ICMAT
INSTITUTO DE CIENCIAS MATEMÁTICAS

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Welcome to the 10th AIMS Conference

On the occasion of the celebration of the 10th AIMS Congress in Dynamical Systems, Differential Equations and Applications, Manuel de León, director of Congress and Shouchuan Hu, director of AIMS, presented the event.


Manuel de León.

From July 7th to July 11th the 10th AIMS (American Institute of Mathematical Sciences) Conference on Dynamical Systems, Differential Equations and Applications will be held in Madrid on the Cantoblanco campus of the Universidad Autónoma de Madrid. This conference has grown in importance since it was first held, and over the years the number of participants has also grown until reaching a spectacular attendance of almost 1,800 participants on this occasion in Madrid.

The success in bringing this conference to Madrid is due to the effort of the ICMAT, together with that of all the universities in the city (Universidad Autónoma de Madrid, Universidad Complutense de Madrid, Universidad Politécnica de Madrid, Universidad Carlos III de Madrid, Universidad Rey Juan Carlos) and the Real Academia de Ciencias Exactas, Físicas y Naturales (Spanish Royal Academy of Sciences).

The Spanish Society of Applied Mathematics (Sociedad Española de Matemática Aplicada - SEMA) is also collaborating in the event. The AIMS Conference series has always been well attended by Spanish mathematicians; in particular, ICMAT researchers have participated assiduously and on several occasions have organized special sessions. I would also like to thank the members of the program committee: Drs. Yaw Chang, Wei Feng, Michael Freeze, and Xin Lu, for their efforts in dealing with the scheduling and abstract editing, the student paper contest, and NSF grant. I especially owe my gratitude to Xin, whose leadership has been indispensable. This years conference is especially significant for the ICMAT because it is fully involved not only scientifically but also in the organization. ICMAT researcher Diego Córdoba will be a plenary speaker, while other ICMAT researchers will coordinate four special sessions.

The conference has outstripped all previous records for participation, virtually doubling the attendance of either the two previous conferences held in Dresden (2010) or Orlando (2012). It has thereby become the second most highly attended mathematical event held in Spain after the 2006 International Congress of Mathematicians (ICM), which was also hosted by the city of Madrid. We would like to think that the attractiveness of our city and our country has also played a part in this success, as well as the growing international profile of the ICMAT. It goes without saying that the conference has its own tradition that makes it an attraction in its own right, and its format (plenary speakers of the highest calibre with considerably broad scope for the organization of special sessions) is very appropriate for an event of this nature.

But those are not the only reasons why this conference is so important. It also brings together a large number of researchers whose work is focused on the application of mathematics in many industrial and technological fields as well as in other sciences. It therefore provides an excellent opportunity to boost knowledge transfer even further. In this regard, in October 2013 the ICMAT set up its own Transfer Office with the aim of giving extra momentum to the transfer of mathematical knowledge generated at the Institute. We know that this initiative is a medium and long-term undertaking, but the activities set in motion since the creation of the Office are proving to be highly promising, and the ICMAT has already entered into contact with various companies as well as participating in several Horizon 2020 programs.

Generally speaking, this conference is an event that provides a great opportunity for expanding Spanish mathematics in new directions. On behalf of the Organizing Committee, I would like to thank all the institutions that have helped to make it possible as well as the AIMS for its trust and confidence in the Institute, and especially all the participants (plenary speakers, organizers of special sessions, and speakers in general) for wishing to share this week in July together with us. This conference will undoubtedly help to strengthen the extraordinary development that Spanish mathematics has undergone over the last 25 years.

Manuel de León, director of the Instituto de Ciencias Matemáticas (ICMAT)

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Welcome to the 10th AIMS Conference


Shouchuan Hu.

As we celebrate the commencement of the Tenth AIMS Conference on Dynamical Systems, Differential Equations and Applications, it is my great pleasure to welcome you to this gathering. Mathematical research has been increasingly becoming more an interactive collaboration via a process of globalization, in which AIMS was created to foster and enhance interactions among a broad spectrum of mathematicians and scientists. The AIMS Conference Series is an integral part of the AIMS activities in order to reach these goals, which provides a primary forum and platform on which collaborative activity is engendered and developed.

This is the tenth AIMS Conference and the third in Europe. The first AIMS Conference was participated by 250 people. Now the tenth is tenfold in size. With more than 2,500 scientists and mathematicians representing all the Continents, the AIMS Conference not only generates a sense of pride but also renders a seal of approval.
The Madrid meeting is featured with over 100 symposia, which have broad and diverse spectrum of topics, organized by research leaders in the fields, and the Invited Keynote Lectures, by some world-renown mathematicians. I hope that you will enjoy the outstanding program and take advantage of the opportunity to renew old acquaintances and make new friends during the conference. Knowing that you are the whole purpose of all AIMS activities, I would like to express my appreciation for your continuous participation and support.

It is a great pleasure to acknowledge the support from the Instituto de Ciencias Matemáticas (ICMAT), the Universidad Autónoma de Madrid (UAM), the United States National Science Foundation, and the University of North Carolina at Wilmington. I would like to thank the members of the Organizing Committee headed by Professor Manuel de León. Their great effort and hard work make the conference possible. I would also like to thank Dr. Xin Lu, whose leadership has been indispensable. I hope you all have a great time at Madrid.

Shouchuan Hu, director of the American Institu of Mathematical Science (AIMS)

Report: 10th American Institute of Mathematical Sciences (AIMS) Conference in Madrid

Great Applications of Mathematics

Translating the vast complexity of the world in which we live into models and equations that help us to understand it, and thus enjoy a certain degree of influence over it, has from the beginning been one of the main objectives of mathematics. Some of the main speakers at the 10th American Institute of Mathematical Sciences (AIMS) Conference, due to take place in Madrid between July 7th and July 11th, talk about their work from this perspective.

Lorena Cabeza. Halting the growth of a tumor, analyzing new materials with surprising characteristics, designing space missions or restoring works of art are just some of the examples in which mathematics has been the vital tool for tackling problems which otherwise could not have been solved. Furthermore, mathematical science faces its own challenges, some of them centuries old, the solution to which would certainly open up new ways of addressing these problems that are still unimaginable today.

Mathematics lies behind everyday applications such as surfing the net, weather forecasting and cyber-security. But not only that; according to a report commissioned by the UK Engineering and Physical Sciences Research Council (EPSRC), the estimated contribution of mathematics to the UK economy in 2010 was approximately 16% of Gross Added Value (GVA) and 10% of all jobs, which is proof of its significant overall contribution to economic growth.

Mathematics holds the key to the door, the threshold of which must be crossed by science in its endeavor to expand the bounds of knowledge and thus our capacity to influence our surroundings. Some of the leading specialists in dynamical systems, differential equations and applications will be the keynote speakers at the 10th American Institute of Mathematical Sciences (AIMS) Conference, which is due to be held on the Cantoblanco Campus in Madrid, where they will outline their work and its relation with the most surprising, innovatory and high-impact applications.

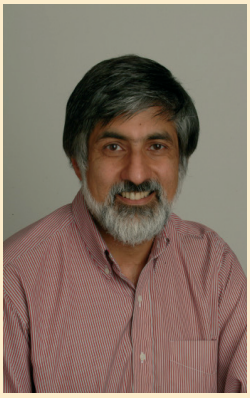
Vital Formulas

Reaching an understanding how life works involves addressing the integration of a multitude of processes that act on a diversity of levels. While the separate study of each melodic line is no doubt necessary, it cannot provide an overall vision of how the symphony will sound as a whole. Philip K. Maini, professor at Oxford University and a leading international expert in the field of mathematical biology, states categorically that, "So far, the only framework we have within which to arrive at an understanding of the complex interactions that occur in biology is mathematics".

"The only framework we have within which to arrive at an understanding of biology is mathematics".

His work is closely linked to applications that are absolutely vital, two examples of which he states are: the first, concerning the growth of tumors, and the other on neural crest cell migration in the developing embryo.

Regarding the first application, Maini explains that, "we are researching into how tumor cells affect the PH of the body to aid their own survival at the expense of normal cells. This leads to the intriguing idea that changes in diet may help to contain tumor development".



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Philip K. Maini.

In the second application, he and his team are studying how to control neural crest cell migration, a fundamental structure in the development of an embryo that gives rise to derivates such as neurons and cells in the peripheral nervous system, or bones and cartilage in the cranium, etc. According to Maini, an abnormal development in this structure may have "catastrophic" consequences for the embryo. The work carried out by this researcher at the Stower Institute for Medical Research in Kansas, has "with the use of mathematical models brought to light completely new ideas about how this process can be controlled". These ideas have subsequently been verified experimentally.

For Maini, the importance of mathematics in this field resides in the fact that this discipline "could become an integral part of the weapons used by biologists and physicians to combat the disease". Thus, mathematics "can help to test and propose new therapeutic strategies, which could save companies a great deal of money in the development of medicines, as well as reducing the number of experiments required".

An Ambassador of Mathematics

"Capturing" the immense complexity underlying an everyday phenomenon such as the motion of gas particles in a room is one of the subjects studied in mathematics, and specifically one of the research fields that has drawn the attention of French scientist and director of the Henri Poincaré Institute in Paris, Cédric Villani, winner of the 2010 Fields Medal and professor at the University of Lyon. Villani finds his inspiration in the highly palpable sphere of physics – "the world is full of problems waiting to be solved", he says - and he is fascinated by translating this complexity into the apparent simplicity of an equation.

"The world is full of problems waiting to be solved"

Furthermore, Villani has recently emerged as an ambassador of the discipline thanks to the popularity he has gained as a Fields Medal winner, to say nothing of his unconventional appearance (his colorful cravats, giant spider brooches and shoulder-length hair parted in the middle), his eloquence and passionate speaking style. Not without reason, one of his concerns is the fall in scientific vocation among young people in Europe, which he hopes to help to stem by extolling the benefits of mathematical science to a broader public. He has worked on kinetic theory, optimal transport and partial differential equations, particularly the Boltzmann equation, all of which are fields with several centuries of history behind them, unfinished buildings that today mathematics seeks to complete.

Espace des Sciences

Cédric Villani.

As Villani explains that the Boltzmann equation, "if it were resolved, could enable us to predict the future evolution of a gas based on the statistical distribution of the positions and velocities of its particles". Moreover, optimal transport is concerned with the best way to transport materials from an initial position to a final one.

He points out that research into optimal transport has been applied in such diverse fields as image processing, financial mathematics, cosmology and meteorology. The Boltzmann equation is used on a daily basis in industry, especially in aeronautics. However, when asked what the greatest impact his field of research has had on our society, he says, "understanding the world is a fine achievement in itself". And it is precisely his fascination with understanding the world that surrounds us that provides him with the impetus to spend so much of his time popularizing mathematics and its beauty for a wider public.

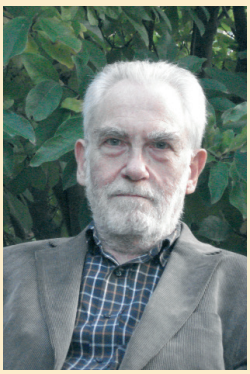
Report: 10th American Institute of Mathematical Sciences (AIMS) Conference in Madrid

Equations for Space

Professor of Applied Mathematics and the University of Barcelona and specialist in dynamical systems, Carles Simó, explains that everything that evolves is ultimately a dynamical system, and in his case this concerns the solar system, the spread of an epidemic or the interaction between neurons. "The advantage of this field", says Simó, "is that many of its tools, whether theoretical or computational, can be used to tackle problems of very different types: the motion of celestial bodies, the design and control of space missions, the design of chemical reactors, the mutations of a virus, lasers, global warming in the Arctic, ecological systems, the flow of blood through the veins, the design of particle accelerators and so on".

"The tools of dynamical systems can be used to tackle problems of very different types"

Winner of the 2012 Catalan National Prize for Research, Simó was the first to introduce this type of mathematical analysis into the design of space missions, work that he has pursued with the European Space Agency (ESP) and the North American Space Agency (NASA). As he explains: "The key idea is to use the 'natural dynamics' of a system to help us reach the desired objective. In the 1980s, this was regarded as a 'mathematical speculation', but the solution to all theoretical problems and the design of precise and efficient symbolic and computational tools has turned these ideas into a standard methodology".


Carles Simó.

The main challenges defined by this mathematician in his field of research are twofold: first, to reduce the distance existing between theoretical analysis and numerical simulations, since as he points out, "there are many theoretical results that only handle 'existing' results of some types of solutions". Computers are able to achieve a great many results, although not all. But what if one of the results lacking consists precisely of the best solution to a specific problem?"

The second challenge, according to Simó, is in many cases that of "finding the right model; one that is sufficiently exact and sufficiently simple", something that occurs in many questions arising directly from the field of physics, but not from many "real-world" problems. "We are still a long away from that in many crucial issues".

From Particles to Models

The fundamental principles of physics are often well-known, but how do we move from these principles to mathematical models that enable us to understand and ultimately predict the behavior of real-world problems that affect us every day? "The key to this issue lies to a great extent in mathematics", says Weinen E, professor of Mathematics and Princeton University and specialist in stochastic multi-scale models.

In this sense, one of the greatest challenges is to be found in materials science and chemistry, where the fundamental principle on which research is based is quantum mechanics. As E explains; "In practice, microscopic models are used in this field to analyze the behavior of materials and devices. We are seeking to establish a rigorous bridge between the fundamental principles (of quantum mechanics) and practical macroscopic models".

"Intuition may lead to confusion. Mathematics provides rationality and clarity"

For example, a "theory of elasticity" could be developed on the basis of atomic models. "This would enable us to analyze the mechanical behavior of nanotubes using the conventional language of solid mechanics", as well as "clarifying important concepts such as stability".


Weinen E. Princeton University

A further problem in the field of materials science and quantum mechanics is that working with models on this scale requires highly complex and very expensive computers, which are therefore difficult to acquire. In order to tackle this question, Weinen E and his collaborators have developed algorithms that greatly reduce the computational difficulty. These algorithms have been implemented in the SIESTA software (originally developed in Spain and whose initials stand for Spanish Initiative for Electronic Simulations with Thousands of Atoms), for the simulation of electronic structures and molecular dynamics.

As this researcher concludes; "Scientists from different disciplines have the advantage of great experience and intuition, but for very complex systems intuition may lead to confusion. Mathematics provides a different perspective on the matter, through rationality and clarity".

Algorithms in aid of Art

If one had to choose a word to describe the work by Ingrid Daubechies, it could well be "interdisciplinarity". This professor at Duke University (USA), who is currently the Chair of the International Mathematical Union (IMU), started her career as a theoretical physicist and then gradually moved on to mathematics, motivated by the pressing need for new tools of this type in her original discipline. In 2012, she was awarded the FBBVA Frontiers of Knowledge Prize in recognition of her work on wavelets, which has been applied for instance to the JPEG 2000 image compression standard.

"Image analysis can be used to distinguish an artist's line or brushstroke"

Daubechies is also attracted by problems arising in other areas, such as art. "Somebody drew my attention to the fact that image analysis can be used to distinguish an artist's line or brushstroke" in order to determine, for example, the authenticity of a work.

The latest work she has completed has to do with just that, and she will talk about it in her appearance at the AIMS 2014 Conference. Together with other collaborators from the University of Brussels (Belgium) and the North Carolina Museum of Art (USA), Daubechies has developed an algorithm that enables the original brushstrokes of artists to be seen by means of X-rays, which also reveal the techniques the artists used, the way in which the paints were prepared, and the state of conservation of the artworks in question.


FBBVA

Ingrid Daubechies.

Between the 12th and 17th centuries, European artists painted on wooden panels. Later, in the 19th and 20th centuries, conservators planed away these panels to make them as thin as possible and backed them with a latticework or stretcher that was inseparable from the work itself and protected it from damage. However, this type of backing makes it difficult to study the original work with X-rays, a technique much used at present to study the state of a painting.

Until now it was possible to eliminate the image of the latticework that showed up on the X-ray by hand, although this was a complicated procedure that could only be carried out on a limited number of paintings. Researchers thought that a more automated way of removing this image would be of great help to conservators and museum curators. The results obtained have turned out to be satisfactory and similar to the techniques employed to date, which shows that mathematics and art go hand in hand on more occasions than one might have imagined.

In Search of Singularities

Getting up in the morning and immediately checking the weather forecast for the day is something we often do as part of our a daily routine. It does not occur to anybody to stop and think that the equations that make it possible to get an accurate forecast are due to the eminent 18th century mathematician Leonhard Euler and the added contribution made in the 19th century by equally distinguished Claude-Louis Navier and George Gabriel Stokes. Even less do we realize that the search for the solutions to these equations are still not complete, and that leading scientists all over the world are devoting all their efforts to deciphering the mystery that still surrounds these formulas.

"We have to have new and revolutionary ideas to resolve the Navier-Stokes equation"

ICMAT researcher and former professor at Princeton University, Diego Córdoba, who in 2008 was awarded one of the prestigious European Research Council (ERC) Starting Grants, focuses his research work on this field of fluid mechanics and Navier-Stokes equations. Specifically, Córdoba is devoted to the study of the formation and development of incompressible fluids (that is, fluids whose volume is conserved). In mathematics, a singularity refers to the unexpected behavior when a variable is introduced into a function which is otherwise continuous. In real life, these singularities take the form of waves at the moment of break-up, as in tornadoes, whirlpools or fronts of cold and warm air.

So, is it possible to explain what happens in such cases using equations that model fluid dynamics?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Diego Córdoba.

"The problem is that solving these equations is impossible, or at least has been impossible so far", says Diego Córdoba. Powerful computers enable us to make very precise approximations that are used not only to predict atmospheric temperature, but also for other applications such as the design of more efficient aircraft or faster Formula 1 racing cars.

Diego Córdoba's research work is related to one of the "Milennium Problems", whose solution carries a prize of one million dollars. Do specialists believe that they are close to solving this problem? Córdoba thinks that "if Navier-Stokes has no singularities, then there should be a proof to that effect within a few years. Nevertheless, if it does have singularities, it may take a lot longer and we may not live to see it. It's easier to prove that these singularities do not exist than that they do. If singularities do indeed exist, numerical simulation is never going to find them. We have to have new and revolutionary ideas on the matter to prove something like that".

Interview: Carlos Kenig, President of the ICM2014 Scientific Committee

"My main goal was to ensure that the most currently active areas of mathematics were represented"

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Carlos Kenig, president of ICM 2014 Scientific Comitté.

Carlos Kenig (Buenos Aires, 1953) is a professor at the University of Chicago where he conducts research in the area of differential equations and harmonic analysis. In recent years he has devoted much of his effort as Chairperson of the Program Committee to designing the scientific program of the International Congress of Mathematicians (ICM), which will be held this coming August in Seoul, North Korea. On the occasion of his visit to the ICMAT for the "Three Days on analysis & PDEs", we spoke to him about the ICM congress program.

Ágata Timón. Question: Carlos Kenig (Buenos Aires, 1953) is a professor at the University of Chicago where he conducts research in the area of differential equations and harmonic analysis. In recent years he has devoted much of his effort as Chairperson of the Program Committee to designing the scientific program of the International Congress of Mathematicians (ICM), which will be held this coming August in Seoul, North Korea. On the occasion of his visit to the ICMAT for the "Three Days on analysis & PDEs", we spoke to him about the ICM congress program.

Answer: Basically, by saying to the people who exerted this pressure that I wasn't going to respond to coercion of this nature.

Q: What difficulties have you encountered?

A: There were a great many people to choose from, because mathematical activity continues to grow at an enormous rate, and drawing up the final lists has proved to be a very difficult job. Furthermore, the lists of those finally chosen were not the only ones; there could have been three or four, all of them excellent. We've done the best we can.

A: You should ask her about that. I imagine she thought that I was the right person for the job. We've known each other for quite a long time.

Q: What did this appointment mean for you?

A: A lot of work; a job like this requires a great deal of effort. It has meant three years of very intensive work.

Q: What was the process like?

A: First you have to organize a team composed of many people. This isn't a job for just one person; there are twelve of us on the Program Committee. We appoint 19 other committees that evaluate each section of the program, and each of these committees has between eight and ten members. Another thing we had to do was choose the sections into which the congress was going to be divided.

"We wanted to make the unity of mathematics much more apparent in the composition of the congress"

Q: Does it vary from one year to another?

A: Yes, there's a tradition about what the sections are going to be, but the idea is to reassess these constantly. This year there have been some changes from the past; two sections on analysis have been fused into one, so that means there's one section less than in 2010.

Q: Are there any new developments in the scientific program?

A: We've tried to ensure that there are many more talks between sections. We wanted to make the unity of mathematics much more apparent in the composition of the congress.

Q: How have you managed to put this idea into practice?

A: The different committees were able to propose joint speakers, who counted as a fraction in the total number of places in each section, which has worked as an incentive, and we've managed to arrange many more talks between sections than in previous congresses.

"My main goal was to ensure that the most currently active areas of mathematics were represented"

Q: What would you say was your main goal as president of the PC?

A: My main goal was to ensure that the most currently active areas of mathematics were represented, and that the program provided an overall vision of the discipline. And then try to respect the balance between gender and geography.

Q: How did you tackle these issues?

A: This is an extremely complicated matter. There are many differing opinions about what is the best way to reach this goal, and there have been a lot of discussions about it.

Q: And finally how was it done?

A: By vote.

Q: As regards the geographical balance, did you and your team encounter any difficulties in choosing leading mathematicians from all?

A: No, that's not the problem, except in the developing countries, which is much more complicated. A lot of progress has been made in Latin America, but in Sub-Saharan Africa it's more difficult.

Q: How did you overcome these difficulties?

A: We balanced it out as far as we were able in order to maintain the scientific level of the congress, which of course must remain high.

Q: What's your opinion about the situation of mathematics in Spain?

A: The situation of Spanish mathematics is very good within the framework of Europe.

Q: What's your relation with Spanish mathematics?

A: Right now I'm attending these Three Days on Analysis and PDE's at the ICMAT, a very pleasant and very interesting conference held in honor of our colleague Alberto Ruiz, with whom I've been collaborating for many years.

"The situation of Spanish mathematics is very good within the framework of Europe"

Q: What problems are you working on at the moment?

A: On nonlinear differential equations and evolution over time; I'm trying to determine the asymptotic behavior, when time increases, of the solutions to dispersive equations. That's the subject of my talk at the ICMAT today.

For more information:

http://www.math.uchicago.edu/~cek/
http://news.uchicago.edu/profile/carlos-kenig

Nalini Anantharaman and Sylvia Serfaty, two rising stars

Andrea Jiménez. These two young French women have made history by being the only females to receive the Henri Poincaré Prize, awarded by the International Association of Mathematical Physics in recognition of their outstanding contributions to mathematical physics.

They are Nalini Anantharaman, professor of Mathematics at the Orsay Laboratory (CNRS/Université Paris-Sud), and Sylvia Serfaty, of the Jacques-Louis Lions Laboratory in Paris (CNRS/Universidad Pierre and Marie Curie), brought together on this occasion, not by a prize, but for the 10th American Institute of Mathematical Sciences (AIMS) Conference on Dynamical Systems, Differential Equations and Applications.

They were both in the same class at the École Normal Supérieure in Paris, a center known for having among its former students ten Fields Medal winners and several Nobel Prize winners. Both these women are currently working on research projects at the French Centre National de la Recherche Scientifique (CNRS).


Sylvia Serfaty.

Anantharaman was born in 1976, one year later than Serfaty, and graduated from the Université Pierre et Marie Curie (Paris), where she gained her doctorate in the year 2000. She subsequently obtained a post as professor at the École Normal Supérieure (ENS) Unit of Pure and Applied Mathematics in Lyon, which she held from 2001 to 2006. She worked as a researcher at the CNRS until 2009.

> They are the only females to receive the Henri Poincaré Prize

For her part, Sefarty worked at the CNRS on a research grant after gaining her doctorate at the Université Paris-Sud in 1999, then went on to become a professor at the New York University Courant Institute from 2001 to 2008, before returning to France as a professor at the Jacques-Louis Leones Laboratory (CNRS / UPMC) in Paris.


Nalini Anantharaman.

While Anantharaman's work is situated at the interface between the classical theory of dynamical systems and the analysis of partial differential equations, Sefarty's work is focused on problems involving partial differential equations and on nonlinear analysis, mainly arising from physics and largely centered on the Ginzburg-Landau superconductivity model.

"I'm working on the Schrödinger linear equation, the one for example that describes the motion of electrons," says Anantharaman. An idea central to quantum mechanics is the duality of the electron, which may behave like a particle or a wave. "What I'm trying to understand is whether these waves tend to be found in a small region of space, or on the other hand whether they may be propagated towards large opposite regions. This depends a lot on the geometry of the environment". Anantharaman was awarded the Gabrielle Sand and Marie Guido Triossi Prize by the Académie des Sciences in 2007, the Salem Prize in 2010, and the Jacques Herbrand Prize by the Académie des Sciences in 2011. She is distinguished by her contributions to the field of quantum chaos, dynamical systems and the Schrödinger equation,

> Serfaty has never felt that she has been object of discrimination during her career

including a significant breakthrough in the quantum ergodicity problem: "Using ideas from chaos theory in dynamical systems, I proved that for certain environments of negative curvature, the waves that obey the Schrödinger equation must be delocalized".

Serfaty's work also concerns the analysis of equations and models coming from physics. As she herself says; "My research is focused on partial differential equations and nonlinear analysis, mainly around the Ginzburg-Landau superconductivity model. I have also

recently been interested in static mechanics models, particularly in Coulomb interaction, which has turned out to be related". Serfaty received a National Science Foundation (NSF) CAREER award – the USA equivalent of a European Research Council Starting Grant – as well as a grant from the Sloan Foundation in 2003. Furthermore, she was also awarded with the European Mathematical Society prize (2004) and the EURYI prize for young European researchers in 2007 (the forerunner to the current ERC Starting Grant). Her work on the detailed analysis of vortices in the Ginzburg-Landau model constitutes one of her main contributions to mathematics.

One of the most novel aspect of the AIMS conference is the appeareance of women

Visible Women

One of the most novel aspects of the 2014 AIMS conference to be held in Madrid this July is the appearance of women as some of the keynote speakers – four out of a total of twelve – among whom are these two renowned scientists. For Saferty, this "is good news, because four women out of a total of twelve is a greater percentage than is usual in the world of mathematics, which is generally around 15%". This fact does not necessarily indicate that the number of women in the field of mathematics is increasing. As Saferty says; "the number of women is more or less stable within the profession, with

"Discrimination can be very subtle and many people are not aware of its existence"

a higher proportion in the south of Europe, and slightly less in the north of Europe and the USA". Even so, she believes that the visible participation of women in an event such as the AIMS conference can be very useful and enriching for young people.

Like Anantharaman, who is vice-president of the French Mathematical Society, Serfaty says she has never felt that she has been the object of discrimination during her career or in the workplace, although she says that she feels very fortunate, because "sometimes women have to struggle harder in order to be taken seriously". She also adds that "discrimination can be very subtle and many people are not aware of its existence".

During the AIMS 2014 conference, at which these two mathematicians will once again share the speakers stand, Serfaty will talk about her latest work on Coulomb gases. She will also explain how the vortices in the Ginzburg-Landau inspired her to conduct her research. "It's a good example of how the analogy between two a priori very different topics can throw fresh light on both of them". Anantharaman, on the other hand, will speak on large graphs and the way in which waves are propagated in these graphs. "I'm very interested in showing some delocalization phenomena", she says.

AIMS 2014 Program

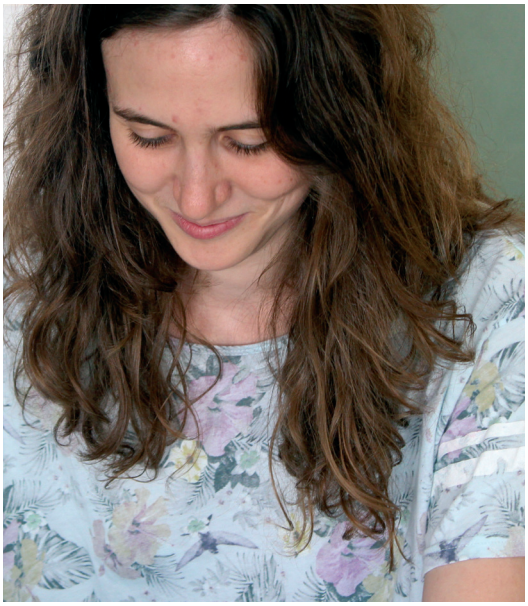
July 7, Monday	July 8, Tuesday	July 9, Wednesday	July 10, Thursday	July 11, Friday
9:00 - 9:30 Opening 9:30 - 10:30 Keynote Speaker Dr. Fefferman	9:00 - 10:00 Keynote speaker Dr. Villani	9:00 - 10:00 Keynote speakers Dr. Ma and Dr. Wilkinson	9:00 - 10:00 Keynote speakers Dr. Serfaty and Dr. Simo	9:00 - 10:00 Keynote speakers Dr. Anantharaman and Dr. Maini 10:00 - 11:00 Dr. Cordoba and Dr. Fiedler
10:30 - 11:00 Coffee Break	10:00 - 10:30 Coffee Break	10:00 - 10:30 Coffee Break	10:00 - 10:30 Coffee Break	11:00 - 11:30 Coffee Break
11:00 - 13:00 Keynote Speakers Dr. Daubechies and Dr. E	10:30 - 12:30 Parallel session 2(PS02)	10:30 - 12:30 Parallel session 5(PS05)	10:30 - 12:30 Parallel session 8 (PS08)	11:30 - 12:30 Parallel session 11 (PS11)
13:00 - 16:00 Back to UAM and lunch	12:30 - 14:00 Lunch Break	12:30 - 14:00 Lunch Break	12:30 - 14:00 Lunch Break	12:30 - 14:00 Lunch Break
16:00 - 19:30 Parallel Session 1 (PS01)	14:00 - 16:30 Parallel Session 3(PS03)	14:00 - 16:00 Parallel Session 6(PS06)	14:00 - 16:30 Parallel Session 9 (PS09)	14:00 - 16:30 Parallel session 12 (PS12)
	16:30 - 17:00 Coffee Break	16:00 - 16:30 Coffee Break	16:30 - 17:00 Coffee Break	16:30 - 17:00 Coffee Break
	17:00 - 19:30 Parallel Session 4 (PS04)	16:30 - 18:30 Parallel Session 7(PS07)	17:00 - 19:30 Parallel Session 10(PS10)	17:00 - 19:30 Parallel Session 13 (PS13)

Profile: Marta Farré, ICMAT researcher specializing in Geometric Mechanics

"I wanted a career in research, but didn't know what it meant in practice"

Andrea Jiménez. Marta Farré (Barcelona, 1989) decided to devote herself to mathematics because she wanted to understand the subject better, but never for a moment did she think about the career outlets that might be open to her after opting to study this hard science. "I've always liked the idea of discovering things and sensed that mathematics could be a great challenge".

She was torn between physics and mathematics: following in the footsteps of Pythagoras, Fibonacci and Bolzano, or those of scientists such as Einstein, Planck or Bohr. In the end, she came to the conclusion that if she chose the first option it would be easier for her to cross the line separating these two disciplines and also embrace physics.


ICMAT

Marta Farré, ICMAT researcher.

"I was certain right from the start that I wanted a career in research, but as I found out later, I had little idea of what it meant in practice". After gaining her degree at the University of Barcelona in 2011, she did a Master in Mathematical Research at the same university with a grant from La Caixa, and from there went on to join the ICMAT. There she has specialized in the field of geometric mechanics, immersing herself in the geometrical modeling of classical and quantum mechanics. One of the most attractive aspects of this discipline is that it provides the opportunity of studying deep mathematical problems, as well as being very close to real and concrete applications.

"I'm working on the so-called 'inverse problem of the calculus of variations', which poses the question that, given a priori arbitrary equations, a known structure may be discerned". The Euler-Lagrange equations have turned out to be vital tools for her Ph.D research. These equations were developed by the Italian mathematician Joseph-Louis Lagrange in the 18th century and constitute a generalization of Newton's Second Law for mechanical systems. The idea is to define a function known as the lagrangian, which measures the difference between the kinetic and potential energy of the system. The solutions (trajectories) of the system are the extreme values of the lagrangian. The inverse problem of the calculus of variations consists in the fact that, given a system of second-order differential equations, is it possible to find a lagrangian having as Euler-Lagrange equations a system equivalent to the one given; that is, with the same solutions. "The resolution of this problem provides qualitative information about the solutions to the original system without having to arrive at these solutions, as well as techniques for performing the operation and the possibility of using numerical methods that conserve these properties".

This problem is associated with the following question: let us assume that we have a system of second-order differential equations with constraints, that is, one in which relations between the velocities of the system exist; for example, a sphere rolling down a plane, even though the solutions may not be Euler-Lagrange solutions: Can they be a subset of those solutions?

This enables us to design numerical methods that conserve certain properties of the system and whose applications can be extended to the most diverse areas of engineering and other sciences, such as robotics, satellite control, biomedical simulation and the modeling of oceanic flux.

Right now, rather than teaching, the first priority of this young Catalan researcher is to continue investigating the fundamental mathematics that nourishes so many specialties of the science. Even so, she knows that both fields of work are closely linked and does not rule out the possibility of taking up a university post.

She says that if she had the choice she would choose a center not unlike the ICMAT, which in her opinion, "is outstanding for its welcoming atmosphere both in terms of work conducted and relations with other researchers in the different areas of research. In addition, there are more and more PhD students, and many conferences and seminars are organized on a regular basis".

From among these meetings, Farré especially mentions the ICMAT School on Geometry, Mechanics and Control, in which she has participated on a couple of occasions and where she is due to give a talk this summer. The main aim of the School, which will be held between June 30th and July 4th this year, is to train young researchers in different topics concerning the latest techniques in geometric mechanics. The School has already become an international reference point in this field, and much outstanding young talent has attended it. It provides an opportunity that Marta Farré is not about to miss, motivated as she is "by all the enthusiasm" surrounding her at the Institute.

Scientific review

Infinite Sidon Sequences

Author: Javier Cilleruelo (Universidad Autónoma de Madrid/Instituto de Ciencias Matemáticas).

Original title: Infinite Sidon sequences.
Date of publication: April 1st, 2014
Source: Advances in Mathematics. Volume 255. Pages: 474-486
http://www.sciencedirect.com/science/article/pii/S000187081400022X

In this paper, published in the journal *Advances in Mathematics*, Javier Cilleruelo provides explicit constructions of Sidon sequences with a certain growth. The existence of Sidon sequences with this growth was already proven by Imre Ruzsa, but no explicit construction was known. To this end, Cilleruelo develops a new method that also enables generalization to B_h sequences. The work constitutes a further step forward towards a conjecture posed by the famous Hungarian mathematician Paul Erdös in 1944.

Sidon sequences are sequences of positive integers having the property that all the sums of two elements (whether distinct or not) of the sequence are different, or, in other words, that all the differences of two elements in the sequence are distinct. For example, the sequence of the powers of 2 (1,2,4,8,16…) fulfills the conditions of this property. A further example, put forward by the Hungarian mathematician Paul Erdös, is the sequence generated by the "greedy algorithm": it begins with 1 and the lowest possible positive integer is added to the sequence such that no two distinct differences appear in the resulting sequence. The first elements in this sequence are 1,2,4,8,13...

The first person to devote any thought to these mathematical objects was the Hungarian analyst Simon Sidon, who around 1932, motivated by questions concerning Fourier analysis, asked Erdös about sequences of integers with this property. The arithmetical and combinatorial aspects of this problem fascinated Erdös.

The most important question concerning Sidon sequences refers to the least possible growth that these sequences may have. If A(x) is the number of elements of a sequence A that are less than or equal to x, then the purpose is to find Sidon sequences in which A(x) is the largest possible. It is known that a limit exists: if $A(x) > x^{1/2}$, then A cannot be a Sidon sequence; we would have too many differences fewer than x and some would have to be repeated. Furthermore, the Sidon sequence generated by the greedy algorithm satisfies $A(x) > x^{1/3}$. Thus, the largest possible exponent of x in A(x) when A is a Sidon sequence will be between the exponent 1/3, which the greedy algorithm provides, and the exponent ½, which cannot be reached by any Sidon sequence. Erdös conjectured that for any $\alpha < ½$ there exists an infinite Sidon sequence A with $A(x) > x^{\alpha}$ for x sufficiently large.

No infinite Sidon sequence denser than that of the greedy algorithm (satisfying that $A(x) > x^{1/3}$) was known to exist for almost fifty years, until Atjai, Komlos and Szemeredi (Abel prize-winner) proved the existence of an infinite Sidon sequence with $A(x) > (x \log x)^{1/3}$. The next and very important step was taken by Imre Ruzsa in 1998: by means of a highly ingenious argument he proved the existence of an infinite Sidon sequence with $A(x) > x^{\alpha}$ y $\alpha = \sqrt{2}-1 = 0.4142\ldots$.

In this article, Javier Cilleruelo takes a further step in this direction by providing an explicit construction for an infinite Sidon sequence A, with $A(x) > x^{\alpha}$ and $\alpha = \sqrt{(2-1)}$. In other words, the same exponent arrived at by Ruzsa, only this time the construction is explicit. Cilleruelo also proves the existence of a sequence B_h (an extension of the idea of the Sidon sequence in which all the sums of elements h of the sequence are different) with $A(x) > x^{\alpha_h}$ y $\alpha_h = \sqrt{((h-1)^2+1)} - (h-1)$. The greedy algorithm only enables us to arrive at the exponent $1/(2h-1)$.

The constructions by Ruzsa and by Ajtai, Komlos and Szemeredi are completely different, but in both cases probabilistic arguments are employed, which prevents the said sequences from being constructed explicitly. For the first time, Cilleruelo has found an explicit construction based on a new method using the discrete logarithm, and which also can be generalized well to the B_h sequences.

In 2010, Cilleruelo obtained another important result on Sidon sets, as did Carlos Vinuesa and Imre Ruzsa, although the methods employed in that case were completely different. Cirleruelo has conducted research into many Erdös problems, although he says this is the result he would single out if he had the chance to tell Erdös about it. He states that it is neither the most technical nor the longest, but certainly the most original. Cilleruelo was invited to give a talk at the Erdös Centennial, held last year in Budapest in honor of the great Hungarian mathematician, where he spoke about this problem.

Javier Cilleruelo

Javier Cilleruelo is a tenured professor at the Universidad Autónoma de Madrid (UAM) and a member of the Instituto de Ciencias Matemáticas. His main research interests are Combinatorial Number Theory, Additive Combinatorics and Analytic Number Theory.

A Graduate in Mathematics at the UAM, Cilleruelo studied for his doctoral thesis at the same university under the supervision of Antonio Córdoba, his subject being "The representation of integers as a sum of two squares". He is the author of 70 research papers, some of which have been published in leading journals such the Annals of Mathematics or the Duke Mathematical Journal. He is also responsible for the Red Iberoamericana de Teoría de Números.

In addition, he has also written popular articles and books on number theory as well as for twelve years being in charge of the "El diablo de los números" section in the RSME Gazette.

Mathematics Today

Obituary

María Wonenburger, a great Galician and universal mathematician

Manuel de León. María Wonenburger Planells, who was born in Montrove-Oleiros in the province of La Coruña on July 19th 1927, died on June 15th of this year in A Coruña at the age of 86. She was the descendant of a family from Alsace, which accounts for her first surname, and her mother was from Valencia. María had a great passion for mathematics from a very early age (her mother left her to do the accounts for the shopping), and although her parents wanted her to study engineering and eventually take over the family business (a foundry), she was drawn to the discipline of mathematics. As a resident at the famous Residencia de Señoritas in the calle Fortuny in the Spanish capital, she studied for her degree at the Universidad Central de Madrid (today the Complutense University), where she also began her doctorate. One of the stories from her time as a student was that she never made notes, but her classmates gave her theirs to correct.

The first call for Fullbright grants took María to the United States, a journey full of adventure on the ocean liner "Constitution", and it was in the USA where she completed her Ph.D at Yale University in 1957 under the supervision of the prestigious algebraist Nathan Jacobson.

Three years later she returned to Spain on a grant from the CSIC Instituto de Matemáticas Jorge Juan, which was a leading center in Spain at that time, only to cross the Atlantic once again when the grant ended, this time to Canada, where she remained for six years, during which time she tutored her first doctoral student, Robert Moody. At that time, María was the only woman on the teaching staff and Moody requested her to be his supervisor. She subsequently returned to the USA, where she had been offered a university chair in Buffalo, Indiana, partly because it would be easier for her mother to visit her there. She returned to Spain in 1983, at the height of her scientific career, precisely to look after her mother. She was 56 years old at that time and would have been able to be of great service to the incipient Spanish mathematics, but preferred to retire to her native Galicia.

María Worneburger's research work was focused on Group Theory, one of the most exciting areas of Mathematics, in which she obtained a great many results, although perhaps the most-well known were those belonging to the so-called Kac-Moody algebras, which have had important applications in Mathematics and Physics. Her work has always been greatly valued by the international mathematical community.

Inexplicably, María remained largely unknown in her own country. It is thanks to Professor Federico Gaeta, her colleague in Buffalo, that she came to the attention of our mathematical community during a meeting on algebraic geometry at the University of Santiago in 2002. María then emerged into the light, due especially to the efforts of two women mathematicians from Galicia, María José Souto Salorio and Ana Doroteo Tarrío Tobar, and eventually became fully recognized by Spanish mathematicians. So the mother of the famous Kac-Moody algebras was none other than a Galician woman!

I first met María Wornenburger in July, 2007, in the Pazo de Mariñán (Bergondo, La Coruña), on the occasion of the III Miguel de Guzmán School on Mathematical Education, organized by AGAPEMA (Asociación Galega do Profesorado de Educación Matemática) and the RSME (Spanish Royal Mathematical Society), where she was presented with a plaque to commemorate her appointment as an Honorable Member of the RSME, and where we also shared the distinction of becoming Honorable Members of the AGAPEMA.

It was there that I also had the opportunity of debating with her for a few hours and was able to see for myself her vitality and excellent humor. It is a great pity that she is no longer with us, and a greater pity still that her discovery came so late. However, we have the consolation that at least in her later years we were able to accord her the recognition she so richly deserved. Salorio and Tarrío remember that in their meetings with María, when they expressed their admiration for her character, she was wont to say to them, "I have a tendency to be happy". May she rest in peace.

María Wonenburger, mathematician recently died.

Agenda

SCIENTIFIC ACTIV ITIES AT ICMAT

CMI Summer School 2014 "Periods and Motives: Feynman amplitudes in the 21st century"

Date: 30th june - 25th july, 2014

8th International Summer School on Geometry, Mechanics and Control

Date: 30th june - 4 th july 2014

Harmonic Analysis to celebrate Michael Cowling's 65th

Date: 1st july-5th july, 2014

DISSEMINATION ACTIVITIES

Summer Course "Arte en las Matemáticas. Matemáticas en las artes"

Date: 30th june - 4 th july 2014

Place: El Escorial

Russian Mathematician Yákov Sinái Receives 2014

On March 26th of this year the Norwegian Academy of Science and Letters awarded the 2014 Abel Prize, regarded as the Nobel Prize for Mathematics, to the Russian mathematician Yákov Grigórevich Sinái. This researcher at Princeton University (USA), who is also a senior professor at the Landau Institute for Theoretical Physics, was awarded this prize for his fundamental contributions to "dynamical systems, ergodic theory and mathematical physics".

The Abel Committee emphasized the broad and profound impact of Sinái's work in mathematics and physics and the interaction between these two disciplines, as well as the research work conducted by this mathematician in the field of dynamical systems. Specifically, one of his main achievements is that of building bridges between the world of deterministic (dynamical) systems and the world of probabilistic (stochastic) systems. The committee responsible for awarding the Abel Prize stated that: "Order and chaos are deeply related. Sinái has discovered surprising connections between both factors by using probability and measure theory in the study of dynamical systems".

Yákov Grigórevich Sinái receiving the Abel Prize.

Sinái has also studied the long-term evolution of dynamical systems within the field known as "ergodic theory". This problem requires its own tools, since even when it is possible to predict what may happen in the short-term, after long periods of time the question becomes much more complex.

The Abel Prize is an international award for outstanding work in the field of mathematics, conferred by the Norwegian Academy of Science and Letters on recommendations from the Abel Committee. The prize has been awarded annually since 2003 and carries a cash award of six million Norwegian crowns, equivalent to approximately 750,000 euros.

ICM 2014, about to start

From August 13th to 21st, Seoul, the capital of South Korea and a world city of some ten million inhabitants, will host the latest International Congress of Mathematicians (ICM) 2004, the biggest event in this discipline held every four years under the auspices of the International Mathematical Union (IMU).

The opening ceremony will also include the prize-giving of the Fields Medals, the highest distinctions to be conferred in mathematics, which are awarded in recognition of the most outstanding results obtained in the last four years; the Nevanlinna Prize, awarded for applications to the information society; the Carl Friedrich Gauss Prize, given for the best contributions to applied mathematics, and the Chern Medal, conferred in recognition of life-time achievements in the study of mathematics at the highest level.

The congress program consists of 20 different sections and many talks on all the specialized fields within mathematics. Both the South Korean government and the mathematical community in this country have pledged their full support in order to make the congress a success.

In the words of Hyungju Park, chair of the Organizing Committee: "We are going to do everything possible to make this ICM a turning point in mathematics; to get across to a broad public and achieve the recognition and appreciation of society".

Conference: "Minds and Machines: Science Fiction and Mathematics"

On April 9th of this year, the "Minds and Machines: Science Fiction and Mathematics" conference, dedicated to the mathematician Alan Turing, was held at the Casa Encendida. This conference was organized by the ICMAT in collaboration with the CSIC Assistant Vice-Presidency for Scientific Culture.

The presentation, given by Alberto Ibort, professor of mathematics at the Universidad Carlos III de Madrid and ICMAT researcher, addressed some of the questions raised by the famous thinker Turing during the 20th century and which today remain as relevant as ever.

What ultimately is reality? How close have science fiction authors come to current issues in science? And how is technology going to model changes in our society? These were some of the questions that were addressed and which have so far only been dealt with in fiction. In his approach to a subject that has traditionally been dealt with by philosophy, researcher Ibort reviewed some of the emblematic works of modern science fiction, such as the Robots series by Isaac Asimov, and the films 2001, A Space Odyssey and Blade Runner. Is it possible for man to construct machines capable of reproducing the capacities of human beings and even outstripping them?

The conference was held as part of the short story competition inspired by science called Inspiraciencia, an initiative launched by the CSIC that brings together science and literature in a festive and participative way, the aim of which is to provide an open space where everyone can approach and imagine science through fiction.

The ICMAT Clay School Opens its Doors

Between June 30th and July 25th, the first Clay Mathematics Institute Summer School to be held at the ICMAT will open with the title of "Periods and Motives: Feynman amplitudes in the 21st century". This initiative funded by the Clay Foundation is aimed at training a new generation of young researchers on a course that revolves around the Grothendieck theory of motives and the amplitudes of the physicist Feynman.

The School will count on the presence of outstanding figures in the field of mathematics such as Hélène Esnault (Berlin), Matilde Marcolli (CalTech and the Perimeter Institute) and Spencer Bloch (Chicago). ICMAT researcher in arithmetic geometry and chair of the organizing committee, José Ignacio Burgos Gil, will also be among them and will give a talk on multiple zeta values and their combinatorial structure, as well as the use of the theory of motives for proving properties of the multiple zeta values.

"The Riemann zeta function is one of the most interesting and highly studied objects in mathematics", says Burgos. The School will be attended by more than one hundred students, according to this researcher a considerable number "for a highly specialized school such as this one".

The purpose of this school is to introduce students to the theory of motives and periods and their relation with quantum field theory, acting as a bridge between the physics and mathematics communities. "Whether students or teachers, we hope to learn a lot and enjoy the experience doing so. At the same time, our aim is to create links between students and teachers from different scientific fields".

ICMAT receives a permanent Chair from the AXA Research Fund worth more than one million euros

On April 3rd of this year, the AXA Research Fund announced in Paris the award of new funding for the international scientific community. Among the projects selected, the committee of experts chose one to be undertaken at the ICMAT, which consists of the analysis of adversarial risk and is worth more than 1.1 million Euros.

Created in 2007 with the aim of funding the study of socio-economic, environmental and health risk prevention throughout the world, in the first five years of its existence the AXA Research Fund devoted 100 million Euros to the financing of 367 projects headed by researchers of 49 different nationalities.

The AXA ICMAT-CSIC Chair headed by David Ríos will study problems in which an individual or an organization is faced with threats that may have a negative or even a catastrophic impact, and in which some of these threats present an intelligent and adaptive behavior.

According to Ríos, "the developments arising from the backing provided by the AXA Research Fund can be applied to problems such as the protection of critical infrastructures in the event of a terrorist attack, the preparation of a bid in an auction involving possible rival bidders, and the protection of company information systems against cyber-attacks. In general, applications to all those situations in which one or more adversaries exist who may observe and learn from our actions and adapt themselves in order to increase the damage they may be able to inflict on us."

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The 10th AIMS Conference on Dynamical Systems, Differential Equations and Applications

July 07 - July 11, 2014 — **Madrid, Spain**

Invited Main Speakers:

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Diego Córdoba es
Ingrid Daubechies us
Weinan E us
Charles L. Fefferman us
Bernold Fiedler de
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http://www.aimsciences.org/conferences/2014/

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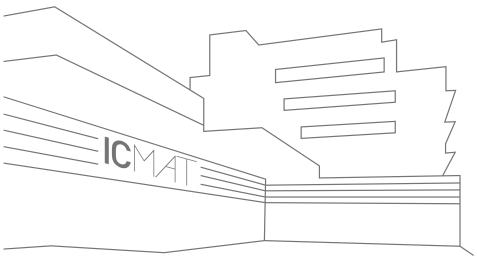

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