration phenomena in aqueous solutions, highly relevant for biology and chemistry. This work has led to >15 publications in top journals such as Science, Nat. Phys., Phys. Rev. Lett., J. Am. Chem. Soc., and Biophys. J. The main results:

- Development of novel ultrafast techniques, in particular terahertz dielectric relaxation spectroscopy and a unique infrared pump terahertz probe technique, allowing for increased understanding of the intriguing proton conduction mechanism and molecular heat flow.

- Investigating hydration dynamics around ions, hydrophobes and model cell membranes using a variety of gigahertz, terahertz and infrared spectroscopy, initiating the concept of semi-rigid hydration of ions, and discovering the importance of cooperative effects in ion hydration.

At Delft University of Technology (the Netherlands), I performed my final M.Sc. thesis, which has led to the first demonstration of coherent spin manipulation of single electrons in a lateral quantum dot, an important step forward in the field of quantum information processing, published in Nature.

Resumen del Currículum Vitae:

Active, highly cited physicist with a strongly multi-disciplinary background and experience in various internationally renowned universities and research institutes. Co-author of >30 peer-reviewed papers, of which 13 as first author and 1 as last author, and 10 in Science and Nature family journals. Currently receiving >500 citations per year, with total citations >3600. H-index of 23. Contributed 24 oral contributions at international meetings, of which 12 invited. Co-inventor of a patent, and author of 3 outreach articles in popular science journals (2 in Dutch, 1 in Spanish). Recipient of 3 personal research grants and a prestiguous Ph.D. thesis award. PI or co-PI of various funded competitive research proposals, among which the FET open project NanOQTech, serving as local coordinator. Co-supervisor of 10 Postdocs and Ph.D./M.Sc./B.Sc. students (4 current). Member of 2 Ph.D. committees and frequent reviewer for all the main international journals (Nature PG, APS, ACS, IEEE).

I studied Applied Physics at Delft University of Technology (the Netherlands), which included a B.Sc. project at the Cavendish Laboratory in

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Cambridge (UK) on nanolithography. My M.Sc. thesis project, which took place at the Kavli Institute of Nanoscience Delft in the field of quantum information processing, resulted in 3 publications, of which one in Nature (>1300 citations). I also hold a M.Sc. degree in Innovation and Entrepreneurship from Chalmers University (Sweden) and a post-graduate diploma in Economics from London School of Economics (UK).

My Ph.D. research took place at FOM Institute AMOLF in Amsterdam (the Netherlands), with a stay as guest researcher at Regensburg University (Germany), studying ultrafast molecular motions in aqueous systems. The covered topics are relevant for a range of disciplines, including chemistry, biology and physics. I employed and developed various ultrafast nonlinear optical techniques in the visible, infrared and terahertz range. My research resulted in >15 publications, of which many in top journals such as Science (>400 citations), Phys. Rev. Lett, Nat. Phys, J. Am. Chem. Soc. and Biophys. J. I also wrote 2 articles in a Dutch popular science journal, of which one was awarded the First Prize for a popular science article. My Ph.D. thesis was awarded with the prestigious FOM Physics Thesis Award 2011.

For my postdoctoral research I received a personal Rubicon (Marie Curie cofund) fellowship to study optoelectronics of 2D layered materials at ICFO - the Institute of Photonic Sciences (Barcelona, Spain) - offering an interesting combination of fundamental physics and potential applications in the fields of photodetection and telecommunications. Later, I became research fellow at ICFO, with funding from the FET Flagship on Graphene, a personal Mineco Young Investigator Grant and a co-written FET Open project, where I am local coordinator. During this time, I initiated and maintained many international collaborations and worked as a guest researcher at the Max Planck Institute for Polymer Research (Mainz, Germany) through a personal grant from the Max Planck Graduate Center. This research has led to >15 publications, of which many in top journals such as Nat. Nanotechnol. (3x), Nat. Phys. (2x), Nat. Commun. (2x) and Nano Lett. (3x), as well as one patent application and a popular science article in 'Revista de Fisica'.

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Turno de acceso general

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Título:

Nuclear structure and reactions with radioactive beams

Resumen de la Memoria:

My main research theme is to study the structure of exotic nuclei through direct nuclear reactions. In these reactions the entrance and exit channel are directly linked by a matrix element and thus information on the nuclear levels and their occupation can be obtained. During my PhD I worked on transfer reactions at REX-ISOLDE (CERN). I performed the first experiment using a two-neutron transfer reaction with a radioactive beam and a radioactive tritium target. The analysis of the excitation energies and angular distributions of the reaction products and gamma rays led to the discovery of the long sought excited 0+ state in 32Mg. The resulting publication (K. Wimmer et al., Physical Review Letters 105 (2010) 252501) has been cited 88 times. I have also lead several other transfer reaction experiments, both at ISOLDE and at TRIUMF (Vancouver, Canada). In 2017 I have been invited by Journal of Physics G, Nuclear and Particle Physics to write a Topical Review paper on this topic. Nucleon transfer reactions with radioactive beams has been accepted and is presently in press.

Another type of reactions to study the single-particle properties of nuclei are nucleon removal reactions. As a postdoc I worked on validating the theoretical description of the reaction mechanism of one- and two-nucleon removal. This work lead to 3 first author publications, including one in Physical Review Letters.

I was also heavily involved in the commissioning of the next generations gamma-ray tracking array GRETINA and its implementation at the NSCL (USA). I am spokesperson of three experiments with this device that for the basis of master and PhD theses projects for my students.

In the last years, I developed a new experimental program RIBF, RIKEN (Japan) using intermediate energy radioactive beams. I am presently spokesperson of four experiments, one of which has been already performed.

In addition to working with presently available beams at the world-leading radioactive beam facilities, I am developing new experimental devices and techniques. Lead my group, we have designed, built, and commissioned a new detector setup for transfer reactions with energy degraded beams at RIBF. This setup will be open to collaborations from around the world to perform transfer reactions in inverse kinematics. For two-neutron transfer reactions I am developing a radioactive tritium target in collaboration with researchers from RIKEN and Univ. of Toyama. For future experiments involving gamma-ray detection, we are aiming to build an array based the newly developed GAGG scintillator material.

Resumen del Currículum Vitae:

I am presently a lecturer at the University of Tokyo, Japan, leading my own research group consisting of two graduate students and a postdoc. Previously, I was assistant professor at Central Michigan University, USA (2012-2014) and postdoctoral research associate at the National Superconducting Cyclotron Laboratory, USA (2010-2012). I have received my PhD from the Technische Universität München, Germany, in 2010, and my Diploma from Ludwig- Maximilians-Universität, Germany, in 2007.

I have supervised graduate and undergraduate students in their research and guided them through their thesis work. I have teaching experience at graduate and undergraduate level.

My research is in the field of nuclear physics, specifically low-energy nuclear structure and reactions. Atomic nuclei show a number of remarkable features such as symmetry, shell structure, and shape coexistence. In particular I am interested in the structure of very exotic nuclei, focusing on experimental studies with radioactive beams to investigate these features in exotic nuclei. Far away from the stable isotopes, several experimental as well as theoretical investigations found evidence that the structure and properties change compared to the valley of stability. My goal is to find and track these changes in nuclear structure through direct reaction studies using a combination of particle and gamma-ray spectroscopy. I am leading established research programs at several facilities around the world, for example at ISOLDE (CERN Switzerland), NSCL (USA), TRIUMF (Canada), and RIBF (Japan).

I have authored 103 peer-reviewed journal publications with a total of 1089 citations. My h-index is 17 (researchersID). My publications include an invited Topical Review published in Journal of Physics G". On nine publications I am first, or corresponding author, on further ten I am one of the main authors. Except for the review paper, all articles are the result of international collaborations. 22 times I have been invited to talk at international conferences and workshops, I have given 32 contributed talks at national and international conferences, and 3 poster presentations. I have been invited to give seminars and colloquia at universities and research centers 22 times.

I am spokesperson of 11 experimental programs at four international research facilities. Each of my research projects involves a number of researchers from all over the world. I also serve as (vice-) chair of the RIBF users executive committee and as a sub-group leader of the ARIEL users committee. I serve as referee for all the main journals in the field of nuclear physics: Physical Review Letters, Physical Review C, Physics Letters B, European Physics Journal A, and Nuclear Instruments and Methods A. I have served as grant proposal reviewer for NSERC, Natural Sciences and Engineering Research Council of Canada, NSF, National Science Foundation, USA, and DFG, Deutsche Forschungsgemeinschaft, Germany.

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My research was previously supported by a grant from the National Science Foundation in the US, at present it partially supported through grants through the University of Tokyo, and a collaborative grant with the University of Toyama.

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Turno de acceso general

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Título:

Fisica de Astroparticulas Experimental

Resumen de la Memoria:

My main field of research is Astroparticle Physics with gamma-rays. I received my PhD in Physics in May, 2011 and the subject of my dissertation was the extragalactic background light (EBL) and its implications for galaxy evolution and gamma-ray astronomy co-supervised by Dr. Francisco Prada (Instituto de Física Teórica - Universidad Autónoma de Madrid) and Prof. Manuel Lozano (Universidad de Sevilla). During my PhD, I participated in the MAGIC collaboration with data analysis, telescope checks, and observational shifts. I also spent about two years of grad school under the supervision of Prof. Joel Primack at the University of California, Santa Cruz, working with both the Astronomy and the High-Energy groups. After my PhD, I moved to the University of California, Riverside where I worked with the observational astronomy group under the supervision of Prof. Brian Siana for three years using mainly Hubble Space Telescope data (photometry and grisms spectroscopy). Later, in 2014, I started another postdoctoral position at Clemson University, South Carolina under the supervision of Prof. Marco Ajello using data from the Fermi-LAT satellite and participating very actively in the Fermi-LAT collaboration. My total stay in United States institutions has been of about 6 years. Curently, I'm working at the Grupo de Altas Energías at the Universidad Complutense de Madrid with a Juan de la Cierva Incorporación Fellowship.

During my research career, I have developed skills in both optical/infrared and gamma-ray astronomy, working between theory and observations. Therefore, my scientific experience in different topics is rather broad, although my main expertise is in the field of gamma-ray (astroparticle) physics. In fact, understanding the EBL (my main expertise) is essential for the correct interpretation of extragalactic gamma-ray observations using present and future Cherenkov telescopes such as MAGIC and CTA.

I have participated in large collaborations such as AEGIS, Multidark, Fermi-LAT and MAGIC but also in small research groups. I have also co-led the effort of producing two complete all-sky Fermi catalog, which are focused on the highest-energies detected by the Fermi-LAT, 2FHL and 3FHL. These catalog are very well acknowledge by the community. These projects required leading and organizing a rather large group of researchers accross the world. Since August 2017, I'm Science Coordinator of the "Blazars, other AGNs, and Galaxy Clusters" working group of the Fermi-LAT Collaboration with approximately 170 members.

I'm also actively participating in the "EBL" and "Source population studies" working groups of the CTA Collaboration and have interest in the future e-Astrogam Space Telescope to which I have written a scientific proposal.

As I described in more detail in other sections of this proposal, I stress that my CV contains articles from many different aspects of Astronomy and also Astroparticle, it contains numerous invited talks, received media attention, refereed several papers for ApJ, published an article in the prestigious Scientific American magazine, and currently I am writing, together with Joel Primack, an invited EBL review article for the high-impact journal "Report on Progress in Physics". Beside this, I am co-editor, together with Marco Ajello, of a Springer book on EBL that will be called "The Cosmic History of Light".

Resumen del Currículum Vitae:

Briefly, I will summarize my Scientific merits and achievements. I have written 10 articles as a first or corresponding author in prestigious refereed journals (Astrophysical Journal, Astrophysical Journal Letters, Monthly Notices of the Royal Astronomy Society, and Journal of Cosmology and Astroparticle Physics) with a total number of 633 citations (only first author papers) since the year 2011. My most cited first author works are Dominguez et al. (2011) with 287 citations (this work describes a reference model in gamma-ray astronomy, used by the whole community), Ackermann et al. 2016 (2FHL catalog) with 117 citations, and Dominguez et al. (2013a) with 82 citations. I have participated in other 15 articles in which I have played a major role (many times as 3rd or 4th co-author) with a total number of citations of 1461. In addition, I have other 90 papers written as a member of the MAGIC collaboration and 10 papers as an affiliated Fermi-LAT researcher. Furthermore, I'm currently very active in the CTA collaboration with an important contribution to the "Extragalactic Background Light" and "Source population studies" working groups. My h-index is 43 as it can be seen on this image along with other productivity measures (https://goo.gl/KJ5Ndd). I'm coordinator of the "Blazars and other Active Galactic Nuclei" group of the Fermi-LAT Collaboration since August 2017 (including approximately 160 members). I have also helped the astrophysics community by referring a few articles for the ApJ and ApJ Letters journals, and refereed many papers internally for the Fermi-LAT Collaboration and some for the MAGIC and CTA collaborations.

I have also written an outreach article for the prestigious " Scientific American" magazine published as Dominguez, Primack, and Bell in the

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June 2015 issue. Furthermore, I have published an article in the Spanish magazine " Investigación y Ciencia" in the August 2015 issue and there is another one for the same magazine coming out in March, 2018 entitled "El Universo Violento". My CV contains numerous presentations and seminars. I have been invited to give talks at 14 international and top-prestigious conferences and workshops, including a highlight presentation at the ICRC'17. I have given other 22 contributed talks in different conferences. In addition, I have also given 25 seminars and colloquia in world-class research institutions worldwide such as Stanford University, University of California - Los Angeles, Santa Barbara, Santa Cruz, San Diego, and Irvine, also at the Carnegie observatories and California Institute of Technology (Caltech), University of Minnesota, University of Delaware, Georgia Institute of Technology (Georgia Tech), Oskar Klein Centre at Stockholm University, Deutsches Elektronen-Synchrotron.

My work has gotten world-wide media attention three times with the press release "Astronomers measure the Elusive Extragalactic Background Light", the NASA press release "NASA's Fermi Space Telescope Sharpens its High-energy Vision", and "International team unveil map of the universe□s most powerful marvels". Furthermore, I have been interviewed by " Science News", in the article "Everlasting Light" in the September 2013 issue and participated several times on outreach activities at the Science Fair in Sevilla. Currently, I am a Juan de la Cierva Incorporación Fellow (2nd ranked in the Physics Area).

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Título:

Nuclear structure to unveil the nature of neutrinos and dark matter

Resumen de la Memoria:

Nuclear theory is progressing spectacularly, with first-principles studies using QCD-based nuclear forces now reaching medium-mass nuclei. My investigations at the Technical University Darmstadt and the University of Tokyo are at the forefront of these developments, covering the shell evolution and spectroscopy of neutron-rich nuclei using three-nucleon forces. My theoretical predictions have triggered collaborations with experimental groups in North America, Europe and Japan.

Since my Ph. D. (Universidad Autónoma de Madrid, 2009) my research extends to fundamental symmetries. Neutrinoless double-beta decay searches aim to establish whether neutrinos are its own antiparticle and determine their mass, and direct detection is key to understand the nature of dark matter. However, fully exploiting these experiments demands reliable nuclear physics input. I obtained reference double-beta decay and dark matter-nucleus scattering matrix elements, considering for the first time the coupling to two nucleons, and identifying crucial nuclear correlations that reduced theoretical uncertainties. World-leading double-beta decay and dark matter direct detection experiments use my results to constrain neutrino masses and dark matter-nucleon interactions.

Resumen del Currículum Vitae:

My work is published in 40+ articles in top journals (including 1 Nature, 7 Physical Review Letters, 1 Reports of Progress in Physics, 1 Annual Reviews of Nuclear and Particle Science, 14 Physical Review articles), has received ~2000 citations (h-factor=23) and was highlighted for the general public by "agencia SINC" news service. I am presenter of 70+ talks (including invited, plenary and colloquia) held in 16 countries, co-organizer of an INT program besides 2 other international workshops, and referee of 10 international journals including Physical Review Letters, Physics Letters B, Physical Review C/D and Journal of Cosmology and Astroparticle Physics.

In Spain, Germany and Japan I have co-supervised 2 Master and 2 Bachelor theses, taught Master and undergraduate courses and been Lecturer at an International Summer School. In addition, I have given outreach talks at High Schools.

I have been awarded a JSPS-KAKENHI research grant (funded with about 20k$) and participated in several international projects. The Editorial Board of Journal of Physics G selected me as "Emerging Leader". I have been offered a tenure-track position at the University of Tennessee, and short-listed at TRIUMF.

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Turno de acceso general

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Título:

Coherent x-ray pulses for a new generation of ultrafast nanoscience applications

Resumen de la Memoria:

The development of new materials, the next generation of electronic and magnetic devices, or the discovery of novel approaches for energy storage and production, represent extremely exciting challenges in modern Physics. In order to tackle these challenges, it is fundamental to access, understand and control the dynamics of the smaller components of matter, such as electrons, atoms or molecules. Nature has been extraordinarily generous providing light as such unique tool to access and manipulate natural processes at a broad variety of spatial and temporal scales. During the last decades, laser technology has boosted an ultrafast revolution towards a new generation of lasers, coherent x-ray lasers: extremely energetic light, oscillating in the nanometer scale, emitted coherently in the form of ultrashort bursts with attosecond (1 as=10-18 s.) durations. Ultrafast x rays, by virtue of their short wavelength and pulse duration as well as their ability to penetrate thick samples, are ideal probes of the fastest (i.e. electronic) dynamics in matter at the nanoscale. Design rules for future functional nanosystems that operate at fundamental limits of density, efficiency and speed, with applications in revolutionary new spintronic, data storage, switching, superconducting, and nanoelectronic technologies, cannot be formulated until the coupled dynamics of spins, charges, phonons and photons in materials and at surfaces can be captured and understood.

During his research career, Dr. Hernández-García has become an expert in the theoretical description of strong field processes and nonlinear optics. Within such processes, novel light sources with unprecedented spatial and temporal resolution have became a reality. During his research career, Dr. Hernández-García has developed unique high-performance computing numerical codes to simulate intense laser-matter interaction towards the generation and characterization of soft x-ray ultrashort laser pulses. His theoretical work has not only guided the next generation of experiments at the frontier of ultrafast nanoscience, but have provided a key support to several groups, a successful synergy that resulted in a number of publications in journals of the highest impact factors (Science, Nature Photon., PNAS, Phys. Rev. Lett., etc.).

The Ramón y Cajal fellowship represents a timing opportunity for Dr. Hernández-García to establish his own group in the field of ultrafast nanoscience, helping to position the Spanish community at the highest international level. His strong collaborations with leading experimental groups worldwide will guide his research into practical proposals. His expertise conveys a great opportunity to tackle not only the development if such unique sources, but their applications in fundamental science. In particular, he envisions a unique opportunity to tailor nanomagnetic domains in the attosecond timescales using structured laser beams. On the other hand, ultrashort pulses are ideal to trigger complicated core-hole migration dynamics that play a relevant role in radiation damage of physical systems of interest, as biomolecules and other organic compounds. The development of attosecond or even sub-attosecond x-ray pulses enables to extend charge migration to the x-ray regime, opening novel scenarios to tailor the response of the molecular nuclei and chemical reactions.

Resumen del Currículum Vitae:

Dr. Hernández-García is hired as Profesor Ayudante Doctor at University of Salamanca (USAL), where he gives regular lectures, supervises PhD, master and undergraduate students, and lead his own research lines within the Research Group of Laser and Photonics Applications in the fields of strong-field physics, nonlinear optics and ultrafast science.

Dr. Hernández-García obtained his Physics degree in 2008, and he is also Computer Science engineer (2011). This particular combination, in addition to the Master in Physics and Technology of Lasers (2008) at USAL, allowed him to develop ground-breaking PhD studies merging theoretical and computational Physics. He obtained his PhD in 2013 at USAL, supervised by Prof. Luis Plaja. His thesis, Coherent attosecond sources based on high-order harmonic generation: influence of the propagation effects was awarded with the highest distinction: excellent cum laude. Right afterwards, he was granted with a European Marie Curie International Fellowship. He spent the first two years of this postdoctoral fellowship at JILA, University of Colorado at Boulder (USA), where he worked with the theoretical and experimental AMO groups led by Prof. Andreas Becker and Profs. Henry Kapteyn and Margaret Murnane, respectively. In 2016, he was hired by USAL, through a special program of excellence aimed to young postdoctoral researchers with outstanding career and group leading potential. Since February 2017 he is Profesor Ayudante Doctor at USAL.

Dr. Hernández-García is renowned by his outstanding theoretical contribution to attosecond science and ultrafast nonlinear optics. He has developed original models that extended the computational capabilities to the most stringent situations encountered in the state-of-the-art experiments, providing a key support to several groups, with a number of publications in high-impact-factor journals (2 Science, 1 Nature Photon., 2 PNAS, 4 Phys. Rev. Lett., 1 Optica, etc.). He is pioneer in the production of zeptosecond pulses and attosecond vortices,

and during the last years he has supervised different research works, leading to outstanding results in the generation of singular x-ray laser beams (published in Phys. Rev. Lett., Optica and Sci. Rep.]. In this field he was recently invited to write a review comment in Nature Physics News & Views [Nature Physics 13, 327 (2017)].

Dr. Hernández-García has published 31 peer-review articles indexed in JCR (30 in Q1), 17 of them as main author (first or last), including 3 of them as supervisor. He has presented his results internationally in 1 plenary talk, 8 invited talks, 25 oral and 20 poster contributions. He has participated in 14 research projects (3 of them international), being Principal Investigator in 2 of them. He has been also PI in two competitive calls for computing time at large facilities (Barcelona Supercomputing Center, in 2017, and Janus at Univ. Colorado, in 2015). He has collaborated with >25 research groups, most of them international. He has been also able to bring funding to USAL, through a contract of $25.000 with Univiversity of Colorado, and with the grant Beca Leonardo a Investigadores y Creadores Culturales 2017, funded by BBVA Foundation with 40.000. He exhibits a large record of outreach activities, and he is president of the Salamanca Local Section of the Royal Spanish Society of Physics (RSEF).

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AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2017

Turno de acceso general

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Título:

Proxima b and the nearest Earth-like exoplanets

Resumen de la Memoria:

My core research is the search for exoplanets similar to Earth. Despite being a new discipline, exoplanets is one of the most vibrant areas in astrophysics, and many agencies have included it in their long-term agendas (eg. ESA's cosmic vision 2015-2025). My expertise is in precision techniques, data analysis, and instrumentation, which I apply mostly to searches around very nearby red-dwarf stars. Red dwarfs are the most abundant stars small planets are more easily detected around them. I also have done significant contributions to astrometry, ground based instrumentation projects and science communication.

My PhD was at Univ. of Barcelona within the Gaia/ESA mission(2002-2007), and I worked as a Postdoctoral fellow at the Carnegie Institution for Washington (USA, 2008-2011), University of Goettingen (Germany, 2012,2014), Univ. of Hertfordshire (2014-2015) and Queen Mary University of London (2014-2015) where I now hold a Readership. I started to work on exoplanets while in the USA, and developed my first instrumentation programs at USA and Germany. I have developed data-analysis methods for precision spectroscopy that lead to the discovery of several potentially habitable planets, which culminated with the Pale Red Dot campaign in 2016 and the discovery of Proxima b, the nearest exoplanet to the Sun.

I would like to highlight the impact that my research -in particular the award winning Pale Red Dot campaign- has had across the scientific community and beyond. The exploration of the nearest Earth-like exoplanets inspire the public and the next generation of scientists, but it is naive to assume that broad impact comes for free. Effective scientific communication requires effort and collaboration with professionals, and it is a global challenge in the current credibility crisis of science. This was a core feature of Pale Red Dot, recognised in most of the awards received abroad.

I also develop new technology for direct imaging and characterisation of nearby terrestrial planets. I participate in on-going intl. instrument consortia (eg. CRIRES+), and the exoplanet survey CARMENES. When the time comes(>2020), I also expect to exploit the Gaia data. My research is not driven by what can be done, but by trying to address relevant scientific questions, develop the necessary means, and the use of extensive collaborations to achieve these goals.

Resumen del Currículum Vitae:

BSc in physics at Universitat de Barcelona (1997-2002) and devoted my PhD to relativistic models for the Gaia Astrometry mission (FPI fellow, Spain, 2002-2007 & Gaia DPAC member). Postdoctoral: Carnegie Postdoctoral fellowship at the Dept. of Terrestrial Magnetism/Washington DC (2012) working with exoplanet experts Alan Boss and Paul Butler; University of Goettingen (w Ansgar Reiners) in the design of the CRIRES+ instrument (project scientists of proposal to ESO, under construction). I'm an active member of the CARMENES/Spain+Germany project, I was part of the core team member of Theia/Teia+ space astrometry proposals ESA M4 & M5 calls (unsuccessful) and member of CRIRES+ consortium. Moved to Queen Mary University of London in a ¿ shared postdoctoral position with University of Hertfordshire (2013-2015), and then obtained a full lectureship (~assist. prof. titular) at QMUL(2015), where I know hold a Readership (~Assoc. Prof. since end of 2016).

SCIENTIFIC HIGHLIGHTS
*Pale Red Dot award winning science and public engagement campaign (Anglada-Escude 2016, Nature; cover; top 10 discoveries of 2016)
*Lead author and co-discovered of first super-Earths mass planets in the habitable zone of red-dwarfs (eg. GJ 667Cc, Anglada-Escude et al. 2012, ApJL)
* Optimal algorithms for precision Doppler spectroscopy on M-dwarfs TERRA project, now a standard(Anglada-Escude & Butler, 2012 ApJS).
* Gas cells for infrared spectrometers IRTF/NASA telescope in Hawaii, later implemented to the CRIRES+ upgrade (Anglada-Escudé et al. PASP 2016)

Honours and awards : Received awards and both as an individual contributions, and as member of science teams. From these I would like to highlight SepNET Science communicator award 2017, Seleccion Española de la Ciencia Revista QUO & CSIC (Oct 2017) & Time 100 List of most influential people of 2017,Time magazine (USA) & Nature's 10, 2017 Nature journal/UK.

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I have given invited and contributed plenary talks in international meetings (eg. European Week of Astronomy and Space Science 2017, Prague/Czech Rep.,Jun 2017, Breakthrough Discuss 2017 – Keynote speaker, Stanford/USA, Apr 19-21 2017). I also have participated in numerous special sessions for more specialised topics in large conferences (at a rate of about 3-4 per year), and I also have been invited to several school colloquiums (~6) and dept. seminars (~12) in the past year.

My work and science often appeared in the media incl. Nat. Geo., BBC, CNN, and most Spanish and UK national main media (TV, radio and newspapers). Before 2016, my science results led to 4 press releases (launched by universities and ESO). I won or participated in awarded grant proposals in both the UK (STFC/consolidated grant PI – 150k, STFC/Narit co-I, 110k EUR), and USA (NASA/SIM concept study 75k USD).

I contributed to about 60 refereed publications, from which I have led or played a major role in 23 of them (first, second or senior author). I also participated in 13 Instrumentation papers (SPIE proc.-like publications), Total Citations : 3060, h-index : 26, i10-index : 40 (source : Google scholar).

I have been taking substantial teaching duties in the last years. I am module organiser of one module (MSc) and taught undergraduate courses. I supervise 5-6 projects/year since 2014 (BSc and MSC level). I participated in the exam board of two PhD thesis, co-supervised 1 thesis, main supervisor of 2 PhDs and one postdoc.

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Turno de acceso general

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Título:

Analysis of the data of the CMS experiment at the LHC: from SM measurements to searches for exotic Higgs decays

Resumen de la Memoria:

My scientific trajectory to date has been developed in the frame of high energy physics research, with the analysis of the data of the CMS experiment at the LHC.

The Large Hadron Collider (LHC) is the world's largest and most powerful particle accelerator, and the Compact Muon Solenoid (CMS) a general-purpose particle physics detector that investigates a wide range of physics, from precision measurements in the Standard Model (SM) context to searches for new physics Beyond the Standard Model (BSM). As a member of the collaboration, I coauthor over 600 papers. I have contributed strongly both to the operation of the experiment and to physics analysis of proton-proton collisions at center-of-mass energies of 7, 8 and 13 TeV.

My PhD thesis, completed thanks to an FPI grant from CIEMAT and defended in the UCM in 2011, focused on one of the first LHC ElectroWeak physics results. It measured the total inclusive production cross section of W bosons at 7 TeV, together with the cross sections of positive W+ and negative W- bosons, their ratio W+ /W-, in the muon-neutrino decay channel. During my first postdoctoral appointment, with the University of Wisconsin-Madison, I expanded these W boson studies to the production of vector bosons associated with heavy flavor jets. During the first Run of the LHC, I was also one of the key CMS experts of the calorimetric trigger system at the hardware level.

The ATLAS and CMS experiments announced the discovery of a new boson with a mass around 125 GeV and properties consistent with the Higgs boson in 2012. While the observed new boson exhibits a behavior compatible with the SM prediction, the associated uncertainties are large, and the possibility of BSM properties remains. I shifted my activity to the study the boson in 2013, focusing on potential exotic decays. My main results in this area are the first direct searches for lepton-flavor-violating Higgs decays. In 2016 I became a MarieCurie COFUND research fellow at CERN and continued this line of study, on which I am working to this date.

Currently, I am involved in the preparation of strategies for the future of the experiment, which goes well beyond the ongoing data taking campaign. One of the key tasks for the CMS collaboration in the coming years is to prepare the upgrade of the detector for the proposed high-luminosity accelerator (HL-LHC). These technical developments are supported by physics performance studies, with the exploitation of the Higgs boson as a central piece.

I have extensive experience supervising PhD students. I have had coordination responsibilities for the collaboration both in the detector performance world (Standard Model and Higgs trigger contact, 2012-December 2014) and in data analysis management (Higgs-Exotics co-coordinator, January 2015 - September 2016, and Future-Higgs Studies, September 2016 - September 2018). Finally, beyond the internal organization of the experiment, I am the CMS convener of the Higgs subgroup of the "Workshop on the physics of HL-LHC, and perspectives at the HE-LHC", a CERN initiative which aims to prepare by the end of 2018 a comprehensive document on the future physics of the LHC to be presented to the European Committee for Future Accelerators (ECFA).

Resumen del Currículum Vitae:

Education:
-Licenciatura en Ciencias Fisicas, Universidad Complutense de Madrid, 2006
-Master en Física Fundamental, Universidad Complutense de Madrid, 2007

PhD:
-FPI Grant, 2007-2011, Centro de Investigaciones Medioambientales y Tecnologicas (CIEMAT, Madrid)
-PhD Defense: June 2011, Universidad Complutense de Madrid
-PhD Title: "Measurement of the W boson production cross section in proton-proton collisions at 7 TeV, in the CMS experiment at the LHC"

PostDoctoral Experience:
-Postdoctoral Research Associate Contract at the University of Wisconsin-Madison: 2011-October 2015
-MarieCurie COFUND Research Fellow at CERN: October 2015 - Current

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Turno de acceso general

Large experience supervising PhD students (technical tasks and data analysis)

Responsibilities in the CMS collaboration:
-Contact for trigger studies, Standard Model physics group - 2012
-Contact for trigger studies, Higgs physics group - 2013-2014
-Coordinator (co-convener) of the Higgs Exotics analysis subgroup January 2015-September 2016
-Coordinator (co-convener) of the Higgs Future analysis subgroup September 2016-September 2018
-CMS convener of the Higgs subgroup (WG2) of the "Workshop on the physics of HL-LHC, and perspectives at the HE-LHC"

Publications:
Member of the CMS experiment since 2007
Inspire profile: http://inspirehep.net/author/profile/M.Cepeda.1

Results presented in seven international conferences and eleven workshops and national conferences on behalf of the CMS collaboration, plus numerous internal CMS meetings and workshops

Conference organization:
-Higgs session of the first meeting of the "Workshop on the physics of HL-LHC, and perspectives at the HE-LHC" (CERN, November 2017)
-Higgs parallel session of SUSY 2017 (Mumbai, December 2017)
-Upgrade parallel session of LHCP 2018 (Bolonia, June 2018)

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Turno de acceso general

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Título:

Single molecule Biophysics of molecular motors: from modeling to experiments

Resumen de la Memoria:

Single-molecule micromanipulation methods (e.g. optical or magnetic tweezers) have provided novel insights on the field of molecular biophysics. These methods allow following time-dependent pathways of chemical reactions (e.g. folding of RNA molecules or activity of molecular motors) that are difficult to synchronize at the ensemble level. My PhD, under the supervision of Felix Ritort (Faculty of Physics in the University of Barcelona), was focused on the modeling of RNA folding in the context of optical tweezers experiments in close collaboration with Bustamante and Tinoco□s labs in Berkeley.

During my postdoc in Vincent Croquette□s lab (ENS Paris), I switched my research towards experimental biophysics. During the last 10 years I have been using magnetic tweezers to study molecular motors, which are proteins that use the chemical energy (hydrolysis of ATP) to generate motion and perform work. In physics, they are a paradigm of small systems. A primary question is how these nano-scale motors achieve high efficiency in the strong Brownian agitation, while being fuelled only by the ATP hydrolysis delivering an amount of energy just a few times higher than this agitation energy. From a more applied perspective, understanding their underlying mechanisms is crucial for different biomedical applications since mutations in some molecular motors are related to diseases such as cancer.

DNA processing enzymes are molecular motors that change the structure of the DNA by unwinding, rewinding, cutting and pasting, etc. They are involved in DNA replication and repair, which are central processes occurring in all living systems. In my research, magnetic traps are used to manipulate a DNA molecule by applying force to its extremities and follow in real time the activity of different molecular motors. The applied force allows either to assist or to hinder motor activities, which gives insight into the mechanisms of individual motors as well as their coordinated action when processing DNA. Besides, my studies revealed that switches in molecular motor activity induced by mechanical stress could be used for single-molecule DNA sequencing. In this direction, we have developed and patented a single-molecule platform that allows DNA identification and sequencing.

Most of my initial research has been focused in DNA replication and repair in viral and bacterial systems, which are widely used as model systems due to their simplicity. In 2011 I came back to Barcelona with a Juan de la Cierva grant and I worked in extending my studies on molecular motors to eukaryotic systems (e.g. human), whose malfunctioning is related to disease. At the same time, I started investigating how drugs used in chemotherapies can target DNA or DNA processing enzymes. Besides, I am starting to combine other single-molecule techniques, such as optical tweezers and nanopore technology, in order to get a deeper understanding on the molecular details of these systems.

My research has been presented in about 40 workshops, published in 25 research publications (Science, Nature Methods, Nature Chemical Biology, Nature Communications, Cell Reports, Physcial Review Letters, NAR, Biophysical Journal...) and 6 conference proceedings, cited by 681 articles (WOS) and leaded to three patents.

Resumen del Currículum Vitae:

Initial research (2002 □ 2007): my PhD (University of Barcelona), under the supervision of Felix Ritort, dealt with the modelling of RNA force-induced folding/unfolding transitions in the context of optical tweezers experiments. My most important contribution was to develop models to extract kinetics and thermodynamic information of the RNA foding reaction from single molecule data. The PhD work was the result of a close collaboration with Bustamante and Tinoco□s labs at Berkeley, where the experiments were performed. During my visits to these labs I became much interested in the experimental aspect of this research line.

Main Research (2007 □ 2015): in 2007, I started a postdoc in V. Croquette□s lab (ENS Paris), pioneer in the use of magnetic tweezers in experimental biophysics. The goal of my research has been to understand how molecular motors involved in DNA replication and repair work at the molecular level. Using magnetic tweezers we can manipulate a single DNA molecule and follow in real time the activity of molecular motors working on DNA. A controlled force is applied to the extremities of the DNA molecule, assisting or inhibiting motor activity and revealing the physical mechanisms behind motor function. We have mostly carried out studies on motors involved in DNA replication and repair in viral systems in collaboration with Benkovic□s lab in Penn State University. Our approach has allowed us to get insight on the molecular mechanisms of individual enzymes as well as on their coordinated action in DNA replication and repair. In the meantime, we have applied some of the results to develop a single-molecule platform that allows DNA identification and sequencing. The platform has been patented and V. Croquette and colleagues formed a startup on DNA sequencing.

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In 2011, I came back to Barcelona with a Juan de la Cierva contract and I pursued my work on DNA motors setting up a magnetic tweezers set up in F. Ritort□s lab. I got funding from V. Croquette□s ERC advanced grant to develop my own research in Barcelona. On the one hand, I have worked with eukaryotic enzymes to investigate how the replication and repair mechanisms we have identified in viral systems extend to more complex systems, a question that has important implications for human health. In this regard, I have started new collaborations with D. Cortez in Vanderbilt University Medical Center and P. Bianco in Buffalo University to study human enzymes. On the other hand, I have started to develop new methods to study how chemotherapeutic drugs interfere with DNA repair.

Recent Research (2017): In 2016, I stopped my academic career for one year for maternity reasons. After my maternity leave, I pursued my research in F.Ritort□s lab, mostly working on three different lines. Firstly, I am extending my work on DNA replication and repair motors and their interplay with drugs. Secondly, I am working on applying tools of the mechanical statistics (such as fluctuation theorems and thermodynamic inference relations) to extract kinetic and thermodynamic information from different biophysical systems. In this subject I am co-directing two Phd students. Finally, I am involved in the European project Proseqo on DNA and protein sequencing, learning new experimental single molecule methodologies based on nanopore technology.

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Turno de acceso general

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Título:

GRAVITATIONAL WAVES AND HIGGS COSMOLOGY

Resumen de la Memoria:

SM = Standard Model
GW = Gravitational Waves
BSM = Beyond Standard model
CMB = Cosmic Microwave Background

Summary Trajectory:

I have solid experience studying non-equilibrium early Universe high-energy phenomena like preheating, phase transitions, cosmic defects, ... I have developed multiple analytical and numerical techniques to study such phenomena, including MPI C/C++ codes for lattice simulations of arbitrary field theory scenarios.

My analytical work about preheating (PRD'08) is the most realistic study to date including all SM fields. I have led pioneering numerical work on GW from preheating (PRL'07, PRD'08), and designed the currently standard algorithm to compute GW in a lattice. I have quantified the spectral signatures in GW backgrounds from gauge fields (PRD'10, PRD'16) and fermions (PRD'12, JHEP'13, JHEP'14), opening up the possibility to probe directly particle couplings through GW. I have pioneered the first prediction about anisotropies in cosmological GW backgrounds (PRL'13, JCAP'14), and predicted that all cosmic defect networks emit a scale invariant GW background (PRL'13). I have improved the inclusion of cosmic defects as a CMB source, finding O(10)% corrections in their temperature and polarization anisotropies (PRD'10, PRD'14). From B-mode polarization data, I constrained the CMB contribution from non-topological defects, ruling them out as a possible explanation (JCAP'14). I am directing the Thesis of Francisco Torrenti (PhD 2014-2018). Together we have studied the non-perturbative dynamics of the SM Higgs after inflation, with minimal (PRD'15) and non-minimal coupling (PRD'17), and including GW emission (PRD'16). Furthermore, we have obtained universal parametric fits (using lattice simulations) to the dynamics of preheating and its GW production (JCAP'16&'17). I have recently finished the most complete review on cosmological GW backgrounds (ArXiv'18, in press)

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Summary line of research to be developed during Ramon y Cajal:

The discovery of the SM Higgs boson in the LHC has initiated a quest for understanding its cosmological implications; in particular its possible role during and after inflation. Neither the concrete particle physics realization of inflation, nor its connection to the SM, are currently known. Fundamental properties of the Higgs, such as its coupling to gravity, or its coupling to the inflationary or BSM sectors, are unknown. On general grounds, however, the Higgs is expected to be largely excited soon after the end of inflation. Many relevant questions remain then to be answered:

- Was the Higgs responsible for inflation, or was it just a spectator field?
- What happened to the Higgs after inflation?
- Did it decay into a hot plasma of SM particles? Did it decay also into BSM species?
- What are the cosmological consequences in each case?
- Can we use them to infer the unknown properties of the Higgs?
- What are the observable signals? What experiments will measure them?

My research will address these and related questions, paving the way towards the understanding of the theoretical and observational implications of the SM Higgs during the early Universe. The outcome of my research will probe the role of the SM Higgs during and immediately after inflation, constraining its unknown properties through an alternative, yet complementary approach, to particle collider studies.

Resumen del Currículum Vitae:

I am currently a research scientist at the Laboratory of Particle Physics and Cosmology at EPFL, Lausanne, Switzerland. From Jan 2015 to Sept 2017, I was a fellow at the CERN theory group. During Oct-Dec 2014 I was a visiting researcher at Columbia University, in NYC, US.

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Before, I have been a postdoctoral researcher in Geneva (2012 - 2014) and Helsinki (2010 - 2012) Universities. My PhD Thesis "Aspects of Reheating" (July 2010) was supervised by Prof. J. Garcia-Bellido in UAM Madrid. During my PhD I was also a 'MARIE CURIE EST-Fellow' at CERN (May-July 2010), and I traveled actively, visiting CITA (Toronto, 2007), UNIGE (Geneva, 2008) and CALTECH (Pasadena, California, 2009) 4 months each.

I have published over 30 peer-reviewed articles, accumulating +1100 citations (Google-Scholar). My research is mainly in the area of high-energy physics of the early Universe. The scope of my research is broad, having calculated important quantities which could help to determine many of the unknowns about the early Universe. I have proven a universal result about the emission of gravitational waves (GW) from cosmic defects, and pioneered the first calculation of anisotropies in cosmological GW backgrounds. I have done the most realistic study of reheating into Standard Model fields to date. I have demonstrated the inability of cosmic defects to fit the BICEP2/Planck data. I have made the first lattice studies of the Higgs decay after inflation. I have made relevant contributions to a variety of early Universe high-energy phenomena, including 3 Physical Review Letters and various Top-cited articles with +100 citations.

I am a member of the LISA collaboration, where I am the coordinator of the 'Inflation' and 'Topological Defects' working groups, since 2015 and 2017, respectively. I have co-supervised the PhD thesis of T. Meriniemi (PhD, Helsinki U., 2010 - 2014), and since 2014 I am directing the PhD of F.~Torrenti (PhD expected by 2018). I am currently supervising the Master Thesis of J. Roberto Canivete and Erwin Tanin, both MSc students at EPFL. I have been invited to lecture in various international PhD schools, including TAE 2013 at Benasque, Sept. 2013, YETI 2017 (annual school on theoretical physics) at IPPP-Durham Univ, UK, Jan. 2017, "Gravitational waves for cosmology and astrophysics" school at Benasque, May 2017, and "Topics in Particle Cosmology" school, at Charles Univ, Prague, Czech Republic, Sept. 2017. I am regularly invited for seminars and as a plenary speaker at workshops (e.g. 15 talks in 2016, 11 talks in 2017). I have been a main organizer of the Benasque Modern Cosmology international workshops in 2012 and 2014 (+60 participants), and of the cosmology seminars and journal clubs at Helsinki (2010-2012) and Geneva (2012-2014) Universities. I was an organizer of the workshops 'Understanding the early Universe' and '1st eLISA Cosmology Working Group Workshop', both held at CERN (Jan and April 2015, respectively) with +60 participants. In 2012 I created (and organised since then) the ECU meetings, a regular encounter among cosmologists from EPFL, CERN and UNIGE. I also give popular science talks and write outreach articles, including a monograph entry in 'Scientific American'. I have also been a teaching assistant of General Relativity (Madrid U., 2 semesters) and Mathematical Methods for Physicists (Geneva U., 1 semester).

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AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2017

Turno de acceso general

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Título:

The Electroweak Scale and the early Universe: from LHC to LISA

Resumen de la Memoria:

My research focuses mainly in the connection between electroweak symmetry breaking, Higgs physics at the LHC and the early Universe, field in which I am an internationally recognised expert, with more than 1550 citations, 10 TopCite 50+ papers (of which 4 are TopCite 100+) and several key contributions to the LHC beyond-Standard-Model (BSM) Higgs programme and the future space-based LISA gravitational wave observatory science.

I explore LHC and future collider signatures of Higgs and electroweak physics as windows into the origin of the baryon asymmetry and the nature/properties of dark matter, having in the former case been Principal Investigator of the research project EWBGandLHC funded by the EU Marie Curie Actions (2014-2016). I have identified key LHC signatures to test the origin of the matter-antimatter asymmetry at the electroweak scale EW baryogenesis and subsequently designed ATLAS/CMS search strategies tailored to these signatures. Several of my studies in the baryogenesis and dark matter context have been adopted by CMS (being now in the core of CMS BSM Higgs physics programme) and ATLAS, yielding new experimental avenues to search for new physics at the LHC. This line of research has also triggered strong attention from the theoretical community, with 250+ citations and plenary invitations to the BLV, SEWM, Invisibles and Multi-Higgs international conference series. I have also performed several key works in Higgs phenomenology and Effective Field Theory, and I am co-Author of the CERN Yellow Report Handbook of LHC Higgs Cross Sections 4, which encompasses the present knowledge of the properties of the Higgs sector.

From an early Universe perspective, I specialise on the physics of the electroweak phase transition a paradigm of the connection between Higgs physics and Cosmology and the generation of relic gravitational wave signatures from the electroweak epoch which could be probed by LISA. My work in this field has had high-impact, with 380+ citations, including 3 TopCite 50+ publications (one of which TopCite 100+). I belong to the core of phase transition experts within the LISA Cosmology Working Group, and have been a leading co-Author of the recent LISA Science Report on gravitational waves from phase transitions.

I am also interested in aspects of neutrino physics, namely the origin of neutrino masses and mixings and its connection to the Dirac vs Majorana nature of neutrinos, and I have recently (2017) started investigating the phenomenology of long-lived particles (LLPs) in theories of dark matter and baryogenesis, being part of the international MATHUSLA science case effort towards a detector concept for LLP searches at CERN for the HL- LHC upgrade (early 2020s). These showcase my ability to successfully undertake new research avenues.

After postdoctoral research stays in IPhT CEA-Saclay, ULB Brussels and Sussex U., I currently hold a research associate position at King's College London, and have been awarded a CAM Atracción de Talento Investigador Doctor con Experiencia Grant to join the IFT-UAM/CSIC in 2018 and establish a research programme at the interface of LHC phenomenology, early Universe and gravitational wave physics.

Resumen del Currículum Vitae:

My research focuses mainly in the connection between electroweak (EW) symmetry breaking, Higgs physics at the LHC and the early Universe, field in which I am an international leader. My work has materialized in 36 publications in high-impact journals with more than 1550 citations (430 cites/year 2015-2017 and h-index = 19), 10 TopCite 50+ papers (of which 4 are TopCite 100+) and several key contributions to the LHC Higgs programme and the future European Space Agency LISA gravitational wave (GW) observatory science. I explore LHC signatures of Higgs and EW physics as windows into the origin of the baryon asymmetry and the nature/properties of dark matter, having in the former case been Principal Investigator (PI) of the research project EWBGandLHC funded by the EU Marie Curie Actions (2014-2016). From an early Universe perspective, I specialise on the EW phase transition and the generation of relic GW signatures from the EW epoch which could be probed by LISA. My breadth of expertise in the Higgs connections to Cosmology and astroparticle physics is further demonstrated by my involvement in the LISA Cosmology, LHC Higgs Cross Section and LHC Dark Matter Working Groups, which belong to very different research communities within high-energy physics.

My research activity is further strengthened by contributions to 36 international conferences/workshops, including plenary invitations to

leading international high-energy physics series like BLV, FLASY, SEWM, PHENO, Invisibles; invited seminars in 40+ research centres worldwide (e.g. CERN, FNAL, Columbia, Cambridge, UMass, Paris-Orsay, Munich, Padova, IPPP-Durham). I have organized various international events, such as the FLASY14 conference and the 2013 BUSSTEPP Summer School, and participated in 10 R&D&I Spanish/international Projects, being PI of a CAM Atracción de Talento Investigador Grant. I have won several prestigious fellowships/grants, like CERN MC EST (2009), CEA-Eurotalents (2011) and MC IEF Fellowship (2014-2016). I am Referee for JHEP, Phys. Rev. D and Phys. Lett. B, and Phys. Rev. Lett. Journals.

I completed my Ph.D. at UAM-Madrid in September 2009, under the supervision of José Ramón Espinosa. In 2009, I was awarded a 6-month CERN EST-UniverseNet Fellowship to study the EW phase transition. I have been a Postdoctoral/Eurotalents Fellow for two years at the IPhT CEA-Saclay (2009-2011) and a 1-year postdoctoral researcher at ULB (2011-2012), before moving as a Postdoctoral Fellow to Sussex U. at the end of 2012, where I held an EU MC IEF Fellowship (2014-2016). In October 2016, I have moved to King's College London (KCL) as a Research Associate, my current position. I have recently been awarded a CAM Atracción de Talento Investigador Doctor con Experiencia Grant to join the IFT-UAM/CSIC in 2018 and establish a research programme at the interface of LHC phenomenology, early Universe and GW physics.

In addition, I have enjoyed a substantial amount of teaching and mentoring activity in the last 4 years: I have co-supervised M.Sc. student Jones and Ph.D. students Dorsch, Freitas, Harman in Sussex, with Tunney ongoing in KCL, together with 150+ hours in teaching B.Sc. courses at Sussex and as Ph.D. Tutor for the 2013 and 2014 editions of the BUSSTEPP Summer School. In 2017 I have received the Annual Mentoring Award
by the Society of Spanish Researchers in the UK.

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AGENCIA ESTATAL DE INVESTIGACIÓN

AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2017

Turno de acceso general

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Título:

The Formation of First Galaxies in the era of Supercomputers and Large Telescopes

Resumen de la Memoria:

My research career has been focused on galaxy formation. I am involved in cosmological simulations of galaxy formation, as one of the world experts of the adaptive mesh refinement (AMR), N-body + gasdynamics, ART code. My cosmological simulations follow the formation and evolution of galaxies from primordial density fluctuations in the early Universe.
My most relevant contribution to the field of galaxy formation is the study of violent disk instabilities in high-z galaxies (more than 1200 citations in the last eight years). These papers involve simulations, analytical modelling and detail comparison with observations, as part of the international SINS project.
I am leading independent research about stellar feedback processes such as supernova explosions, stellar winds and radiation processes. These are crucial ingredients for the self-regulation of star formation processes within galaxies.
Within the CANDELS international collaboration, I work on the theoretical interpretation of the observational data, as a collaborator in nine papers. I lead and coordinate the third phase AGORA comparison project.
My research also focuses on the formation and settling of today□s disc galaxies and their evolution during the last 8 billion years.
I am leading the FirstLight project about the formation of the first galaxies. The first published paper shows good agreement between simulations and current Hubble surveys.
My research in Spain includes the CLUES project (UAM), the link between metallicity drops and gas inflow (IAC) and synthetic observations of galactic outflows from simulated galaxies (CAB).
The launch of the James Webb Space Telescope (JWST) in October 2018 will revolutionize our understanding of the early Universe. Now it is a crucial time for theoretical predictions about the properties of the first galaxies. The FirstLight database is the largest set of simulations of first galaxies. The next step of the project is the analysis of the simulations and the generation of a public database with all galaxy properties and mock JWST images that will generate a mock JWST survey. These simulated images will be compared with current and future surveys using JWST and large telescopes.
I have an extensive experience in writing successful grant proposals, including MINECO grants AYA2012- 31101 and Programa Acciones Conjuntas Hispano-Alemanas / DAAD-UNIVERSIDAD.ES. I am the PI of the FirstLight project that received 30M cpu-h of computing time at LRZ (2016-2020)
Since 2008, I have attended 5 conferences per year with oral contributions. Since 2005, I give seminars and colloquia at different institutions (twice per year).

Resumen del Currículum Vitae:

Dr Daniel Ceverino was born in Seville, Spain, in 1978. He earned a Physics degree in Fundamental Physics at the University of Seville (2002). In 2008, he defensed his PhD thesis in Astronomy at New Mexico State University, Las Cruces, New Mexico (USA). The tittle of his dissertation was □The Formation and Evolution of Galaxies in an Expanding Universe□, under the supervision of Prof. Anatoly Klypin. His first postdoc (2008-2011) was hosted at the Hebrew University, Jerusalem, Israel (supervisor: Prof. Avishai Dekel). Between 2011-2014, Dr Ceverino was supported by a "Juan-de-la-Cierva" fellowship at the Universidad Autonoma de Madrid (supervisor: Prof. Gustavo Yepes). In 2015, he was a postdoctoral researcher in the group of Dr. Luis Colina at the Center for Astrobiology (CAB-INTA-CSIC) in Madrid. He is currently a researcher (PI of FirstLight) under an ERC advanced grant at the "Institut fur Theoretische Astrophysik" at Heidelberg University, Germany (Supervisor: Ralf Klessen).
His teaching experience includes: teaching assistant of the Astronomy laboratories at New Mexico State University (2004-2006); teaching assistant and lecturer at two summer schools on Astro-Computing (2006 and 2010); Tutorial sessions about simulations of galaxy formation (2011 and 2015); Formal teaching of the undergraduate course □Advance methods in mathematics□ at the Universidad Autonoma de Madrid (2012-2013); Close supervision of master and undergraduate students on their research projects at Jerusalem (2008-2011), and Madrid (2012-2013) and a PhD student at the Heidelberg University (2017).
Dr Ceverino participates in several large international collaborations: SHARDS, AGORA, SINS, and CANDELS. He has contributed to the Marenostrum Numerical Cosmology project, led by Prof. Gustavo Yepes (2013-2015) M.I.C.I.NN. (AYA2012-31101); Galaxy Formation in a Cosmological Context, led by Prof. Avishai Dekel (2009 & 2015); and the structure formation on small scales and the nature of cold dark matter, led by Prof. Anatoly Klypin, NSF AST-0507752 (2006-2008); HST theory proposal led by Prof. Joel Primack (HST- GO-12060.12-A) (2016-2019). He was Co-PI on a Programa Acciones Conjuntas Hispano- Alemanas / DAAD-UNIVERSIDAD.ES (2014-2015). He coordinated successful proposals for CPU-time at NASA NAS (USA) (2008-present); NERSC (USA) (2005-present); and LRZ: Leibniz-Rechenzentrum (Germany) (2011-present).
Daniel Ceverino has published 77 articles (49 refereed papers) since 2007, 38 papers in the last 4 years. They all sum about 3700 citations

(700 citations received in 2017) with h-index=30, i100-index=10.
Since 2008, Dr Ceverino has attended a median of 5 conferences per year with oral contributions. Since 2005, Dr Ceverino give seminars and colloquia at different institutions (twice per year). He has co-organized two summer schools on computational astrophysics, and third workshops. He organized weekly seminars in Madrid (2015) and he currently organizes weekly discussions about research papers. Every year since 2006, he spend a long visit (longer than 2 weeks) in one or two different research institutions in USA, Germany or Spain.
A list of his awards includes a 'Juan de la Cierva fellowship (2011-2014); the Astrophysics Rosenblum Prize (travel grant); and the 'Golda-Meir' fellowship (2008-2011). Media Coverage: Baby brutes, 2009 NERSC Annual Report, based on the results published in Ceverino & Klypin (2009) and Ceverino, Dekel & Bournaud (2010).

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AGENCIA ESTATAL DE INVESTIGACIÓN

AYUDAS RAMÓN Y CAJAL
CONVOCATORIA 2017

Turno de acceso general

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Título:

Shortcuts to Adiabaticity in Solid-State Physics

Resumen de la Memoria:

In 2001, Dr. Xi Chen, as a Ph.D student in Shanghai University, China, began with the earliest study on mesoscopic quantum transport. The focus at that time was on the delay time and Goos-Hanchen (GH) effect. Since there is a connection between ac-response and timescales, his work, as pointed out by Buttiker, touches certainly on an important subject of the role the various time scales are playing in semiconductor barriers. Since GH shift is related to the tunneling time, he thus moved to the study of GH effects and beyond. Particularly, the electronic analogy of GH shift in semiconductors and graphene is found to be useful in electron optics devices. This work has been cited by the most relevant publications.

Drawing analogy to optics, one envisions various graphene-based electron optics devices. Along this research line, he has found many interesting electron-optical phenomena, such as Bragg-like reflection, zero-average wave number gap, and electron waveguide in graphene. More importantly, electron waveguide has been carried out by C. M. Marcus's group in Harvard University to realize the electronic fibre in graphene. Indeed, optical analogies can provide a deep understanding of some phenomena in atom optics or complex condensed matter systems and other multidisciplinary areas. Since his contribution, he has published a review article in Journal of Optics, and a book chapter.

Awarded with a Juan de la Cierva fellowship, he entered the QuInST group of Prof. J. Gonzalo Muga at UPV-EHU, Spain. He concentrated first on a new cooling method based on harmonic trap expansions and on state preparation of two or three level atoms. During his stay at Bilbao, he was extremely successful. He has developed the emerging field of shortcuts to adiabaticity. Several results have been implemented experimentally in the group of G. Labeyrie, O. Morsch, D. Suter and also are extended to other fields. He has already published 1 Nature Communications (IF=12.124), 5 Physical Review Letters (IF=8.462) and 3 Scientific Reports (IF=4.259).

His research so far is multidisciplinary and covers different aspects in physics, such as physical optics, mesoscopic physics, quantum control, quantum optics, and atom physics. His proposed research is just at the interface between mesoscopic physics on the one side, and quantum optics on the other side. His first step is to use his extensive knowledge for rapid preparation, control, corrections of spin and charge states with high fidelity in semiconductor nanostructures. The next plan aims, in the light of the objectives and state-of-the-art exposed, to provide new shortcuts to adiabaticity in solid-state physics, including (i) fast and robust manipulation of spin qubit, charge qubit and hybrid qubits in quantum dots or quantum wire; (ii) efficient spin transistor devices and their atomic analogue. (iii) fast controllable transport of cavity-coupled graphene system in quantum optics.

Dr. Xi Chen has the experiences in quantum optics and quantum control. The perspective host group of Prof. Gloria Platero has a strong reputation on mesoscopic physics, spin-electronics, graphene physics and quantum transport. The expertise would ideally complement his own scientific background and will be particular beneficial for the main research lines and his career.

Resumen del Currículum Vitae:

Dr. Xi Chen received his Ph. D in Shanghai University in 2007, and immediately obtained the position of lecturer in the Department of Physics, Shanghai University. During 2009-2013, he did the postdoctor at the group of Prof. J. Gonzalo Muga in University of the Basque Country, Spain, supported by Juan de la Cierva Program. After almost 4-year staying at Bilbao in Spain, he went back to Shanghai University and selected as the professor of Special Appointment, called as Eastern Scholar in 2014.

During these years, the field of expertise in the host group of Bilbao, especially quantum optics and atom physics, complemented his own scientific background. This was extremely useful to enrich his knowledge and skills, and thus broaden his research lines, ranging from mesoscopic physics to quantum optics. His international experiences, interacting with J. Gonzalo Muga (Bilbao), E. Ya Sherman (Bilbao), E. Solano (Bilbao), D. Guery-Odelin (Toulouse), T. Busch (OIST), and G. Platero (Madrid), fostered fruitful connection with the group in Shanghai University strengthen the international collaborations in physics community, and promote multi-lateral culture exchange.

He has over 90 publications in international journals with high impact factors including 1 Nature Communications (IF=12.124), 5 Physical Review Letters (IF=8.462) and 3 Scientific Reports (IF=4.259), 30 Physical Review A,B&E. He is the 1st author of 35 publications and the corresponding author of 18 publications. He is the principal investigator of 11 projects including Juan de la Cierva program. He has more than 20 invited talks in International Conferences and Workshops and was invited to have academic short visit in other international

laboratories: OIST Quantum System Unit (Prof. T. Busch), Weizmann Institute of Science (Prof. G. Kurizki), University of Regensburg (Prof. K. Richter), University of Leiden (Prof. C. W. Beenakker).

He is the editorial board for Scientific Report and the referees for Nature series, PRL, PRA, OL, OE and APL ect. He also reviews frequently the projects from NSFC and S&T committee of Shanghai Municipal. He is the main organizer of 2 international workshops on shortcuts to adiabticity and more than 10 other workshops in China. In addition, he is the vice dean of College of Science who is responsible for graduate/undergraduate educations and international affairs. He is also the director of Institute of Nanomicro Energy and vice director of Quantum Artificial Intelligence and Information Science with E. Solano. He is the supervisor of 6 Ph.D candidates. He teaches courses of College Physics, Quantum Mechanics and Introduction to Quantum Optics.