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AYUDAS RAMÓN Y CAJAL CONVOCATORIA 2013

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Nombre: ALARCON LOPEZ, ANTONIO

Referencia: RYC-2013-12616

Área Científica: Matemáticas

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Título:

Global Theory of Minimal Surfaces

Resumen de la Memoria:

My research is included in the field of Geometric Analysis, in particular, Minimal Surface Theory; a major topic of geometry ever which is currently a very active focus of research. The theory of minimal surfaces in the Euclidean 3-space, R^3 , began with the calculus of variations developed by Euler and Lagrange 250 years ago. The global theory of these surfaces was developed by Osserman in the 1960s, although many of the global problems and classical conjectures have remained open until the last few decades. An example of this picture is the Calabi-Yau problem (which dates back to 1966), dealing with the existence of complete bounded minimal surfaces in R^3 ; Nadirashvili provided the first example of such a surface in 1996. Another good example is a question posed by Schoen and Yau, in 1985, whether there exist hyperbolic minimal surfaces in R^3 properly projecting into a plane.

My main research line is the study of the Global Theory of Minimal Surfaces in R^3 by using both classical and modern Complex Analytic tools. My main contribution to the field is a Runge-Mergelyan type approximation theorem for minimal surfaces in R^3 , which is a very powerful and versatile tool for constructing such surfaces and also null curves in the Complex Space C^3 (that is, complex curves whose real and imaginary parts are minimal surfaces in R^3), and has many applications. Among other results, we have proved that every open Riemann surface is the complex structure of a minimal surface in R^3 properly projecting into R^2 , giving answer to the question by Schoen and Yau. We have also provided general existence results of complete bounded embedded null curves in C^3 , solving the corresponding Calabi-Yau type problem. Further, we have proved that every bordered Riemann surface is the complex structure of a complete bounded minimal surface in R^3 , solving the so-called conformal Calabi-Yau problem for surfaces.

I have also obtained relevant contributions to the theories of maximal surfaces, harmonic mappings between Riemannian manifolds, constant curvature surfaces in R^3 , null curves in the Special Linear Group $SL_2(C)$, constant mean curvature one surfaces in the Hyperbolic space, and complex curves in C^2 . Concerning constant curvature surfaces, a major subject in Surface Theory, we have shown and classified the family of surfaces in R^3 with positive constant Gauss curvature, extrinsic conformal structure a circular domain, and Gauss map a diffeomorphism onto a finitely punctured sphere. Regarding complex curves, a major topic in Complex Analysis, we have constructed the first examples of complete bounded embedded complex curves in C^2 ; whether such curves exist was asked by Yang in 1977.

A highlight between my scientific contributions is the development of the theory of directed holomorphic immersions of open Riemann surfaces into complex Euclidean spaces. Directed immersions have been studied in many classical geometries (symplectic, contact, totally real, Lagrangian, etc.); surveys can be found in the monographs by Gromov, and Eliashberg and Mishachev. Apart from specific examples, our analysis seems to be the first systematic investigation of this subject in the holomorphic case. In particular, we have proved approximation and desingularization results, and, as application, we have provided properly embedded null curves in C^3 with arbitrary conformal structure.

Resumen del Currículum Vitae:

Antonio Alarcón was born in Barcelona, Spain, in 1980. He received B. Sc. degree in Mathematics from the University of Granada in 2003, and Ph. D. degree in Mathematics from the same University in 2008; developing his work in the Department of Geometry and Topology. During Ph. D. studies he was recipient of several predoctoral grants (from the University of Granada, from the Region of Andalusia, and an FPU grant).

After that, Alarcón had a teaching position at the University of Murcia until the end of 2010. Then he was awarded a postdoctoral grant at the University of Granada in 2011, and he currently enjoys a researching position given by the University of Granada.

During this time, he spent some periods at the University of Marseille (France), the University of Paris Diderot - Paris 7 (France), the University of Ljubljana (Slovenia), and the Technical University of Denmark at Copenhagen. Some of these researching stays were completely/partially supported by the host institutions.

Alarcón is author of 20 published/accepted papers in journals included in the JCR ranking; 15 of them in the first quarter (highlights



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are papers in *Inventiones Mathematicae*, *Journal of Differential Geometry*, *Journal für die reine und angewandte Mathematik* (Crelle's Journal), *Mathematische Annalen*, *Geometric and Functional Analysis*, *Commentarii Mathematici Helvetici*, *Transactions of the American Mathematical Society*, *Calculus of Variations and PDEs*, etc.). Further, among other stuff, he is author of 5 preprints already submitted, and has published in the proceedings of 4 conferences.

Currently, Alarcón keeps active collaborations with several national and international researchers (in Spain, France, and Slovenia).

Alarcón has participated in 12 research projects. In particular, he has been the main researcher of one of them, obtained from *Campus de Excelencia Internacional CEI BioTIC GENIL (CEB09-0010)* - Spanish Ministry of Science and Innovation, in a competitive call. Moreover, Alarcón is member of an *International Scientific Coordination Network* (international funds) which comprises an important number of researchers from France and Spain. He is also member of the *Spanish Net of Geometric Analysis*.

Alarcón has given invited lectures in a bunch of national and international congresses, in Europe and Brazil, as well as in the local seminars of several European universities. Furthermore, he is member of the *Scientific and Organizing Committee* of an *International Conference in Differential Geometry*, holding annually in Romania. In addition, he has organized two congresses in the University of Granada (one of them of international character).

Currently, Alarcón is supervising the final project of a student, at the University of Granada, to obtain the Degree in Mathematics. Moreover Alarcón is supervising the final project of a student of a Master Program (Universities of Almería, Cádiz, Granada, and Málaga) in which he teaches. Furthermore, Alarcón is advisor of a student enjoying a *Grant of Initiation to the research*, given by the University of Granada. He has also participated in the jury that evaluated a Ph.D. Thesis.

Finally, he has referenced papers for high level mathematical journals, such as *Journal für die Reine und Angewandte Mathematik*, *Commentarii Mathematici Helvetici*, *International Mathematics Research Notices*, among others.



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Nombre: LOPEZ FERNANDEZ, MARIA

Referencia: RYC-2013-13600

Área Científica: Matemáticas

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Título:

Análisis y numérico para ecuaciones de evolución no locales

Resumen de la Memoria:

We consider the analysis and numerical integration of several types of non local evolution equations.

We propose the application of contour integral methods for the time integration of convolution-evolution equations, with emphasis in the introduction of variable step sizes. Our main applications are wave scattering problems formulated as integral equations on the boundary of the scatterers. This leads to hyperbolic time-domain integral equations, for which adaptive methods in space and time and fast and memory reducing algorithms are of great interest.

We consider implicit changes of coordinates for the numerical computation of traveling waves associated to nonlinear evolution equations. We intend to study the suitability of this approach by analyzing the dynamics of the resulting non local problems.

We also address the numerical approximation of integral equations arising in fluid dynamics in order to detect the possible formation of singularities.

Resumen del Currículum Vitae:

Licenciada en Matemáticas por la Universidad de Valladolid en 2000. Un año de experiencia en la empresa privada, sector consultoría. Doctora en Matemáticas por la Universidad de Valladolid en 2005, bajo la supervisión de Cesar Palencia de Lara y Christian Lubich. Investigadora post-doctoral en la Universidad Autónoma de Madrid de 2007 a 2009, con contrato Juan de la Cierva desde 2008. Ayudante Doctor en la Universidad Carlos III de Madrid en 2009 y contratada JAEDoc en el CSIC de 2009 a 2010. Desde 2010, lecturer en el Instituto de Matemáticas de la Universidad de Zurich (Suiza). Soy autora de una quincena de artículos de investigación en el área de Análisis Numérico y de Análisis de Ecuaciones en Derivadas Parciales, la mayor parte de ellos en las mejores revistas del área y muy citados. He impartido una veintena de seminarios por invitación en distintas instituciones del mundo así como varias conferencias invitadas en diversos congresos internacionales. En la actualidad soy la investigadora principal de un proyecto financiado por la Swiss National Science Foundation, que cubre el sueldo de un estudiante de doctorado bajo mi supervisión.



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Nombre: ARAGON ARTACHO, FRANCISCO JAVIER

Referencia: RYC-2013-13327

Área Científica: Matemáticas

Correo Electrónico: fran.aragon@gmail.com

Título:

Optimization and variational analysis: theory, algorithms and computational experimentation

Resumen de la Memoria:

My research has been mainly focused on problems in variational analysis and optimization, specially on metric regularity. Among my publications, roughly half of them are dedicated to contribute with new theoretical results and techniques in this field. In the other half, we study the convergence of some algorithm applied to variational analysis problems, and/or we introduce a generalization of it.

Metric regularity ensures that the set of solutions of a generalized equation does not change drastically when the parameter changes slightly. This has important consequences in numerical analysis. Metric regularity, together with some variations of it (e.g., strong regularity, metric subregularity, Lipschitz continuity), has become a central notion in variational analysis. These properties have been fundamental in most of my research.

Regarding the algorithms, I have mainly done research on the following: Newton and quasi-Newton methods, proximal point algorithms, and projection-type algorithms, particularly Douglas-Rachford. With the exception of the Douglas-Rachford method, I have analyzed the convergence of some generalization of these algorithms for solving generalized equations under some type of metric regularity. The Douglas-Rachford algorithm has been widely studied and applied for finding the intersection of two (or more) convex sets. Despite the absence of a theoretical justification, the algorithm has also been successfully applied to various non-convex practical problems. We have been mainly studying the convergence of the algorithm in these non-convex problems, and we have showed some new possible applications of the algorithm.

Computational experimentation, together with high performance computing, has become in the last two years very important and useful for my research, mainly thanks to the expertise acquired during my postdoc in CARMA with Prof. Borwein. By computational experimentation it is possible to test the behavior of an algorithm by sampling different regions, getting some intuition about its convergence. This approach forms part of what is being called Symbolic-Numeric and Graphic Computation. In addition, analytical and visual tools are needed in order to extract useful information from big data, and visual tools can be very helpful. This is the main aim of our project "Walking on real numbers", where we offer various tools for representing floating point numbers as planar walks and for quantitatively measuring their "randomness". This project has received an important media attention (Wired, Gizmodo, Huffingtonpost, and Spiegel, among others).

My current research at the LCSB is focused on constructing globally convergent algorithms to find solutions of some generalized monotone mappings arising from models of biochemical networks, together with finding a characterization of such mappings. This shall contribute to solidify the mathematical and computational basis for high-dimensional nonlinear reaction kinetic modeling of biochemical networks. Mathematical models of biochemical reaction networks are formal representations of experimental observations. The corresponding computational model can be used as a means to predict the outcome of new experiments, interpret new experimental results and design new experiments. This is an interdisciplinary project, at the intersection of mathematics and biochemistry.

Resumen del Currículum Vitae:

I obtained my degree in Mathematics at the University of Alicante (Spain) in 2002, and was awarded with the "Premio extraordinario de fin de carrera" for the highest GPA among the graduates in Mathematics at this university in the class of 2002.

In the academic year 2002/2003 I joined the PhD program in Mathematics at the University of Murcia (Spain). I was supported during the four years of my PhD studies by an FPI grant by the Ministry of Education and Science of Spain. The grant was associated with the Research Project "Semi-infinite optimization and systems: geometry and stability" (Chief Investigator: Prof. Miguel Ángel Goberna Torrent). Thanks to a complementary grant, in 2004 I visited Prof. Asen L. Dontchev for three months at the University of Michigan (USA). In 2005 I repeated the experience with a stay of six months at this same university. Prof. Dontchev became my thesis advisor, co-supervised by Prof. Marco Antonio López Cerdá (University of Alicante). During my second visit to the University of Michigan, I started a collaboration with Prof. Michel H. Geoffroy (University of the Antilles and Guyane, Guadeloupe, France). In 2006 I visited



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him for six months.

In June 2007 I obtained my PhD with "European Mention" at the University of Murcia, awarded "Sobresaliente Cum Laude" (highest mark). The main theme of my thesis was the study of metric regularity in Variational Analysis and Optimization.

After the completion of my PhD, I worked for nine months as a Portfolio Valuation Analyst at the company "Multigestion Iberia S.A." (Madrid, Spain). Subsequently, I took a postdoctoral position of three years at the University of Alicante, supported by the postdoctoral program "Juan de la Cierva". This is a highly competitive postdoctoral grant given by the Ministry of Science and Innovation in Spain (in that year, only 13 grants were given to mathematicians).

In 2010 I was awarded with a competitive "José Castillejo" grant by the Ministry of Science and Education of Spain for stays in foreign research centers (450 grants offered that year for PhD holders with less than ten years since their completion). This grant enabled me to visit Prof. Adrian S. Lewis for five months at the School of Operations Research and Information Engineering at Cornell University (USA). In that same year I was one of only 13 Spanish young mathematicians awarded with a "Premio i-MATH en India", a grant that supported my participation in the International Congress of Mathematicians held in Hyderabad (India) at the end of August.

In 2011 I moved to Australia to become a Research Associate at the Priority Research Centre for Computer-Assisted Research Mathematics and its Applications, under the direction of Laureate Professor Jonathan Borwein. Since then, I've actively worked with Prof. Borwein, having still several ongoing projects.

In September 2013 I moved to Luxembourg, where I'm a Research Associate at the Systems Biochemistry Group at the Luxembourg Centre for Systems Biomedicine (LCSB). Recently, I have become a Marie Curie Fellow after obtaining an  AFR Postdoctoral Grant  of two years. My application obtained the maximum rating A+ (Excellent Proposal).

My academic positions during the past years have been research only, with limited teaching allowed. Nevertheless, between 2008 and 2011 I taught three different courses at the University of Alicante.



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Nombre: ARAMAYONA DELGADO, JAVIER

Referencia: RYC-2013-13008

Área Científica: Matemáticas

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Título:

Algebraic, geometric, and combinatorial rigidity for mapping class groups.

Resumen de la Memoria:

My research is in geometry and geometric group theory, with a focus on mapping class groups of surfaces and the various spaces upon which they act. Mapping class groups appear prominently in geometric group theory, partly because of their connections with other areas of mathematics, such as algebraic geometry, dynamics, and low-dimensional topology.

There is a well-established analogy between $\text{Map}(S)$ and $\text{SL}(n, \mathbb{Z})$ ($n > 2$), or more generally an arithmetic lattice in a semi-simple algebraic group. In this comparison, the roles of the symmetric space and the locally symmetric space are played, respectively, by the Teichmüller space $T(S)$ and the moduli space moduli space $M(S)$.

This comparison has motivated many, possibly most, advances in the understanding of the mapping class group. The dictionary between $\text{Map}(S)$ and $\text{SL}(n, \mathbb{Z})$ represents the main motivation behind my recent research. More concretely, a problem that I find fascinating is to study to what extent there is an analog, in the context of mapping class groups, of classical rigidity about lattices in Lie groups, such as those of Mostow and Margulis.

I present a summary of some of my recent results around the comparison between $\text{Map}(S)$ and $\text{SL}(n, \mathbb{Z})$: all of them will involve some flavour of rigidity for mapping class groups and/or the spaces on which they act.

Resumen del Currículum Vitae:

Currently Maitre de Conférences in Toulouse. Held previous positions at Galway (permanent), Urbana-Champaign (4 months), MSRI (4 months), Marseille (5 months), and Warwick (2.5 years). Author of over 15 research articles. Completed short-term stays in various institutions, including Barcelona (3 months), Bonn (2 months), Singapore (2 months). Co-organizer of 17 research conferences in various countries. Currently co-supervising a Ph.D. thesis, and supervised a masters thesis.

See the attached CV for more details.



Nombre: CASTRO MARTINEZ, ANGEL

Referencia: RYC-2013-14317

Área Científica: Matemáticas

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Título:

Singularidades en flujos incompresibles

Resumen de la Memoria:

The applicant carried out the studies of his thesis in the Consejo Superior de Investigaciones Científicas and he obtained his Ph.D degree in July of 2010 in the Departamento de Matemáticas of the Universidad Autónoma de Madrid. His thesis, Nonlocal and nonlinear one dimensional models in fluid mechanics, gave rise to six articles. His research interest is focused on PDEs and fluid mechanics. He has coauthored 18 research papers including articles in Ann. of Math., Arch. Ration. Mech. Anal., Advances in Math., Proc. Nat. Acd. of USA, among others.

Since his Ph.D Angel Castro has held post-doctoral positions at the Instituto de Ciencias Matemáticas (CSIC) of Madrid, the École Normale Supérieure of Paris and the Departamento de Matemáticas of the Universidad Autónoma de Madrid:

From Sep-2010 to Sep-2011 he has been a post-doc at the Instituto de Ciencias Matemáticas (CSIC) funded by the ERC-Grant ERC-2007-StG-203138-CDSIF. During this year he participated in the organization of the trimester Calculus of Variations, Singular Integrals and Incompressible Flows and lectured the master course Mecánica de fluidos in the Departamento de Matemáticas of the UAM together with professor Diego Córdoba.

From Sep-2011 to Sep-2012 he obtained a post-doc position at the Département de Mathématiques et Applications of the École Normale Supérieure of Paris. He worked with the professor David Lannes. This collaboration has resulted in two papers:

- Well-posedness and shallow-water stability for a new Hamiltonian formulation of the water waves equations with vorticity (with David Lannes), arXiv:1402.0464.
- Horizontal vorticity generation in a fully nonlinear shallow water model (with David Lannes).

From Sep-2012 to the present he has been in Departamento de Matemáticas de la UAM funded by the ERC-Grant ERC-2013-307179-GFTIPFD. During this period he has lectured the undergraduate course Matemáticas for Ciencias Ambientales. Also he has lectured the Master Course Fundamentos de Análisis Matemático I together with professor Daniel Faraco.

Resumen del Currículum Vitae:

The research of the applicant has been focussed on PDEs and fluid mechanics. In particular, his interest lies in the dynamics of incompressible flows. In this field, the main equations are the incompressible Euler equations and the Navier-Stokes equations. It is well-known that the study of global regularity in 3D is one of the most important problems in partial differential equations. But they are not the only equations we can find in Fluid Mechanics, since, from different physical situations, other models appear such as the surface quasi-geostrophic equation (SQG) or the incompressible porous media equations. The main work of the applicant has been the study of the formation of singularities in equations which arise from these systems. In his thesis he studied the formations of singularities in models which come from the SQG equations, the vortex-sheet problem, the vortex-patch problem and the incompressible porous media equation. This thesis gave rise to six papers.

While a post-doc, his research has mainly treated contour dynamics problems in fluid mechanics. In particular, in the Muskat and in the water waves problems. He has obtained results about the formation of turning waves and singular solutions for the Muskat problem, the formation of splash singularities for the water waves problem. During his stays in the École Normale Supérieure of Paris he initiated a collaboration with professor David Lannes. This collaboration has resulted in two research papers:

- Well-posedness and shallow-water stability for a new Hamiltonian formulation of the water waves equations with vorticity (with David Lannes), arXiv:1402.0464. In this paper the authors study the asymptotic limit of shallow water for water waves when the vorticity of the fluid is different from zero. The potential case (vorticity equal to zero) had been previously studied and the analysis shows the difficulties of this singular limit. The introduction of the vorticity makes the problem harder. Two points



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can be remarked: a careful analysis of the div-curl problem must be carried out taking into account the shallow water parameter and new energy estimates have to be produced in order to pass to the limit.

2. \blacklozenge Horizontal vorticity generation in a fully nonlinear shallow water model \blacklozenge (with David Lannes). In this paper, the Green-Naghdi model is obtained in the presence of vorticity and analysis of the solution is carried out.

The candidate has coauthored 18 research papers including articles in *Ann. of Math.*, *ARMA*, *Adv. in Math.*, *Proc. Nat. Acad. of USA*, *Nonlinearity*, *J. of Math. Phys.*, *DCDS*, *Chinese Ann. of Math.* He has been an invited speaker at more than 15 conferences, workshops and seminars in the University of Chicago, *École Normale Supérieure* of Paris, University of Texas at Austin, University of Cambridge, University of Lund, Universidad de Sevilla among others. He has also been plenary speaker of the congress \blacklozenge Congreso de Jóvenes Investigadores \blacklozenge de la Real Sociedad de Matemáticas Española.

Angel Castro has been member and a participant, since 2008, of the following international grants:

European Research Council grant ERC-2007-StG-203138-CDSIF. (2008-2013),
MathOcean project from the French Agence Nationale de la Recherche ANR-08-BLAN-0301-01,
European Research Council grant ERC-2013-307179-GFTIPFD. 2013-2018,

as well as several national grants.

In addition he has also participated in the organization of conferences and seminars.