



AYUDAS RAMÓN Y CAJAL CONVOCATORIA 2018

Turno de acceso general

Nombre: RONCAL , LUZ
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Área Temática: Ciencias matemáticas
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Título:

Harmonic Analysis and applications to PDE's

Resumen de la Memoria:

My research concerns problems from Harmonic Analysis, Fourier Analysis, Special Functions, and Partial Differential Equations.

My first stages of research, starting from my Phd Thesis, are strongly related to the study of classical Harmonic Analysis and Fourier Analysis topics in the context of special functions and orthonormal expansions. In this direction, I was investigating weighted inequalities for several kind of operators, such as multipliers, maximal functions, Riesz transforms, square functions and fractional integrals mainly in the setting of Bessel functions, but also Laguerre, Hermite and Jacobi polynomials. This research led me to learn and use different techniques from real Harmonic Analysis. I have also developed investigation in potential theory related to orthogonal series and I carried out research on summability methods, such as Bochner-Riesz, and transplantation problems.

Some time after the defense of my Phd, I began to be interested in PDE's problems related to the fractional Laplacian, due to some collaboration initiated with researchers on PDE and Harmonic Analysis. Since then, I have studied several questions related to the extension problem, Schauder estimates, Harnack inequalities and Hardy inequalities. I am interested also in equations involving local and non-local discrete operators.

Meanwhile, I have also enlarged my former research on Fourier analysis by dealing with several projects on vector-valued extensions and mixed norm estimates in different settings, including general compact Riemannian manifolds, and summability methods and other issues in the Dunkl setting. Harmonic Analysis in the discrete setting has been also another topic of research (motivating in this way the abovementioned research on local and non-local discrete operators). Spherical means and the solution of the wave equation when the initial data is radial have been others topics in my research. I have also got into some problems related to the so-called sparse domination theory and quantitative estimates for general singular integrals.

My recent interests include Hardy inequalities in several settings, such as the Heisenberg group or more general H-type groups, as well as the connections with the extension problem. Besides, I have developed a deeper research on aspects of the Classical Harmonic Analysis in the Euclidean setting concerning weighted theory. With regard to PDE, I continue studying topics related to fractional operators, and very recently I have begun to think on problems on unique continuation in this context.

Along my career I have been collaborating with researchers of different Universities and Institutions around the world, some of them very well-recognised (T. Hytönen, C. Pérez, K. Stempak, S. Thangavelu, J. L. Torrea). After several years learning and interacting with people from both Harmonic Analysis and PDE, I conclude that I enjoy specially finding connections among different branches of the Harmonic Analysis and Partial Differential Equations, and applying results from one area into problems of another to get the solutions in an efficient way.

Resumen del Currículum Vitae:

I got a degree in Mathematics at Universidad de La Rioja (UR) in 2003 and received my PhD thesis at UR in 2009. In the period September 2010 - September of 2016 I have been working as Titular de Universidad Interina at the Department of Mathematics and Computer Sciences at UR. From September 2016 I am working as a Researcher at Basque Center for Applied Mathematics (BCAM) in Bilbao. I had a pre-doc grant from Universidad de La Rioja from 2006 to 2008. In 2008 I passed public exams and I obtained a position as a civil servant as a Secondary and High School Mathematics Teacher. In September 2010 I asked for a leave of absence to move to University.

My scientific activity is attached to the area of Mathematical Analysis, specially in Harmonic Analysis and Partial Differential Equations. I have developed my research in the Mathematical Analysis research group of the Department of Mathematics at UR and the Harmonic Analysis and PDE research groups at BCAM, although I have collaborators around the world.

As for my scientific work, I have 33 publications in JCR journals (Mathematics and Applied Mathematics), 85% in Q1 and Q2 (70% in Q1, 20% in D1), 4 preprints submitted for publication and 6 publications in conference proceedings and book chapters. I have delivered more than 30 talks in national and international conferences, most of them by invitation, and I have presented 28 invited seminars in national and international institutions.



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I have taught 2 Invited minicourses (at BCAM and India). I have done research stays in different distinguished institutions (Wroclaw - Poland, Texas at Austin - USA, IISc Bangalore - India, Helsinki - Finland...). I emphasize the mobility grant from the Spanish Ministry "José Castillejo" in 2014/15, and the stay in the Mathematisches Forschungsinstitut Oberwolfach, under the Research in Pairs Programme in June 2017.

I have been also awarded with a grant "Beca Leonardo para Investigadores y Creadores Culturales Fundación BBVA", with a budget of 40.000 euros (obtained in June 2017, the only one in Mathematics).

I have been research member of more than 10 research projects from 2006, including Severo Ochoa, Spanish Ministry MTM's, Basque regional BERC and EGI from Universidad de La Rioja. In the period 2018-2020, I am Principal Investigator (joint with Carlos Pérez) of the project with reference MTM2017-82160-C2-1-P.

I have under my supervision 2 Phd Students: Emilio Fernández (Universidad de La Rioja), expected date - October 2019 and Javier Martínez (BCAM), expected date - December 2020

I have attended more than 40 courses and conferences at national and international institutions. I have been member of the Organising or Scientific Committee of more than 10 national and international conferences, sessions in conferences and schools.

I am referee for several international journals included in JCR, and I have served as evaluator for research projects for the Argentinian research council.

As for my teaching, I have taught subjects on Mathematics at the degree of Primary Education. The teaching evaluations have been positive. From 2010 until 2016, I have been coordinating a problem seminar for students High School, focused on the preparation for mathematical Olympiads.

Finally, I have received positive evaluation of ANECA for the positions of Ayudante Doctor, Contratado Doctor and Titular de Universidad.



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Nombre: BARRIOS BARRERA, BEGOÑA
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Título:

Estudio de ecuaciones en derivadas parciales con operadores no locales y su relación con ecuaciones locales

Resumen de la Memoria:

Since I have finished my degree in Mathematics in 2008 I have treated in my research several themes of the PDE s, Calculus of Variations, and also Harmonic Analysis touching different topics and learning to handle many techniques.

During the first year of my career, I have learned some tools of Harmonic analysis like wavelets transforms, maximal functions and the Littlewood-Paley theory obtaining new characterizations for the anisotropic Besov spaces and establishing the behavior of the Fourier transform on these spaces (see my three papers published with J.J. Betancor)

Since I started working deeply in my Ph.D. thesis I have been interested in the study of PDE S that involve nonlocal operators. In particular, during the first years of my career, I have been interested in the study of regularity, existence, and multiplicity of nonlocal equations in bounded regular domains. I have been studied important topics in Calculus of variations and PDE S like the Mountain Pass theorem, Concentration and Compactness Principle among others. I established the existence and multiplicity results for the elliptic problems with zero boundary conditions where the spectral fractional Laplacian and the standard fractional Laplacian (see my works in JDE (2012) and Ann- Henri. Poinc (2015)). Moreover in my work published in Rev. Mat. Iberoam (2018) we obtain the a priori bounds by adapting the classical scaling method of Gidas and Spruck in this framework. I continued the study of nonlocal concave-convex problems but, in this case, analyzing the interplay between the Hardy-Leray potential and the fractional Laplacian (see my works published in Comm. Contemp. Math and Open Math (2015) and J.d'Analyse Mathematique (2018)). I also work with different kinds of boundary conditions, like mixed or Neumann, (see my works in Proc. Royal. Soc. Edimb. and Nonlinear analysis). I have also studied parabolic problems like the heat equation in this nonlocal framework. In my work on ARMA (2015) I get a Widder's kind result for this equation.

I studied more general nonlocal operator than the fractional Laplacian like the elliptic integrodifferential equations. In my work in ASNP (2014) I obtain a regularity result for integrodifferential equations that allows us to show that C^1 nonlocal minimal surfaces are in fact C^∞ .

In the last years, I have also worked on free boundary problems that involve nonlocal operators that appear in many areas of applied sciences. The most classical and motivating example in the study of free boundary problems is the obstacle problem studied in the seminal paper of L. Caffarelli. In my works published in American J. Math and CPAM (2018) we get the regularity of the free boundary in the stationary fractional obstacle problem under the natural assumption that the obstacle is convex near the contact region completing the structure of the free boundary was known only in the case of the classical Laplacian. The parabolic problem was also studied.

During the last years, I was also interested in the qualitative properties, like monotonicity, symmetry, and periodicity of solutions of nonlocal problems in nonbounded domains. To get them, different kind of Liouville's theorems have to be used or proved in this nonlocal framework. See my works done in collaboration with J.J. García Melián, Del Pezzo and Quaas.

Resumen del Currículum Vitae:

Until de date of presentation of this CV, January 2019, the researcher Begoña Barrios Barrera has published 22 articles (15 of them are in the first quartile of ISI impact factor) and has submitted , works.

Her scientific production has the following quality indicators:

Google Scholar: total publications = 22, number of cites = 667 (the most cited article has 277 cites), h index = 10

SCOPUS: total publications = 19, number of cites = 395 by 333 documents (the most cited article has 194 cites), h-index = 8

MathScinet: total publications = 19, number of cites = 366 (the most cited article has 177 cites), number of co-athors= 25

Other aspects related to the scientific research of Begoña Barrios Barrera are summarized as follows:



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- i) The researcher has supervised one European master thesis (UAM-Statale Milano) and one End-degree project in Mathematics (ULL). She is now nonlocal two end-degree projects in applied mathematics in pharmaceutical sciences.
- ii) She has obtained the special prize in the higher degree (ULL) and the PhD-special prize (UAM).
- iii) She is a member of one national R&D projects (MEC). She has been including in a new competitive research group as part of the application for a National Project in 2018 (the resolution of such application is not available yet).
- iv) The researcher has been an international Postdoc project evaluator (FONDECYT) in 2016 and has done more than fifteen referee report for international journals indexed in the JCR list.
- v) She has obtained two competitive Postdoc grants (Ramon Areces and Juan de la Cierva Formación FJCI-2014), one competitive Predoc grant (FPI-MEC) and two competitive grants dedicate to introduce the undergraduate students in the research work (Collaboration-MEC, CSIC).
- vi) Begoña has done scientific stays in Rome (Italy), Milan (Italy), Calabria (Italy), Santiago de Chile, Valparaiso (Chile), Austin (USA), Madrid (Spain), Granada (Spain) and Buenos Aires (Argentina).
- vii) The researcher has given 17 invited talks in international conferences and 10 invited seminars in national and international universities.
- viii) She has been part of the organizing committee of five international conferences and two interuniversity seminars.
- ix) She has participated in 6 competitive projects (5 of them national and one international)
- x) Begoña Barrios Barrera has obtained in March 2014 the ANECA accreditation of "Ayudante Doctor", "Contratado Doctor" and "Profesor Universidad privada" and has reached more than 800 hours in several official degrees (UAM, UEC, ULL) obtained an average mark of 4.66 over 5 in the official teacher evaluation.



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Título:

GEOPHYSICAL FLUID DYNAMICS: EQUATIONS, METHODS AND SOLUTIONS

Resumen de la Memoria:

My research focuses mainly on applied mathematics in geophysical fluids and related problems. More specifically I work in the application of bifurcation theory and time evolution problems to heat transfer fluid mechanics. Specifically I dealt with convection and Phase Change materials (PCM). I approach these problems from the numerical point of view, since many of them are too complex to present exact solutions. I am also involved in the analysis of vector fields and their transport implications, by means of novel dynamical systems tools, Lagrangian Descriptors, which I have contributed to develop and to implement problem in oceanic and atmospheric contexts. Recently I also apply this tool in the study of transition state theory (TST) in chemistry.

During my PhD, I have studied convection problems with viscosity strongly depending on temperature, both from the standpoint of the analysis of stationary and time-dependent solutions, as well as from the computational methods used to calculate them. My studies are focused mainly on viscosity laws that model an abrupt transition of the viscosity in terms of temperature. In particular, both smooth and abrupt transitions are explored. As regards abrupt transitions, attention is mainly given to time-dependent solutions in which an upper stagnant layer is formed with a layer or plate that moves rigidly either to the left or the right. These results provide an innovatory approach to the understanding of styles of convection in the interior of planets. The existence of subduction is not ruled out, but the processes that we describe may be particularly illustrative for the understanding of convective styles prior to subduction. In order to solve this convection problem, spectral numerical methods based on a primitive variable formulation are proposed.

During my postdoc in the Laboratoire de Géologie de Lyon, I have worked in the study of compressible effects in geophysical and astrophysical convection models with the purpose of studying differences in the diffusion term of the fluid equations in the different approximations used nowadays to add compressibility effects: the anelastic approximation, the anelastic liquid approximation, the Boussinesq approximation etc.

Thanks to JdC formación, I started to work in identifying and describing the main dynamic regimes occurring during the melting of the PCM. The importance of this problem is that the high latent heat involved in the solid/liquid phase change allows PCM to store or release a significant amount of energy during melting or solidification barely changing the temperature.

Together with my collaborators, we have introduced a dynamical system tool called Lagrangian descriptors (LD) which is able to highlight geometrical objects in phase portraits of dynamical systems with a general time dependence. This tool has been successfully applied to transport in geophysical flows: ocean and atmosphere; as well as in transition state theory in chemistry. I have work in study the behaviour of the stratospheric polar vortex as well as the study of transport across the West African Monsoon. Recently, we start to work in the detection of phase space bifurcation with LD and their applications to chemical reaction, in TST.

Resumen del Currículum Vitae:

Graduated in Mathematics at the University of La Laguna (2006), I finished the Master of Mathematics and Applications (2010) and I received my doctorate in mathematics at Universidad Autónoma de Madrid (UAM, 2014). I was a PhD student in the JAE-Predoc fellowships program under the supervision of Ana M. Mancho at Instituto de Ciencias Matemáticas ICMAT and Teaching Assistant ("Profesora Ayudante") at Departamento de Matemáticas, UAM. In December 2014, I started a Postdoc in Lyon, France, at the Laboratoire de Géologie in Lyon: Terre, Planètes, Environnement (CNRS, ENS, Lyon1) thanks to a grant from the excellence program LabeEX LIO (Laboratoire d'excellence. Lyon Institut des Origines). In April 2016, I joined the Escuela Técnica Superior de Ingeniería Aeronáutica y del Espacio at Universidad Politécnica de Madrid with a Juan de la Cuerva Formación postdoc to which I resigned in September 2016 to be Assistant Professor (Profesor Ayudante Doctor) in the Departamento de Matemáticas of the UAM.

I have been awarded for my research with the 2015 "Vicent Caselles" on Mathematical Research by the RSME-Fundación BBVA and with the 2015 Donald L. Turcotte Award from the American Geophysical Union (AGU). I am the first Spanish that has obtained this award. This is the most prestigious international award in geophysics for PhD students.

I have coauthored 19 scientific works (14 + 2 published papers + 1 chapter of a book + 2 preprints). Many of them have been published in prestigious journals (7/14 D1). I have participated in more than 35 conferences, workshops, seminars, presenting my works in different



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formats such as poster, oral communication, seminar, etc. most of them by invitation. Among which highlights the invited talk at the Nonlinear Geophysics Session of the 2015 AGU Fall Meeting (conference with more than 22,000 participants), the Invited Earth Science seminar in NASA, Jet Propulsion Laboratory, California, 2016 or the plenary talk in the IV Congress of young researchers RSME 2017. I have also organized or collaborated in the organization of several activities both nationally and internationally that have been held in Spain. My research has a high impact in a wide audience, for instance, according to the WOS 87 different articles (without self citations) cite my papers which belong to 10 different research areas. (h-index 8 google scholar)

I have been invited to visits at prestigious research centers for interdisciplinary collaboration such as The department of Atmospheric and Oceanic Sciences, UCLA (40+40+40 days), the Laboratoire de Géologie de Lyon, (CNRS, ENS, Université Lyon1), (30+40 days) or the Département des Sciences de la Terre de l'ENS Lyon (Invited Professor, 30 days) and I have a large number of collaborators in different areas.

I have teaching more than 480 hours at the UAM in subjects of different grades and levels and tutorized two TFG and two ICMAT Introduction Research grants. Also, I have involved in outreach activities such as AULA, collaboration in newspapers, PRECIPITA crowdfunding, Semana de la ciencia, MathsShe, 11deFebrero.org, etc. Several newspaper, journal and agencies have echoed of my research, in interviews, press releases and news, among which: the Earth & Space Science News, SINC or ABC.



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Título:

Special metrics in complex geometry and moduli spaces

Resumen de la Memoria:

My research is in the areas of differential geometry and algebraic geometry and has strong links with geometric analysis and mathematical physics. The main projects I have carried out include special metrics and connections in complex geometry, spin geometry, and the theory of moduli spaces in algebraic geometry.

During my PhD thesis at ICMAT (2006-2009), supervised by García-Prada and Álvarez-Cónsul, I studied Kähler geometry (Geom. Top. '13). In 2010 I did a postdoctoral visit to the Max Planck Institute in Bonn, and a subsequent visit to the Humboldt University funded by the SFB647 project. In Bonn and Berlin I started independent research on the Hull-Strominger system of PDE (HS) in complex non-Kähler geometry, motivated by the moduli problem for Calabi-threefolds in algebraic geometry. As a result of a collaboration with B. Andreas (FU Berlin), we solved the Kähler case of Yau's Conjecture for HS (CMP 12).

In 2010 I started a 2-year postdoc at the Centre for Quantum Geometry of Moduli spaces (Aarhus) funded by the Danish National Research Foundation (DNRF), with Andersen (ERC Syn. Grant). I continued my work in Kähler geometry in collaborations with Ross (UI Chicago) (PLMS 13) and Tipler (Brest) (JLMS 14). I also did a 5-months visit to the Mathematical Institute in Oxford with Hitchin, funded by the DNRF, where I developed a new approach to the Hull-Strominger system using generalized geometry (CMP 13) (only author).

In January 2013 I started a 2+2-year postdoctoral position at the Ecole Polytechnique Federal de Lausanne with Hausel, one of the leading figures in the theory of Higgs bundles and mirror symmetry (ERC Adv. Grant). Hausel proposed to me the problem of understanding the hyperKähler metric on the moduli space of Higgs bundles; a very difficult problem that I attacked with my collaborators from two different points of view: Kähler geometry (Math. Ann. 17) and Donaldson-Thomas theory (Selecta Math. New Ser. 17). For personal reasons, in 2014 I moved to the ICMAT in Madrid to start a 2-year postdoc at the Hitchin Laboratory, under the supervision of Hitchin and García-Prada. During 2015 we found striking relations between the Kähler-Yang-Mills equations in my PhD Thesis and cosmic string solutions in cosmology. This led us to a solution of a conjecture by Y. Yang in (CMP 17) and (arXiv:1606.07699, submitted).

In 2015 I was awarded a 2-year Marie Curie Individual Fellowship at ICMAT. During these years I focused on developing an independent line of research on non-Kähler complex geometry, special holonomy with torsion, and mirror symmetry. In 2017 I joined the Department of Mathematics at the Universidad Autónoma de Madrid as a Profesor Ayudante Doctor, where I actively continue working on my new line of research. The main aim of my research is twofold: on the one hand, to develop a theory of canonical metrics in complex non-Kähler geometry, and, on the other hand, to provide mathematical underpinnings for a conjectural generalization of mirror symmetry, known as (0,2)-mirror symmetry. For this, in my present work I transfer techniques from Kähler geometry to address problems in complex non-Kähler geometry, using Courant algebroids, gerbes, and other objects reminiscent from higher gauge theory, combined with spinors and the theory of vertex algebras.

Resumen del Currículum Vitae:

Mario García Fernández (Alicante, 1982), Ph. D. in Mathematics, Universidad Autónoma de Madrid (UAM).

Current Position: Profesor Ayudante Doctor, Universidad Autónoma de Madrid, since September 2017.

Previous Positions: Marie Curie Individual Fellow at ICMAT (2015-2017), postdoctoral positions at the Hitchin Lab. of ICMAT (2014-2015), the École Polytechnique Federal de Lausanne (2013-2014), the Centre for Quantum Geometry of Moduli Spaces (Aarhus, 2010-2012).

Publications: 11 papers in research journals listed in the JCR (WOS); 10 are in Q1 of their respective fields (2 Mathematische Annalen, 1 Geometry and Topology, 1 Selecta Mathematica New Ser., 1 Proceedings London Math. Soc., 1 Journal London Math. Soc., 4 Communications in Mathematical Physics --Mathematics, Mathematical Physics); Lecture Notes in Travaux Mathématiques (School GEOQUANT 2015); 8 preprints: 5 currently under evaluation.

Among them, I have papers where I am the only author: 1 Comm. Math. Phys., 1 Lecture Notes Travaux Mathématiques, 2 preprints under evaluation.



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12 co-authors: Álvarez-Cónsul and García-Prada (ICMAT), Andreas (Freie Univ.), Clarke (UFRJ), Filippini (Cambridge), Keller (Marseille), Pingali (Bangalore), Ross (UI Chicago), Rubio (UB), Shahbazi (Hamburg), Stoppa (SISSA, Trieste), Tipler (Brest).

Selected Fellowships (competitive calls):

2015 Profesor Ayudante Doctor UAM (5 years).
2015 Marie Skłodowska-Curie Individual Fellowship (2 years).
2015 Juan de la Cierva Incorporación (DECLINED).
2014 ICMAT Hitchin Laboratory Postdoctoral Fellowship (2 years).
2013 EPFL Postdoctoral Fellowship (2 + 2 years).
2011 Hausdorff Research Institute visiting Fellowship (3 months).
2010 QGM Postdoctoral Fellowship (2 years).
2010 MPIM Postdoctoral Fellowship (6 months).

Funding: I have participated in 7 international funded projects (including funding from the European Commission and the ESF) and 12 national funded projects (Severo Ochoa and national calls). I have obtained European funding through a Marie Curie IEF Fellowship competitive call.

Talks: 34 invited talks at international conferences (plenary talks at VBAC 2018, Young Geometric Analysts Forum 2018, GEOQUANT 2017, StringPheno 2017, Hitchin70) and over 30 seminars and colloquia, some in prestigious research institutions such as the Kolloquium über Reine Mathematik in Hamburg, the IMS Colloquium in ShanghaiTech, the Geometry and Quantum Theory Colloquium (the Netherlands), the SFB-647 Seminar (closing ceremony) at the Humboldt University, the Rencontres Théoriciennes at the Institut Henri Poincaré, Oxford University, Newton Institute (Cambridge).

Advanced Courses: Yau Mathematical Sciences Center, Scuola Internazionale Superiore di Studi Avanzati (SISSA, scheduled), Un. Zaragoza, Geoquant School 2015, Hausdorff Research Institute for Mathematics.

Supervision of students and postdocs: I am currently supervising a postdoc (ICMAT), and co-supervising a PhD Thesis (UCM). I have co-supervised a Master Thesis (UCM). I supervised 2 Bachelor Thesis (UCM, EPFL) and 3 Severo Ochoa Introduction to Research Fellowship (ICMAT).

Other merits: Accreditation "Profesor Contratado Doctor" ANECA. Hiring committee assistant professors, ShanghaiTech. PhD Thesis Examiner, Australian National Un.. Reviewer (Invent. Math., CMP, Adv. Math., ...). Member of 4 PhD committees and 2 fellowship committees.



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Título:

El problema de restricción y aplicaciones

Resumen de la Memoria:

To date, my research has focused on the study of the restriction problem and the wave equation. Highlights of my achievements include the following:

- i) I gave the first proof in the literature of a multilinear restriction type estimate with a non trivial (the sharp one) dependence on the transversality. This was an important open problem, considered as crucial for the expert in order to progress in the understanding of the restriction theory. This result was published in American Journal of Mathematics.
- ii) In a joint work with Sanghyuk Lee we refined the square function estimates for the wave equation in three dimensions, and obtained improvements on the local smoothing conjecture. The proof uses refined Kakeya estimates and the approach of i).
- iii) I improved the classical Strichartz inequality for the wave equation in terms of some refined Besov spaces. The result allowed to obtain the profile decomposition for the Lorentz invariant wave equation, which is a crucial ingredient in the nonlinear theory and in the proof of existence of maximizers for the Strichartz inequality. Later on, I used the decomposition for a characterization of the dynamics of blow up nonlinear solutions.

After obtaining my PhD in 2012 from the UAM, where I also received the Outstanding PhD Award, I went on to accept a position at IMPA (Brazil) with an Excellence Postdoctoral Grant, also known as the institution's most demanding postdoc. Over the course of three years, I established connections with the nonlinear dispersive equations and harmonic analysis research groups around Brazil, visiting many universities (among others, Campinas, São Carlos, Porto Alegre and UFRJ) and led seminars. In addition, I taught the official PhD course of Partial Differential Equations, and participated on more than 10 juries for students aiming to enter into the PhD Programme, and serve on one PhD tribunal.

Over the last four years, I have been the main supervisor for the PhD candidate Felipe Ponce, who defended his thesis in May 2018, and was awarded a Laureata distinction and the Yu Takeuchi prize. The thesis includes two published papers (in IMRN and PAMS) and one preprint (joint work with me). Furthermore, I have been also invited to give talks in many international conferences, including the Harmonic Analysis/PDEs Workshop of the London Mathematical Society (Birmingham 2011), 2nd Mathematical Congress of the Americas (Guanajuato 2013), Joint International Meeting RSME-SCM-SEMA-SIMAI-UMI (Bilbao 2014), 30th Colòquio Brasileiro de Matemática (Rio de Janeiro 2015), Conference on Interactions Between Harmonic and Geometric Analysis (Tokyo 2016), and the Conference on Harmonic Analysis celebrating the 60th birthday of professor Bak (Seoul 2017). I was also part of the organizing committee of some conferences, including the satellite conference in Harmonic Analysis of International Congress of Mathematics 2018 (ICM 2018). My commitment to serving the mathematical community both in the role of supervisor and by carrying out numerous talks clearly demonstrate my leadership abilities in the generation and dissemination of mathematical knowledge.

Having acquired expertise in the restriction theory, I now aspire to broaden my fields of knowledge to inverse problems and geometric measure theory. The bridge between the restriction theory and these fields already exists; however, i

Resumen del Currículum Vitae:

In 2012, I received a Ph.D. from the Universidad Autónoma de Madrid under the direction of Keith Rogers and Ana Vargas. The thesis received the Outstanding Ph.D. Award. The following three years I held a postdoctoral position (Pós-Doutorado de Excelência) at IMPA, in Brazil. In the last three years I have featured a Severo Ochoa postdoctoral position at ICMAT. I have publications as a sole author in top level journals as American Journal of Mathematics, Advances in Mathematics, Journal of Functional Analysis and International Mathematical Research Notices. I have supervised as the main supervisor the Ph.D. thesis of Felipe Ponce. His thesis was awarded with the Yu Takeuchi award (the most prestigious prize for thesis in science in Colombia). I have given invited talks in conferences organized by institutions like the London Mathematical Society or the American Mathematical Society. In addition I have organized conferences such as the 2018 ICM satellite for harmonic analysis.

I gave seminar talks in places like U.K, South Korea, Brazil, Colombia or Spain. I also have given mini courses for PhD students and



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postdoctoral fellows about topics related with my research, and taught a doctoral course in PDEs. I did some reseach stays in the University of Edinburgh, Seoul or Porto Alegre. This year I also will be given a summer school in Bilbao and mentoring a JAE student at ICMAT.



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Título:

Aplicaciones de topología geométrica y algebraica a sistemas dinámicos

Resumen de la Memoria:

My main interest lies in those questions in dynamics that lead to appealing problems in geometric and algebraic topology, especially in low dimensional manifolds. Dynamics are a natural source of sets with a complicated topological structure, and this usually requires the use of methods of a Čech nature, such as Čech cohomology.

In my Ph.D. thesis and early career I focused mainly on continuous dynamical systems (flows). I studied some topological properties of attractors (either stable or exhibiting mild forms of instability) and their basins of attraction, often with the aid of the Conley index. I also obtained results that provide information about properties of an "unobservable" invariant set -for instance, its Betti numbers, or its knottedness- in terms of its "observable" isolating neighbourhoods.

After finishing my Ph.D. my research has gradually shifted towards discrete dynamical systems (homeomorphisms or even continuous maps) rather than flows, because they pose more challenging problems since they exhibit a much more exotic behaviour than their continuous counterparts even in dimensions as low as two. Technically, flows provide homotopies for free whereas homeomorphisms do not, and this makes it more difficult to apply the methods of geometric topology. To overcome this issue my research has become more algebraic and less geometric.

Along my career I have broadly worked on three problems:

(1) The relation between the cohomology of an attractor and its basin of attraction. This is a classical problem which has been profusely studied for flows. The literature on the discrete case was much more scarce and, alone and together with F. R. Ruiz del Portal, we have obtained substantial results in this case. Working on this problem in increasing degrees of generality have led us to introduce novel algebraic techniques such as the summation of power series in cohomology.

(2) Conditions on how an attractor sits in phase space. When trying to understand how complicated an attractor may be, one soon notices that even sets that are intrinsically simple (such as a sphere) may lie in ambient space in such a contorted way that they cannot be realized as attractors for a homeomorphism or a flow. Heuristically, even if attractors can be very strange indeed, there is some bound to this strangeness. In an attempt to understand this I have introduced a crude numerical measure of the crookedness of a subset of Euclidean space and used it to prove that certain classical wild sets from topology cannot be realized as attractors. In joint work with R. Ortega and also with H. Barge we have extended the catalogue of these examples to include other objects such as knotted solenoids or wild knots.

(3) The discrete Conley index. This index may be very roughly described as a generalization of the fixed point index to arbitrary invariant sets. Its definition for discrete dynamical systems is rather algebraic and, although intuition suggests that the index captures information about the dynamics around the invariant set, it is not easy to understand the precise nature of this information. In collaboration with L. Hernández-Corbato and F. R. Ruiz del Portal we have extended previous results of them and P. le Calvez to obtain a very geometric description of the first (co)homological Conley index of an arbitrary continuum.

Resumen del Currículum Vitae:

I obtained my degree in Mathematics at Universidad Complutense de Madrid (1998-2003) and was awarded a "Premio Extraordinario de Licenciatura" as well as a "Premio Extraordinario por Campos Científicos". I also did my Ph.D. at UCM, supported by an FPU grant, under the supervision of J. M. Rodríguez-Sanjurjo. The title of my thesis was "Aplicaciones de Topología Geométrica y Algebraica al estudio de flujos continuos en variedades" and in it we studied several dynamical situations of interest using tools from algebraic and geometric topology, mainly in low dimensions. The thesis was awarded a "Premio Extraordinario de Doctorado".

As I was finishing my Ph.D. I took a state exam to become a High School teacher, a position which I obtained and exercised for a year while looking for a postdoc position. I was then offered a year-long contract as a Research Fellow at the University of Warwick, in a project funded by the EPSRC. After that I returned to Spain and worked for two years at the Universidad of Castilla-la Mancha, moving afterwards to Universidad Autónoma de Madrid, where I am currently employed at the Facultad de Ciencias Económicas y Empresariales.



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AYUDAS RAMÓN Y CAJAL CONVOCATORIA 2018

Turno de acceso general

Since 2007 I have continuously belonged to competitive research projects funded by the Ministry of Science (in its various names along the years). Starting in 2016 I am also a member of a research project in Economics funded by the Comunidad de Madrid.

I have written nineteen papers, either as a single author or in collaboration, of which four are currently in refereeing process and the remaining fifteen have been published; some of them in prestigious journals such as Transactions of the AMS, Advances in Mathematics, J. Differential Equations, Ergodic Theory and Dynamical Systems or Nonlinear Analysis Series A. Most of my papers are concerned with one of these broad three topics: the relation between the cohomology of an attractor and its basin of attraction; the peculiar properties of attractors as subsets of phase space; the Conley index and its applications.

I have been an invited speaker in eleven national and international conferences, and plenary or semi-plenary speaker in three of them. I have also been invited to give talks in several seminars in Madrid, Seville, or Granada.

I have been a referee for journals such as International Journal of Bifurcations and Chaos, the Bulletin of the London Mathematical Society, or Revista Matemática Complutense. I have also been asked by the National Science Center of Poland to evaluate joint research projects between Germany and Poland (programme Beethoven 2).