



AYUDAS RAMÓN Y CAJAL CONVOCATORIA 2016

Turno de acceso general

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Área Científica: Matemáticas
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Título:

Geometric Analysis in the large

Resumen de la Memoria:

I focus my research in Geometric Analysis with special interest in constant mean curvature and minimal surfaces in three-manifolds, other surfaces with certain relation of its curvatures constant, conformal geometry and overdetermined elliptic problems.

During my ph. D. I developed the theory of Codazzi pairs, an abstract theory on pairs of quadratic forms on surfaces that can be applied to various different fields as surface theory or elliptic PDEs. Using this theory I was able to classify surfaces of certain constant curvature in homogeneous spaces, as those of constant Gaussian Curvature or Constant Extrinsic curvature and various classification results on constant mean curvature surfaces in homogeneous spaces.

Surfaces of Constant Mean Curvature, in particular, Minimal Surfaces, arise naturally in the realm of our physical world as least action surfaces because, of all possible configurations you can have, the ones that actually occur have the least energy. In Leibniz's words, Nature is thrifty in all its actions.

Minimization (or least action) has been a foundational concept in both geometry and physics. Loosely speaking, stable surfaces are minimizers for a certain functional and one of its mayor representatives are the minimal surfaces. Minimal surfaces are critical points of the area functional and we say that a minimal surface is stable if it is a local minimum for the area functional. More generally, we can consider constant mean curvature surfaces, critical points of the area functional under volume restrictions. The study of stable surfaces is crucial in a wide variety of fields as Biology, Engineering, General Relativity, Quantum Mechanics or String Theory. I studied stable minimal and constant mean curvature surfaces using Schrodinger operators, classifying them under conditions on the potential and its application to surface theory.

One of the most important problems in Partial Differential Equations is the Nirenberg Problem: which functions on the n sphere arise as the scalar curvature of some conformal metric on the sphere? This problem, still open in all its generality, opened the door of a rich subject in the last few years, Conformally Invariant Equations. We developed a geometric point of view to study conformal equations, in essence, given a solution to a conformally invariant equations we associated, in a unique way, a hypersurface in the hyperbolic space. This new point of view in the field of conformal geometry allowed us to relate the Nirenberg problem in the sphere with the Christoffel problem in the Hyperbolic space. Moreover, we study Escobar, Yamabe or Min-Oo type problems for fully nonlinear conformally invariant elliptic equations, non-degenerate and degenerate.

Finally, Partial Differential Equations are the core of most of the physical problem we can think of. Also, after the establishment of the General Relativity, PDEs in Riemannian Manifolds, and not only in the Euclidean Space, are fundamental in the comprehension of our Universe. In particular, we focus on overdetermined elliptic problems that arise naturally in free boundary problems. Using geometric tools and Codazzi pairs theory, we are able to classify extremal domains in space forms.

Resumen del Currículum Vitae:

I obtained my ph. D at Universidad de Granada in 2008 under the thesis entitled La ecuación de Codazzi en Superficies, with the highest qualification 'suma cum laude'. My research is based on Geometric Analysis, I focus on Minimal and Constant Mean Curvature Surfaces (among other curvature functions) in three-manifolds, with special interest in Homogeneous Spaces. My thesis, on the theory of Codazzi Pairs, is one of my main research lines in Geometric Analysis. Another important line opened in the last few years in on Conformal Geometry and Geometric PDEs in general. Moreover, Overdetermined problems and its relation with capillary hypersurfaces has attracted my attention recently.

I accomplished (author/co-author) 24 research papers all of them in journals indexed in the JCR (other 8 papers are currently under revision). In addition, 2 book's chapters and 2 complete books. I advised 2 postdoctoral researchers. I did multiple long/short-term research visits at leading international centers including Princeton University, IHES in Paris or Stanford University. Multiple conferences in international congresses, as well as seminars, to enlighten some of them we mention: Congress of Young Researchers of the Royal Spanish Mathematical Society, Congress of the Americas and Second European Young and Mobile Workshop: Geometric Analysis and PDEs.

I obtained the J. Simons Chair (IMPA - Rio de Janeiro, Brasil) through a competitive world-wide position, financed with 4 million dollars for 2 places in tenure-track mode by the Simons Foundation, one of the most prestigious in the world. Currently, since March 2016, as Permanent Researcher of IMPA.



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During my career I taught more than 1000 hours at Master and Ph.D. courses. Member of the Teaching Commission at IMPA since 2012. I have advised 2 ph.D. students (Dimas P Abanto and Haimer A. Trejos) and 4 others in progress, 1 completed Master's Degree student (Dyego Soares) and other 2 ongoing. 1 student of Scientific Initiation completed (Iago Arcas). All of them as the unique advisor. It should be noted in this part the abundant organization of scientific events, to be highlighted as organizer: International Congress of Mathematicians Rio de Janeiro 2018 as head of Mathematical Intelligencer Rio de Janeiro 2018, School of Differential Geometry Brazil 2016, the most important geometry event in Brazil, 30 Brazilian Colloquium Of Mathematics (Session of Geometry). As scientific committee: School of Differential Geometry 2014, Biennial of Mathematics of Brazil 2107, Biennial Congress of the RSME 2017. Currently I'm Secretary at Sociedade Brasileira de Matemática since July 2015. Member of the Editorial Board at Sociedade Brasileira de Matemática since 2013.

I have participated in numerous research projects in Spain, France and Brazil, being the Principal Researcher for those carried out in Brazil under the titles Geometric Vision of conforming Equations, Stable surfaces: geometric aspects of general relativity and string theory, and Geometric Analysis and Geometric Differential Equations of surfaces in three manifolds among others. I also collaborate as a researcher on the team of Professor J.A.o Gálvez (University of Granada) in the project Global Surface Theory and Geometric Differential Equations, or in the team of Pr. H. Rosenberg (IMPA) in the project Constant Mean Curvature Surfaces



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Título:

Kinetic limits of interacting particles

Resumen de la Memoria:

The project addresses the mathematical theory of systems of many interacting particles. Especially, we investigate the transition from the microscopic modelling of physical systems to the equations ruling the phenomena that we can perceive and measure. This connection is the crossroad of partial differential equations, stochastic analysis, and dynamical systems theory.

A cornerstone in the field is the kinetic theory of gases and plasmas and, more generally, the theory of collision processes. The mathematical validity of kinetic equations is a traditional topic. However, as of today, the theory is far from being in a mature state.

In the past three years, there has been a renewed, intensive effort in the branch of classical dilute gases, and a considerable amount of new tools has been developed. Moreover, we have detected technical connections to different areas such as percolation, chaos and graph theory.

This is a proposal for several related problems which can be the target of a medium- to long-term research.

The Mathematics Department of Universidad Complutense offers excellent possibilities of cooperation within the area of kinetic equations, partial differential equations in mathematical physics and stochastic systems, and shares scientific methodology and interests with the topics of this proposal.

Resumen del Currículum Vitae:

I am a mathematical physicist from Rome, 32 years old, currently working at the Zentrum Mathematik of the Technical University of Munich. My main interests are kinetic theory, statistical mechanics and stochastic analysis, with special enthusiasm on topics where a combination of those succeeds.

I was trained in Rome under the supervision of Giovanni Gallavotti (Master's degree: September 2008; Ph.D.: December 2011) working in the areas of constructive quantum field theory and classical statistical mechanics. After my PhD I focused mostly on problems related to Boltzmann type equations and I am now the Principal Investigator of the DFG (German Research Foundation) project "Mathematical analysis of dilute classical gases".

Among my achievements I shall mention the rigorous derivation results for the classical Boltzmann theory (Jour.Stat.Phys.2012; Rev.Math.Phys.2014; Inventiones Mathematicae 2016) and the discovering that the statistics of collisions in rarefied gases is equivalent to a coalescence process with percolation (M3AS 2015; Physica D 2016). My net of collaborations extends over several institutions including Italy, Germany, France, Japan.



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Área Científica: Matemáticas
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Título:

Algebraic coding theory, secret sharing and quantum stabilizer codes

Resumen de la Memoria:

During my PhD studies at the University of Valladolid and the postdoctoral positions at the University of Kaiserslautern and the Technical University of Denmark-DTU, my research has been focused in applying algebraic geometry and computer algebra (Gröbner bases) techniques to the theory of error-correcting codes. I have worked with several families of linear codes, namely toric codes (algebraic geometry codes defined using toric varieties), matrix-product codes (a construction of new codes from old ones) and evaluation codes (using the Feng-Rao or order bound). I worked in estimating their parameters, developing unique and list decoding algorithms and finding codes with very good parameters.

Moreover, a bound for the number of rational points of a curve was obtained by considering Weierstrass semigroups defined by several points. An application of coding theory to algebraic geometry was obtained in this case (usually, it is the other way round). I have also worked with the McEliece cryptosystem using algebraic geometry codes, I attacked it, for some parameters, using Gröbner bases.

Since 2013, as associate professor at Aalborg University, my research has mainly consisted of applying the previous families of codes and techniques into the fields of secret sharing and quantum codes. A secret sharing scheme is a cryptographic method to encode a secret into multiple shares later distributed to participants, so that only specified sets of participants can reconstruct the secret. I have studied the precise security of secret sharing schemes, both classical and quantum, coming from algebraic geometry codes. The main tool was the Feng-Rao bound.

One can define quantum stabilizer codes from classical error-correcting codes using the CSS construction and the Steane's enlargement. I considered the families of codes mentioned above and our own version of the Steane's enlargement using affine-variety codes to obtain quantum codes with excellent parameters (records).

Resumen del Currículum Vitae:

I am an associate professor at the department of Mathematical sciences of Aalborg University, Denmark.

I studied Mathematics at the University of Valladolid (2002), obtaining "premio extraordinario de licenciatura", and in the University of Kaiserslautern (2003), Germany, under a double degree agreement. I had a FPU scholarship at the Singacom group of the University of Valladolid from 2003 to 2007. I was a postdoctoral researcher at the University of Kaiserslautern (2007) and a H.C. Ørsted postdoc fellow at the Technical University of Denmark-DTU (2008). From 2009 to 2012, I worked as an assistant professor at Aalborg University and since 2013 I have a permanent position.

My research has consisted of applying techniques of algebraic geometry and computer algebra to the theory of error correcting codes (classical and quantum) and cryptography.

I have published 18 journal articles (17 indexed in JCR and 3 in first quartile), 2 book chapters and 11 conference proceedings. Moreover, I have written a book and co-edited another one. My h-index is 7 in Web of science (ResearcherID) and 9 in Google scholar. I have 98 citations in Web of Science and 229 in Google Scholar.

I have given 14 invited talks and 13 contributed talks at workshops and seminars, and 16 invited talks at research centers. I have developed a network of collaborators at the Technical University of Denmark-DTU (Denmark), Jaume I University (Spain), San Diego State University (USA), Valladolid University (Spain) and Tokyo Institute of Technology (Japan), among others. Furthermore, I have done research stays in Denmark, Germany, Ireland, Italy, Japan, Spain and USA.

I have participated as researcher in 4 national Spanish research projects, 2 regional research projects in Castile and Leon, 1 Danish-Chinese research project and 1 national Danish research project. I was a management committee substitute member in Denmark for the COST action IC1104. I am an active member of the Spanish research group SINGACOM since 2004 and of the Danish research group "Reliable and secure communication" since 2009.

I have co-supervised one PhD thesis at Aalborg University and I am currently co-supervising another 3 PhD theses (2 of them as the main



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supervisor). I have supervised 7 master theses at Aalborg University. I have been a member of a PhD thesis defense committee at the University of Valladolid. I have been teaching bachelor, master and PhD courses at Aalborg University since 2009. I have the Spanish ANECA accreditations for "Profesor contratado doctor" and "Profesor titular de universidad".

I am an area editor for the journal JACODESMATH-Journal of Algebra Combinatorics Discrete Structures and Applications, since 2014. It is a young journal supported by the Yildiz Technical University (Turkey) and indexed in Mathscinet. I have been reviewer for 7 journals and 5 conferences.

I co-organized the popular meetings YMIS-Young Mathematicians in Sedano from 2005 to 2008. I have likewise co-organized the PhD school S3CM at the Valladolid University's campus of Soria, from 2008 to 2010, this school was held as an Erasmus action from the European Commission. Finally, I have co-organized a parallel session of the ACA-08 conference at RISC (Austria).



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Título:

Ecuaciones en derivadas parciales no lineales

Resumen de la Memoria:

Durante mi carrera he trabajado en varios temas de las Ecuaciones Diferenciales en Derivada Parciales y del Cálculo de Variaciones. En más detalles puedo enumerarlos como sigue:

- Cotas sobre el gradiente para soluciones de ecuaciones elípticas no lineales singulares en la frontera;
Entre otros, generalicé algunos resultados de P.L.Lions sobre gradient bounds para soluciones de ecuaciones elípticas no lineales, que tienen una fuerte singularidad en la frontera. El caso de ecuaciones del primer orden, con el método de vanishing viscosity, también se ha considerado.

- Large solutions para ecuaciones elípticas y parabólicas;
He probado la existencia de large solutions para ecuaciones cuasi-lineales, tanto en el marco elíptico como parabólico. Sus propiedades cualitativas han sido también investigadas (en particular, la dependencia de la curvatura media de la frontera)

- Ecuaciones no locales;
La contribución principal es un paper sobre las estimaciones básicas de ecuaciones lineales con difusión fraccionada. Se ha desarrollado una exhaustiva teoría L^p .

- Ecuaciones no lineales Singulares;
En varios artículos he investigado la existencia de solución para ecuaciones elípticas en presencia de términos de orden inferior no lineales singulares.

- Influencia del potencial Hardy en las ecuaciones elípticas;
He investigado la influencia del potencial de Hardy, en particular, la existencia, la no existencia y la velocidad de explosión, para soluciones de las ecuaciones elípticas no lineales.

- Las ecuaciones con los datos irregulares;
He tratado a soluciones de ecuaciones con datos L^1 o medida.

- Las soluciones de las ecuaciones que involucran el p -Laplaciano
Principio Comparación (en sus formulaciones débiles y fuertes), el problema de la prueba de estimaciones a priori sobre el gradiente, la resolución del problema de Dirichlet y muchas otras preguntas interesantes se han investigado para las soluciones de las ecuaciones elípticas degeneradas que involucran el p -Laplaciano.

- Elasticidad no lineal

También he impartido clases tanto de grado como de postgrado en varias universidades.

He dirigido tre tesis de máster: dos en la Universidad de Granada (en 2011 y 2016) y otra en 2015 en la Universidad de Turín

Actualmente estoy co-dirigiendo dos tesis de doctorado.

Soy organizador del Seminario de Ecuaciones Diferenciales de la UGR / IEMATH-Granada.

También he sido miembro de los comités organizadores de un Workshop internacional (Madrid, Octubre de 2013) y de dos Congresos internacionales (Roma, Junio de 2015 y Granada Mayo 2017).

Resumen del Currículum Vitae:

El día 12 de noviembre de 2002, concluí la Licenciatura de Matemáticas en la Universidad de Roma "La Sapienza" leyendo la tesis titulada:



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"Equazioni ellittiche con termine di ordine inferiore a crescita naturale nel gradiente e dati misura", la cual fue dirigida por el Prof. L. Orsina y valorada con 110/110 cum laude.

Disfruté una beca predoctoral desde Noviembre de 2002 a Octubre de 2005 en la Universidad de Roma "Tor Vergata".

Bajo la dirección del Prof. A.Porretta en la Universidad de Roma "Tor Vergata", el día 3 de marzo del 2006, leí la tesis doctoral titulada: "Large Solutions for a class of Nonlinear Elliptic Equation with Gradient Terms", la cual fue valorada con Sobresaliente cum laude.

Después de la lectura de la tesis tuve dos contratos postdoctorales. El primero de ellos (2006-2007) en la Universidad "La Sapienza" de Roma y posteriormente, durante el curso 2007-2008, en el CMUC-Universidad de Coimbra (PT).

Al terminar mi periodo postdoctoral en Portugal me incorporé en la Universidad de Granada con un contrato "Juan de la Cierva" (1 de Enero 2009 - 31 de Diciembre 2011) con supervisor el Prof. D.Arcoya.

Desde Enero 2012 hasta Julio 2014 estuve en la Universidad Carlos III de Madrid con una plaza de Profesor Ayudante Doctor.

En Julio 2014 congelé la plaza de Profesor Ayudante Doctor y regresé a la Universidad de Granada con un contrato de "Reincorporación de Jóvenes Doctores" del Plan Propio.

Estoy acreditado como Profesor Titular tanto en España como en Italia, desde el año 2013.

He dado más de 30 seminarios entre congresos y conferencias invitadas en centros de investigación de reconocido nivel internacional. Además he hecho unas 30 estancias como profesor visitante (de entre 1 y 3 semanas) en centros de investigación de reconocido prestigio internacional.

Desde que soy doctor, de acuerdo con las exigencias de los departamentos a los que he pertenecido, he impartido clase todos los años. Además he dado clase en cursos de Doctorado y de Máster.

He sido codirector (con el Prof. D.Arcoya) de la tesis de Master del programa FisMat de Laura Gonella (2011, Univ. de Granada), (con el Prof. D.Arcoya y la Prof. S.Terracini) de la tesis de Master (Laurea Magistrale) de Stefano Buccheri (2015, Università di Torino), y de la tesis de Master del programa FisMat de Antonio Jesus Fernandez Sanchez (2016, Univ. de Granada).

Actualmente estoy co-dirigiendo dos tesis de doctorado (Salvador Lopez y Stefano Buccheri) con los proff. J. Carmona y L. Boccardo, respectivamente.

He participado en 19 proyectos financiados por los Gobiernos de Italia, España o Portugal.

He publicado más de 20 trabajos en revista de prestigio internacional (entre otros, en Arch. Rat Mech. Anal., en SIAM J. Math. Anal, dos en J.Diff.Eq., dos en Calc.Var., Comm.P.D.E.) citados un total de 217 veces (Google Scholar). Además tengo un libro de ejercicios (del curso de Ecuaciones en Derivadas Parciales) y dos Proceedings (del ICM 2010 de Hyderabad, India y CEDYA 2011). Más papers están sometidos o en progress.

He sido organizador del "Workshop on nonlinear equations", (17-18 Octubre del 2013) en la Universidad Carlos III de Madrid (<https://sites.google.com/site/nonlinearmadri2013/home>), del Congreso Espalia3 (17-19 Junio del 2015) en la Università de Roma "Sapienza" (<http://www.sbai.uniroma1.it/conferenze/espalia2015/>)