ICMAT
INSTITUTO DE CIENCIAS MATEMÁTICAS

Quarterly newsletter
First quarter 2017
CSIC - UAM - UC3M - UCM

EDITORIAL

"Only dead mathematics can be taught where the attitude of competition prevails: living mathematics must always be a communal possession". **Mary Everest Boole**

Every day of the year is women's day in science

On December 15th, 2015 the United Nations General Assembly approved a resolution in which it was decided to make February 11th of every year the *International Day of Women and Girls in Science*. The resolution was accompanied by an invitation to all collectives, both public and private, to celebrate this day by a series of educational and awareness activities. Some initiatives were carried out in 2016, while in 2017 the response was extraordinary at both institutional and private levels.

In my opinion, the celebration of this day is both good and bad news. It is something positive because it demonstrates a "certain" concern for the inequalities that still persist today in the world of science, and encourages society to become more aware of the problem, to reflect on it and to put pressure on those who govern us to solve it. "Political correctness" has forced many institutions to back the initiative; their organizational capability and the means at their disposal have helped to make this appeal both gobal and effective. Even so, it is my belief that initiatives undertaken with enthusiasm, although modest, are those that achieve the best results.

As I have said, it is also bad news, because the need to set aside a special day for the purpose shows that, contrary to what a cursory glance might reflect, even with the 21st century well under way, an enormous gender gap still exists in the world of science.

I have no wish to overload this article with statistics that confirm the growing inequalities that exist as one rises through the positions of responsibility in science. Such data is readily available to anyone who wishes to consult it. I would rather float some ideas to stimulate thought about the matter; ideas that might well be applied to mathematics just as to other branches of science.

The problem for women in science, and in particular in mathematics, is largely due to what happens to girls from a very early age, both at school and in the family. This stage in their lives has much to do with female scientists who have never been, as well as those who have managed to get on the ladder but find themselves facing a rather demoralizing outlook, both in purely scientific terms and in science management. Young women and girls receive little incentive; they are systematically discouraged, very often unintentionally, as the result of a paternalistic attitude that protects them excessively. It is for this reason that when the

Image: Julian Beever

Marta Macho-Stadler is a professor at Universidad del País Vasco (UPV/EHU).

CONTENTS

time comes for them to choose a career, science and mathematics largely appear as something remote and inaccessible. Among those girls who fail to choose mathematics because they feel they have no talent for it, could some of them have perhaps solved the Riemann hypothesis or the Goldbach conjecture? And among those who do choose to study mathematics at university, and do so brilliantly but later drop out, could some of them perhaps have been Fields Medal winners if only they had received the right support?

Like many other institutions, the ICMAT is committed to launching a "gender action plan" with laudable goals aimed at attaining a greater representation of women in all its programmes – in research, dissemination and management – as well as serving to stimulate mathematical vocation among younger women and girls. I was very pleased to learn about this initiative. If I am not mistaken when consulting the data on the ICMAT website, of the 56 members on the "research staff" only 4 are women (7.1% of the total); of the 26 "postdoctoral researchers" only 6 are women (23% of the total), and of the 46 "predoctoral researchers" only 6 are women (13% of the total). These figures speak for themselves, and while all those belonging to the Institute work there thanks to their scientific merits – no one places this in doubt – such figures should at least give grounds for thought. Why are there so few women?

Having a women's commission at the ICMAT – at universities or research institutes – is as important as having one in any working environment. We sometimes forget that we who do science are no different from anyone else. We are subject to the same stereotyping, complexes and beliefs that make us behave unfairly in all aspects of our daily lives. It is important that those at the head of these initiatives believe fully in what they are doing and have the strength to reach the objectives that motivate the grass roots. It is not easy to remind systematically those who make the decisions that there shouldn't be congresses without keynote women speakers or decision-making commissions without women scientists who are able to express their opinions.

Nobody these days has things easy in the sphere of research. Mathematics is exciting, but getting started is tough. The pressure to get results is considerable, and it is even harder for women. It is also difficult to detect problems for those who have no wish to see them, because some of these problems are very subtle, and imperceptible for the majority.

The quote from Mary Everest Boole at the head of this article makes reference to one of the problems that, in my opinion, makes scientific endeavour unappealing to women; a mistaken concept of competitiveness. A predoctoral women student at my university said the other day that during many discussions between various people at the blackboard she ends up keeping quiet, because she is soft spoken and her voice is drowned out by her classmates. While this may not seem a very serious problem, it is for her, because she is unable to participate on an equal footing. This is just one example of a situation that may easily be overlooked by the majority, but it contributes to the feeling of discouragement by those women who experience it.

Stereotyping, insecurity or a lack of self-worth plays against women in areas like mathematics. Science is the driving force of our society, and women have the right to participate there on equal terms by determining and deciding on trends in research. Society cannot afford to carry on ignoring people with more than enough capacity and creativity necessary to contribute to its improvement.

It is for all these reasons that, while the existence of an *International Day of Women and Girls in Science* is important, I firmly believe that *every day of the year is women's day in science*.

Marta Macho-Stadler

Professor at Universidad del País Vasco (UPV/EHU).

Image: ICMAT

Some ICMAT members, during the past International Day of Women and Girls in Science

INTERVIEW: Consuelo Martínez, professor of Algebra and Mathematics at the University of Oviedo

"It hurts me that anyone should think you've achieved something for the mere fact of being a woman"

Image: Consuelo Martínez

Consuelo Martínez is an expert in non-associative algebra and superalgebra.

Patricia Ruiz Guevara. Consuelo Martínez López (El Ferrol, 1955) graduated in Mathematics from the University of Zaragoza in 1977, where she also obtained her doctorate under the supervision of Javier Otal. She has been a Professor of Algebra at the University of Oviedo since 2005 and is a visiting researcher at the KIAS (Korean Institute of Advanced Studies), where she conducts research work jointly with Fields Medallist winner Efim Zelmanov, with whom she has been collaborating since the 1990s. Her work is focused on non-associative algebra and superalgebra, their interrelations with group theory and their applications to cryptography and error-correcting code theory, such as group codes. She has recently given talks at the CUNY (City University of New York), at the Stevens Institute of Technology, USA, and the INDAM Meeting of European Women in Mathematics 2015, where she was invited as a plenary speaker. In recent years she has also been coordinator for mathematics on the Evaluation Committee set up by the *Agencia Nacional de Evaluación de la Calidad y Acreditación* (ANECA) for the Spanish Ministry of Education, Culture and Sport FPU grants (University Lecturer Training). She is also a member of the Physics and Mathematics branch of the *Comisión Nacional Evaluadora de la Actividad Investigadora* (CNEAI) and the *Comité de Ciencias Experimentales de la Agencia Vasca* (UNIBASQ).

Q: You graduated in Mathematics in 1977 from the University of Zaragoza. How did your family react when they learned you wanted to study mathematics?

A: I think I was privileged as far as my family was concerned. My father was a teacher and he liked mathematics very much, so quite likely there was something heriditary involved, and the fact that I wanted to study mathematics came as no surprise at home. What's more, there was not too much difference in the number of boys and girls studying mathematics at that time, so it was nothing out of the ordinary for me.

Q: Neverthless, there was quite a big gap when it came to research. Was that the case in your field?

A: Generally speaking, in Spain there are quite a lot of women engaged in algebra. It's something that has been mentioned a lot at international conferences; the number of women involved in this field in Spain is higher than in other countries. So I've never felt that in my environment and in the conferences I've attended it was anything exceptional. I don't deny that discrimination on the grounds of gender exists, because it's obvious that it does; but in my case, throughout my academic career I have never felt discriminated against, and neither have I encountered obstacles because of the fact that I'm a woman.

Q: In what way do you think this discrimination operates?

A: There are many interrelated factors involved. When you're working with a full commitment to research, it's difficult to combine this dedication with family life and other obligations if you can't count on good support. As a woman, you have to take into account other conditioning factors that probably stem from background and education. All of that is very limiting. In general, for reasons of tradition and education, our male colleagues don't have to confront these problems.

Q: You've worked in different countries; for example, in recent years you've had research stays at the KIAS (Korean Institute of Advanced Studies), in South Korea. What's the situation like there for a female mathematician?

A: In South Korea it's similar to the situation here. In general, I think the situation for female researchers in mathematics is similar the world over. For instance, in the United States there are still proportionally fewer female researchers when compared with the number of men. I think it has a lot to do with historical development. Men have been studying at university and working in research for many years, during which time women were not accepted. For example, Emmy Noether was not allowed to teach at universities because she was a woman. We women have started our university careers only recently, so it's going to take us some time to get on an equal footing.

Q: What strategies do you think are useful for reducing these inequalities?

A: I think that education is vital. If we could arrive at the point in our society where our parents taught their children that men and women are exactly equal when it comes to doing a job or carrying out intellectual activity, and that couples could support each other in terms of equality, then I think that the most important problems could be solved. On this point, the essential role also falls to women themselves, because sometimes we're the first to educate young people in inequality without realizing we're doing so.

Q: Do you notice any difference between the behaviour of girls and boys in the classroom?

A: I often think that we're doing something wrong, because I see many girl students reproducing patterns from the past. At the end of the course, many outstanding girls, who are natural candidates for building solid academic careers or pursuing research, tend to drop out because of other priorities that shouldn't be incompatible, such as sentimental relationships or because of starting a family. However, it's also true that not everyone understands that a researcher is required to travel, spend time abroad, attend conferences or work for months with colleagues. It's vital that the people close to you provide you with support.

Q: Institutions are drawing up gender plans to try to close this gap. What's your opinion of positive discrimination?

A: I have mixed feelings about this, because the word "discrimination" by definition seems to me to be negative. In principle, it doesn't seem fair to me to discriminate against anybody; neither does it seem positive for women in the medium and long term. For instance, it makes me happy when a woman like Maryam Mirzakhani (Stanford University, USA) is awarded a Fields Medal, because I'm convinced that she deserves it for accomplishing marvellous work. What hurts me is that anybody should think you've achieved something for the mere fact of being a woman. If a woman has attained a certain position it's because at the very least she's just as good as her colleagues, and not just because she's a woman. On the other hand, I understand that gender plans are measures that may be required at certain junctures, and anything that can help seems welcome to me.

Q: You do research into abstract algebra. What course is your work taking?

A: We want to apply our knowledge on algebraic structures to information theory, in cryptography and error-correcting codes. Number theory methods have traditionally been used for designing the cryptographic schemes used in cards and digital signatures. The idea now is to design encryption schemes using algebraic structures that are resistant and may be useful in the future, if necessary, for complementing current systems.

Q: You've also been working for years with Fields Medallist Efim Zelmanov (University of California San Diego). What has this collaboration been like over the years?

A: Working with Zelmanov is wonderful; it's very stimulating. You have to be very mentally awake to follow his thought processes. After many years working together we have established a great understanding, which often means that either one of us knows what the other one is thinking. Together we have obtained results like the classification of simple finite dimensional Jordan superalgebras of prime characteristic. It was highly gratifying to apply models that had been constructed in infinite dimension and characteristic zero, which turned out to be the key points of our classification. It's fascinating for a mathematician to see how things that are apparently disparate relate to each other, how everything adds up and fits together at the end. These kinds of results are those that have given me the most satisfaction.

Q: Apart from the pleasure of dedicating yourself to research, what do you get out of teaching?

A: Teaching helps to keep us alive and see things from different perspectives. In particular, I like teaching PhD courses very much, because it's stimulating to work with people who are just starting out in research, guiding them and learning new things along the way. It's important for students to explore their own avenues with your help, but they have to be new avenues, not only the ones that you might have directed them towards.

Q: What would you say to someone who doesn't understand why basic research is important?

A: Most of us who work in basic research do so first of all for the pure aesthetic pleasure of it. I imagine that this pleasure is similar to the one that musicians might feel when they compose a piece that is exactly what they were looking for. But apart from that, basic research is essential for a country. It enables progress to continue; it aids and lays the foundation for applied research, which leads to a more immediate outcome. Basic research is the only way to open new doors that will perhaps pave the way to an application. For example, for years it was thought that number theory had no practical use, and finally it turned out to be essential for the emergence of public key cryptography. If one works with a vision of the future, one cannot relinquish basic research; that would be terribly short-sighted and lead to dire consequences.

Image: Consuelo Martínez

Consuelo Martínez is an expert in non-associative algebra and superalgebra.

"A study finds that family values determine girls' performance in mathematics"

Image: ICMAT

The culture is a determining factor in gender difference when it comes to the subject of mathematics.

The traditional belief that girls are bad at mathematics is still deeply rooted in our society, and there are even those who believe that it constitutes a biological fact. Nevertheless, it amounts to nothing more than a further stereotypical notion. A recent study puts an end to this false debate; it all boils down to a cultural and discriminatory issue. "The Math Gender Gap: The Role of Culture", published in the journal *American Economic Review*, confirms that women's interest in mathematics depends on the values of gender equality imparted to them in the home: the lower the level of equality that exists in the communities to which girls belong, the lower will be their performance in mathematics.

Laura Moreno Iraola. The world of mathematics has a long way to go before reaching a state of equity between the sexes. To date, only one woman has won a Fields Medal (the highest prize awarded in mathematics) since this distinction was created in 1936. She was the Iranian Maryam Mirzakhani, a professor at Stanford University (USA), who was awarded the prize in 2014. In addition, another Iranian, Sara Zahedi, has come to prominence this year for being the only woman mathematician to be distinguished by the European Mathematical Society (EMS) at the European Congress of Mathematics (ECM), held in July last year in Berlin. The mathematical community itself is increasingly aware of this situation, and is redoubling its efforts to overthrow the stereotypes associated with this science, most of which are attributable to men, and which are traditionally embedded in the values of our society.

It appears that the culture and ideals predominant in each family are the determining factors in gender difference when it comes to the subject of mathematics. This is the conclusion reached in a study entitled "The Math Gender Gap: The Role of Culture", published last year on May 13th in the *American Economic Review*. The authors are three economists, two of whom are Spanish women: Núria Rodríguez-Planas, of the City University of New York (CUNY) Department of Economics; Almudena Sevilla, of the University of London Queen Mary School of Business and Management (QMUL), and the third a Uruguayan, Natalia Nollenberger, who belongs to the IE University, IE Business School.

The study was based on a sample of 11,527 boys and girls of 15 years of age, all of them born and living in nine different countries, but whose parents emmigrated from 35 different places. The results in mathematics obtained by these boys and girls were taken from the 2003, 2006, 2009 and 2012 PISA (Program for International Student Assessment) reports, issued by the Organization for Economic Cooperation and Development (OECD). In order to measure gender equality in their parents' country of origin, the authors used the Gender Gap Index (GGI) drawn up at the 2009 World Economic Forum.

They say that: "We started our research after reading an article published in "Science"[1] in which it was shown that in most of the countries participating in the tests covered in the 2003 PISA report, girls scored lower than boys in mathematics, although there are a few countries in which the girls did better." This article showed that in areas where there is a greater level of gender equality, the results between boys and girls are similar. They go on to say that: "Only correlations are observed. It is not clear to what extent the influence of institutions, the labour market, the salary difference between men and women, the educational system, laws and so on have on the access of women to the world of mathematics, or if, on the other hand, it is the beliefs in gender roles that exert greater influence. We saw that it was in this area where we could make a contribution".

Their work is the first in which reference is made to the values created in home life rather than to those coming from society, the educational system or the labour market. While the boys and girls participating in the study were brought up in the same conditions of the countries they share, these researchers remark that: "they are influenced by the beliefs (culture) imparted in the country of origin of their parents, and gender differences are lower for those adolescents whose parents come from countries where there is a greater level of gender equality." They also say that: "We find that an increase between the GGI of the country of origin of their parents is associated with an improvement in the girls' results in mathematics in PISA when compared with the boys coming from the same origin, and this is equivalent to a month and a half of schooling". For example; "if the girls whose parents come from Turkey, where according to our indicator there is a low level of gender equality (GGI=0.58), themselves are brought up in countries with greater equality, the gender gap observed between boys and girls whose parents come from Turkey, which is calculated at 13.8 points, would disappear".

The authors of the paper point out that the influence of culture in this respect is so significant that, according to the results of the study, "it could in itself account for almost two thirds of the total effect of gender equality in a country, which includes the effect of both culture and institutions". They therefore propose that it is precisely in this area where attention should be focused in order for the gender gap in all places to disappear. They further conclude that: "What our paper suggests is that it is not enough to introduce institutional changes, such as greater access for women to the labour market or a greater participation in politics, but rather that it is also necessary to bring about a change in our beliefs regarding the part that men and women play in our society. This is important because changing beliefs is a much more difficult task and takes much more time".

Click on this link for the full text of the paper.

1 Luigi, Guiso; Monte, Ferdinando; Sapienza, Paola; Zingales, Luigi. "Culture, Gender, and Math". 2008. *Science* 320: 1164–65.

Image: ICMAT

It is necessary to bring about a change in our beliefs regarding the part that men and women play in our society.

PROFILE: Sonja Lea Heinze

"In every part of the world there's a way of thinking about mathematics"

Image: Sonja Lea Heinze

Sonja Lea Heinze started her doctoral studies at the ICMAT as part of the La Caixa Severo Ochoa programme.

Sonja Lea Heinze

Sonja Lea Heinze was born in Essen (Germany) in 1988. She studied for her degree in Mathematics at the University of Aachen, where for her end-of-course project she conducted a geometric characterization of certain sets - those in which the Cauchy integral operator is bounded. It was then that her interest in studying connections between mathematical concepts in different fields began. She went on to do a Master in mathematics at the same university, the first year of which she spent at Nottingham University in the United Kingdom. In 2013, she started her doctoral studies at the ICMAT as part of the La Caixa Severo Ochoa programme, under the supervision of Javier Fernández de Bobadilla (BCAM). Since then she has focused on algebraic singularities, employing concepts from other fields such as topology and geometry.

Patricia Ruiz Guevara. One of the characteristics that scientists have in common is their passion for tackling challenges. Research in abstract mathematics is without doubt one of the greatest of these challenges, and one which is highly motivating for Sonja Lea Heinze. There was never any doubt in her mind that she wanted to study sciences, and finally she opted for the purest of all. After earning her degree in Mathematics in Aachen (Germany), where the remains of the emperor Charlemagne are located, this young German mathematician explains that; "I wasn't exactly sure what direction I wanted to go in, so I decided to do a Master. I was attracted by research work and wanted to pursue it." Just like Charlemagne, Heinze decided to take on several challenges (mathematical) at once.

"I like solving abstract problems and responding to challenges" says this researcher, who since 2013 has been working at the ICMAT in the field of bi-Lipschitz geometry, classifying algebraic singularities. "Previously, algebraic singularities were classified with topology, not with geometry, and for a long while it was thought that geometry and Lipschitz topology were the same. However, about fifteen years ago examples of complex surfaces were found in which the two are not the same", explains Heinze. "In a complex dimension greater than one, the geometry is richer and is able to differentiate two singularities that topology cannot". It is for that reason that she is now looking for invariants of bi-Lipschitz geometry.

Heinze says that her research is highly theoretical. "What I'm studying has no application at the moment; we are establishing the basis of the pure mathematics so that it can be applied later on". Very few women work in this abstract branch of mathematics, as Heinze knows from her own experience. "In Germany, your studies start with mathematics in general for everybody, and there's an equal number of male and female students. Then it splits and you have to choose between teacher training and a Bachelor of Sciences in mathematics, and at this point the proportion is 80% and 20%". At the post-graduate level, she chose pure mathematics rather than applied, and she was the only women in most of the subjects, but she says that she was never made to feel out of place.

What is the reason for this difference? Heinze believes that "There's a lot of pressure on women to start a family, to get a steady job early on to become independent, and this pressure comes from society rather than the mathematical community. Our parents' generation is afraid that if you don't get a regular job while you're young you're going to have to depend on your husband. They think that it's better to get a career and find a job as soon as possible. Working in research doesn't provide this stability". Nevertheless, this young researcher has no doubts that this is what she likes doing, and encourages other young women to do the same with their future. "You have to think carefully about what you want to do and not take any notice of other people or outside impediments. If you want to study mathematics or work in research, then do it".

In particular, Heinze says of her work that she learns a great deal when on research stays: "In every part of the world there's a different way of thinking about mathematics, even between one department and another. A kind of culture is created about how people think and how things can be explained. When you're on a visiting stay you get involved a little in that culture". For her, this is a difference that is difficult to explain. She describes it as an inner feeling, the fine distinctions in the universal language of mathematics. She is also interested in finding out what other mathematicians are working on, and that is why she always attends the Junior Seminar organized by the Autonomous University of Madrid.

But this 28-year-old German researcher, who has spent the last three years in Spain, does not live on mathematics alone. "I love walking, and hiking in the mountains", she says, "and having a beer and discussing politics. I also do Capoeira. I'm a volunteer with an animal welfare group and I also play bass in a jazz band in Madrid". Heinze started to learn this instrument when she was 15 years old, and believes that there are basic things about numbers and mathematics that help a lot with the rhythm of the music. "I think that what you have to do to be a good musician is to learn a lot of technique, then forget about it and try to be creative. Just like in other activities, this is also true in mathematics". Indeed, Sonja Heinze is a mathematician who tackles the daily challenges involved in mathematical research with creativity and determination.

SHE DOES MATHS: Amalia Pizarro

Image: ICMAT

Amalia Pizarro during her visit at ICMAT in October, 2016.

Amalia Pizarro

Amalia Pizarro is the director of the University of Valparaíso (Chile) Insitute of Mathematics and also a member of the Academic Committee of the Consortium PUCV-UTFSM-UV (Pontificia Universidad Católica de Valparaíso, Universidad Técnica Federico Santa María, Universidad de Valparaíso), where she is responsible for coordinating the Mathematics doctorate programmme. It forms part of the Red Iberoamericana of Number Theory, whose director is Antonio Córdoba, who is also director of the ICMAT. This collaboration brought Amalia to the ICMAT on a research stay during October, 2016.

Field of Research:

Computational aspects of Algebraic Number Theory and diophantine problems with applications to tools for Analytic Number Theory.

Laura Moreno Iraola. The percentage of women engaged in mathematical reseach in Chile barely reaches 20%. Amalia Pizarro forms part of this scant proportion through her involvement in number theory, where "it is vital to be intuitive and creative, as well as mixing emotions". In fact, she is the only woman among the twelve mathematical researchers who work at the University of Valparaíso Institute of Mathematics.

Pizarro conducts research into computational aspects of algebraic number theory, a field that extends number theory to the so-called *algebraic numbers*; that is, those that are roots of a non-zero polynomial with rational coefficients. This branch of mathematics is devoted to the study of the properties of certain algebraic objects, algebraic number fields and their rings of integers, which are generalizations of rational numbers and integers. Furthermore, she is interested in diophantine problems; those that are related to the resolution of equations with rational coefficients or integers, for which tools belonging to analytic number theory are employed.

Last year, and especially during her stay at the ICMAT in October, Pizarro studied the growth of the Artin conductor. This value is an invariant associated with a function (the character) of the Galois Groups, which is the source of a great deal of information, both arithmetic and algebraic. This was the subject of her doctoral thesis, and she has been able to prove some interesting properties, such as the fact that it can grow exponentially with respect to the degree of representation to which it is associated.

Pizarro combines her research work with teaching and is especially involved in mathematical outreach and dissemination. She participates in programmes that reveal to students what kinds of mathematics lie beyond the classroom by setting challenges, posing questions and arousing their curiosity, with the aim of raising their awareness of this discipline as part of their cultural capital.

From her position as both teacher and disseminator of mathematics, she seeks to encourage the mathematical potential of women, which she found to be lacking in her own time as a student, as well as providing a role model for women in Chile to follow. She says that even today there exists an obvious gender gap in the classroom; for example, she points out that boys do not hesitate to respond to questions, without asking themselves whether or not they are good at mathematics, while girls are still timid and insecure in this regard. She also remarks on this inequality in the field of research, where men are more usually involved, which makes women mathematicians compare themselves unfavourably and constantly question their worth. This amounts to a two-fold task to which women must apply themselves in order to gain greater confidence and belief in themselves as deserving of their position. Pizarro believes that the situation is improving and sites as an example the work carried out by collectives like female mathematicians in Chile, who are gradually ensuring that advances in gender equality are being made in South American society.

ICMAT QUESTIONNAIRE: Pilar Bayer Isant, professor of algebra at the University of Barcelona

"In difficult moments it's good to remember Gloria Gaynor's *I will survive*"

Image: Pilar Bayer

Pilar Bayer is a mathematician and a pianist.

Pilar Bayer Isant

Pilar Bayer Isant was born in 1946 in Barcelona. She is a professor of algebra and this year became a professor emeritus at the University of Barcelona. She specializes in number theory and has conducted her research work at the University of Regensburg (Germany) and the Barcelona Seminar of Number Theory. Prior to that, in 1967, she qualified as a piano teacher at the Barcelona Municipal Conservatory of Music. Among her many awards, she was named "Emmy-Noether-Professorin" in 2004 by the Georg-August-Universität Göttingen (Germany).

Patricia Ruiz Guevara

1. Why did you decide to study mathematics?

For me, studying mathematics is something that came naturally. There have always been mathematical questions that have aroused my interest and that I wanted to learn about – in the first instance – or investigate – at a more advanced level.

2. What was your first experience in mathematical research?

It's difficult to say what the very "first" experience was. Early on in my studies, when I managed to solve a problem requiring a lot of effort I felt very happy. However, I got my first real research experience when I was doing my thesis.

3. What do you like most about research?

The inner peace it brings. Being able to work on a mathematical problem throughout a whole day is a privilege and leaves you with the feeling that it has been a day well spent.

4. Is there a theorem or mathematical result that you particularly like?

There are many. The theory of complex multiplication taken to its final consequences is something I find especially fascinating.

5. What mathematical problem do you think presents the greatest current challenge?

It depends on the speciality. In our area, number theory, I'd say it's the Birch and Swinnerton-Dyer conjecture. It's both a great challenge and probably accessible in the coming decades.

6. How would you explain the importance of mathematics to someone who doesn't understand it?

I'd distinguish between applied and fundamental mathematics. The former is easy to justify; you only have to mention any of the extraordinary applications in new technologies such as medicine, robotics, computer vision, communications, transport and so on. When it comes to fundamental mathematics, I could only say that it's an experience that one has to live for oneself in order to understand it.

7. Why is mathematics so vital for current scientific and technological development?

Because mathematics provide a language that machines can understand.

8. How would you describe your present research work in a few words?

I'm involved in understanding and developing noncommutative structures that lie behind arithmetic phenomena that can be visualized by means of calculus.

9. What research work has given you the greatest satisfaction?

All my published work has been a long time in preparation and has often been the result of collaboration with other people, and so is very dear to me. The results published by my PhD students are also important, even though they don't bear my name. But maybe as a more human response, I'm happy to know that there's a theorem called the Bayer-Neukirch theorem concerning special values of zeta and L functions...

10. What was the award that pleased you most?

I was especially gratified on being named an "Emmy Noether Professorin" by the University of Göttingen. On the one hand, because it enabled me to teach at that university, and on the other because it is named after one of the women mathematicians whom I most admire.

11. Who is your favourite woman mathematician?

Apart from Emmy Noether, among contemporary mathematicians I'd choose Marie France Vignéras.

12. There are still few women involved in mathematical research: What can be done to remedy this situation?

With work, work and more work by women. If one perseveres, recognition should come by itself. Fortunately, the intrinsic importance of a theorem is independent of gender – and the nationality – of the person who discovers it. Whether or not we are generous enough to acknowledge it is another matter. Neither should we forget that in recent years mathematics has become an increasingly competitive activity.

13. What would you say to young women to encourage them to pursue careers in science and mathematics?

That it's a question of very personal decisions... As a matter of principle, I've never tried to exert any direct influence on such decisions. Women are capable of excellent work in the field of sciences just as much as in the humanities or in politics, taking into account the improvement in social conditions, which is much needed. If a woman is convinced of her scentific vocation, or more precisely, her mathematical calling, I would advise her to put aside any possible fears she might have about being a woman. Obviously, she's going to come up against a lot of difficulties, but these must be seen as opportunities for improvement and setting things straight. In particularly difficult moments it's good to remember Gloria Gaynor and listen to her 1978 recording of *I will survive*.

14. Your students say very positive things about you. What do you like most about teaching?

When I'm giving a class I try to be the first to learn new things. In my classes, or when supervising work, I've always tried to teach not what I already know but what I'd like to understand myself. It's been fantastic to be able to work together with motivated students.

15. Your other passion is music: What does that give you?

Ah, music! Music is an excellent travelling companion. As I said before, mathematical research is a relaxing activity, while on the other hand teaching mathematics is stressful, and very tiring physically. Fortunately, music acts like a compensatory factor; if you're a musician it's a stimulating activity, but if you're part of the audience it has relaxing powers. So after a day devoted to research it's good to be able to play an instrument, and after a day spent teaching it's recommendable to go to a concert or listen to an LP or a CD.

16. What for you is the relationship between music and mathematics?

More and more I see the similarities. Both disciplines involve creative work (composing/researching), dissemination (playing an instrument/teaching) and appreciation (music lovers/students). I'm just beginning a new phase as professor emeritus. I'm going to have more time, so I've started to experience the similarities between mathematical creation and musical creation.

17. What books or authors would you recommend?

For relaxation, I like reading books on philosophy. I'd particularly recommend books by philosophers who are also mathematicians as well as authors who have a philosophical spirit: Plato, Ramon Llull, Francis Bacon, Descartes, Pascal, Spinoza, Leibniz, Bertrand Russell, Hermann Weyl, María Zambrano, Simone Weil, etc.

18. What is your favourite book on mathematics?

Cours d'arithmétique by Jean-Pierre Serre, published by Presses Universitaires de France in 1970.

19. If you could have a conversation with a mathematician from the past, who would you choose and what would you talk about?

I'd choose Felix Klein. He was a person open to "new trends", but with his feet firmly on the ground. We might talk about writing a book together, a choral work with "lessons on the development of mathematics in the 20th century".

20. Why is the dissemination of mathematics important?

Mathematics, like all human activity, requires appreciation by a public. The works of any human being need a soundboard; if this is lacking, the creative person can get depressed and this affects his or her performance. Dissemination is important at every level and ensures the continuity of mathematical endeavour, which indeed is one of the oldest pursuits.

INTERVIEW: Simon Donaldson, professor at the Simons Center for Geometry and Physics and at Imperial College; also codirector of one of the ICMAT Laboratories

"Finding a theorem that has always been there but nobody saw is gratifying"

Image: ICMAT

Donaldson is a codirector alongside Nigel Hitchen (Oxford University) of one of the ICMAT Laboratories.

Sir Simon Donaldson (Cambridge, 1957) is a professor at the Simons Center for Geometry and Physics (Stony Brook, EE. UU.) and teaches Pure Mathematics at Imperial College London. He is also codirector alongside Nigel Hitchen (Oxford University) of one of the ICMAT Laboratories. Donaldson gained his doctorate from Oxford University in 1983 and is especially known for his work on the topology of 3-dimensional differential manifolds, and for the theory that carries his name, the Donaldson-Thomas theory, on invariants in a compact modular space. He was awarded a Fields Medal in 1986 for his results on the geometry and topology of differentiable 4-manifolds through the study of a key concept in mathematical physics, the *instantons*. In addition to this award, also known as the "Nobel Prize for Mathematics", he also received the Royal Society Medal in 1992, the London Mathematical Society Polya Prize in 1999, the Shaw Prize in 2009 and the Breakthrough Prize in Mathematics in 2014. He is a member of the Royal Society, and in January of this year he was made Doctor Honoris Causa by the Complutense University of Madrid.

Patricia Ruiz Guevara

Q: Do you remember how and when your interest in mathematics began?

A: I already liked mathematics when I was about 13 years old, although I showed no particular prediliction for it. Nevertheless, I was very interested in designing boats, and that's when I realized that I needed to find out something about mathematics that I wasn't being taught at school. That's when I decided I wanted to devote myself to it fully.

Q: Your supervisors during your early years as a PhD researcher were Nigel Hitchin and Michael Atiyah. How did they influence you?

A: Hitchin got me started on a very good project and I developed it in a way that was different from what he expected. I certainly absorbed his style of doing and thinking about mathematics. Atiyah, on the other hand, had a very geometric point of view and I soaked up his ideas.

Q: Now you are supervising doctoral theses. How do you try to help your students?

A: It's work I enjoy very much. I have many PhD students; some of them have been very good and have hardly needed my help. In general, I try as far as possible to help students to find their own way. I see the role of supervisor as someone who makes it possible for students to decide for themselves which direction they want to take.

Q: You were only 25 when you obtained an impressive result that had a big impact in the mathematical world: the existence of "exotic" 4-dimensional spaces that are topologically equivalent to the Euclidian space R^4, but not differentially equivalent. What was that like, being so young?

A: When I proved that result we held a little celebration. At that time I was doing a post-graduate course at Worcester College, in Oxford, and it didn't have as much repercussion there as in other places. It was greatly talked about in the United States, and was even mentioned in the press. But I don't think that anybody really took much notice of me until I won the Fields Medal (laughs).

Q: You were awarded your first prize in 1985 and since then you've won one after another. What value do you put on these prizes?

A: The prizes are a recognition of the road you've travelled to come this far, and that's satisfying. But the important point is that, thanks to these prizes, mathematics acquires a greater visibility and makes people realize that it's not just a subject you study at school.

Q: For example, you were awarded the Shaw Prize, which is endowed with one million dollars, and that attracted a lot of attention from people.

A: Of course; people thought "Oh, a mathematician has won a big cash prize!" That enhances the reputation of mathematics in society, which is important.

Q: You were also knighted in 2012. Did that affect you in any way?

A: Not in essence, no; but sometimes my family tells me that's why I get to fly club class (laughs). But it's an honour I really appreciate, and once again it's fantastic because it gives more visibility to mathematics. It hasn't changed my life in any particular way, but it makes me very happy.

Q: What has been the most enjoyable episode in your academic career?

A: It's difficult to say. Perhaps I'd choose the first prize I received, the one we've already mentioned, when I was 25 years old. It was quite memorable and surprising to arrive at those results so soon. I solved a problem on symplectic manifolds, one on which a lot of people had been working for many years. I never imagined I would do it and it gave me a lot of satisfaction.

Q: You've worked on geometry, topology and algebraic geometry. What research are you doing right now?

A: I'm mainly thinking about problems concerning spaces of small dimension, specifically dimensions 7 and 8. It's an area to which I've devoted much thought over the years, but indirectly, through my work with students. I'd never really focused on it directly; it's something rather new for me, and therefore refreshing.

Q: What are the applications of your research work, in mathematics or other areas?

A: The things I'm working on have important connections with theoretical physics, but at a more general level. The main application of my results is getting results in one field of mathematics and using them in another.

Q: How would you explain the value of research to people?

A: Finding a theorem or result that has always been there but which nobody saw is always gratifying. You can appreciate its beauty, above and beyond its applications. What's more, mathematics is a very broad field with many interrelations; nobody can really understand it all. Some parts are more applied and others more theoretical, but in the end it's all related and it's all useful. For instance, partial differential equations are applied mathematics and very crucial, but they also have an aspect that involves fundamental theoretical questions of analysis related to geometry and other branches.

Q: You participate in the ICMAT Laboratories. What do you think of this project?

A: The laboratory is another level of collaboration that's different from what you do at particular times when you're trying to prove a particular result. It's less formal; more like a conversation: people gather around a blackboard and discuss things, but they don't necessarily have to write a paper together. One day I was talking to Óscar García-Prada and another colleague about a problem concerning the Yau-Tian-Donaldson conjecture; then later on, I was talking to Fran Presas about symplectic areas. There are various topics in the Laboratory programme that touch on my areas of interest and I'm looking forward to discussing them there.

Q: About the Yau-Tian-Donaldson conjecture, in 2012 you proved a result together with two other scientists.

A: That's right; I'd been working in this area for about fifteen years, but I tended to avoid this result in particular because there were a lot of people engaged in trying to prove it. Finally, in 2008, I started thinking about it seriously. Xiuxiong Chen had experience in some particular aspects that I thought might be relevant, so we joined forces in the project. Together with Song Sun, we found a way of overcoming one of the greatest problems. I'd already written other papers in collaboration before, but this was the first time I'd worked continuously with two colleagues.

Q: It's said that mathematics is universal. You've worked in different countries; is mathematics really a universal language, or are there different ways of working and thinking?

A: The first response of course is that mathematics is international. People ask me what's the difference between working half the time in London and the other half in the United States... The truth is that there's no difference, and that's true in general as well. You can go to India, Poland or any other place in the world and talk about mathematics. In the end, it's more or less the same experience. But the second response is that there's a diversity of enthusiasm and cultural differences. It's dangerous to generalize, but for example some mathematicians are more focused on solving problems or theorems, and others more concerned with understanding the theory. But some cultural mathematical differences certainly exist.

Q: Right now, mathematics seems to be highly regarded as a professional option. What do you think the future holds?

A: There's certainly a high demand for mathematicians, and I think it's something that makes people more aware of the importance of our discipline. It's taking off more and more, and I think it's rise will continue in the coming years, since mathematics forms the basis of almost every activity. For example, as computation continues to develop, mathematics will be increasingly present in the search for intelligent ways of solving problems.

Image: ICMAT

Donaldson during his last visit to the ICMAT.

SCIENTIFIC REVIEW: Infinitesimal moduli for the Strominger system and Killing spinors in generalized geometry

Title of article: Infinitesimal moduli for the Strominger system and Killing spinors in generalized geometry.

Authors: Mario Garcia-Fernandez (ICMAT), Roberto Rubio (IMPA), Carl Tipler (Université de Bretagne Occidentale).

Source: Mathematische Annalen.

Date of publication: 01 September 2016 (online).

doi: 10.1007/s00208-016-1463-5.

The Strominger system of partial differential equations has its origins in string theory in physics. It was first considered in the mathematics literature in a paper by the Fields medalist Shing-Tung Yau and Professor Jun Li, from Standford University, published in 2005 in the Journal of Differential Geometry. The mathematical study of these equations was proposed as a generalization of the *Calabi problem*, solved by Yau in 1977.

The existence problem for the Strominger system has been an active area of research in the last ten years. By analogy with the *Calabi problem*, Yau has proposed a conjecture based in the large classes of examples known up to date. This conjecture is widely open, the main difficulties being the impossibility of applying techniques from Kähler geometry, used in the Calabi problem, and the lack of understanding of the geometry of the equations.

A question closely related to Yau Conjecture is the construction of a moduli space of solutions for the Strominger system. This is motivated by the classification problem of Calabi-Yau manifolds in algebraic geometry, *Reid's fantasy,* and its relation with *mirror symmetry*. The Strominger system, as many other equations with origin in field theory in physics, admits continuous families of solutions due to the existence of (gauge) symmetries. The moduli problem addresses the construction of a space (tipically a manifold with singularities), whose points parameterize solutions up to symmetries. The equations dictate a geometric structure on the moduli space, which plays an important role in the existence problem. The moduli problem for the Strominger system is still open, and we do not even understand the geometry around a given solution.

In a recent publication in Mathematische Annalen, Mario Garcia-Fernandez (ICMAT), Roberto Rubio (IMPA) and Carl Tipler (Université de Bretagne Occidentale) have made a contribution to this problem. The researchers construct the space of infinitesimal variations of a solution and an obstruction space to integrability, proving that the moduli space is finite-dimensional by means of elliptic operator theory. They have also initiated the study of the geometry of the moduli space, discovering a natural foliation, that is, a decomposition of the moduli space into leaves, given by subspaces of smaller dimension. A leaf corresponds to (the homotopy class of) a *string structure*, a sophisticated topological quantity introduced by Timothy Killingback and Edward Witten in the eighties.

By investigating the tangent space to a leaf, the authors discovered a surprising relation with generalized geometry, introduced by Professor Nigel Hitchin (Oxford University). For this, they gave an interpretation of the leaves as moduli spaces of solutions of suitable spinorial equations on an algebraic structure, called Courant algebroid, determined by a choice of string structure. The construction provides a unifying framework for metrics with special holonomy, according to Berger's classification, and solutions of the Strominger system, that it is expected to have future applications to Yau's Conjecture.

The methods introduced in this paper lead very recently to the proof of a T-duality type principle for the Strominger system by the first author (under review), relating pairs of solutions on manifolds with different topology.

References:

1. J. Li, S.-T. Yau, J. Diff. Geom. 70, 2005.
2. J.-X. Fu, Proc. ICM, Hyderabad, India, 2010.
3. L.-S. Tseng, S.-T. Yau, Proc. Sympos. Pure Math., 85, Amer. Math. Soc., Providence, RI, 2012.
4. M. Garcia-Fernandez, Travaux Mathématiques, Vol. XXIV, 2016.

SCIENTIFIC REVIEW: The Berry problem for the harmonic oscillator solved

Title of article: A problem of Berry and knotted zeros in the eigenfunctions of the harmonic oscillator.

Authors: Alberto Enciso (ICMAT), David Hartley (ICMAT) and Daniel Peralta-Salas (ICMAT).

Source: Journal of the European Mathematical Society.

Date of publication: en imprenta.

Summary: The Schrödinger operator is a key factor in quantum mechanics that is employed for analyzing different systems. Its so-called *eigenfunctions* are wave functions for a system with potential V. The nodal set of these eigenfunctions represent the points at which an event has zero probability of occurring. In 2001, the physicist Michael Berry (University of Bristol) managed to construct wave functions for the hydrogen atom for which the nodal set contained a curve known as the trefoil knot. Furthermore, he conjectured that it is possible to generate any topology as part of the nodal set of a wave function for any quantum system. This is precisely what Alberto Enciso (ICMAT), David Hartley (ICMAT) and Daniel Peralta-Salas (ICMAT) have proved in a paper that is due to appear in the next issue of the European Mathematical Society journal.

More information:

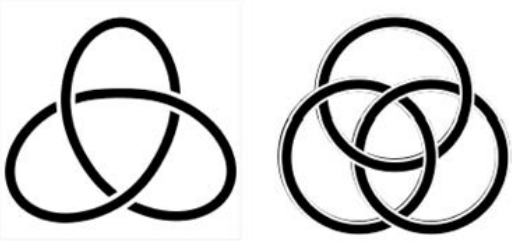
Complex-valued functions, that are eigenfunctions of the Schrödinger operator, i.e. that satisfy the relationship

$$(-\Delta+V)\,\psi = \lambda\,\psi \qquad (1)$$

for some constant λ, are the wavefunctions for a system with potential V . Here Δ is the Laplacian in $\mathbb{R}^3$ which is given in Cartesian coordinates by

$$\Delta = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z} \qquad (2)$$

The nodal set $\psi^{-1}(0)$, also called the zero set, of a wavefunction represents where an event has zero probability of occurring. It is also related to the dislocations of the system (singularities of the current field). Note that typically the nodal set of a complex-valued function will be a curve in $\mathbb{R}^3$. In 2001 Professor Sir Michael Berry was able to construct wavefunctions of the hydrogen atom ($V = -2/r$, with $r^2 = x^2 + y^2 + z^2$) where the nodal set contained a trefoil knot, see Figure 1(a).



(a) A trefoil knot (b) The Borromean rings

Figure 1: Two types of knots

He also conjectured that it should be possible to realize any topology, for example the Borromean rings in Figure 1(b), as part of the nodal set of a wavefunction to some quantum system.

In a paper to appear in the Journal of the European Mathematical Society researchers Alberto Enciso (ICMAT), David Hartley (ICMAT), and Daniel Peralta-Salas (ICMAT) provided a proof of this conjecture. In fact the paper, titled A problem of Berry and knotted zeros in the eigenfunctions of the harmonic oscillator, considered only the quantum harmonic oscillator system ($V = r^2$) and proved that for any link in $\mathbb{R}^3$ there exists a wavefunction of this system containing the link in its nodal set. The eigenvalues (values of λ in (1) for which a wavefunction exists) of the harmonic oscillator are of the form $\lambda_N = 2N + 3$, for $N \in \mathbb{N}$, which allows the authors to consider what happens at large energies (large λ).

In this situation, after a rescaling of space by a factor of $\sqrt{\lambda}$, the wavefunctions approximate, in the sense

$$\left\| \psi_N \left(\frac{\cdot}{\sqrt{\lambda_N}} \right) - \varphi \right\|_{C^1(B)} \leq \frac{C}{N} \qquad (3)$$

where B is a bounded set, solutions of the Helmholtz equation

$$(\Delta + 1)\,\varphi = 0 \qquad (4)$$

The authors show that any link can be realized as a component of the nodal set of some solution to (4) and that the component is structurally stable, i.e. perturbing the function slightly does not a ect the topology of the nodal set. The existence of a high energy wavefunction with a nodal set containing a link of the same topology as the one considered then follows from the approximation mentioned above.

An important property of the Schrödinger operator is that there is high degeneracy of each eigenvalue, in particular for each $N \in \mathbb{N}$ there are $1/2(N + 1)(N + 2)$ linearly independent solutions to (1). This ensured the existence of families of wavefunctions, all of the same energy, with a rich behavior in the angular variables. This was key in proving any solution of (4) has a wavefunction close to it (in the sense of the estimate (3)). An interesting aspect of the result is that the rescaling of space means that the important component of the nodal set of the wavefunction will be contained in a small ball of order $\lambda^{-1/2}$.

In a recent paper by the same authors, *Dislocations of arbitrary topology in Coulomb eigenfunctions* (accepted for publication in Revista Matemática Iberoamericana) the problem is reconsidered in the hydrogen atom setting, which was where Berry did his original work. This setting introduces new problems such as the singularity of the operator at the origin and the energy of the wavefunctions being bounded, $\lambda_N = -1/N^2$

However, the high degeneracy in each eigenvalue remained and allowed the authors to again prove the conjecture using this potential, in this case realizing the links inside a ball of radius $\sqrt{\pi}/4$ (that is, of order 1).

The fact that fine aspects related to the degeneracy of the eigenspaces is crucial for the proof is remarkable. Indeed, the harmonic oscillator and Coulomb potentials are the prime example of what is called in physics "accidental degeneracy", which is the property that the proof actually hinges on. Accidental degeneracy is a manifestation of the superintegrability of the Coulomb and harmonic oscillator systems. Therefore, in a way, the proof can be regarded as a quite surprising application of superintegrability to the study of nodal sets of eigenfunctions of Schrödinger operators.

MATHEMATICS TODAY: ICMAT news

ICMAT researcher Alberto Enciso appointed member of the State Research Agency Committee

Image: ICMAT

Alberto Enciso received an ERC Starting Grant in 2014.

The Spanish Ministry of the Economy, Industry and Competitiveness has announced the names of the 12 scientists who will comprise the Committee of the *Agencia Estatal de Investigación* (State Research Agency), one of whom is Alberto Enciso, a researcher with the European Research Council (ERC) at the Institute of Mathematical Sciences (ICMAT). The Committee is the main consultative body of the Agency and will meet regularly every four months for the purpose of advising the Agency on its annual programme of activities as well as the principles, methodologies and practices of scientific and technical evaluation. "It's a great responsibility", says Enciso, "because we'll be contributing to the decision-making process for maximizing scientific results with the resources available."

Born in 1980, this mathematician is the youngest member of the Commission, whose members form a balanced range across all the main areas of knowledge. In addition to Enciso, the other members are Luis Fernando Álvarez-Gascón, Manuel Arellano, Avelino Corma, Ana María Cuervo, Violeta Demonte, Antoni Esteve, Luis Liz Marzán, Susana Marcos, Ángela Nieto, José María Ordovás and Carme Torras.

Alberto Enciso studies the geometric and topological structures of partial differential equations and mathematical physics, for which he develops and employs tools at the boundary between analysis and geometry. Together with Daniel Peralta-Salas, another ERC researcher at the ICMAT, he has obtained important results in this field. In 2011 he obtained the RSME José Luis Rubio de Francia Prize for the best young Spanish mathematician, and in 2013 the SEMA Antonio Valle Prize for the best Spanish applied mathematician. In 2014 he was awarded the Príncipe de Girona prize for Scientific Research, and in 2015 the Barcelona Dynamical Systems Prize. Since 2014, he has been working on an European Research Council Starting Grant project

Mathematics for analyzing the deaths of mothers and babies in Ghana

Image: ICMAT

Adebanji will be at ICMAT during six months as part of the Women for Africa programme Science by Women.

Atinuke Adebanji (Kwame Nkrumah University of Science and Technology, Kumasi, Ghana) has joined the ICMAT DataLab as part of the Women for Africa programme Science by Women. In her project, which will last for six months, she will be using statistical techniques to evaluate the effectiveness of public health policies in reducing perinatal mortality.

The project is a response to a social problem: the highest rates of birth-related mortality amongst women and mortality among young children under five years old are recorded in Sub-Saharan Africa countries. In Ghana, out of 100,000 births, between 270 and 340 women die, while for every 1,000 newborn children, 41 die shortly after birth. Faced with these troubling figures, in 2010 the Ghanaian Government introduced a series of measures to tackle the problem, and an exhaustive evaluation employing statistical techniques is required to determine how effective they have been.

"We want to carry out a space-time analysis to enable us to see if at certain times and in certain places there are higher rates of mortality," Adebanji explains. "Areas exist in which certain practices that are damaging to health have prevalence, such as female genital mutiliation, and it is interesting to see if there is any relation with a greater risk of female mortality. Establishing these relations may help to improve conditions of health and promote a change in behaviour in these communties."

This project is one of the main lines of research in the ICMAT gender plan, set in motion through the Severo Ochoa Programme. Ana Bravo, director pf the ICMAT Gender Commission, says that: "It is an opportunity that may benefit both sides; on the one hand, the programme provides support for the work conducted by female researchers in Africa, and on the other hand it constitutes a positive contribution to the more applied side of mathematics carried out at the Institute."

The programme is currently in its second year, and once again the ICMAT is participating together with other Severo Ochoa centers of excellence, such as the National Center for Oncological Research, the Institute of Photonic Sciences, the Carlos III Institute of Health, the National Center of Biotechnology, the Center for Genomic Regulation and the Barcelona Graduate School of Economics. This year, eight senior African female researchers will be joining these Spanish centers.

The ICMAT celebrates the 10th anniversary of the European Research Council with a scientific meeting

The European Research Council (ERC) is 10 years old this year and celebrated the event during the week March of 13th with activities across the continent. The ICMAT joined in these celebrations with a scientific meeting on mathematics and the ERC in Spain, which took place at the Institute March 13th and 14th. "The aim is to analyze what this programme means for the Spanish mathematical community", said Manuel de León, researcher with the ICMAT and also its founder, who organized the meeting.

The event was graced with the presence of José Manuel Fernández de Labastida, the ERC director, who gave the inaugural address, as well as with most of the mathematicians who have been recognized by the ERC through the funding of their projects in Spain and who presented these projects at the meeting. The encounter also included a round-table discussion in which the following people took part: José Manuel Torralba Castelló, director general of the Community of Madrid Universities and Research; Jorge Velasco González, Institutional Coordinator of the CSIC, Brussels; Marina Pilar Villegas Gracia, Director of the State Research Agency, and Alberto Enciso Carrasco, ERC researcher at the ICMAT.

The ERC projects are awarded in recognition of the best researchers in Europe, and ICMAT members have been granted funding for ten projects of this type, a figure greater than all other mathematical institutions in the world. As ICMAT deputy director, David Martín de Diego, says: "From its very beginnings, the ICMAT was committed to seeking out the most promising young mathematicians at the time. A proof of the success of this policy is the number of ERC projects obtained over the short time that the Institute has been in operation."

Image: ICMAT

The encounter included a round-table about the ERC future. From left to right: Manuel de León, Marina Villegas, Jorge Velasco, José Manuel Torralba and Alberto Enciso.

European Commissioner for Research, Science and Innovation, Carlos Moedas, visits the ICMAT

The European Commissioner for Research, Science and Innovation, Carlos Moedas, visited the ICMAT on February 10th of this year. In addition to visiting the facilities at the center, Moedas also attended a meeting with six of the eight ERC Grant researchers belonging to the Institute, as well as Carmen Vela, Spanish Secretary of State for R+D+I, Juan María Vázquez, general secretary for Science and Innovation, Marina Villegas, director of the State Research Agency, Clara Eugenia García, director of Policy for R+D+I, José María Sanz, rector of the UAM, Rafael Garesse, UAM vice-rector for Research and Innovation, Emilio Lora, chairperson of the CSIC, Cristina de la Puente, CSIC vice-president for Scientific and Technical Research, Juan Romo, rector of the UC3M, José Manuel Pingarrón, UAM vice-rector for Knowledge Transfer and Entrepreneurship, and Antonio Córdoba, David Martín and Javier Parcet, director and deputy-directors of the ICMAT.

The Commissioner remarked on the support deriving from the ERC projects for the careers of brilliant scientists, since they enabled the development of cutting-edge research work in the Member States. "Europe is the sheet anchor for science," said Moedas. He also underlined the importance of transmitting such scientific progress to society. He also remarked that: "The secret of being a scientist today is knowing how to tell a story."

"We are proud that the Secretary of State and the European Commission have honoured the ICMAT, a center only recently created, with an official visit as an example of the research of excellence being conducted in Spain", said ICMAT deputy director, David Martín de Diego. For his part, ICMAT director Antonio Córdoba said that: "It is an acknowledgement of the endeavour of the Institute as a place for creation and interaction for the mathematical community worldwide."

Image: UAM

Carlos Moedas (center) visiting the ICMAT library with Antonio Córdoba (right) and David Martín de Diego (left).

The play "L'Augmentation" brings mathematics to the stage

Image: Blanca Gómez Terán

The actors of the play represent the logical patter of a logical diagram.

During February and March, the ICMAT organized performances of the play "L'Augmentation" ("The Increase", 1967) by the French author Georges Perec (1936-1982) at different cultural centres in Madrid: the Auditorium of the Universidad Carlos III de Madrid, La Casa Encendida, the MUNCYT, the Institut Français, the IES Beatriz Galindo Secondary School and the Residencia de Estudiantes. It was assisted in this venture by the El Hijo Tonto (EHT) company and the playwright Andrea Díaz, who were responsible for the staging of the play. This turned out to be a resounding success, since all the venues where the play was performed enjoyed a full house.

Mathematics is the main inspiration behind this experimental work and appears not in the content but in the structure. The plot follows mathematically a flowchart that models a simple situation; an employee asks his boss for a salary increase. The author identifies a series of obstacles (meeting the boss in his office, starting a conversation with the secretary, striving to be convincing...) as Boolean variables; that is, variables that can take only two values, either zero or one, positive or negative. The actors represent the logical pattern that appears with each obstacle (proposition, alternative, negative hypothesis, positive hypothesis, choice and conclusion). Each conclusion gives rise to a different path to follow, which ends at a single outcome: the refusal of the salary increase with the hope of being successful the next time.

The text of the play follows all these paths in the graph to weave a combinatorial drama in which Perec's absurd sense of humour is the main feature. In the words of ICMAT deputy director, David Martín de Diego: "Our aim with this play is to show the general public how mathematics is associated with art; in this case, with the theatre." The mathematical ideas behind the play can be found in the leaflet drawn up by the ICMAT, in which concepts such as "graph", "modelling" and "logical implication" are explained.

"L'Augmentation" falls within the literary current of the Workshop of Potential Literature, OuLiPo (Ouvroir de Littérature Potentielle) to which Georges Perec belonged. It is comprised of mathematicians and writers who explore the creative possibilities arising from a combination of rational "restrictions", mainly mathematical, and the word.

Charles Fefferman, winner of the Wolf Prize in Mathematics

Image: ICMAT

Fefferman is the director of one of the ICMAT Laboratories 2016-2019.

The Wolf Prize, one of the most important prizes awarded to living artists and scientists for "their achievements in the interest of mankind and friendly relations, irrespective of nationality, race, colour, religion, sex or political views", has this year been presented to Charles Fefferman (Princeton University, USA), director of one of the ICMAT Laboratories. The prize is awarded in six fields, one of which is mathematics. Fefferman shares the prize with Richard Schoen (Stanford University and the University of California, USA), "for their contributions to analaysis and geometry", respectively.

Fefferman is a regular collaborator with the ICMAT and is currently the director of one of the laboratories of the Institute that began with the first Severo Ochoa programme (2012-2015), which was recently renewed (2016-2019). He has supervised the doctoral theses of seven Spanish mathematicians, among whom are Diego Córdoba (ICMAT) and Antonio Sánchez-Calle (UAM). Fefferman also pays frequent visits to the Autonomous University of Madrid, by which he was made Doctor Honoris Causa in 1990. He has contributed with fundamental results to important areas such as Harmonic Analysis, Differential Equations, Complex Variables, Quantum Mechanics, Fluid Mechanics and Conformal Geometry. He has also been editor of the *Revista Matemática Iberoamericana* journal since its foundation.

The other Wolf Prizes, all endowed with 100,000 euros, were awarded to Robert Bergman (University of Berkeley, USA), in chemistry; Michel Mayor (Cambridge University, UK) and Didier Queloz (University of Geneva, Switzerland), in physics; James Allison (University of Texas, USA), in medicine; and in the arts (music, architecture, painting or sculpture), Laurie Anderson and Lawrence Weiner, both from New York, USA. This year there was no award in agriculture.

Eva Miranda, the first Spanish female mathematician to be distinguished with a *Chaire d'Excellence* by the *Fondation Sciences Mathématiques de Paris*

Image: Philippe Monnier

Eva Miranda is a collaborator of the ICMAT.

Eva Miranda, a professor of Geometry and Topology at the *Universidad Politécnica de Catalunya* (UPC) in Barcelona and member of the ICMAT Viktor Ginzburg Laboratory during the first Severo Ochoa programme (2012-2015), was last month awarded with a Chair by the *Fondation Sciences Mathématiques de Paris* (FSMP). This distinction, known as a *Chaire d'Excellence*, enables scientists from abroad to conduct research projects in centers belonging to this Foundation. The projects run over a period of between four to twelve months. In addition to Miranda, another chair was awarded this year to Tim Gowers, a British mathematician who is a professor at Cambridge University and a Fields Medal winner in 1998.

This distinction constitutes a recognition of excellence that has been conferred in previous years on mathematicians of the calibre of Edward Frenkel, Sergiu Klainerman, Gunther Uhlmann, Herbert Spohn and Nader Masmoudi, among others. In this case, it is especially remarkable because it is the first time that it has been awarded to a Spanish mathematician. Furthermore, Eva Miranda is only the second woman to be recognized in this way, after Hélène Esnault, who merited a Chair in 2011.

The project on which Miranda will be working during her occupancy of her FSMP Chair is "Singular symplectic structures in Geometry and Celestial Mechanics", a research field that brings together singular symplectic structures with celestial mechanics, and which as Miranda explains "is a fusion of various ideas, some of which were under investigation at the Viktor Ginzburg Laboratory."

AGENDA

ICMAT Scientific activities

Gauge Equations, Geometry and Strings
April 17th and 18th

Entangle this: tensor networks and gravity.
May 8th - 10th

XIV Advanced course in Operator Theory and Complex Analysis
June 19th – 22nd

ICMAT School - 11th International Summer School on Geometry, Mechanics and Control
June 26th – 30th

New Trends in Applied Geometric Mechanics -- Celebrating Darryl Holm's 70th birthday
July 3rd – 7th

ICMAT
INSTITUTO DE CIENCIAS MATEMÁTICAS

Quarterly Newsletter
Instituto de Ciencias Matemáticas
#14 – First quarter 2017

Production:
Instituto de Ciencias Matemáticas (ICMAT)
C/ Nicolás Carrera nº 13-15
Campus de Cantoblanco, UAM
29049 Madrid ESPAÑA

Divulga S.L
C/ Diana 16-1º C
28022 Madrid

Editorial Committee:
Jared Aurentz
Antonio Córdoba
Alberto Enciso
Daniel Peralta-Salas
Ágata Timón

Coordination:
Ignacio F. Bayo
Laura Moreno
Ágata Timón

Design:
Fábrica de Chocolate

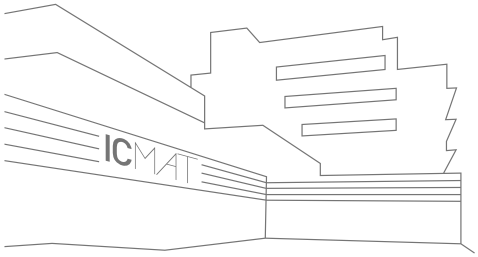
Layout:
Equipo globalCOMUNICA

Translation:
Jeff Palmer

Editorial department:
Elvira del Pozo
Laura Moreno
Patricia Ruiz
Ágata Timón

ICMAT

INSTITUTO DE CIENCIAS MATEMÁTICAS



C/ Nicolás Cabrera, nº 13-15
Campus Cantoblanco UAM
28049 Madrid, Spain
www.icmat.es