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INSTITUTO DE CIENCIAS MATEMÁTICAS

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EDITORIAL

Time for transfer at the ICMAT

The transfer of knowledge generated by basic research is one of the big gaps in Spanish research work, save for a few noteworthy exceptions. This is even more worrying in the case of mathematics, where occasionally the gulf from the idea to the marketplace seems almost insurmountable. Nevertheless, the well-known and widespread applications from fields as fundamental as Graph Theory and Combinatorics or Operational Research show that this does not necessarily have to be the case, and that the problem does not reside in the intrinsic nature of the discipline, but very often in old prejudices that have been handed down and serve to conceal underlying opportunities.

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The European mathematical community recently analyzed transfer in this area, and the way to strengthen it by means of a project, launched by the no longer extant European Science Foundation, known as "Forward Look" aimed at mathematics and industry. The mathematical community also proposed the creation of a European Institute for the transfer of mathematical knowledge. Unfortunately, this project never materialized, but its spirit remains alive in our country thanks to the Math-in initiative, a network in which the different agents of mathematical transfer across Spain are currently involved.

The Math-in Spanish network is one of the legacies of the project Consolider Ingenio Mathematica, one of whose main goals was to reinforce transfer. This task fell largely upon the CESGA node in Galicia, due mainly to the strength of groups in Galicia engaged in Applied Mathematics and Statistics. Among the actions undertaken, a map of industrial mathematics in our country was drawn up, to which now may be added the Institute of Mathematical Sciences. The ICMAT is essentially an institute devoted to basic research of excellence, but since its inception it has always pursued of policy of transfer. As part of the Severo Ochoa Project, granted in 2012, was the setting up of an ICMAT TRANSFER Office to strengthen transfer at the Institute. Despite all the bureaucratic hurdles that Spanish research has to face on a daily basis, this goal has been achieved. Since November, 2013, the ICMAT has been running its Transfer Office, headed by a specialist in the field.

The first task was to configure a map of the possibilities for transferring the results of research work conducted by researchers at the Institute by means of interviews. In addition, the ICMAT now belongs to the Math-in Spanish Network, with five of its own research groups, and is currently attending various national fairs with the purpose of presenting its research work and seeking partners. It is also working together with different leading companies in their respectivesectors to explore the possibility of collaboration in the near future. And of course we are sounding out European cooperation alongside small and medium-size companies as part of the ambitious Horizon 2020 program.

Transfer is already a vital part of the ICMAT, and while the Institute still nurtures fundamental research as a key feature of its identity,this new scheme opens up fresh work scenarios that we trust will also provide new opportunities for young Spanish researchers.

Report: X Congress of the American Institute of Mathematical Sciences (AIMS) held in Madrid

Mathematics ready to apply

Next July, almost 2,000 mathematicians will take over the Cantoblanco campus for one of the biggest meetings in this discipline to be held in Spain: the 10th Congress of the American Institute of Mathematical Sciences (AIMS) on Dynamical Systems, Differential Equations and Applications. The event will be attended by the leading experts in the conversion of written equations into technologies capable of transforming our daily lives.

Lorena Cabeza. What does the growth of a tumor, the movement of a tornado or equal opportunity have in common? Very little, except for the fact that they are all phenomena that can be explained and whose behavior can to a certain extent be predicted in the light of mathematics. This is due specifically, and especially, to a branch of this discipline, differential equations, which are used to model the behavior of systems in movement, for example, physical and biological systems, and thus these equations are closely allied to the development of practical applications. This area now has on its agenda an important engagement, the 10th Congress of the American Institute of Mathematical Sciences, which will be held on the Cantoblanco campus in Madrid between July 7th and July 11th. As AIMS director and coordinator of the event, Shouchuan Hu, states: "Quite simply, there is no other conference on the planet that attracts so many scientists and mathematicians in this field".

This meeting will be the second most highly attended event of its kind in mathematics in Spain, surpassed only by the 2006 International Congress of Mathematicians, also held in Madrid, and the biggest held in our country to date on applied mathematics. As ICMAT director and chairperson of the organizing committee of the congress, Manuel de León, points out: "Mathematics is continually used in the development of new applications, and the congress will help to give greater visibility to this fact. Furthermore, it will help the Spanish mathematical community to open up new spaces in common with industrial and technological sectors as well as biomedical fields".

"There is no other conference on the planet that attracts more scientists and mathematicians in this field"

The last time this congress was held in Orlando (USA) in 2012, it attracted more than 1,300 people, and this year the attendance is expected to rise significantly to about 2,000, far more than those who went to the previous European celebration of the congress in Poitiers in 2006. As Shouchuan Hu remarks: "The meeting in Madrid is very promising, and this may be attributed to the interest aroused by the congress in Europe, to the influence of many internationally recognized Spanish mathematicians who will attend, and to the excellent work done by the organizing committee", to say nothing of the "important invited speakers, who include two Fields medalists and the more than one hundred symposia to held on different subjects".

AIMS

AIMS this year will be held on the campus of Cantoblanco in Madrid.

AIMS

The AIMS 2012 in Orlando, USA, drew in more than 1,300 people.

The congress has the financial backing of the US National Science Foundation and is structured around a series of plenary talks to be held at the Palacio Municipal de Congresos and the Auditorium of the Autonomous University of Madrid (UAM) Escuela Politécnica Superior, and also a large number of specific sessions that are to be held in the facilities of the Cantoblanco campus.

An interdisciplinary meeting

The subjects to be addressed are many and varied, from fundamental theoretical questions to biological and biomedical models; from climatic processes to information management and infectious diseases; from the behavior of tumors and their response to different treatments; from applications to robotics; satellite control; liquid crystals, and measures against oil spills. These undertakings often involve theoretical mathematics and advanced research work in other disciplines such as biology, medicine, engineering, physics and geology. As Manuel de León explains, "This is probably the most interdisciplinary conference in the international mathematical community. It addresses virtually any problem that can be dealt with by applied mathematics".

The Madrid conference will also mark the occasion of the coming-of-age of the AIMS congresses, since the first was held 18 years ago at the Southeastern State University in Missouri (USA). Since then they have been held every two years without interruption in different cities throughout the USA as well as in countries such as France,

Report: X Congress of the American Institute of Mathematical Sciences (AIMS) held in Madrid

AIMS

About 2.000 mathematicians are expected to attend the conference this year.

Germany and China, and now in Spain. With these congresses, AIMS seeks to contribute to scientific progress in the area of differential equations, dynamical systems and applications, as well as raising the social profile of these activities and facilitating the creation of links among the leading world experts in this field.

For the countries that host these meetings, and especially for the organizing institute, they provide a chance to put themselves "on the map" as regards the research community, by showing their scientific expertise and organizational capability as well as broadening their range of contacts, thereby increasing their possibilities and establishing new and fruitful alliances in a global and highly competitive world.

This meeting will be the second most highly attended event of its kind in mathematics in Spain after the ICM 2006

In the words of Manuel de León, a further outcome that the ICMAT expects from this congress is the opportunity "to show what mathematical applications exist that may be of use in many areas, and furthermore directly, as will be explained by the speakers who are going to participate". He goes on to say that: "Another big congress is due to take place in Spain in 2019, the International Congress of Industrial and Applied Mathematics, which will be held in Valencia, and this current congress should help the future one to achieve greater success".

"It will open up new spaces in common with industrial and technological sectors as well as biomedical fields"

Bringing mathematics into closer contact with industry is another goal to which the ICMAT aspires, especially given the recent creation of its Tranfer Ofice which is working to attract companies to attended the sessions of a more applied nature, and thereby draw their attention to the mathematical research work that is being conducted in Spain, which in many cases is in the vanguard in this specialty as regards international research groups.

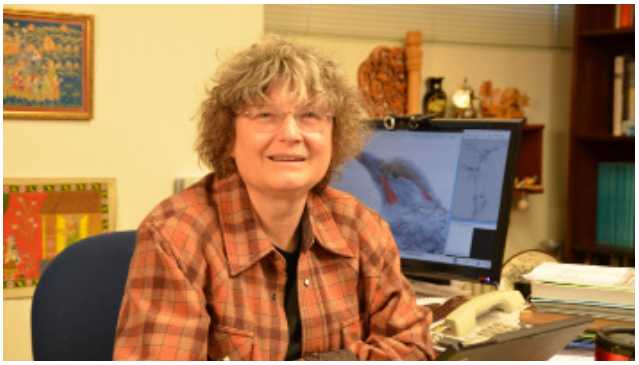
Three stars for a congress

Two Fields Medalists and the President of the International Mathematical Union (IMU) will be the most outstanding mathematical figures present. The first of the winners of the Fields Medal – the equivalent of the Nobel Prize for Mathematics for scientists under 40 years old – is Charles Fefferman. He is a Full Professor at Princeton University and has had a close relation with Spain from the beginning of his career, when he supervised the PhD of Antonio Córdoba, a subsequent winner of the National Prize for Research and currently an ICMAT member. Fefferman was awarded the Fields Medal for his work on convergence and divergence of trigonometric series. He works with the team led by Diego Córdoba (ICMAT) on fluid dynamics, specifically on the so-called "water wave equation", which is associated with one of the Millennium Problems.

The second of the Fields medal winners, Cédric Villani, is a Professor at the University of Lyon and director of the Henri Poincaré Institute. Villani was awarded a Fields Medal in 2010 for "his deep mathematical interpretation of the concept of entropy", as stated in the official communiqué of the International Mathematical Union. As a result of this work, mathematical responses were developed towards a greater understanding of how systems are driven to disorder, according to the laws of thermodynamics. Furthermore, something "quite unexpected" was also discovered: "Although entropy always increases, it sometimes does so more quickly and sometimes more slowly".

Professor of Mathematics at Duke University (USA) and President of the International Mathematical Union (IMU), Ingrid Daubechies began her career by studying theoretical physics and from there, prompted by the need for new formulations in her initial field, commenced her transition to mathematics. Among other distinctions, she has been awarded the FBBVA Frontiers of Knowledge Prize for her work on wavelets, which has had a great impact on a multitude of technologies, such as those involved in efficient audio and video transmission and the JPEG 2000 format for image compression.

In addition to these "stars" of the mathematical firmament, among the other main speakers will be outstanding researchers such as Philip Maini, a specialist in mathematical biology, and Bernold Fiedler, whose work has led to numerous applications in different fields. Two further notable figures are Spanish: Carles Simó, a leader in the field of dynamical systems and author of works related with the design of space missions and the study of the motion of the stars, and Diego Córdoba, ICMAT researcher and winner of the Miguel Catalán Prize for scientists under the age of 40.



FBBVA

The president of the International Mathematical Union (IMU), Ingrid Daubechies, will be one of the stars of Congress.

Report: X Congress of the American Institute of Mathematical Sciences (AIMS) held in Madrid

AIMS

Andrew Majda (New York University) and Avner Friedman (Ohio State University) in the AIMS conference in Orlando in 2012.

From the ICM 2006 to AIMS 2014

Manuel de León recalls how he reacted to the proposal that the ICMAT should host the event: "I've been collaborating with the AIMS for some years now. I'm a director of one of its journals (Journal of Geometric Mechanics) and I've organized some of the special sessions at several of its congresses. In Dresden, the AIMS director, Shouchuan Hu, asked me if I would be prepared to organize the next congress in Madrid. He'd been very impressed with the ICM 2006 (the International Congress of Mathematicians in Madrid), and wanted the next AIMS congress to take place here".

One of the axes of the AIMS activity is the organization of these biannual congresses, while the other revolves around dissemination, with the publication of 20 scientific journals on mathematics and areas concerning information technology, electronic, engineering, topology and biosciences. These journals have increased their impact over the years thanks to their quality and their rigorous reviewing system.

"This is probably the most interdisciplinary international mathematical conference"

Furthermore, the AIMS has also widened its activity in the sphere of dissemination with the publication of specialized books aimed at conveying relevant research results to a broader readership. The books of this type published to date are "Random & Computational Dynamics", "Applied Mathematics" and "Differential Equations & Dynamical Systems".

The big meeting on mathematics that is currently under preparation in Madrid will certainly address these subjects and many more, since the almost 40 sessions that will be held at the same time and at different locations on the Cantoblanco campus, the greatest difficulty facing those who attend will to work out their own schedule and choose from among the many and varied topics that will be addressed.

In search of an equation

Ignacio F. Bayo. One of the most novel features of the 10th AIMS Conference is the notable presence of women mathematicians among the main invited speakers; four out of twelve, in fact, a proportion that is still far from parity but substantially higher than at previous congresses or similar events.

For Sylvia Serfaty, one of the four main speakers, "this is good news because it's a higher percentage than is usual in the world of mathematics, which is about 15%". Serfaty is a professor at the Université Pierre et Marie Curie Paris 6, and while she says that she has never felt discriminated against for being a woman, she thinks that she has been "very fortunate, because sometimes women have to struggle harder in order to be taken seriously. Discrimination is sometimes very subtle and many people are not aware of its existence".

Another of the invited speakers at the next AIMS conference is Nalini Nantharaman, who also says that she has never felt discriminated against in her professional career, but reserves her opinion about the change in tendency that this AIMS appears to show. A professor at the Université Paris-Sud, Nantharaman thinks that the figures in general are not very optimistic: "The presence of women in the world of mathematics is not growing and may even be decreasing". Serfaty is somewhat of the same opinion, because although she believes that the situation is stable, she sees big regional differences, with data that may appear surprising. As she says: "There's a higher proportion of women in southern European countries but a lower proportion in the north of Europe and in North America".

On the positive side, although the presence of women is not increasing it is at least more visible, because for the first time ever women occupy the presidencies of two of the most important institutions in the world of mathematics; the European Mathematical Society, headed by the Spaniard Marta Sanz-Solé, and the International Mathematical Union (IMU), presided over since 2010 by Ingrid Daubechies, who will also be an invited speaker at the AIMS conference in Madrid.

Together with Serfaty, Nantharaman and Daubechies, another woman who will be in Madrid to give one of the main talks is Amie Wilkinson, professor at the University of Chicago. The fact that women will make up a third of the speakers constitutes a step in the right direction, although there is still a long way to go before the equation is concluded; that is, equality.

In addition, mathematicians do not live from mathematics alone; on July 7th a welcoming cocktail will be provided at the congress after the opening sessions, and a gala dinner on July 9th at the Universidad Complutense de Madrid (UCM) Alfonso XIII Royal Botanical Gardens. There will also be guided visits to the historic medieval city center of Madrid – the Madrid of the House of Austria; the Royal Palace; the cities of Toledo and Aranjuez and also the Escorial. Other visits to places such as the Santiago Bernabeu Football Stadium and the Madrid Zoo will round off an event at which not only the latest advances in the discipline will be addressed, but above all those whose daily work consists in making this progress possible will also come together.

Interview: Shouchuan Hu, director of the American Institute of Mathematical Sciences (AIMS)

"AIMS has contributed very positively to interdisciplinary research at an international level"

Lorena Cabeza. Professor of Mathematics at the University of Missouri (USA), Shouchuan Hu has been the director of the American Institute of Mathematical Sciences (AIMS) and coordinator of all its activities throughout the twenty years of its existence. He arrived in the United States almost thirty years ago to do his PhD, since in his native country China "there were few viable options". His field of research is differential equations and dynamical systems. He is the author of the books "Handbook of Multivalued Analysis: Theory and Applications" (Volume I and II) and "Time-dependent subdiferential evolution inclusions and optimal control", and has supervised twelve doctoral theses. He says that throughout his time as head of the AIMS he has learned to be "humble", and when asked about what being the director of this institution for so many years means to him, he replies: "It has been a great experience and a great privilege to serve this international community".


AIMS

Shouchuan Hu is specialized in differential equations and dynamical systems.

Question: What is the American Institute of Mathematical Sciences? How was it born?

Answer: It was created twenty years ago as an international organization for the advancement and dissemination of mathematical sciences. AIMS promotes mathematical science education through its publications and conferences.

Q: You have led AIMS from its very beginning. What do you remember of those days?

A: They were exciting days when we realized the definite need to create such a platform from within the community instead of from outside. The initiative immediately got overwhelming support from leading scientists and mathematicians in the fields.

"We realized the definite need to create such a platform from within the community"

Q: ¿What are its main goals?

A: The mission of AIMS is to foster and enhance interactions across a broad spectrum of mathematicians and scientists worldwide.

Q: How has the situation changed over the years? Is it more common now for mathematicians to work with scientists from different fields?

A: AIMS has certainly contributed in a very positive way to the collaboration among scientists from different fields and to interdisciplinary research worldwide. This is clearly reflected by the mix of the participants in the AIMS conferences and the sheer size, and the resulting collaborations and publications. The collection of all AIMS journals covers all the major areas of analytical mathematics, pure and applied; another indication of this evolution.

Q: What are its main scientific activities?

A: Organizing the biennial international conference series – the most attended in the world– on Dynamical Systems, Differential Equations and Applications, and publishing 20 international journals in mathematics and related fields.

Q: Mathematics are key to the development of new applications, but very often non-mathematicians are not conscious of this. What would you say to them to highlight this relevance?

A: Mathematics is considered the 'Queen of Sciences'. It relies on logic and creativity and is pursued both for a variety of practical purposes and for its intrinsic interest. For the growth of science and technology, it was crucial for there to be progress in the field of mathematics. Mathematics is also like science and technology in that it incorporates both finding answers to fundamental questions and solving practical problems

Q: Why would you say that the AIMs congresses are so highly attended?

A: The fact that the AIMS conferences are organized by the members of this community itself (from within) makes all participants feel it is their own conference. The high quality of the talks and very balanced covegae of subjects also contribute to the success. Another feature of the AIMS Conferences is its appeal to youngsters (graduate students and young PH.Ds), via the poster sessions and student paper competition.

Q: How would you describe these conferences to non-mathematicians in a few lines?

A: The AIMS Conferences provide a key platform for

Interview: Shouchuan Hu, director of the American Institute of Mathematical Sciences (AIMS)

mathematicians and scientists to gather together, exchanging ideas and forging collaboration. Topics include theoretical research, which can potentially provide new methods and approaches to practical problems. And, as far as applications are concerned, research in areas such as the modeling of diseases, populations, climate and economics, all of which are committed to solving real-world problems.

Q: Do companies usually participate in these conferences?

"One of the goals is to promote interdisciplinary research and studies"

A: So far, the participation has been mostly by institutes and leading publishers. We should put more effort into recruiting companies to participate in the AIMS Conferences

Q: Let's talk now about dissemination. AIMS has launched several highly recognized magazines. What are the keys for achieving recognition?

A: All of AIMS journals are created within communication and support from the members of the community, such as editors, authors, referees and readers. The journals and the conference series are complementary and serve the community well. High quality and a rigorous and rapid reviewing process are part of the elements leading to the success and recognition.

P: Which of these journals would you highlight?

A: "Discrete and Continuous Dynamical Systems" is AIMS' first and flagship journal. Seven Fields medalists, among many other world-renowned research leaders, have contributed to this journal. The journal has become a prime publication in the field, for its recognized high quality and rapid publication.

"The AIMS Conferences have become more and more popular and the majority of participans come again and again"

Q: These journals address very different issues. Do they manage to reinforce collaboration between mathematicians and scientists from other disciplines?

A: Yes. One of the goals is to promote interdisciplinary research and studies. The collection of all the AIMS journal titles shows a well-balanced coverage of pure and applied mathematics. They were created on the basis of the needs and proposals from the community, since scientific research has become increasingly interdisciplinary.

Q: Why did you choose Spain this year as the place to hold the 10th AIMS Conference on Dynamical Systems, Differential Equations and Applications?

A: There are numerous leading Spanish scientists in this field, including Professor Manuel de León, whose leadership and organizing skills made the 2006 ICM a great success. It is certain that he can repeat it by making the 10th AIMS Conference a new milestone.

Q: What would you highlight about these conferences?

A: The AIMS Conferences have become more and more popular and the majority of participants come again and again. This is mostly due to the intrinsic need for the community, and the conference is always organized by members of the community from within.

Q: Applications are a very central issue at this congress. Could you highlight some of the applications that are going to be addressed?

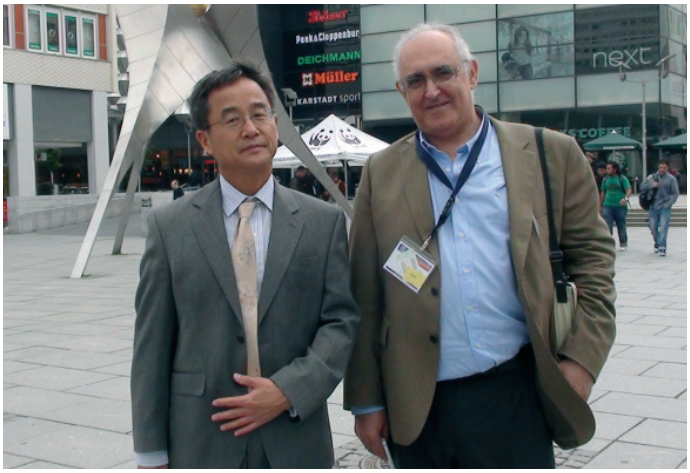
A: For instance, the symposium, "Mathematical models in the systems biology of cancer," organized by Professor Philip Maini, among others, aims to bring together researchers from all over the world to present their new results on mathematical and computational models in the field of tumour biology. These will include new advances in mathematical analysis, as well as novel diagnostic, prognostic and therapeutic ideas. The conclusion of this session will likely shed light on cancer diagnostics and treatment. Other subjects that will be addressed are imaging issues, engineering matters, population models, weather, social aggregations, tumor dynamics and the biology of cancer.

Q: The first Student Paper Competition will take place at this conference. Can you tell us about that?

A: The student paper competition is held to identify and honor outstanding student papers in the fields of differential equations and dynamical systems, in the broadest sense. The idea came up when we tried to find ways to broaden the spectrum of the Conferences and, in particular, to contribute to fostering rising stars in mathematical research.

Q: Some round-table meetings will also be held. Which one of them would you highlight?

A: "Funding Policies and Practice in Europe and America". It should interest a lot of participants, and is a unique opportunity to learn about and compare such policies and practices coming from different continents.



Shouchuan Hu with ICMAT director, Manuel de León. Dresden (Germany), 2010.

Interview: Madhu Sudan, Professor of Computer Science at the MIT and Nevanlinna Prize-winner 2002

"To verify a proof written in the right format, we need only a probabilistic strategy"

ICMAT

Madhu Sudan at Heidelberg Laureate Forum.

Ágata A. Timón. Madhu Sudan (India, 1966) was awarded the Nevanlinna Prize in 2002 for his significant contribution to different theoretical areas of Computer Science, closely related to the great unknown of the discipline, designated by the Clay Institute as one of the seven Millennium Problems: ¿P=NP?, or what amounts to the same: Whenever the solution to a problem can be verified efficiently, can its solution also be calculated efficiently? This question concerns the speed with which computers can perform their tasks. With a degree from the Indian Institute of Technology in New Delhi (India), Madhu Sudan did his doctoral thesis at the University of California in Berkeley and is currently professor with the Departament of Electrical Engineering and Computational Science at the Massachusetts Institute of Technology (MIT). He was one of the invited speakers at the first Heidelberg Laureate Forum, held in September of last year. We were able to speak with him at this meeting, which brought together young researchers in mathematics and computatonal sciences and some of the leading scientists in these fields.

Question: The Nevanlinna Prize recognizes outstanding work in the mathematical aspects of computer science: How are these two disciplines related in your career?

Answer: Theoretical computer science, which is the area I come from, builds mathematical analysis of algorithms: How fast can some computation problems be solved with computers? Where are the limits? Why are there some problems that cannot be solved? This area is absolutely driven by our need to understand computers and computations, but everything is mathematical. We study the mathematical model of a computer, not the computer itself. It can be considered as a special part of mathematics.

P: You develop the idea of probabilistically checkable proofs; What was your motivation?

R: Let's imagine that we are looking at people who are submitting solutions to the Clay Millennium Problems. There are many of them. Actually, as an editor of a journal I receive so many proofs of P=NP or PNP. Most of the time, when you look at it, you can see that the paper doesn't make sense, but still, in order to be able to go back to the author and say that the proof is wrong, we have to find the mistake. And mistakes are very hard to find in proofs. I can give you 20, 200, 2000 pages, and they might be hidden anywhere inside… and it takes a lot of time to read it and find out what's wrong.

"There is another way of writing proofs in which the errors are more visible"

P: And in this sense, what do these kinds of proofs contribute?

R: It is a logical concept; it's true that it's very hard to find errors in current ways of writing proofs, but maybe there is another way of writing proofs in which the errors are more visible, and if there is one, it will be possible to find them quickly. The probabilistic checkable proof is a definition of a system for writing proofs in that way. And there are two important considerations to this. Firstly, if there is something that I want to prove, and I have the proof, I should be able to write it in this format. So if the proof is correct, one finds no errors. And secondly, if some theorem is not true, then no matter what you try to write, errors will be evident.

"If some theorem is not true, then no matter what you try to write, errors will be evident"

P: But does this format actually exist?

R: That's a good question. Anybody can have definitions: maybe you want to be able to travel faster than light, but you need to have a vehicle that enables you to do that. Similarly, we need to be able to find such a format. And there is one. It takes a lot of time to design it, but we were able to design one.

P: How does it work?

Interview: Madhu Sudan, Professor of Computer Science at the MIT and Nevanlinna Prize-winner 2002

R: Once you have written the proof in the specific format, we only need a probabilistic strategy to verify it. We pick some locations (each of them will be just one bit, 0 or 1), and after reading, lets say, three of them, if the theorem is not true, there's a 50% chance that I would have detected an error (and a 50% chance that I would not), and if I don't like this chance, we can read three more bits, and it will become a 25% chance, and so on. The probability indicates regularity and goes on to 0, depending on the number of bits that I read.

"I'm working on a theoretical mathematical approach to massive data"

P: What kind of problems can be written in this format?

R: This is completely general. So any statement, in any consistent system of logic, can be written in this way. If the classical proof has say 100 pages, maybe my proof will be 200 pages, and if I want to demonstrate to you that I have a proof for this Theorem, you only have to read 3 bits to check it

P: So, why mathematicians are not doing this?

R: First of all, they don't want probabilities of correctness, but rather totally unambiguous correctness. And, on the other hand, no proof in mathematics is formally complete. If you actually have to write any proof formally, something like Pythagoras Theorem will take 50-60 pages. Mathematics is often built into many other things. So there is the problem of length. And the scaling is a little too much. And even if the last problem can be solved, the first ones are more sociological.

P: Then where is it used?

"Our algorithm has been able to recover the information of the original signal of the Moon"

R: We're very much likely to have computations formally verified. We would like to confirm that if I run this computer program, and it gives me some output, it is correct. You can imagine someone running a massive program (for example, analysis of the climate change data…), and if you want to verify the solution, you have to check roughly every step of the program. In this case, it's better to write a longer proof (in our format), and then just checking some bits. Here the scaling is not significant.

P: You built another concept to guarantee the correctness of the code: error-correcting codes. Could you explain this concept?

R: This is a way in which we can store information. If I take your computer's hard drive, you always expect that, over time, some scratches will appear, and you won't be able to implement it as it is. It would be interesting to store information in a way that when a few things are corrupted, you can still recover the original information.

P: How do you do that?

R: You start with the original information and you expand it. When a few things go wrong, there's a compression mechanism that will remove all the errors and give you back the original.

P: Does it have applications in real life?

R: Yes, it has been applied in recent years. It is especially useful in settings where you really expect a lot of errors. For example, it's use by amateur radio people, who build radios in their homes. They are a lot of them around the world. There is a group of them who are trying to see if they can reflect radio waves on the moon. Imagine I send something and somebody in Tokyo has an amateur radio that is receiving the signals. The moon is reflecting things back to the earth, but is pretty far away, so the signal is very disturbed, and the level of error is very high. One of these radio amateurs decided that he would use our error correcting algorithm, and he got significant improvement of the signal. They were able to recover the information of the original signal, after its journey to the Moon. And that's quite romantic.

P: What are you working on now?

R: I'm working on a theoretical mathematical approach to massive data. Everybody is looking at the problem of there being more and more data available, and they would like to know how to analyze it quickly and find the proprieties that they want. There are many cases in which you look to this massive amount of data and you want to know if it satisfies some global propriety, or even more than that, before we find the parameters, we want to know if there is any reason to explore it.

P: What are the main goals in the area of Computation and Communication in the coming years?

R: There is an increasing level of automation in the world, and there's a lot of communication between computers, and computers are both acting on physical things and selecting information from other places in order to determine what action they should take. In these kinds of settings it is very easy to go wrong. Humans, on the other hand, also do this: they collect information from other humans, and then they act. But humans are not rigidly prescribed, and as a result they can be little bit more robust to errors, and noise… I would like to be able to understand what the mechanics of this process are, so that we can also put it onto computers.

"We're very much likely to have computations formally verified"

P: Do you have any idea of what the origin of this error is?

R: It's a fault of communication, because a computer on its own won't misunderstand itself or the data that it generates, although it's very capable of misunderstanding information that it's getting from other places. We would like to understand how under these conditions it can detect the misunderstanding, and how can it correct these errors. If you and I are both computers, and I don't understand what you are saying, maybe I'll be able to interact with you, to figure out what it is that you meant.

Profile of Joan Tent, ICMAT researcher specializing in group theory

"I find research intellectually stimulating"

Andrea Jiménez. When Joan Tent discovered algebra while at university, he decided that he wanted to steer his career towards the invention of new equations and revealing the unknown elements of the most complex among them, particularly through the study of groups that provide the basis for other more elaborate algebraic structures.

Thanks to a Severo Ochoa post-doctoral contract, he is currently conducting research at the ICMAT into problems concerning the representation theory of finite and pro-finite groups. "The groups are objects that describe symmetry in nature. They are abstract objects and can be difficult to understand, but one way of understand them better is by

Group theory has a wide variety of applications both within and outside mathematics

their actions; that is, by studying the way in which they move the points of the object presented by the symmetry". So explains this 30 year-old researcher from Valencia who graduated in Mathematics at the University of Valencia in 2007 and went on to do a Master in Mathematical Research a year later.

ICMAT

Joan Tent, ICMAT researcher.

Group theory has a wide variety of applications both within and outside mathematics. "It is used a lot as a tool in number theory, analysis and geometry, and in reality groups appear everywhere". It is also included within other sciences such as quantum physics and chemistry. In fact, the way to describe a symmetry in nature is done by group theory, while in chemistry it is especially important in crystallography. "The molecules of crystals possess highly symmetric, ordered configurations in space. The groups that describe these symmetries are called crystallographic groups".

Furthermore, their applications extend to subjects such as the study of quarks, the solution to the Rubik cube (the best-known, three-dimensional, mechanical conundrum), cryptography and even the binary theory that lies behind internet networks.

The way to describe a symmetry in nature is done by group theory, while in chemistry it is especially important in crystallography

Joan Tent is in a position to say that he has touched science with both hands, because in addition to his research work he has also had teaching experience. He worked as a lecturer at the Autonomous University of Madrid and at the University of Valencia while he was studying for his doctorate. "While research can be intellectually more stimulating, it is far more specialized and solitary than standing before a blackboard imparting knowledge, which I also like very much".

His thesis project has taken him abroad to do research work with other mathematicians specializing in his subject, first at the University of Wisconsin and then at the National University of Maynoth in Ireland. Working in these places has enabled him not only to learn a lot but also to broaden his professional horizons. He is not happy to be working at the ICMAT, a center that, as he says, "is very good for doing research, both for its diversity of subjects and for the good working environment". As part of his professional training, he knows that he will probably have to move abroad for a few years, although eventually he would like to be able to settle down in Spain in the future.

Their applications extend to subjects such as the study of quarks, the solution to the Rubik cube cryptography and even the binary theory that lies behind internet networks

Passionate about cinema and a confirmed traveler, he does not hesitate to answer when asked about his favorite theory: "Galois Theory, named after the mathematician who coined the term 'group' and founded a discipline", the discipline to which Tent remains loyal, for although he would like to study other branches of mathematics, his intention for the foreseeable future is to continue devoting himself to navigating the ins and outs of algebra.

Self-portrait: Marc Noy, professor of Applied Mathematics at the Polytechnic University of Catalonia

ICMAT

Marc Noy, professor of Applied Mthematics at the Politechnic University of Catalonia.

Marc Noy (1958) graduated in Mathematics at the University of Barcelona and in 1983 earned a Masters in Mathematics from Brandeis University (Massachusetts). He became Ph. at Computer Science by the Polytechnic University of Catalonia in 1989 and since 2003 has been teaching as a professor of Applied Mathematics at the Polytechnic University of Catalonia . He is also the author of 70 research papers.

Question: You have been chosen as a guest speaker at the next ICM to be held in Seoul. What's your reaction to the news and what does this recognition mean for your professional work?

Answer: Of course, I feel very happy and honoured. To be invited to speak at the ICM is an important international recognition. That said, some close colleagues deserve this distinction as much or even more than me, and I hope that their work will receive this recognition in future ICMs.

Q: Could you give us an outline of your professional career?

"To be invited to speak at the ICM is an important international reconognition"

A: Like that of other colleagues of my generation, the course of my career is rather atypical, because among other things I started research work late. The fact that I work in Combinatorics is to some extent a matter of chance. Discrete mathematics was included in the study plan in the early 1990s, and we had to prepare the new courses. I soon became passionately interested in the subject, above and beyond the classes we had to give. My first work was in discrete geometry alongside Ferran Hurtado, a recognized specialist in the field. We worked together on problems concerning enumeration of geometric configurations, and that led me to enumerative combinatorics. Oriol Serra also helped to fuel my passion for combinatorics; its mathematical elegance and depth have exerted an attraction over me ever since. Then a little later I was lucky enough to meet Philippe Flajolet, who with his proverbial generosity introduced me to analytic and probabalisitic methods in combinatorics. Since that time, Philippe was an unfailing source of inspiration for me and for many others. His premature death two years ago deprived us of an exceptional mathematician and colleague. I subsequently met Dominic Welsh, another great academic, who aroused my interest in

"When the FME was set up 20 years ago, it completely changed the panorama of mathematics at the UPC"

graphs and other aspects of combinatorics. In fact, a work my Dominic ten years ago made me wonder about the enumeration of flat graphs, a problem that seemed beyond solution with the techniques available at the time. Fortune smiled on me again, because at that time Omer Giménez was doing his thesis with me. Omer was a really exceptional student, and after a year struggling with the problem we finally found the solution, which combined combinatorial ideas with analytic tools. That led onto an analysis of random flat graphs, graphs on surfaces and other types of graphs. I'd also like to mention the collaboration with Michael Drmota: his mastery of analytic techniques enabled us to tackle increasingly complex parameters of random graphs, particularly extremal parameters. The enumeration and properties of random topological graphs have currently become a very active area in combinatorics, and I'm glad to be able to feel that I had something to do with it. I'd also like to mention the role of the Universitat Politècnica de Catalunya Faculty of Mathematics and Statistics in my career. When the FME was set up 20 years ago, it completely changed the panorama of mathematics at the UPC. With the Degree Course in Mathematics we managed to attract some very able and motivated students to the Faculty. The introduction of these new courses was carried out in a generous spirit of collaboration among the mathematicians at the UPC, a spirit that fortunately still exists. It all helped to give great momentum to the doctoral courses and quality research. After that came the CFIS, a unique center at the UPC que offers outstanding students with the opportunity to achieve double qualifications. The CFIS has achieved a success beyond all expectations and mathematical studies have benefitted enormously. All this has made the UPC a very attractive

Self-portrait: Marc Noy, professor of Applied Mathematics at the Polytechnic University of Catalonia

university in which to study mathematics. I would also like to make especial mention of the role played by Josep Grané in this adventure; his work in the creation of the FME and the CFIS, and his generosity towards students have all proved decisive in the success of this undertaking.

Q: Could you describe briefly the research you are engaged in?

A: My interest is focused on the typical properties of large combinatorial objects. Some classical examples may help to understand the subject. How many cycles does it take for a random permutation of length n to decompose? What is the typical height/altitude of a binary tree of n nodes?

"My interest if focus on the typical properties of large combinatorial objects"

We have very precise answers to these two questions. The predicted number of cycles in a random permutation is the harmonic number $H_n = 1 + ½ + \ldots + 1/n$, which asymptotically is log n; even further, the distribution of the number of cycles is asymptotically normal and highly concentrated around its mean. If X_n is the predicted height of a binary tree of n nodes, we know that the expectation of X_n is asymptotically $2\sqrt{\pi n}$ even further, $X_n/\sqrt{n}$ converges towards an explicit distribution that can be expressed in terms of a function θ.

"A probabilistic vision helps to simplify and understand complex structures better"

The basic tools for proving these results are generating functions and singularity analysis. If A_n is the number of combinatorial objects (permutations, tres, graphs, etc) of size n that interests us, then the sequence $A(z) = \sum n \geq 0\ A_n z^n$ encapsulates all the enumerative information. If we now take A(z) as a función de variable compleja, its singularities and their nature (poles, points of ramification, essential singularities, etc) determine precisely the asymptotic behaviour of the numbers A_n.

"Probability has been without doubt one of the great triunphs of the last century"

The same scheme enables us to analyze combinatorial parameters with multivariate functions. If $A_{n,k}$ is the number of objects of size n with a parameter value equal to k, the sequence A(z, u) that has the $A_{n,k}$ as coefficients completely encapsulates the distribution of the parameter. The question then is to determine how the singularity of A(z, u) varies in function of u close to u = 1. For example, if the singularity varies analytically in u, one typically obtains a Gaussian law with expectation and linear variance in n. if the nature of the singularity changes on moving from u < 1 to u > 1, non-Gaussian continuous laws then appear naturally. These tools, and others more sophisticated, have enabled us to determine fine properties of random flat graphs and other families of graphs.

Classes of graphs exist for which we have no generating functions. In this situation, more combinatorial arguments sometimes allow us to obtain relevant properties of random graphs. The results are less precise than when using analytic tools, but they have quite a wide range of application. Lately I've been interested in these problems in classes defined by prohibited graphs, whether as contractions or as subgraphs. This is a field with very attractive open problems.

Q: How do you view the field of Combinatorics in Spain?

A: AI think it's quite good at the moment. There are some very good researchers in several areas: graph theory, discrete geometry and combinatorial number theory, as well as associated subjects such as code theory and and theoretical informatics. Particularly worthy of mention are Javier Cilleruelo in Madrid, Francisco Santos in Santander and Oriol Serra and Simeon Ball in Barcelona, who have obtained notable results and enjoy great prestige on the international scene. However, I'm worried about the situation of young people. We've got some highly gifted students in the up-and-coming generation, brilliant young students who have studied under us and who are now in Germany, France and Canada. But will there be places for them in our universities when some day they return? If not, it will be very difficult for the healthy situation of combinatorics in Spain to be maintained.

Q: How can you get young students interested in Combinatorics?

A: That's the easiest qustion to answer. Combinatorics has the advantage that you can quickly reach the frontiers of research without having to rely on a large amount of technical apparatus. Furthermore, combinatorics has reached a stage of maturity and is becoming increasingly central in mathematics. This is reflected in the recognition of mathematicians whose research work includes a significant combinatorial component: Bourgain (1994), Gowers (1998), Okounkov, Tao, Werner (2006), Lindenstrauss and Smirnov (2010) have all received Fields Medals, and to a great or lesser extent they are all working on problems of a discrete nature. You only have to remember that Szemerédi was awarded the Abel Prize in 2012 "for his fundamental contributions to discrete mathematics and theoretical informatics" to see that the outlook is very bright. I'd also like to point out the important role of probability theory in this boom in combinatorics. Probability was without doubt one of the great triumphs of the last century and its influence can be felt in practically all the fields of mathematics. A probabilisitic vision helps to simplify and understand complex structures better. What's more, the probabilisitic method has enjoyed spectacular success, not only in combinatorics but also in analysis, geometry, number theory, computer science, physics and other disciplines. For example, Green and Tao's great theory on arithmetic progressions of primes wouldn't exist without the combinatorial and random ingredients of the proof.

But to return to your question; if a young scientist today has to decide on a research field, he or she can be sure that they will find in combinatorics many opportunities and fascinating problems of great beauty and current relevance, and enjoy tackling them, which is saying a great deal.

Scientific review

Large Cardinals and Basic Sequences

Author: Jordi Lopez-Abad (ICMAT).
Original Title: Large cardinals and basic sequences
Date of publication: December 2013
Source: Annals of Pure and Applied Logic. Volume 164, Issue 12. Pages 1390–1417. http://dx.doi.org/10.1016/j.apal.2013.06.016

Banach spaces, which are named after the Polish mathematician Stefan Banach, are some of the main objects of study in the field of functional analysis. They are normed vector spaces, that is, those in which an application exists that enable distances to be calculated, and complete vector spaces, that is those in which Cauchy sequences – a type of sequence whose elements become closer to each other - on approaching the infinite, always converge to a point in space. Typically, they are infinite-dimensional function spaces.

This paper, published by Jordi Lopez-Abad in the "Annals of Pure and Applied Logic", is a study on several problems concerning the existence of systems of coordinates that enable positions to be determined in Banach spaces. One of these systems of coordinates, the Schauder basis, is of particular interest because every vector of the space has a unique representation as a sum of a (possibly infinite) series with coefficients on the base.

More specifically, this work deals with non-separable infinite-dimensional spaces (i.e. of uncountable topological density), in which set theory and infinite combinatorics are fundamental. As a result of this interrelation, problems on non-separable spaces exist that cannot be solved either positively or negatively, because for example they do not depend on the cardinality of the continuum (continuum hypothesis) and are therefore undecidable.

Lopez-Abad has obtained the first non-trivial result on the separable quotient problem, which poses the question whether every infinite-dimensional Banach space has an infinite dimensional subspace, such that the quotient space of both is infinite-dimensional and separable. Perhaps the main outcome is that, under certain conditions involving sets, every large-dimension Banach space has a separable quotient with an unconditional Schauder basis, where the series defining a vector converges unconditionally in signs.

The work sets forth various results on the existence in non-separable spaces of subspaces with an unconditional basis. It also provides examples of non-separable spaces in which non-enumerable biorthogonal systems do not exist. The existence of these systems of coordinates is related to properties of the differentiability of the space norm.

Furthermore, certain problems concerning the geometry of Banach spaces are also characterized in terms of well-known infinite cardinals, such as the first cardinal or Ramsey cardinal.

In set theory, the cardinal is the generalization of the number of elements of any set, whether finite or infinite. We say "generalization" because although the set is finite, the cardinal is the natural number corresponding to its number of elements. However, where infinite sets are concerned, transfinite numbers are required, which serve to differentiate between different types of infinite.

This step forward belongs to the field of abstract functional analysis; namely, to the study of the structure of Banach spaces. This branch addresses the study of subspaces of certain types of continuous functions; those real functions defined on the unit interval or more generally on a compact space. Furthermore, they also employ applications of infinite combinatorics and set theory, since diverse results presented are analytic-combinatorial constructions.

Link to the article: http://www.sciencedirect.com/science/article/pii/S0168007213000857

Jordi López Abad

Jordi López Abad is a Ramón y Cajal researcher at the Instituto de Ciencias Matemáticas (ICMAT). His main areas of research are combinatorics, functional analysis and set theory. He is currently working on applications of Ramsey's theory and infinite combinatorics to the study of the geometry of Banach spaces, yielding new examples of spaces and obtaining structural results. More specifically, he is interested in weak properties of unconditionality of basic sequences acting as compact families of finite sets of Banach spaces, or in the Banach-Saks property of a set. He has recently been working on the existence of unconditional basic sequences of Banach spaces, and has partially resolved the separable quotient problem for large density spaces. Abad is the author of more than 20 articles published in high impact journals, such as "Advances in Mathematics", "Mathematische Annalen" and the "Journal of Functional Analysis".

Mathematics today

ICMAT News

The ICMAT is awarded two Consolidator grants from the European Research Council worth 2.5 million Euros

José In January of this year, José María Martell and Javier Fernández de Bobadilla, scientists belonging to the CSIC and members of the ICMAT, were awarded two of the prestigious Consolidator Grants by the European research Council (ERC) worth 1,430,000 and 1,140,000 Euros, respectively.

3,500 projects were submitted in answer to the call this year, of which only approximately 10% were chosen. Thanks to these grants, these two researchers will be able to consolidate their research teams and continue working at the frontier of mathematical knowledge.

The ICMAT has so far been awarded six of these grants, in the form of Starting Grants, which are awarded to young researchers able to lead important scientific projects. These two latest grants, which in this regard put the Institute on an equal footing with Oxford University, which also has eight all together, belong to the Consolider Grant scheme. In the words of the director of the Institute, Manuel de León: "These results are a clear indication of the excellence of the ICMAT".

The work conducted by José María Martell is at the interface between harmonic analysis, partial differential equations and geometric measure theory. Furthermore, these types of problems arise in very day-to-day situations. As Martell says, "When designing a library in which you want to create areas of silence, we need to modify the diffusion of sound in the building, which comes down to the solution of mathematical problems like the ones we are posing".

On the other hand, Fernández de Bobadilla's project is being conducted in highly theoretical fields of mathematics. His proposal consists of an extensive mosaic in which some of the central problems in the field of singularity theory are uppermost, but which are closely linked with other mathematical fields.

An ICMAT mathematical model provides an alternative to subduction as a cause of tectonic plate dynamics

The workings of the Earth's interior continue to be a mystery for geologists and physicists. One of the theories – still to be confirmed but widely accepted – holds that the movement of tectonic plates is caused by subduction, that is, the sinking of one plate beneath another due to differences of density. However, a recent work under the direction of CSIC researcher and ICMAT member, Ana María Mancho, provides examples of fluids in convection that indicate that this movement may occur spontaneously as the sole result of the internal dynamics of the fluid and in the presence of symmetry.

The results, published in January of this year in the journal Physics of Fluids, suggest that the symmetry of the terrestrial sphere may be instrumental in the formation of plates in movement. As Mancho says, "in our paper we see that spontaneous movement is a global solution of the system in which symmetry has great significance, although in our study the symmetry is simpler than the symmetry in the Earth".

The paper proposes a model of the lithosphere over the convection mantle, on the basis of which the instabilities of the fluid are analyzed. These equations give rise to certain solutions related to the presence of symmetry and correspond to a fleeting and spontaneous movement of the plates.

This conclusion has been reached by solving basic equations of fluid dynamics with numerical analysis methods designed by the research team. As PhD student at the Autonomous University of Madrid, ICMAT member and co-author of the article, Jezabel Curbelo explains: "The initial idea was to adapt previous procedures to our equations, but they did not yield good results, so we came up with a method of our own". In order to perform these calculations, the research team approached the ICMAT computation centers (Ada and Grace) and those at the UAM Centro de Computación Científica (CCC) as well as the CESGA in Galicia.

AGENDA

SCIENTIFIC ACTIVITIES AT ICMAT

Research Trimester on the Geometry and Physics of Moduli Spaces

Date: 14th april-11th July, 2014

Three days on analysis & PDEs

Date: 3th-5th June, 2014

Workshop Geometry and Semiclassical Analysis in interaction with Spectral Theory and Physic

Date: 9th-13th June, 2014

DISSEMINATION ACTIVITIES

Mentes y máquinas: Ciencia-ficción y Matemáticas. Inspiraciencia talk

Date: 9th April 19:00 Place: La Casa Encendida (Madrid)

Mathematics at the Residence: I'm a math-magician

Date: 24th April Place: Residencia de Estudiantes (Madrid)

Talk: Un mundo libre de armas nucleares: ¿deseable? ¿factible?

Date: From 5th-20th May Place: Residencia de Estudiantes (Madrid)

Mathematics today

ICMAT News

The Japanese popularizer of science Jin Akiyama presents his show on maths and magic in Madrid

Mathematics is one of the stars of Japanese television thanks to Jin Akiyama, a professor at the Tokyo University of Science and famous Japanese popularizer of science. Now, Akiyama is bringing his fascinating show to Spain on April 24th at the Residencia de Estudiantes in Madrid.

Jin Akiyama in his show.

Akiyama is a researcher in the field of graph theory, discrete geometry and combinatorics. Since the early 1980s, he has put mathematics in the media spotlight and brought it to a wide audience with great success in Japan thanks to his television show "The Most Fascinating Lecture in the World", which has topped ratings in his home country since 2005.

The popularity of this mathematician extends to appearances on radio programs, in films, television series and Nintendo video games, and even as a character in manga comics.

As a researcher, he has written more than a dozen books (on discrete mathematics and recreational mathematics), and has published more than one hundred articles in scientific journals.

The show in Madrid revolves around the mathematical principles that can be used in magic tricks and will be presented by Fernando Blasco Contreras, professor of Applied Mathematics at the Universidad Politécnica de Madrid, who is also a magician and popularizer of science.

A mathematical model shows how the Internet and social networks strengthen meritocracy

A work published last December in the journal belonging to the "Nature" group, Scientific Reports, shows the importance of this connectivity in economic activity and the compensation that individuals receive for their work.

As professor at the Autonomous University of Madrid, ICMAT member and one of the authors of the work, Florentino Borondo explains: "Until now, the role of connectivity in economics had not been taken very much into account. The model we have developed shows that a highly connected network will be meritocratic; in other words, it will benefit those with most talent, otherwise it will be topocratic and favor those who are better connected".

The question that the researchers asked themselves was: Under what conditions does the position of the network matter more than the talent of the agents? The reply they obtained was that this factor predominates in less connected networks, and thus the connectivity of a network determines whether the system is meritocratic or topocratic. The model predicts that the Internet and new technologies contribute to the creation of a system in which compensation is more closely related to the talent of individuals than to their position in the network.

As the author of the work explains, "in order for an economic system to be very meritocratic it needs to be very highly connected, and we only require some fairly simple calculations to see that that is not the case in today's society". The good news is that the increase in connections provided by new technologies is helping to spread meritocracy, since it makes it possible for someone to come into contact easily with many other people and eliminate intermediaries.

This work, which falls within the area of complex networks, has been undertaken by researchers in disciplines as varied as physics, chemistry and economics. Says Borondo, "this is a clearly multidisciplinary field, because the connectivity we have used in this case to represent economic transactions can also be used to study the human brain, the behavior of genes and the spread of diseases. And it is mathematics – specifically, graph theory – that provides the basis for this discipline.

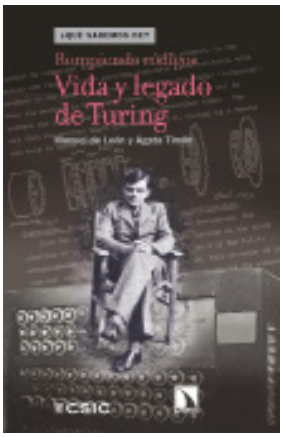
ICMAT News

The CSIC and publishing house La Catarata publish "Rompiendo códigos: Vida y legado de Turing" ("Breaking Codes: the Life and Legacy of Turing"

In February of this year, the biography Rompiendo Códigos: Vida y legado de Turing by ICMAT director Manuel de León and Institute member Ágata Timón, was published as part of the outreach collection '¿Qué sabemos de?' ("What Do We Know about…?"). The book consists of Turing's contributions to different mathematical disciplines and the historical and scientific context in which they occurred, together with stories from the fascinating life of this English mathematician.

The enormous influence of Turing's work in the development of computer science sometimes makes us forget that he was above all a mathematical genius, perhaps one of the most brilliant of the 20th century. He is regarded as the father of computation, but his groundbreaking ideas also had a unique impact on disciplines such as logic and philosophy, as well as contributing to the creation of new branches of knowledge like mathematical biology and artificial intelligence, to say nothing of his work on cryptography, which proved vital for bringing World War II to a speedier close.

As the authors of this book point out, the main contribution of this mathematician, who was instrumental in the development of the information society and knowledge, was the creation of the Turing machine. This theoretical construction negatively resolved a key question about the foundations of mathematics: Can all mathematical problems be solved?



"Rompiendo códigos. Vida y legado de Turing",
Manuel de León & Ágata Timón.
Colection ¿Qué sabemos de?. CSIC y Ediciones La Catarata, 2014 (Madrid)
Prize: 12 euros.
ISBN: 978-84-00-09768-4

The ICMAT brings its work closer to secondary school pupils in the 4ESO+empresa Program

On April 7th, 8th, 9th and 10th the Instituto de Ciencias Matemáticas (ICMAT) opens its doors to 4th grade secondary school students to enable them to get first hand experience of how mathematical researchers work in a center of excellence.

This activity forms part of the Community of Madrid 4ESO+empresa program, which provides pupils with educational stays at companies and research centers. Over a period of four days, a group of 4th grade boys and girls will visit the ICMAT and be introduced to the daily activity of the Institute consisting of a range of talks and workshops in which the scientists in person will explain their work to them. The aim of the Institute is to show students how mathematical research can be a good career choice, to provide them with experience of the daily work of mathematical scientists and explain what avenues are open to them to access this profession.

This is the second year in which this activity has been arranged, and according to ICMAT director, Manuel de León, after the success of the first year, they have been "inundated with requests". Furthermore, de León points out the "excellent involvement of our young researchers and the intrinsic value of the initiative".

ICMAT INSTITUTO DE CIENCIAS MATEMÁTICAS

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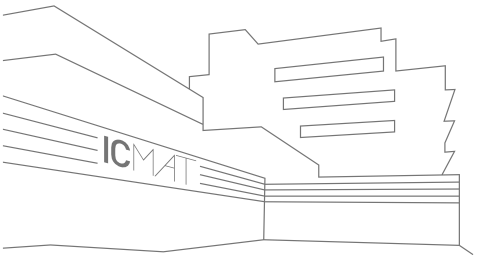

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