19TH JULY 2024 | #5

9TH EUROPEAN CONGRESS OF MATHEMATICS

ECM Sevilla2024

July 15th to 19th

9ECM Daily News

Information and current events from the Congress

Farewell

Dear Colleagues,

On behalf of the Organizing Committee, and now that the congress is coming to an end, I would like to express our most sincere gratitude for your collaboration in making this event a success. Seeing each and every room at the congress venues filled with participants enjoying the outstanding lectures and panel discussions brings us great joy and satisfaction.

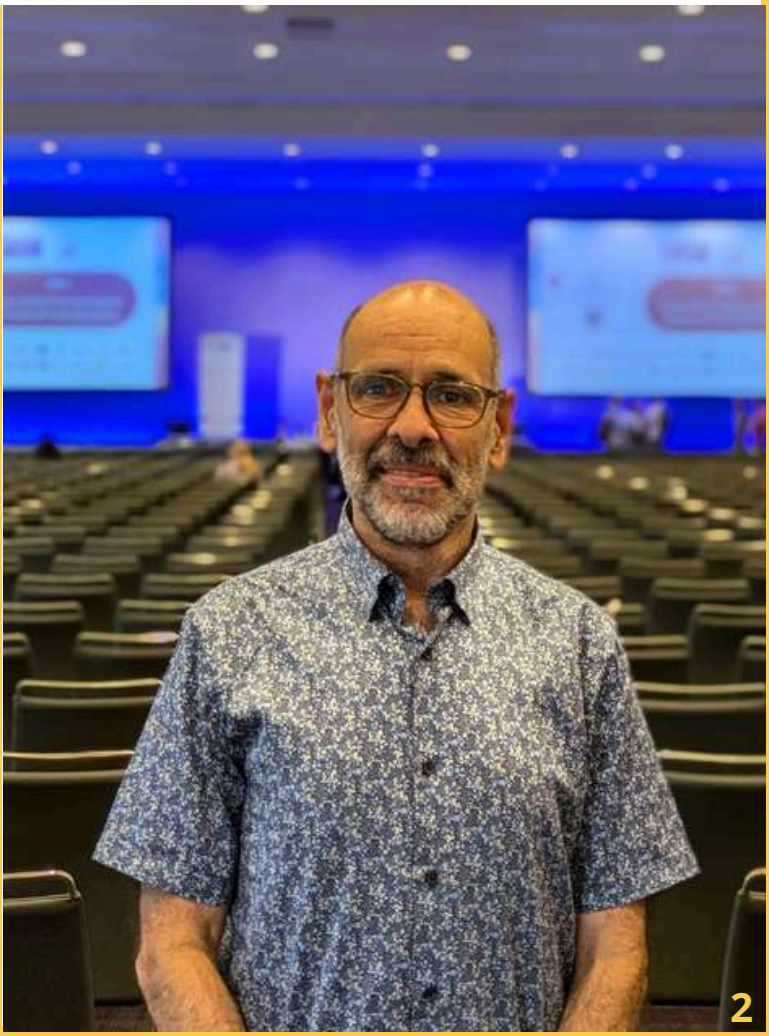
In my speech at the opening ceremony, I expressed my hope that this congress would help build new collaborations and reinforce existing ones. After this intense week, I am convinced that this has indeed happened.
Thank you for every word of appreciation you have shared with us. We apologize for any disappointments you may have. I hope you will take with you fond memories of your time in Seville, and that you will return to our University to continue strengthening the bonds that have emerged in this congress.
I cannot conclude without thanking our team of 100 volunteers—undergraduate and master's students in mathematics from all over Spain— our Technical Secretariat, and our press service for their impeccable work, always done with a smile.
Ci vediamo a Bologna nel 2028!

Isabel Fernández Delgado
Vicepresident of the Organizing Commitee

“The Congress has actually exceeded my expectations”

Jan Philip Solovej, President of the European Mathematical Society

Jan Philip Solovej (Copenhagen, Denmark, 1961) is a mathematician and mathematical physicist working on the mathematical theory of quantum mechanics. Solovej obtained his Ph.D. in 1989 from Princeton University with the thesis on "Universality in the Thomas-Fermi-von Weizsäcker Model of Atoms and Molecules" supervised by Elliott H. Lieb. As a post-doctoral researcher, he went to the University of Michigan (1989/90) and the University of Toronto (1990). Has been sucessibily member at the Institute for Advanced Study, Assistant Professor in the Department of Mathematics at Princeton University, research professor at the University of Aarhus, and since 1997 and until today professor in the Department of Mathematics at the University of Copenhagen. Since 2016, he is also leader of VILLUM Centre of Excellence for the Mathematics of Quantum Theory (QMATH). He was elected in 2022 President of European Mathematical Society for the term 2023-2026.



Has the congress met your expectations?
Although the congress is not over yet, so far it certainly has. Or maybe it has actually exceeded my expectations. I have attended plenary, invited, and prize lectures as well as minisymposia and panel discussions. It is immensely encouraging to get this overview of the exciting progress happening in mathematics currently.

The number of attendees at previous congresses has been exceded. Is this a symptom of the good health of European mathematical research?
Yes I would certainly interpret it in this way. It is a testimony to the level of research activities in mathematics and the engagement of the European mathematical community. But it is also a sign that the European Mathematical Society and the local organizers at the University of Seville have managed to put together an exciting and attractive program.

And especially, do you think that the participation of young people and women mathematicians is growing?
I have not yet seen statistics on career level and gender diversity at the congress. I believe we will see that both have improved at the congress but also in mathematics in general. In particular, I believe that the involvement, in the congress, of the European Mathematical Society Young Academy (EMYA) and the association of European Women in Mathematics (EWM) has been instrumental in strengthening both career level and gender diversity.

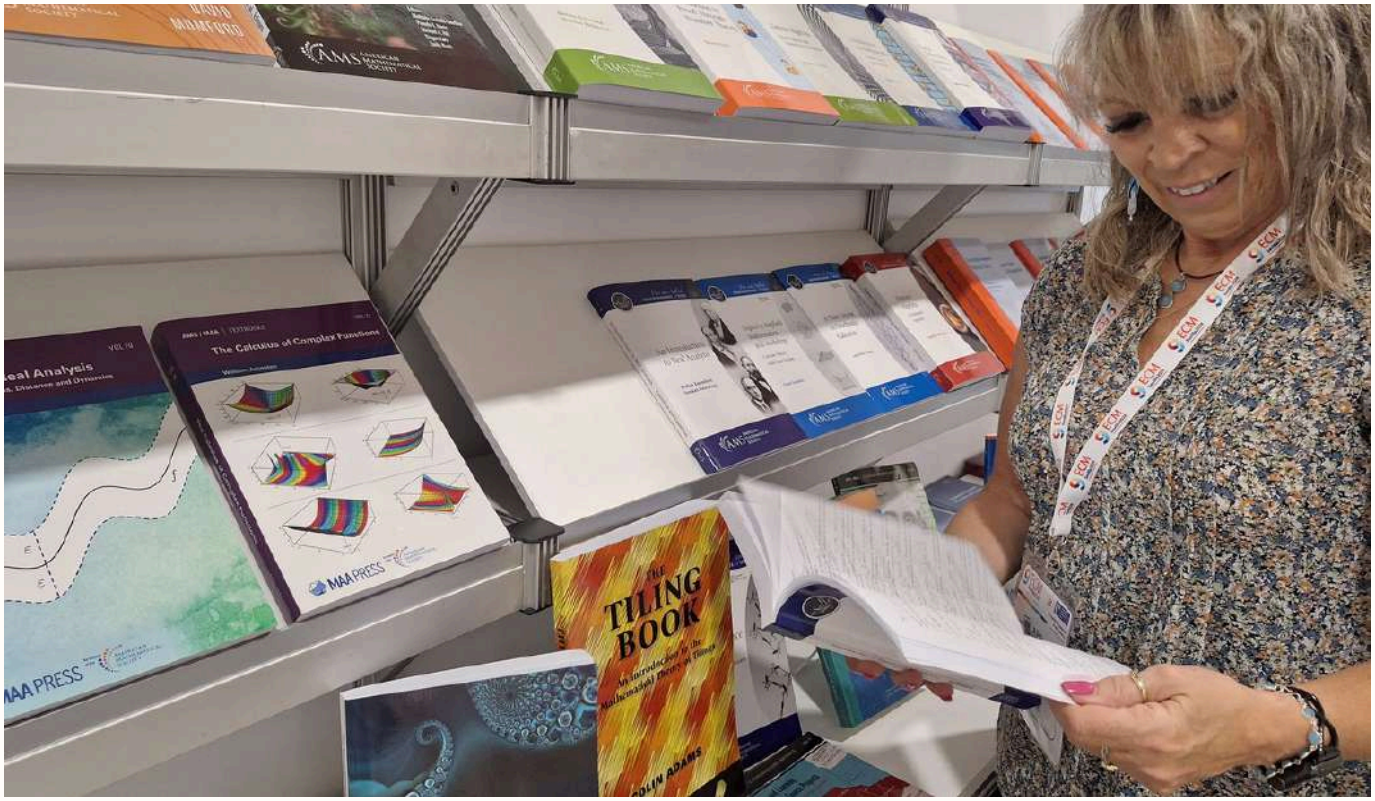
"The Bologna organizers are present and I hope, in fact, I know, that they are drawing inspiration from the current congress"

There have been any special moments during the Congress?
At a personal level it was a very special moment when I presented the prize winners at the opening ceremony.

What conclusions regarding scientific content can be highlighted? Have any unexpected and important results been presented?
All the results presented are excellent. I have been introduced to so many beautiful recent mathematical breakthroughs and I would not like to highlight some over others. But one important aspect of such a diverse congress is exactly to be made aware of the most important progress in the field.

What lessons does this 9ECM offer for the organization of the next one in Bologna?
The congress here in Seville has been a great success also from the organizational point of view and I am immensely grateful to the local organizers for all their hard work and efforts to make this come true. The Bologna organizers are present and I hope, in fact, I know, that they are drawing inspiration from the current congress.

Science only grows if it is open



A key theme of the 9ECM is undoubtedly academic cooperation. This is exemplified by the 120 scholarships awarded by the conference organizers to young mathematicians and those from developing countries who lack the resources to attend.

The International Data Corporation (IDC) estimates that next year, in 2025, the size of the Internet will reach 175 zettabytes -equivalent to one trillion ninety-nine thousand five hundred and eleven million six hundred and twenty-seven thousand seven hundred and seventy-six (1,099,511,627,776) gigabytes-. Despite its large size, much of this content is not necessarily available to everyone, especially when it comes to knowledge: books, studies and papers, among others. While anyone can access them, some require a payment or subscription to read them. These obstacles are what Open Science seeks to eradicate, a concept through which UNESCO seeks to make “scientific knowledge openly available and accessible to all, as well as usable by all”.

Let's start at the beginning: **Open Science is not the same as Open Access. Open Science** is a movement arising from the scientific community that advocates for greater accessibility, collaboration, efficiency and transparency of research, to make it more democratic and more closely linked to the needs of society. And, within this, **Open Access** promotes free and open access to scientific literature to be available on the Internet. So that any user can read, download, copy, print, distribute and use it in any other way freely, without any financial or technical barrier.

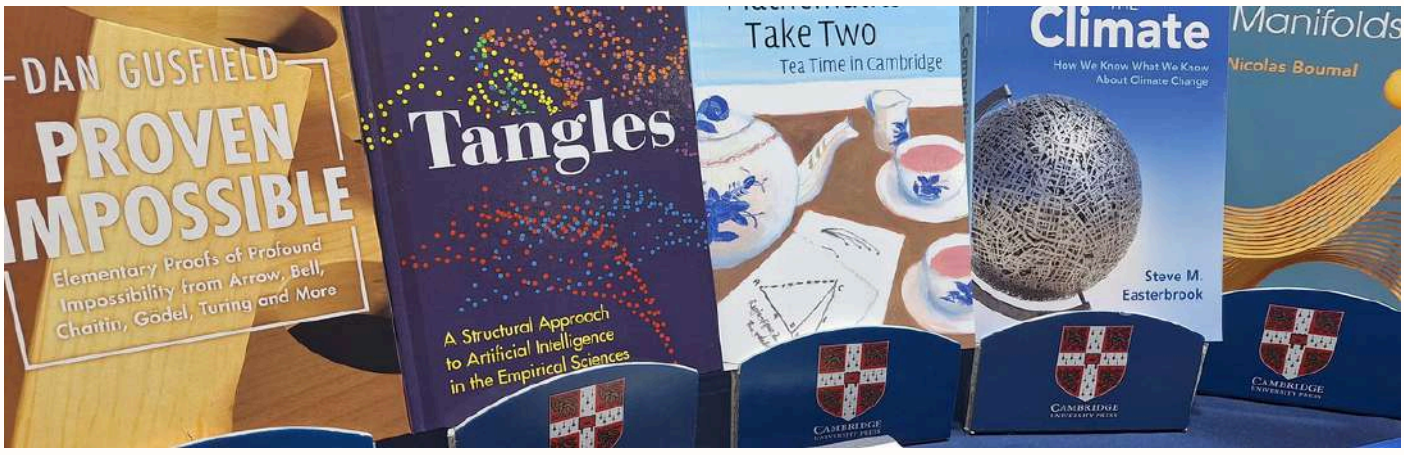
This last aspect was the focus of the debate in one of the Wednesday sessions at the 9th European Congress of Mathematics, especially in the **panel discussion "New scenarios in open science"**. Organized by the Centre de Recerca Matemàtica, the speakers were Miguel Benítez, from the Basque Center for Applied Mathematics (BCAM), Pilar Rico, from the Spanish Foundation for Science and Technology (FECYT), Ignasi Labastida i Juan, from the University of Barcelona, and André Gaul, representative of the European Mathematical Society (EMS) Publishing House.

In a well-attended debate, current problems were addressed, such as the inaccessibility even today of many researchers to scientific publications and the reluctance of some publishers to change to a model of greater openness. Rico mentioned that, from his point of view, in order to reconcile this open access with the work of scientific publishing companies, the solution is to work at the political level to promote institutional repositories of publications. "We are not talking about free access. We are talking about guaranteeing that knowledge, quality and long-term communication and preservation infrastructures are public goods that must be supported by public institutions," he said.

For his part, Gaul affirmed that "Open Access means that information is accessible, which is the only way for science in general, and mathematics in particular, to grow" but that a solution must be found to peer review, which guarantees scientific publications. "Money should not be a problem for the advancement of knowledge, it is possible to find solutions," he concluded.

Labastida specified that one of the measures being implemented are contracts between publishers and library consortia to convert current subscription payments into open access publications at no cost while maintaining reading access. In fact, he pointed out that in recent years these contracts have been made for all state universities like CRUE and CSIC, which have established agreements with major scientific publishers such as Elsevier, Springer Nature, Wiley and ACS Publications.

In Mathematics, as in any other scientific discipline, the trend, they concluded, is to move towards open access, finding formulas for coexistence and sustainability through different models that do not prioritize commercial interest, but rather the development of mathematical knowledge.



What worries young mathematicians?
A look into mental health & environmental impact

Youth can be (is) a tough moment in life - particularly if you are an **upcoming researcher** or a **Ph.D. mathematician**. There are many things that can worry us and provoke stress, **anxiety or pressure**, from the work itself and its goals, to the uncertain future and problems of work-life balance. If there is one place in the world where young mathematicians are reunited, that is for sure an European Congress of Mathematics. That's why **the European Mathematical Society Young Academy** (EMYA) has taken this opportunity to celebrate different activities to listen and give voice to them, in a panel yesterday.

"In general in academia, the **high rate of expectations**, and the **overwork** that is expected for PhD students or early stage researchers can be a **source of mental issues or problems**", details Irene De Blasi, Research Fellow in Mathematical Analysis at the University of Turin and co-chair of the EMYA. Also "the perspective of short term positions, getting a permanent position very late in life or having to move frequently" plays a role. "I think it is something that involves all young researchers in academia at the moment. For example, I've seen that in the last months of the PhD, just before the defense, many, many people **have a burnout** because of the stress and of not knowing what will happen next", she adds.

There is also a material side of the impact: "Careers are becoming more and more **precarious**, and overall in Europe it is getting harder and harder to get in certain positions, which creates a lot of insecurities", analyzes Idriss Mazari-Fouquer, researcher at Paris Dauphine University and Secretary of EMYA.

The list of reasons grows as you talk to other young mathematicians: expectations in terms of results and getting positions and grants, the **pressure to publish**, the problems of **reconciling professional and personal life** or the culture of working without established working hours, adds María Ángeles García, researcher at Institute of Mathematical Sciences (ICMAT) in Spain, representative of EMYA and new member of the Executive Committee of the European Mathematical Society (EMS).

Studies confirm that **mental health issues among Ph.D. students are prevalent and on the rise**, and that they are more likely to experience symptoms of mental health-related issues than general population. *Work organization and mental health problems in PhD students*, published in 2017 in Research Policy, reveals that one in two PhD students experiences psychological distress and one in three is at risk of a common psychiatric disorder. This is analyzed in *How is your thesis going? Ph.D. students' perspectives on mental health and stress in academia* (PLoS ONE, 2023).

What to do

If this is the situation, things need to change. What can be done? "**Change is needed at different scales**, from the most personal to the most institutional", considers García, but the first step is to identify the main problems. In addition, it is not so easy to talk about these things, as "it is not an **openly discussed but stigmatized** topic", considers García. That's why the EMYA is working on different initiatives.

"Within EMYA we aim at addressing this in quantitative and qualitative manners. First, we have organized a **discussion panel** to understand what are the issues that are taking place", explains Mazari-Fouquer. The panel, celebrated yesterday, was called *A EMYA panel for 9ECM. Sustainability panel & group discussion*, was attended by around 15 people. The idea of the session was to discuss in small groups about these topics, share experiences, opinions and ideas. "From here, we will propose solutions based on the pooling of ideas", García explains. De Blasi goes ahead with optimism: "It's true that academia is like this but there are many places in which there are centers for health care for students. Also, **raising awareness amongst supervisors** about these problems could be another way of tackle the situation"

The panel has been based in **this survey** that anyone else is invited to fill. Moreover, another survey will be sent to young mathematicians in Europe to get quantitative feedback "so we can make more concrete propositions", details Mazari-Fouquer. The idea is to use the networks of national societies across Europe.

Sustainability panel and group discussion organized yesterday by EMYA.

Environmental worry

Being a researcher is a profession with a strong social character, where travel to interact with colleagues and attend congresses plays a key role. But traveling a lot and having huge conferences with people coming from all over the world has an impact. How do we deal with the environmental impact of these displacements? "Digital meetings are not a substitute for face-to-face meetings", recognizes García, "but we are concerned about finding a balance between the two and **minimizing the carbon footprint of our travel**".

"In general in academia, the high rate of expectations, and the overwork that is expected for PhD students or early stage researchers can be a source of mental issues or problems"

"We are worried about the medium and long term climate issues. Of course I'm not saying we have to cancel all of this, but maybe it is time to think about **alternative or hybrid solutions**, or any kind of new concept", De Blasi adds.

Other concerns, as both mention, are linked to the resources, from paper consumption to the construction of major infrastructure. Also, people working on computer science are putting the emphasis on the energy consumption of the servers. It's time to go back to the blackboard instead of the digital screen? Well, for sure, as De Blasi concludes, "it's time to ask questions about it and try to understand if we can **think of something different to deal with this kind of situation**".

ON TODAY'S MENU

PLENARY LECTURES

Fabio Toninelli: Large-scale behavior of (super-)critical stochastic PDEs

9:00. BARCELÓ CONVENTION CENTER

Fabio Toninelli got his PhD in Physics at Scuola Normale Superiore (Pisa) in 2003. He was CNRS researcher at ENS Lyon (2004-2012) and at University Lyon 1 (2012-2020). Since 2020, he is professor at the Technical University of Vienna. His research topics are probability theory and statistical mechanics. He was ICM invited speaker (2018), ICMP plenary speaker (2018) and SPA plenary speaker (2014). In recent work he has studied the equation known as KPZ (by Kardar, Parisi and Zhang), which models growth and aggregation processes, that have their laws, but they also include an element of chance, which is why the equations that describe them are called stochastic differential equations.

Anna Wienhard: A beautiful world beyond hyperbolic geometry: Anosov representations and higher Teichmüller spaces

11:30. BARCELÓ CONVENTION CENTER

Anna Wienhard (Germany, 1977) is Director of Research at the Max Planck Institute for Mathematics in the Sciences in Leipzig since 2022. She studied theology and mathematics and has received various scholarships and awards, such as from the European Research Council (ERC). She is an expert in differential geometry and moduli spaces, and is also interested in the applications of geometry to quantum field theory and machine learning. She also works with persistent homology, an application of topology to big data. She is using geometry and features of symmetry clusters to search for computationally graphical representations and machine learning applications. Science communication plays an important role for her as she wants "to give people the opportunity to enjoy and experience the strange beauty of mathematics".

Maxim Kontsevich: Generalized Riemann-Hilbert correspondence, wall-crossing and resurgence

10:30. BARCELÓ CONVENTION CENTER

Maxim Kontsevich (Khimki, Russia, 1964) is a professor at the Institut de Hautes Études Scientifiques in France since 1995. Winner of a the Fields Medal in 1998, his main interest are the fundamentals of geometry, algebra and theoretical physics, specifically quantum field and string theories. One of the most profound mathematicians of his time, he has had famous breakthroughs: At 26 he devised the solution of a conjecture by E. Witten after having heard it in a talk; at 30, he conjectured an unexpected relationship between homological algebra and symplectic geometry that explained certain mysterious predictions of theoretical physicists.

PRIZE LECTURES

Cristiana De Filippis: Nonuniformly elliptic Schauder theory

14:05. SCHOOL OF ENGINEERING ROOM 7

Frederick Manners: Rough structure theorems in additive combinatorics and their applications

14:05. SCHOOL OF ENGINEERING ROOM 301

PAUL LÉVY PRIZE LECTURE

Jeremy Quastel: The KPZ fixed point

14:05. SCHOOL OF ENGINEERING ROOM A

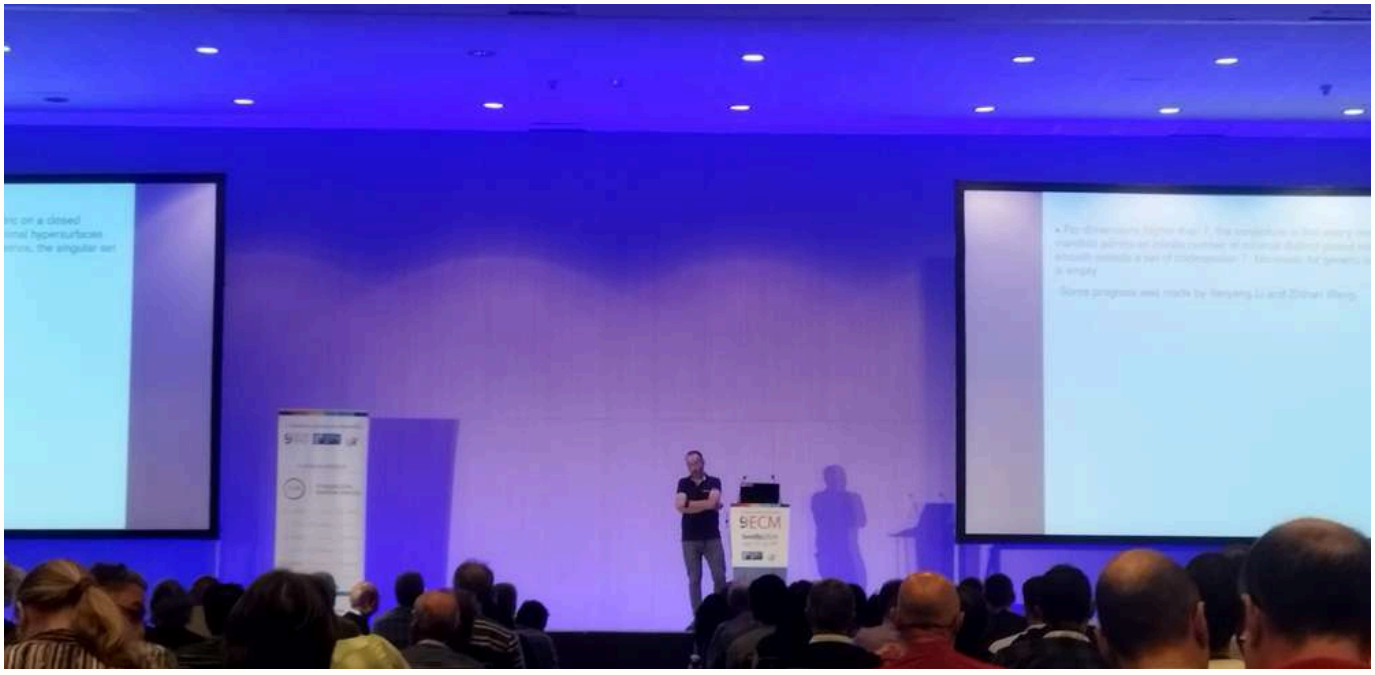
CLOSING CEREMONY

17:30. SCHOOL OF ENGINEERING ROOM A

This evening will take place the closing ceremony of the 9ECM, after days of intense activity and numerous initiatives. In this event, the following speakers will offer their perspectives on the outcomes of the meeting: Eva Ortega-Paino, General-Secretary of the Ministry of Science, Innovation and Universities; María Isabel Hartillo Hermoso, vice chancellor of Digital Transformation of Andalucia Goverment; Jan Philip Solovej, President of the European Mathematical Society (EMS); María Ángeles Japón, Deputy Director of the Institute of Mathematics of the University of Seville (IMUS); Andrés Sáez, Director of the Superior Technical School of Engineering (ETSI); and Juan González-Meneses, President of the organizing committee.

YESTERDAY AT A GLANCE

“The Morse theory for the area functional is now fully complete"



This was one of the main takeaways from today’s first plenary lecture, “Recent progress in the theory of Minimal Surfaces”, by André Neves, professor at the University of Chicago. For the past ten years, Neves and his colleague Fernando Codá-Marques have revolutionised our understanding of minimal surfaces.
“Minimal hypersurfaces arise from a optimization problem, and so it is not surprising they are found in many physical situations”, explained Neves, “from soap bubbles to general relativity”. Neves started by reviewing a familiar analog of such objects: closed geodesics on surfaces. Starting in the 1930s, their study was a driving force behind the development of Morse theory and dynamical systems. We know, for instance, that there are always infinitely many of them. A celebrated conjecture by Yau states the same is true for minimal surfaces. “I think the beautiful mathematics coming from the study of geodesics motivated Yau to pose his conjecture”. For a long time, this was a challenge. “If things are less rigid, you have more examples”, says Neves, but somewhat paradoxically, he continues, “this means they are harder to find”.
Neves went on to explain how he and his collaborators used min-max theory on the space of cycles to solve Yau’s conjecture, amongst other fundamental breakthroughs. The lecture finished with some further results in the negative curvature case, where he explained a problem on rigidity of hyperbolic metrics in terms of the minimal area in each homotopy class. “This is a problem I find fascinating”, he concluded.

What is good mathematics?

"A mathematical theory is not to be considered complete until you have made it so clear that you can explain it to the first man you meet on the street," or so Hilbert thought. Étienne Ghys (Ecole Normale Superieure de Lyon) seems to think the same, though he relaxes the condition: instead of the first man on the street, the first mathematician at the 9ECM. With this spirit of making mathematics as clear as possible, Ghys delivered the Hirzebruch lecture, starting with the memories of a lecture he heard by Hirzebruch himself. "Maybe I should just repeat the same talk", he wondered, "it was so clear, so clever".

He then went back to Hilbert who, in his famous 23 unsolved problem list, gave a number of criteria to do "good mathematics": understandability, history, surprise, motivations, proof, and perspective. Ghys chose to test these criteria on a recent result by Dan Christofaro-Gardner, Vicent Humilière, and Sobhan Seyfaddini: "The group of homeomorphisms of the sphere of dimension 2 which respect area and orientation is not a simple group." He first evaluates the understandability of the statement, explaining all the terms. Then he discusses the history of this result, tracing it back to July 1935 and the Polish mathematician Stanisław Ulam, and guides the audience through the advances made throughout the 20th century. The surprise element of the statement is discussed. Ghys admits to being very surprised since, he says, "I spent years trying to prove the opposite". In terms of motivation, he mentions the potential of developing a theory of fluid dynamics based on homeomorphisms, an idea he got from Dennis Sullivan. He then runs through the proof of the theorem, that is based on pseudoholomorphic curves and the associated symplectic capacities, and finishes by taking on the perspective of the problem, calling back to its interest in the study of fluids.

Complete disorder is impossible

The last plenary lecture of the day, “Restricted subgraphs of edge-colored graphs and applications”, was delivered by Benny Sudakov, a professor of mathematics at ETH Zurich. Sudakov started by defining the terms in the title, and answering some interesting questions on the history of graph theory. A graph with a coloring of its edges (edge-colored graph), is properly colored if no vertex has two edges with the same color. The main question is finding, within such graphs, subgraphs with each edge of a different color (fittingly called rainbow subgraphs). He further stated an equivalent problem of the one proposed by Euler in the 1780’s on Latin squares: “For which n, a complete bipartite graph K_n,n has a proper n-edge-coloring which can be decomposed into n disjoint rainbow perfect matchings”. In the second part of the session, he presented some of the recent breakthroughs on the subject he has made with his collaborators, together with applications that range from additive combinatorics to coding theory. The whole talk was interspersed with the proposal of open conjectures.

How the invasive species problems affects the world

This Thursday Monserrat Vilà gave a very informative lecture which focused on biology, specifically on species and how their transportation from one place to another can have drastic effects. Species diversity is the one providing air water quality, disturbances, food provision, etc. Nowadays, biodiversity is threatened due to globalization and human intervention. Vilà expressed that there is a global change undergoing, which is causing climate change, habitat degradation, contamination, overexploitation of species, diseases…

Vilà showed the change from the marine trading routes in the 19th century to the vastly interconnected world we have nowadays. She expressed examples of Biotic homogenization by global species exchange, and said that we now have 37.000 outside their natural habitat due to human agency. Vilà then went on to explain the stages of the invasion process, which are the following: transport of the species, introduction in the habitat, establishment, invasion. There are also accidental introductions. She explained that major biotic homogenization was caused by European colonization (in California, half of the grasslands are invaded by European plants). It causes disruption to the ecosystem (reduces native species and increases fire risks). This situation causes a lot of problems to the ecosystem, such as changes in competition and predation, trophic alteration, changes in plant-pollination networks, nutrient cycling changes… She also mentioned that more than 399€ billion is the estimated global annual costos of biological invasions in 2019. The situation is worrying, and it is important to take action. Vilà ended her talk with some tips in order to help revert the problem, and remarked on the importance of spreading awareness of the problem and how it affects us.

Research institutes must push for a more favorable science policy

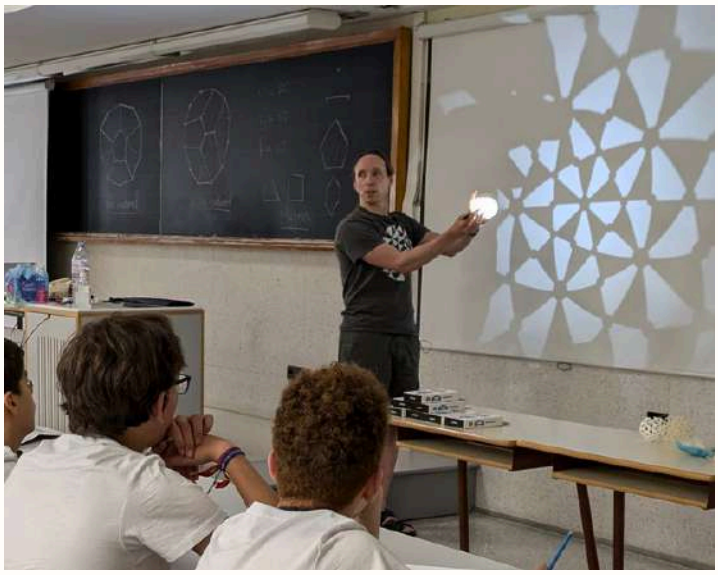
The panel discussion "The role of mathematical research institutes: an IMUS panel" was led by the director of this center of the University of Seville, Justo Puerto, and the meeting addressed, among other topics, the attraction of talent through mathematics institutes, visiting and doctoral programs, agreements with companies, knowledge transfer, funding and recognition in international rankings. Among the participants were Lluís Alsedà, Director of the Centre Recerca Matemàtica (CRM); Martin Bridson, President of the Clay Mathematics Institute (CMI); Rosa Crujeiras, Director of the Centro Gallego de Investigación y Tecnología

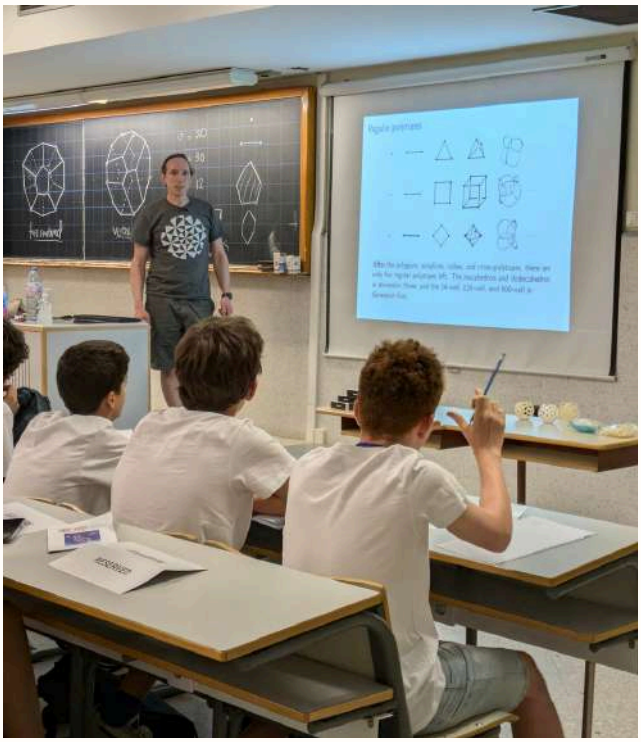
Matemática (CITMAGA); Miguel Sánchez, Director of the Instituto de Matemáticas de la Universidad de Granada (IMAG); Anna Wienhard, Director of the Max Planck Institute for Mathematics in Science (MPIM); José A. Lozano, Director BCAM and Javier Aramayona, Director of ICMAT-CSIC. A recurring idea was the urge to cooperate more closely among all mathematics research institutes. In the words of the director of the UGR's IMAG, "there is a need for greater cooperation among the institutes, especially among the Spanish ones; and also for us to lobby together in terms of scientific policy, because we have limited resources". According to Miguel Sanchez, "Spain remains an eighth world power in mathematics according to the latest rankings", but it has a challenge as a country: to achieve excellence.

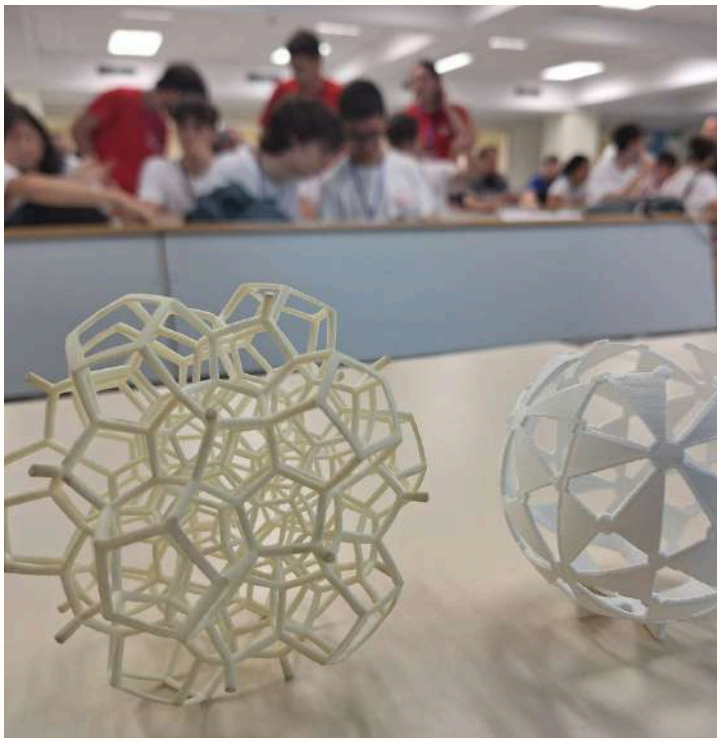
Puzzling the 120 – cell and 46 teenagers!

"**Turn off the lights! We are going to demonstrate the stereographic projection**". Saul Schleimer does know how to keep the attention of his public. During his special lecture *Puzzling the 12-Cell*, the geometric topologist and currently an Associate Professor at the University of Warwick, explained the construction of interlocking puzzles (also called burr puzzles). In particular, the "Quintessence", a new family of 3D-printed interlocking based on the geometry and combinatorics of the 120-cell.
Schleimer, who was wearing a **t-shirt with a stereographic projection** specially for the occasion, had a special audience: the 9ECM attendees plus 46 teenagers between the ages of 14 and 17, the participants of the 9th Estalmat International Mathematics Summer School in Spain. Estalmat is an international project for the identification and stimulation of mathematical talent in students in the first and second cycle of secondary education.

Schleimer started by asking the students the vertices, edges and faces of a **dodecahedron**. The following was not (in theory) so simple: the boundary of a hypercube, orthogonal projections, dodecahedral symmetries… But he managed nicely to make them comprehensible for everyone. During the lecture, the **students also asked** Schleimer a lot of questions and at the end they received a 4D puzzle as a present.







Thank you volunteers!

We want to take a moment to thank our 100 volunteers, since without their help the Congress could not have been possible. From registration, to helping speakers, to the press team, providing general information and always being available for what was needed, always with a smile on their faces.

Enjoying Seville

Itálica

Just 7 kilometers away from Seville the Itálica Archaeological Complex can be visited, which is one of the most valuable Roman sites in the world. Nowadays this ancient Roman colony exhibits an amphitheater, a Roman Theatre, Roman Baths, an aqueduct, ancient houses of patricians... Fun fact: Itálica has twice been the scene of the famous international TV show 'Game of Thrones'.

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The content of this magazine does not necessarily reflect the opinion of the organisation.