ICMAT

INSTITUTO DE CIENCIAS MATEMÁTICAS

Annual Report

2025



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EXCELENCIA SEVERO OCHOA

diciembre 2011 - marzo 2030



ICMAT Annual Report 2025

The Institute of Mathematical Sciences (ICMAT) is an internationally recognized leading center for mathematical research located in Madrid, Spain, jointly established by the Spanish National Research Council (CSIC), the Autonomous University of Madrid (UAM), Carlos III University of Madrid (UC3M), and Complutense University of Madrid (UCM). ICMAT has been awarded the Severo Ochoa Excellence Accreditation granted by the Spanish Ministry of Science, Innovation and Universities.

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1. A MESSAGE FROM ICMAT'S DIRECTOR

The year 2025 has been marked by sustained and intense scientific activity at ICMAT, further consolidating the institute's position as a leading centre for mathematical research at both the national and international levels. Over the course of the year, ICMAT hosted more than 1,000 visitors and organised over 250 scientific activities, including conferences, workshops, seminars and advanced training events.

During 2025, ICMAT researchers obtained high-impact scientific results, which were published in some of the most prestigious international journals in mathematics, including *Annals of Mathematics, Inventiones Mathematicae, PNAS, Duke Mathematical Journal, Journal für die reine und angewandte Mathematik (Crelle), and Journal of the European Mathematical Society.* These achievements reflect the quality, breadth and international visibility of the research carried out at the institute.

The international recognition of ICMAT researchers was further reinforced by the invitation of Javier Parcet (ICMAT-CSIC) and David Pérez García (ICMAT-CSIC) as speakers at the International Congress of Mathematicians, to be held in Pennsylvania (USA) in the summer of 2026. In addition, Ágata Timón García-Longoria (ICMAT-CSIC) was invited to participate in a panel devoted to the communication of mathematics.

In 2025, ICMAT launched the first edition of the Mathematics Intensive Program (MIP), a new strategic initiative aimed at fostering mathematical talent from the earliest stages of undergraduate education. Four first-year undergraduate mathematics students were selected and assigned individual academic mentors, with access to advanced courses and research-oriented activities. This programme, which is entirely pioneering in Spain, is inspired by well-established European institutions such as the Scuola Normale Superiore di Pisa and the École Normale Supérieure, and is free of charge for students. Upon completion of their degree, and in addition to the corresponding university qualification, participants will receive a certificate from CSIC accrediting their participation in the programme.

This initiative strengthens ICMAT's long-standing commitment to the training of young researchers and complements its broader portfolio of formative activities, including the Pequeño Instituto de Matemáticas (PIM) and the JAE School, a CSIC programme aimed at the early identification and support of outstanding undergraduate talent.

Throughout 2025, ICMAT also remained actively involved in outreach and public engagement activities. This year marked the conclusion of a long-standing collaboration with El País, and the discontinuation of the section Café y Teoremas. At the same time, the institute secured two new regular media spaces: Entre Teoremas in ABC and Dimensión Fractal in eldiario.es.

Finally, ICMAT continued to play an active institutional role within the national and international mathematical community. The institute remained strongly involved in the SOMMa Alliance and in ERCOM, and further consolidated the *Mathematical Bridges with Latin America* programme, which has been highly successful and is expected to continue in 2026.

2. FACTS AND FIGURES

Highlighted moments of 2025

March

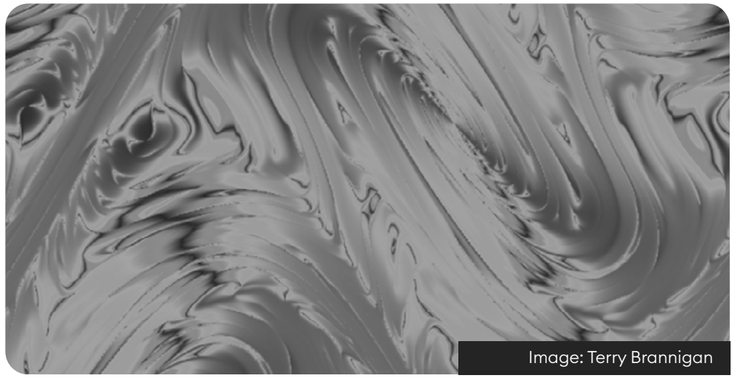


Image: Terry Brannigan

ICMAT researchers prove the existence of fluids with unexpected behavior

A paper published in PNAS presents flows whose equilibrium is disrupted by any small perturbation. Their proof refutes, in three dimensions, a conjecture that claimed the impossibility of such flows. This changes the way we think about the structure of a fluid in equilibrium.

April

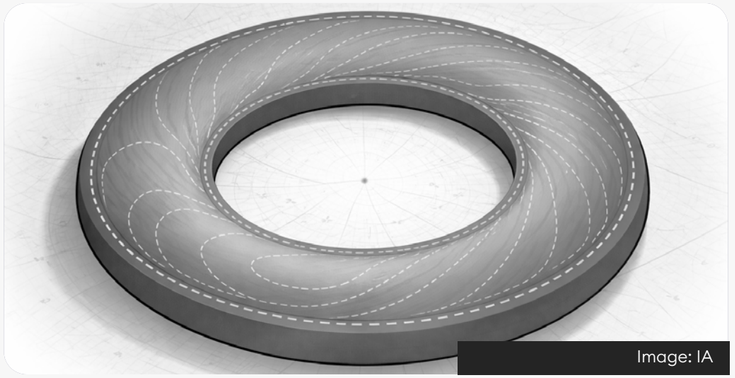


Image: IA

New solutions to a classic problem in spectral geometry

New research shows that certain geometric rigidity breaks down when considering domains with two boundaries. By studying a relaxed version of Schiffer's famous conjecture, mathematicians have discovered new spectral solutions in ring-shaped domains, revealing unexpected connections with the existence of steady fluid flows without radial symmetry.

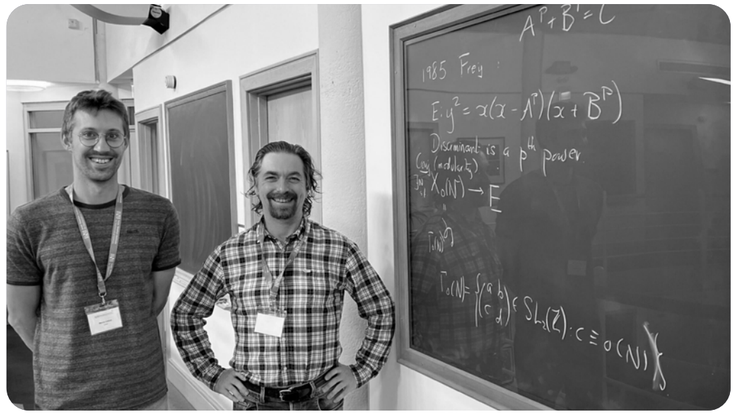
April



Experts in geometry from across Ibero-America gather at ICMAT

ICMAT hosted the Conference on Geometry at Large, co-organized with IMSA at the University of Miami.
It was the first event under the program "Enhancing Mathematical Bridges between Spain and Latin America."
The conference brought together leading researchers and included participation from the Mexican Ambassador to Spain and other representatives.

July



Mathematicians Crack a 50-Year-Old Symmetry Problem

A study, published in the journal Annals of Mathematics, proof a conjecture about a particularly complex and important class of algebraic structure. The new techniques developed could be applied broadly within group theory.

July



Image: provided by the researchers

ICMAT Increases Its Presence at the World's Largest Mathematics Congress

From 23 to 30 July 2026, the International Congress of Mathematicians (ICM) will take place in Philadelphia (USA). Three members of ICMAT will participate: Javier Parcet (ICMAT-CSIC) and David Pérez García (ICMAT-UCM), who will deliver scientific lectures as invited speakers, and Ágata Timón (ICMAT-CSIC), who will take part in a roundtable on public communication of mathematics.

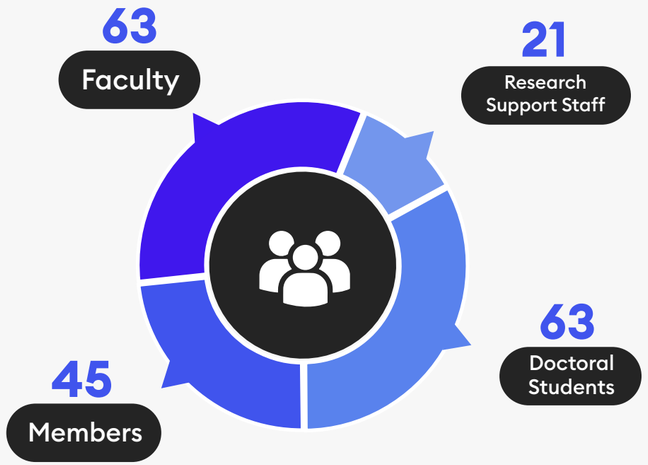
October



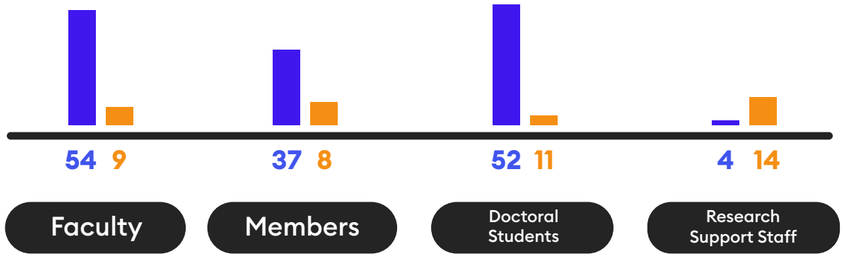
ICMAT launches Spain's first high-performance mathematics programme for university students

The Mathematics Intensive Program (MIP) offers a very small group of undergraduates with extraordinary mathematical talent a high-level complementary education in a stimulating environment. The programme nurtures the early development of highly capable university students, as found in other European countries.

PERSONNEL



Distribution by Gender



200

Articles
in international scientific journals by ICMAT researchers.

1073

Visitors

259 ACTIVITIES

9	Workshops
17	Theses
11	Schools
2	Special Colloquia
1	Distinguished Lectures
4	Joint Mathematics Colloquia (ICMAT-UAM-UC3M-UCM)
18	Joint Mathematics Junior Colloquium (ICMAT-UAM-UC3M-UCM)
12	Courses
174	Seminars
3	Working groups
12	Outreach activities
2	MIP activities



3. PERSONNEL

Around 250 people make up ICMAT: permanent research staff, researchers on post-doctoral contracts, students working on their theses at ICMAT, master's students collaborating with the centre and research support staff. These personnel are contracted through the institutions that form part of ICMAT: CSIC, UAM, UCM and UC3M.

3.1. Research groups

The scientific staff of ICMAT is structured around three main research groups:

GROUP A: Algebra and Geometry

The group conducts research in a broad variety of topics, in the areas of abstract algebra (group theory, commutative algebra), algebraic geometry (arithmetic geometry, number theory, moduli spaces of bundles), differential geometry (geometric analysis, geometric mechanics, dynamical systems and the geometry of PDEs) and topology (topological fluid dynamics, symplectic and contact topology, low-dimensional topology).

As such, their research is naturally interdisciplinary, fostering an important level of cross-fertilization between the different areas. In addition, a number of the themes they study find their motivation in ideas stemming from physics, such as special metrics, gauge theories and their algebro-geometric counterparts.

The main research lines may be grouped into the following four general directions:

Algebraic Geometry and Mathematical Physics: The research of this line is devoted to the study of moduli spaces of vector bundles and related objects, and their interplay with various algebraic and geometric structures, involving techniques from algebraic geometry, differential geometry, topology, Lie theory, geometric analysis and theoretical physics.

Differential Geometry, Symplectic Geometry and Geometric Mechanics: The research of this line centres on differential and contact topology, differential and Riemannian geometry, geometric mechanics with applications to control theory, dynamical systems and the geometry of PDEs.

Group Theory: This line includes several areas of group theory with applications to other fields, such as ring theory, topology, dynamics, and logic. Connecting threads of this line are the approximation of infinite groups by finite structures, and the study of groups through their actions on non-positively curved spaces.

Arithmetic Geometry: The research in this line is devoted to problems at the core of arithmetic geometry, like the equivariant Tamagawa number conjecture or the development of Arakelov geometry, as well as its interplay with related fields like complex and non-Archimedean analysis, algebraic geometry and even theoretical physics.

Faculty
Luis Álvarez Cónsul
Yago Antolín Pichel
Javier Aramayona Delgado
Nuno Ricardo Barroso de Freitas
Ana Bravo Zarza
José Ignacio Burgos Gil
Oscar García Prada
Mario García Fernández
Ernesto Girondo Sirvent
Tomás Luis Gómez de Quiroga
Enrique González Jiménez
Gabino González-Diez
Luis Guijarro Santamaría
Andrei Jaikin Zapirain
Manuel de León Rodríguez
Ignacio Luengo Velasco
Daniel Macias Castillo
David Martín de Diego
Daniel Peralta Salas
Francisco Presas Mata
Piergiulio Tempesta
Orlando Villamayor Uriburu

Members
Dominik Bullach
Caterina Campagnolo
Eva Elduque Laburta
Emilio Franco Gómez
Dominik Francoeur
Manuel Garzón Martínez
Roberto Giménez Conejero
Willi Kepplinger
Ondrej Kubu
Marco Linton
Leo Margolis
Mario Moran Cañón
Maxim Mornev
David Alexander Perrella
Binggang Qu
Gonzalo Emiliano Ruiz Stolowicz
María de la Paz Tirado Hernández

Doctoral students
Pablo Alberto Alvarado Seguel
Enrique Aycart Maldonado
Isidro Benaroya Garzas
Nestor Blázquez Hernán-Gómez
Alejandro Calleja Arroyo
Javier Casado Álvarez
José Antonio Castro Moreno
Iván Chércoles Cuesta
Rodrigo Alonso De Pool Alcántara
Sergio Domingo Zubiaga
Sergio García Rodrigo
Martín González Rodríguez
Miguel González González
Rubén Izquierdo López
Alfredo Llosa Losa
Juan Manuel López Medel
Daniel Martínez Marqués
Henrique A. Mendes da Silva e Souza
Claudia Muñoz Jerónimo
Victoria Pelayo Alvaredo
Javier Peñafiel Tomás
Daniel Reyes Nozaleda
Diego Ruiz Cases
Pablo Sánchez Peralta
Wei Zhou

Associated members
Federico Cantero Morán
Alejandra Garrido Angulo
José Ángel González Prieto
Juan Carlos Marrero González
Edith Padrón
Ana José Reguera López

GROUP B: Mathematical Analysis and Differential Equations

Mathematical analysis and partial differential equations are very active, deeply interrelated fields of research with a preponderant position within the mathematical sciences. This line deals with fundamental problems in the fields of harmonic analysis, partial differential equations, geometric group theory, functional analysis, geometric measure theory, operator algebra, differential geometry and probability, and has been awarded with a total of seven ERC grants.

The group is formed by two sublines:

Mathematical analysis: This subline focuses on classical problems around the Kakeya conjecture and Bochner-Riesz multipliers, the Schrödinger and wave equations, elliptic PDE in rough domains and connections with geometric measure theory, harmonic analysis and geometric group theory for nonamenable groups, classical and abstract Calderón-Zygmund theory and problems around the invariant subspace problem. Other fields such as operator theory, geometry of Banach spaces, complex analysis, quantum probability and analytic number theory are also well represented.

Differential equations and applications: This subline studies differential equations arising in fluid mechanics, spectral theory, mathematical physics and mathematical biology. This is an interdisciplinary subject, with significant applications to engineering, biology and physics.

Faculty

José María Arrieta Algara
Davide Barbieri
Matteo Bonforte
Pablo Candela
María Jesús Carro Rossell
Ángel Castro Martínez
Fernando Chamizo Lorente
Diego Córdoba Gazolaz
Antonio Córdoba Barba
Alberto Enciso Carrasco
Daniel Faraco Hurtado
Eva Gallardo Gutiérrez
María Ángeles García Ferrero
María del Mar González Nogueras
Jesús Ángel Jaramillo Aguado
José María Martell Berrocal
Carlos Mora Corral
Jesús Munarriz Aldaz
Rafael Orive Illera
Arturo de Pablo Martínez
Javier Parcet Hernández
Ana Primo Ramos
Fernando Quirós Gracián
Aníbal Rodríguez Bernal
Keith Rogers
Alberto Ruiz González
F. Javier Soria de Diego
Pedro Tradacete Pérez

Members

Mingming Cao
Félix Del Teso Méndez
Antonio Jesús Fernández Sánchez
Miguel García Bravo
David Gómez Castro
Francisco Javier González Doña
Runan He
Phillipo Lappicy
Salvador López Martínez
David Meyer
Marc Nualart Batalla
Yamilet Quintana
Javier Ramos Maravall
Guillermo Rey Ley
Alberto Salguero Alarcón
Clara Torres Latorre
Carlos Valero Saez
Shan Wang
Zhenguo Wei
Hao Zhang
Liu Zhen-Chuan
Fan Zheng

Doctoral students

Antonio Álvarez López
Itahisa Barrios Cubas
Norberto Clemente Delgado
David De Hevia Rodríguez
Joaquín Domínguez de Tena
Rafael Jose Fernandez-Delgado Ruiz
Carlos Fuertes Morán
Enrique García Sánchez
Alba Dolores García Ruiz
Irene Gonzálvez Martínez
Pablo Hidalgo Palencia
Jorge Santiago Ibáñez Marcos
Jesús Illescas Fiorito
Andrés Laín Sanclemente
Francisco Javier Larcada Sanchez
José Antonio Lucas Manchón
Miguel Martínez González
David Muñoz Lahoz
Jorge Pérez García
Mencía Reborido Fuentes
Jorge Ruiz Cases
Nazaret Trejo Arroyo

Associated members

José Manuel Conde Alonso
María Medina de la Torre

GROUP C:
Applied Mathematics

This research group works to develop the mathematical foundations and models needed to deal with the main new societal challenges, with a focus on data science, machine learning and quantum technologies.

This group is divided in the following research lines:

Mathematics of quantum information theory: Quantum technologies are nowadays one of the most promising technologies for the near future. They exploit quantum effects to develop new techniques in fields like cryptography, metrology, material science, pharmacology and many others, which have the potential to go far beyond the current (classical) state of the art. The group "Mathematics and quantum information" at ICMAT works in a wide variety of mathematical problems which are motivated by quantum technologies. Some of the topics considered in this line are: condense matter and many body systems, quantum control, foundational aspects of quantum mechanics and the theory of operator algebras.

Machine learning and data science: Machine learning and data science are disciplines that are at the core of many current significant societal developments. Embedded in the disciplines of statistics, probability, optimization and algebra, with strong support from computer science developments, this line emphasizes, methodological developments focusing on providing efficient Bayesian approaches to the treatment of large scale inference and prediction problems and methods to deal with the presence of adversaries ready to perturb the data and structure in a problem though adversarial risk analysis and adversarial machine learning. Moreover, it also emphasizes dealing with complex applied problems mainly in the areas of security and cybersecurity, with the aid of its DataLab.

Mathematical modelling and simulation: This covers a wide spectrum ranging from the multidisciplinary mathematical approach to the problems, with emphasis in numerical computation, to the promotion of applications by means of collaborations with other departments such as engineering, biology, physics and earth sciences all around the world. This research includes topics such as microfluidics modelling and technological applications, geophysical fluid dynamics, etc.

Faculty
- José Ramón Berrendero Díaz
- Ana María Carpio Rodríguez
- Antonio Cuevas González
- Marco Antonio Fontelos López
- Alberto Ibort Latre
- Fernando Lledó Macau
- Ana María Mancho Sánchez
- Carlos Palazuelos Cabezón
- David Pérez García
- David Ríos Insua
- Nuria Torrado Robles
- Julio Iñigo de Vicente Majúa
- Ignacio Villanueva Díez

Members
- Joan Claramunt Carós
- Nicolas Fayard
- Adrián Franco Rubio
- Si Liu
- Alberto Redondo Hernández
- María Eugenia Ulzurrun de Asanza Vegas

Doctoral students
- José Manuel Camacho Rodríguez
- Laura Castilla Castellano
- Mario Chacón Falcón
- Antonio Coín Castro
- Daniel Corrales Alonso
- Juan Carlos Diaz Rodríguez
- Pablo García Arce
- Carlos García Meixide
- Laura González Bravo
- María Jiménez Vázquez
- Arnau Mas Dorca
- Pablo Páez Velasco
- José Ramón Pareja Monturiol
- Laura Sáenz Diez
- Miguel Santos Pascual
- Pablo Varas Pardo

3.2. Executive team and board

ICMAT Executive team



Director: Javier Aramayona



Deputy Director: Ana María Bravo

Heads of Department



Fundamental Mathematics: Ángel Castro



Applied Mathematics: Piergiulio Tempesta

ICMAT Board

The ICMAT Board is composed of the center's executive team and the following personnel:



Personnel Representative: Daniel Peralta



Personnel Representative: Carlos Palazuelos Cabezón



Secretary: Rebeca Alameda

3.3. Research Support Staff

ICMAT research Support Staff enables the Institute to develop its own activities, internationalization, knowledge transfer, outreach programme, among others.



Administrative Office
Marta Comas
Yolanda Fuentes
Natalia Potapova
Laura Rojas

ICT Office
Eduardo de Córdoba
Lucia Lafuente Roldán

Mahematical Culture Unit
Laura Moreno Iraola
Ágata Timón G. Longoria

Severo Ochoa Office
Esther Fuentes
Nadia Velasco

Project Management Office
Mónica Castresana (International projects)
Sara Sepulcre (National projects)

Transfer Office
Marta Sanz González

Project Staff
Miriam Martín Sánchez
Adrianna Tryskuc
Daniel Pulido Cortázar
Álvaro Pascual Mesa

CFTMAT Management Department
Managers:
Clara Isabel García Suelto (Until 20/04/2025)
Beatriz Horcajuelo Herrero (21/04/2025 - 30/06/2025)
Marc Cornadó Camí (01/07/2025 - 02/12/2025)
Rebeca Alameda Ortega (since 03/12/2025)
Authorised payers:
Claudia García Carballo (until 30/04/2025)
Maria Rabanal Martin (since 01/05/2025)
Management staff:
Laura Rojas Sanz
María Isabel Castillo González
María Del Carmen Pantoja Gómez
Elena Sabina Castaño Nieto
Alicia Garcia Morencos
Maria Roldán Aygues

CFTMAT 'Jorge Juan' Library
Ricardo Martínez de Madariaga

CFTMAT is the Centre for Theoretical Physics and Mathematics, a service centre that handles management tasks affecting both ICMAT and the Instituto de Física Teórica

3.4. ICMAT's External Scientific Advisor Committee

ICMAT External Scientific Advisory Committee is composed of eight prestigious international mathematicians:



Martin R. Bridson (University of Oxford and Clay Mathematics I nstitute)



Jill Pipher (Brown University)



Jean-François Le Gall (Université Paris-Saclay)



Antonio Ros (Universidad de Granada)



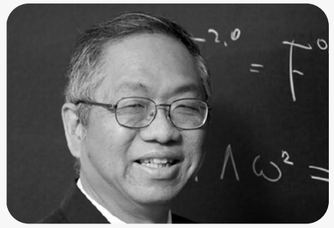
Peter Constantin (Princeton University)



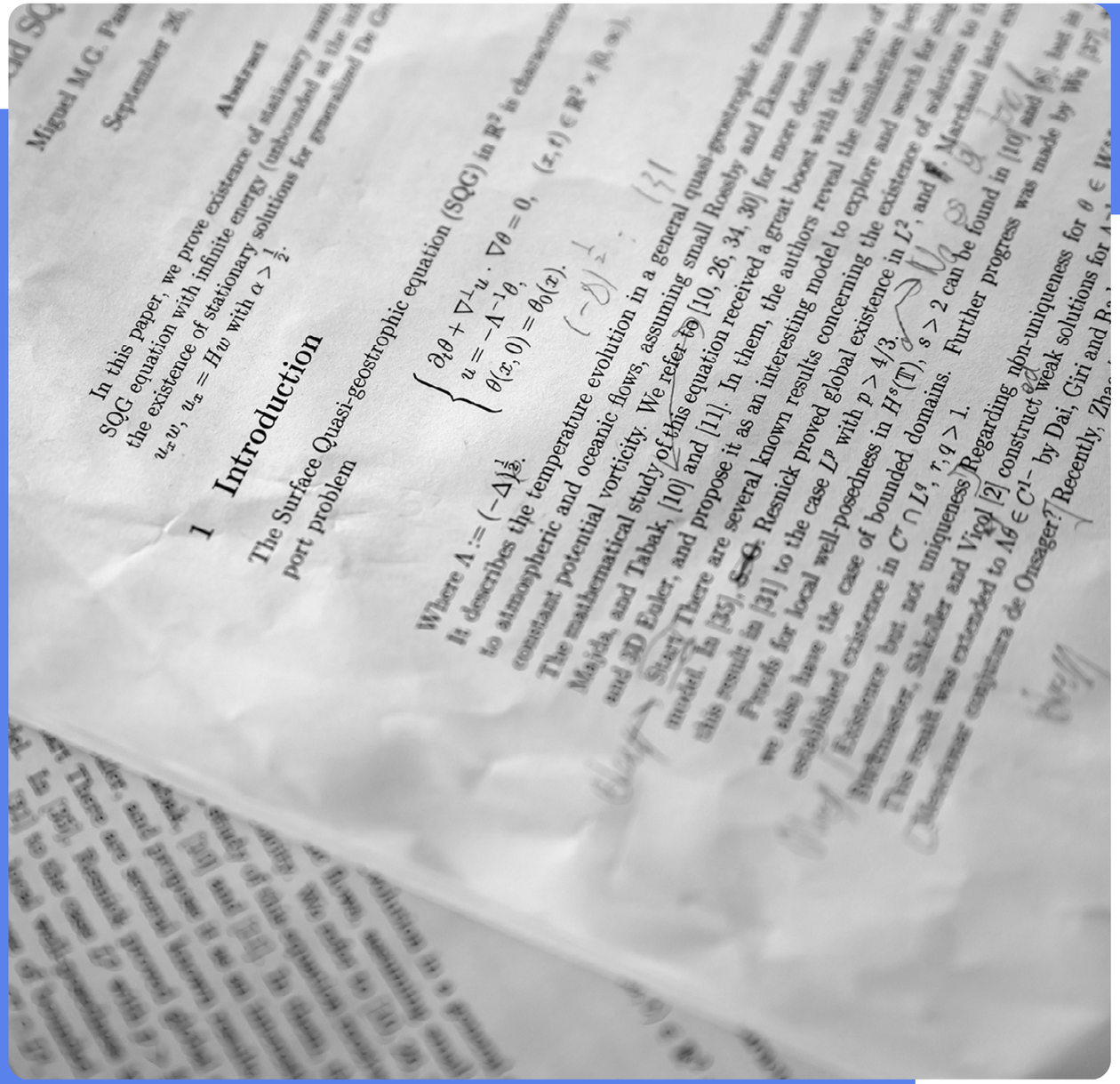
Claire Voisin (CNRS)



Frances Kirwan (University of Oxford)



Shing-Tung Yau (Tsinghua University and Harvard University)



4. SCIENTIFIC PUBLICATIONS

Among the 200 results obtained by ICMAT staff in 2025, the following outcomes have been achieved:

Stability in Gagliardo-Nirenberg-Sobolev inequalities: flows, regularity, and the entropy method

Authors: Matteo Bonforte (ICMAT-UAM), Jean Dolbeault (University of Paris-Dauphine-CNRS, France), Bruno Nazaret (University of Paris 1 Panthéon-Sorbonne, France). and Nikita Simonov (Sorbonne University, France).
Source: Memoirs of the American Mathematical Society.
Date of Publication: April 2025.
Link

Review: Functional inequalities are a central tool in mathematical analysis and in the study of partial differential equations. Among them, Gagliardo–Nirenberg inequalities occupy a prominent place: they allow us to relate different norms of a function (for example, how much it 'oscillates' and how much it 'grows') and are fundamental in problems ranging from diffusion (including non-linear diffusion) and fluid mechanics to mathematical physics, biology, engineering and, more recently, machine learning.

In a recent paper, researchers Matteo Bonforte (ICMAT-UAM), Jean Dolbeault (University of Paris-Dauphine-CNRS, France), Bruno Nazaret (University of Paris 1 Panthéon-Sorbonne, France) and Nikita Simonov (Sorbonne University, France) establish a stability result for a broad class of Gagliardo–Nirenberg-Sobolev inequalities, in the subcritical and critical regimes.
The breakthrough not only confirms when the best possible case is achieved in these inequalities, but also measures precisely and constructively (that is, all the constants involved are calculated explicitly) what happens when we are 'close' to that optimum.

Many mathematical inequalities have functions that reach the optimal value of the constants in the inequality, i.e., those that satisfy the equality, which are called extremal functions. In the case of Sobolev inequalities (in the critical case), these functions were found in the 1970s, independently, by Thierry Aubin, Giorgio Talenti and Eugene Rodemich. In the case of Gagliardo-Nirenberg inequalities (in the subcritical case, which is more delicate), they were discovered by Manuel Del Pino and Jean Dolbeault in 2002. However, in real applications, it is common to work with functions that are not exactly optimal, but almost optimal (as Plato said, the difference between the 'world of ideas' and the 'real world').
Now, if a function 'almost reaches' equality in a Gagliardo–Nirenberg-Sobolev inequality, is it necessarily close to the optimal functions? A stability result answers this question in the affirmative and, moreover, quantifies this closeness so that the result is useful in applications and allows quantitative information to be extracted about this 'almost optimal' function, which is particularly interesting in applications, as it allows accurate predictions to be made.
In this new work, the deviation from the optimal case is measured by means of a deficit, which controls in strong norms the distance to the variety (or family) of extremal functions. In other words, not only is it known that the function is close, but it is also possible to measure precisely how close it is and to state that a 'quasi-optimal' function is always close to the extremal functions, which are explicit in this case.
The approach developed in the article connects the stability of a static inequality with the dynamic behaviour of a partial differential equation, specifically, the rapid diffusion equation. Thus, demonstrating stability in the inequality is equivalent to proving that the dynamic flow converges more rapidly towards its steady state (or equilibrium), using an entropy method.
One of the key points is to understand the 'entropic nature' of these inequalities: in fact, they can be rewritten as inequalities between entropy and entropy production, associated with the fast diffusion equation. This also reveals a 'hidden' feature in these inequalities: their deep connection to the reality of certain physical phenomena.
In addition, the authors propose an interaction between nonlinear analysis, spectral theory, and partial differential equations, which allows the different time scales of the problem (from the initial behaviour to the asymptotic regime) to be connected in a unified framework. The underlying idea is that the non-linear rapid diffusion flow transports a certain function, which represents an initial temperature distribution, for example, in its state of dynamic equilibrium (the non-linear analogue of the Gaussian), which is precisely one of the extremal functions of the Gagliardo-Nirenberg-Sobolev inequalities 'with the same mass', which is conserved throughout the evolution.
One can thus understand the deep relationship between convergence to equilibrium in nonlinear diffusions and proximity to extremals in functional inequalities. These are two equivalent, but not obvious, ways of interpreting the stability described above. This profound idea, which connects two fields that are a priori very distant, has been introduced in this work for the first time and has the potential to be used for the study of other stability problems, both static and dynamic.

An extension theorem for weak solutions of the 3d incompressible Euler equations and applications to singular flows

Authors: Alberto Enciso (ICMAT-CSIC), Javier Peñafiel (ICMAT-CSIC), Daniel Peralta-Salas (ICMAT-CSIC).
Source: Forum of Mathematics Pi 13:e21 1-84.
Date of Publication: 29 September 2025.
Link

Review: Euler's equations, formulated in the 18th century, describe the motion of incompressible fluids (i.e., fluids whose volume is constant, such as water) without viscosity and constitute one of the pillars of fluid mechanics. Their solutions offer, based on initial conditions, a prediction of how the fluid will behave in the future. So-called weak solutions describe highly irregular flows, in which the velocity of the fluid may cease to be smooth or even exhibit discontinuities. These solutions are very flexible and are particularly useful for studying turbulent phenomena, but they may not be unique and may exhibit behaviour that is very different from that expected from classical physics.
A new paper by Alberto Enciso (ICMAT-CSIC), Javier Peñafiel (ICMAT-CSIC) and Daniel Peralta-Salas (ICMAT-CSIC) shows the extent to which weak solutions of Euler's equations in three dimensions can be extraordinarily flexible. The authors demonstrate that any classical and smooth solution, defined only in a limited region of space and time, can be extended to the entire space as a weak solution during that same time interval. This extension coincides exactly with the original solution where both are defined and retains a certain degree of regularity, although always below a critical threshold. The result is based on the convex integration technique, a tool that has revolutionised the study of fluid equations over the last decade.
Based on this extension theorem, the paper presents two particularly striking applications. The first demonstrates that, starting from a very simple initial configuration known as a vortex sheet, it is possible to construct an infinite number of different weak solutions that coincide with the prescribed sheet outside a small turbulent region. This phenomenon highlights an extreme form of non-uniqueness: the same initial state can give rise to an infinite number of mathematically valid evolutions.
The second application shows that even when starting from a completely smooth flow defined in a periodic domain, it is possible to modify it within a specific open region to obtain a weak solution that develops singularities in a set of space-time of positive measure. In other words, highly irregular behaviour can emerge in a localised manner, while the flow remains smooth and well-behaved outside the chosen region.

Instantaneous continuous loss of regularity for the SQG equation

Authors: Diego Córdoba (ICMAT-CSIC), Luis Martínez-Zoroa (Cunef Universidad), Wojciech S. Ożański (Florida State University).
Source: Advances in Mathematics Volume 481, December 2025, 110553.
Date of Publication: December 2025.
Link

Review: A fundamental question in mathematical fluid theory is how and why classical solutions to equations describing flow motion can rapidly lose their regularity. The aim is to understand whether these equations behave correctly over time or whether, on the contrary, they develop irregularities or singularities. New work by Diego Córdoba (ICMAT-CSIC), Luis Martínez-Zoroa (Cunef University) and Wojciech S. Ożański (Florida State University) provides advances in this problem for the surface quasi-geostrophic equation (SQG).

The SQG equation describes the evolution of a temperature or density defined on a surface (for example, the ocean surface or an atmospheric interface) that determines the movement of the fluid. This equation is widely studied as a simplified analogue of the three-dimensional Euler equations. It retains enough structure to model realistic physical phenomena, while being more manageable than the full Euler equations. As a result, it has become a popular testing ground for studying ideas about instability, turbulence and singularity formation.
Previous research has shown that, in certain regimes, the SQG equation is ill-posed: very small perturbations of the initial state can cause drastic changes in the solution.
Now, recent work demonstrates, for the first time in incompressible fluid mechanics, that the continuous loss of Sobolev regularity can occur in a controlled and explicit manner, even when the solutions remain unique and classically defined.
Mathematicians have managed to construct classical solutions that start out with a supercritical Sobolev norm arbitrarily small but immediately lose their regularity and continue to do so continuously and quantifiably as time passes. Instead of a sudden collapse at a single moment, the solution gradually becomes more irregular, losing regularity at a constant rate. This shows that even when solutions exist and are unique in a reasonable sense, their regularity can deteriorate endlessly. It is important to note that this loss of regularity occurs while the solution remains classical in time and space and remains compact.

This new result is entirely constructive, i.e., the authors explicitly construct solutions that exhibit this behaviour. Their construction is based on carefully arranged flow patterns that create strong stretching and compression effects, similar to what occurs near hyperbolic points in flows, while maintaining control over errors and interactions.
By assembling infinite structures of this type at different spatial scales, the authors produce a solution whose regularity continuously decreases over time. This multiscale mechanism is robust and accurate enough to track exactly how much smoothness is lost at each moment, with an exceptional level of detail.

Finite-time singularity via multi-layer degenerate pendula for the 2D Boussinesq equation with uniform $C^{1,43\sqrt{-1-\epsilon}} \cap L^2$ force

Authors: Diego Córdoba (ICMAT-CSIC), Andrés Laín-Sanclemente (ICMAT-CSIC) and Luis Martínez-Zoroa (CUNEF Universidad).
Source: Advances in Mathematics 480 (2025), part A, Paper No. 110480, 205 pp.
Date of Publication: November 2025.
Link

Review: The search for singularities in the equations governing fluid motion has become one of the great challenges in current mathematical research. New work has shown that singularities also form in finite time in the forced incompressible Boussinesq equations. These equations model the interaction between velocity, temperature (or density) and buoyancy. They are used to describe, for example, thermal convection: hot air rising from the Earth's surface and giving rise to atmospheric currents, or water heating up from the bottom of a container and forming convective cells. Boussinesq equations play a central role in the study of geophysical and atmospheric flows. They are considered to be closely related to Euler's three-dimensional equations, with which they share many of their most profound mathematical challenges.
Although the Boussinesq system is often considered to be slightly more structured than Euler's, due to the presence of a buoyancy force, it has long been expected to capture the most relevant mechanisms for the formation of singularities. In their work, Diego Córdoba (ICMAT-CSIC), Andrés Laín-Sanclemente (ICMAT-CSIC) and Luis Martínez-Zoroa (CUNEF Universidad) confirm this expectation in a decisive and thoroughly rigorous manner.
The researchers identify and implement a precise cascade mechanism that leads to the singularity, using purely analytical methods, without resorting to numerical simulations or computer-assisted demonstrations. With pen and paper, they explicitly construct solutions and follow their evolution with great precision, demonstrating how the cascade mechanism inevitably leads to the explosion.
Specifically, they show that the coupling between velocity and temperature generates a hierarchy of increasingly thin and intense flow structures, which progressively concentrate energy and gradients on increasingly smaller scales. Thus, the singularity does not emerge from chaotic turbulence, but from a highly organised and hierarchical process, in which vorticity layers and temperature gradients collapse towards a single point. As the cascade accelerates, the key quantities grow without limit, culminating in a mathematical singularity in finite time. This provides a clear and compelling conceptual picture of how singularities can form in non-viscous fluid models when buoyancy effects are present. By isolating the essential ingredients responsible for singularity, the paper sheds light on which structural features of the equations drive extreme behaviour and which play a secondary role.
This result strongly supports the idea that singular behaviour is consistent with the fundamental structure of inviscid fluid models. Beyond the Boussinesq equations themselves, the ideas developed here have broader implications. They offer new insight into the possible pathways for singularity formation in related systems, including the Euler equations, and contribute to our understanding of extreme phenomena in fluid flows, such as sharp fronts and intense vortical structures.

A proof of Vishik's nonuniqueness theorem for the forced 2D Euler equation

Authors: Ángel Castro (ICMAT-CSIC), Daniel Faraco (ICMAT-UAM), Francisco Mengual (Universidad de Sevilla) and Marcos Solera (Universitat de València).
Source: Journal für die reine und angewandte Mathematik (Crelles Journal), vol. 2025, no. 824, 2025, pp. 253-288.
Date of Publication: 29 April 2025.
Link

Review: Euler's equations continue to pose some of the most profound and difficult problems in contemporary mathematics, especially with regard to the existence and uniqueness of their solutions.
In two dimensions, one of the fundamental results is Yudovich's theorem, which guarantees that Euler's equations admit a unique global solution when the initial vorticity (a quantity that measures the local rotation of the

fluid) belongs to a specific class of functions, $L^1 \cap L^\infty$.
This theorem has served for decades as a reference for understanding when the behaviour of an ideal fluid is well determined by its initial conditions.
If these hypotheses are weakened (for example, if the vorticity is required to be in $L^1 \cap L^p$, with p a finite value), it is known that existence remains valid, but proving uniqueness in this regime remains an open problem of great interest.
In 2018, mathematician Misha Vishik took a decisive step forward by demonstrating that uniqueness can fail if an external force is introduced into the system, provided that this force belongs to the natural space $L^1(L^1 \cap L^p)$. Their demonstration, developed in two articles totalling more than 130 pages, highlighted the extreme delicacy of the problem and opened up new lines of research into the instability of flows.
In a new paper, Ángel Castro (ICMAT-CSIC), Daniel Faraco (ICMAT-UAM), Francisco Mengual (Universidad de Sevilla) and Marcos Solera (University of Valencia) present an alternative and considerably simpler proof of this result, reducing the argument to about 30 pages. The main innovation of the article is the construction of a much simpler unstable vortex than the one originally proposed by Vishik. Unlike the previous vortex, the new example has zero mean and compact support, properties that greatly simplify the analysis and reinforce the conceptual clarity of the non-uniqueness mechanism.
Beyond the specific result for Euler's equations, the ideas proposed in this work can be transferred to other fundamental models of fluid dynamics. In fact, in an independent study, the authors have demonstrated the non-uniqueness of solutions for the α-SQG (generalised Surface Quasi-Geostrophic) equation in the range $0<\alpha\leq 1$, within the critical functional class $W^{(s,p)}$ with $s<\alpha+2p$. The result includes the limiting case $\alpha=1$, corresponding to the classical SQG equation, which is of great relevance in geophysics and meteorology.

A Schiffer-type problem for annuli with applications to stationary planar Euler flows

Authors: Alberto Enciso (ICMAT-CSIC), Antonio J. Fernández (Universidad Autónoma de Madrid), David Ruiz (Universidad de Granada), Pieralberto Sicbaldi (Universidad de Granada).
Source: Duke Mathematical Journal 174 (2025) 1151-1208.
Date of Publication: 15 April 2025.
Link

Review: The shape of the region of space where a problem arises (the domain) profoundly influences the physical and mathematical phenomena that can occur. The precise way in which this happens is studied by spectral geometry, an area of mathematics that analyses how the topology or geometry of an object influences the operators defined on it. This allows us to understand, for example, how the shape of a drum affects the sound it produces.
The shape of the domain can also determine the movement of a fluid inside it. For example, whether or not the flow has symmetries, whether it is confined to a specific region, or whether it can have more complex structures.
One of the best-known problems in this field is Schiffer's conjecture, formulated in the 1950s, which predicts strong geometric rigidity: if a flat domain admits eigenfunctions of the Laplace operator that are constant on the boundary, then that domain must necessarily be a disc. This result, confirmed in numerous contexts, suggests that imposing seemingly simple spectral conditions can very strictly determine the geometry of the domain.
Now, in 'A Schiffer-type problem for annuli with applications to stationary planar Euler flows', Alberto Enciso (ICMAT-CSIC), Antonio J. Fernández (Universidad Autónoma de Madrid), David Ruiz (Universidad de Granada) and Pieralberto Sicbaldi (Universidad de Granada) question this rigidity by studying a relaxed version of Schiffer's problem in flat domains with two boundary components, such as rings. In this new approach, eigenfunctions are sought that are constant in each component of the boundary, although not necessarily with the same value.
The main result demonstrates the existence of non-trivial solutions in doubly connected domains, which implies that, by allowing a second boundary and slightly relaxing the conditions, domains other than the disc appear that admit this type of eigenfunctions.
This finding shows that Schiffer's phenomenon does not literally extend to rings. Surprisingly, the breakdown of rigidity is not total: the problem still exhibits very strong rigidity properties, of the same type as in the original conjecture. That is, although new examples exist, they are strongly restricted by the geometry of the domain.
Beyond its theoretical interest, the result has direct applications in fluid mechanics. In particular, it allows us to construct stationary flows of the plane that satisfy Euler's equations, are continuous in the Lipschitz sense, have compact support, and do not exhibit radial symmetry.
These types of solutions provide new explicit examples of stationary flows with complex geometries, expanding the known repertoire and reinforcing the link between spectral geometry and fluid dynamics.

On the coherence of one-relator groups and their group algebras

Authors: Andrei Jaikin-Zapirain (ICMAT-CSIC) and Marco Linton (ICMAT-CSIC).
Source: Annals of Mathematics 909-959.
Date of Publication: 29 April 2025.
Link

Review: The reviewed article addresses one of the classical problems in combinatorial and geometric group theory: Baumslag's coherence conjecture, formulated in 1974. This conjecture asserts that all one-relator groups are coherent, meaning that all of their finitely generated subgroups also admit finite presentations. Although one-relator groups appear simple from the standpoint of presentations, their internal structure has proven to be surprisingly complex and difficult to control.
The notion of coherence is a crucial property, as it allows many algebraic and geometric tools (normally available only for finitely presented groups) to be extended to the study of their subgroups. Important examples of coherent groups include free groups, polycyclic groups, fundamental groups of three-dimensional manifolds, and free-by-cyclic groups, illustrating the structural relevance of this property.

The article is situated within a recent line of research driven by work of Wise and Louder–Wilton, who introduced innovative topological methods in the study of coherence, particularly through two-dimensional complexes with non-positive immersions. One of the main results of the paper shows that the fundamental group of such complexes satisfies a weaker property, namely homological coherence, which turns out to be sufficient–when combined with additional results–to deduce full coherence.
This homological approach constitutes one of the most novel aspects of the article. Rather than relying on traditional topological or combinatorial methods, the authors develop a strategy based on homological algebra. Specifically, they prove that finitely generated subgroups of one-relator groups satisfy the FP_2 condition, meaning that they admit a finite description from the homological point of view. A key step in the argument is showing that, in this context, the FP_2 property is sufficient to guarantee that these subgroups are in fact finitely presented, thereby establishing the coherence of the original group.
This result definitively resolves Baumslag's conjecture, which had remained open for more than fifty years and had been a constant reference point for researchers working on one-relator groups. The proof reveals that, despite their often unpredictable behavior (some of these groups are non-hyperbolic and exhibit phenomena considered pathological), this class admits a sufficiently rigid internal structure to ensure coherence, something that does not hold for groups with two or more relations.
From a technical standpoint, the proofs combine sophisticated tools from homological algebra with the theory of L2-invariants. A fundamental ingredient is the use of the recent resolution of the strong Atiyah conjecture for locally indicable groups, due to Jaikin-Zapirain and López-Álvarez, which allows for precise control of certain homological dimensions associated with the groups under study. This connection illustrates how deep advances in seemingly technical areas can unlock long-standing classical problems.
The work goes beyond the original conjecture, as it also establishes the coherence of the group algebra associated with a one-relator group, thereby extending the scope of the results from the purely group-theoretic to the algebraic setting. Moreover, the techniques introduced are not limited to this particular case: the homological approach developed is applicable to a much broader class of groups, opening new avenues of research in the study of coherence and its variants.

Futaki invariants and Yau's conjecture on the Hull-Strominger system

Authors: Mario Garcia-Fernandez (ICMAT-CSIC) and Raúl Gonzalez Molina (SISSA and Universidad Politécnica de Madrid).
Source: Journal für die reine und angewandte Mathematik (Crelles Journal), vol. 2025, no. 822. Pages 221-257.
Date of Publication: 14 March 2025.
Link

Review: The Hull–Strominger system is a set of partial differential equations that originated in string theory. Its purpose is to characterize certain special geometries that arise in the description of the most realistic models of the universe within this theoretical framework.

In string theory, spacetime is originally formulated in ten dimensions. In order to recover the observable four-dimensional physics, it is postulated that the six extra dimensions are compactified, that is, curled up into very small geometric shapes that cannot be detected directly. The Hull–Strominger system provides the equations that these internal geometries must satisfy in order for the resulting physical model to be consistent. In this sense, it not only connects string theory with effective four-dimensional physics, but also describes a very broad class of geometric spaces with particularly favorable predictive properties.
These equations were first studied from a purely mathematical perspective in a 2005 article by Fields Medalist

Shing-Tung Yau and Jun Li, from Stanford University. In that work, the authors proposed their study as a generalization of the Calabi problem, which had been solved by Yau in 1977. Unlike the classical setting of the Calabi problem, the geometric constraints imposed by the Hull–Strominger system go beyond the realm of algebraic geometry and even that of Kähler geometry.
By analogy with the Calabi problem, Yau proposed a conjecture (still open) based on the large classes of examples known to date. The main difficulties in addressing this conjecture stem from the impossibility of applying techniques from Kähler geometry and from the limited understanding of the geometry underlying the equations.
In recent years, the problem has attracted the attention of mathematicians from a wide range of areas, including non-Kähler Hermitian geometry, geometric analysis, algebraic topology, and Hitchin's theory of generalized geometry. At present, the search for solutions to this system has become a guiding principle in the study of canonical geometries on these more flexible complex spaces. Recently, Mario García-Fernández (ICMAT-CSIC) and Raúl González Molina (SISSA and UPM) have made significant progress on this problem. Their results have been published in the Journal für die reine und angewandte Mathematik.
Building on previous work in generalized geometry, García-Fernández and González Molina reformulate the Hull–Strominger system in terms of natural equations for complex and geometric data associated with Courant algebroids in the holomorphic category, which are the basic building blocks of generalized geometry. In this way, they show that the system can be reinterpreted as a Hermite–Einstein equation for a generalized metric, providing a rigorous mathematical proof of a statement that had previously been put forward by physicists using perturbative methods.

As an application, the authors construct an invariant that detects the impossibility of solving the Hull–Strominger system. This invariant takes the form of a holomorphic character derived from a moment-map-type equation, in close analogy with the invariant introduced by Akito Futaki in 1983 to measure the obstruction for a complex manifold to admit a Kähler–Einstein metric.
These new results provide a powerful tool for addressing Yau's conjecture in the context of the Hull–Strominger system. More broadly, this conjecture is related to another open problem in complex geometry: the geometrization of surgeries (transitions and flops) that arise when passing from algebraic varieties to non-Kähler Calabi–Yau varieties in complex dimension three, a phenomenon known as Reid's fantasy. The appearance of a Futaki-type invariant sheds new light on this picture and suggests that the original expectations may need to be refined.
On the other hand, the interpretation of the Hull–Strominger system as a higher-order instanton represents an important step toward a Hitchin–Kobayashi-type correspondence. In this formulation, solutions of the system, within an extended version of gauge theory, should be equivalent to certain geometric objects–yet to be identified–that satisfy an appropriate notion of stability in the sense of geometric invariant theory in algebraic geometry.
Overall, this work provides a rigorous mathematical foundation for a class of equilibrium configurations that are physically relevant yet mathematically challenging, and it significantly advances our understanding of MHD equilibria in realistic three-dimensional settings.

On Darmon's program for the generalized Fermat equation

Authors: Nicolas Billerey (Universite Clermont Auvergne), Imin Chen (Simon Fraser University), Luis Dieulefait (Universidad de Barcelona) and Nuno Freitas (ICMAT-CSIC).
Source: Journal für die reine und angewandte Mathematik 822 (2025), 107–146.
Date of Publication: 2025.
Link

Review:
For more than three centuries, Fermat's Last Theorem was one of the most famous and elusive problems in mathematics. Formulated in the seventeenth century, it states that the equation $x^n+y^n=z^n$ has no non-trivial integer solutions x, y, z when n>2. Its definitive proof came in 1994-95, when Andrew Wiles solved it by combining deep ideas from number theory, algebraic geometry, and complex analysis. Beyond settling a historic problem, Wiles's work inaugurated a powerful new strategy for studying so-called Diophantine equations–polynomial equations whose solutions are sought in integers–known as the modular method.

The central idea of this method is to translate a putative solution of a Diophantine equation into an apparently very different object: a Galois representation. These representations describe deep algebraic symmetries and encode how the solutions of polynomial equations are related to one another. In the context of the modular method, each possible solution is associated with a two-dimensional Galois representation with values in 2×2 matrices whose entries are the integers modulo a prime number. The goal is to show that these representations must arise from very well-classified analytic objects,

namely modular forms, which in many cases leads to a contradiction and allows one to rule out the existence of solutions.
In the proof of Fermat's Last Theorem, the bridge between Diophantine equations and Galois representations was provided by the so-called Frey elliptic curves. However, when one moves to more general equations (such as the generalized Fermat equations of the form $x^r+y^q=z^p$) this strategy is no longer sufficient. In 2000, the mathematician Henri Darmon proposed an ambitious program to extend the modular method by replacing elliptic curves with more complex objects: abelian varieties of GL2-type defined over totally real fields. Although conceptually very promising, this approach relied on deep conjectures that have made its practical application difficult for many years.
A new work now takes a decisive step in this direction. In it, Nicolas Billerey (Université Clermont Auvergne), Imin Chen (Simon Fraser University), Luis Dieulefait (Universidad de Barcelona), and Nuno Freitas (ICMAT-CSIC) develop and refine the tools needed to effectively apply the modular method based on Frey abelian varieties to new Diophantine problems. In particular, they are able to treat almost completely the Fermat equations $x^r+y^r=z^p$, significantly expanding the scope of Darmon's program.
Moreover, the work addresses an important technical difficulty that had not been resolved in the original framework: even under favorable hypotheses on residual Galois representations, one still needs to eliminate certain modular forms (namely Hilbert modular forms without complex multiplication) that do not fit into the classical modular method scheme. The new techniques developed begin to offer solutions to this problem.
As a concrete application of these advances, the authors obtain new results for the equations $x^r+y^r=z^p$, in the cases r=5 and r=11, providing new proofs of the non-existence of non-trivial integer solutions over wide ranges of exponents.

MHD equilibria with nonconstant pressure in nondegenerate toroidal domains

Authors: Alberto Enciso (ICMAT, CSIC), Alejandro Luque (Uppsala University), Daniel Peralta-Salas (ICMAT, CSIC).
Source: Journal of the European Mathematical Society (JEMS) 27 (2025), no. 6, 2251–2291.
Date of Publication: 28 December 2023.
Link

Review:
To describe the macroscopic behaviour of electrically conducting fluids ,such as plasmas, liquid metals, and astrophysical fluids, it is necessary to combine fluid dynamics and electromagnetism. This framework is provided by magnetohydrodynamics (MHD), whose fundamental equations model the interaction between the fluid velocity, the magnetic field, and the pressure, and play a central role in plasma physics, astrophysics, and controlled nuclear fusion.

From a mathematical standpoint, these equations form a highly constrained and geometrically intricate nonlinear system of partial differential equations, especially in three-dimensional domains. The existence and regularity of solutions depend very sensitively on the topology of the domain and on the prescribed boundary conditions. In toroidal geometries (which are particularly relevant for magnetic confinement devices such as tokamaks and stellarators) these difficulties are further compounded by the lack of symmetry and by the complex structure of magnetic field lines.
When one restricts attention to fluids at rest, known as stationary or equilibrium states, the system no longer evolves in time and an exact balance between magnetic and pressure forces is imposed, leading to a simplified but still highly nontrivial set of equations. In this context, the present article proves the existence of piecewise smooth MHD equilibria in three-dimensional toroidal domains of Euclidean space, where the pressure is constant on the boundary but varies in the interior. It also establishes the existence of free-boundary steady states surrounded by vacuum and supported by an external surface current. The toroidal domains in which these equilibria are shown to exist need not be small perturbations of axisymmetric domains and may, in fact, exhibit arbitrary knotted topology.
The building blocks of the construction are analytic toroidal domains satisfying a suitable nondegeneracy condition, which roughly asserts the existence of a force-free field that is ergodic on the surface of the domain. The proof relies on three main ingredients: a gluing construction of piecewise smooth MHD equilibria; a Hamilton–Jacobi equation on the two-dimensional torus, which can be interpreted as a nonlinear deformation of the cohomological equation and for which the nondegeneracy assumption plays a crucial role; and a new KAM theorem tailored to the study of divergence-free vector fields in three dimensions whose Poincaré map cannot be computed explicitly. Together, these results yield counterexamples to the celebrated Grad conjecture in the setting of stepped-pressure equilibria far from rotational symmetry.
Overall, this work provides a rigorous mathematical foundation for a class of equilibrium configurations that are physically relevant yet mathematically challenging, and it significantly advances our understanding of MHD equilibria in realistic three-dimensional settings.

The local geometry of idempotent Schur multipliers

Authors: Javier Parcet (ICMAT-CSIC), Mikael de la Salle (CNRS, Université de Lyon) and Eduardo Tablate (KU Leuven).
Source: Forum of Mathematics Pi, Volume 13 (2025), e14.
Date of Publication: 24 March 2025.
Link

Review: What happens to a given function if we redefine its Fourier transform to be zero outside certain domain? This is in the root of foundational problems in harmonic analysis. Fefferman's celebrated theorem for the ball (1971) shows that this transformation preserves Lp-integrability if and only if the boundary of such domain is piecewise flat. What if we truncate the Fourier transform on a curved space like a Lie group? What do we mean by "boundary flatness" in that case? And if we truncate the entries of a given matrix with Euclidean entries? How do we relate the shape of such domain with its effect on the singular numbers of this matrix?
In this paper, the authors fully characterize the local geometry of such Lp-preserving truncations for these (apparently unrelated) problems in terms of a surprising lax notion of boundary flatness. The matrix ones are all diffeomorphic variations of a fundamental map: the triangular projection or matrix Hilbert transform. The Lie group ones are all modeled on one of three fundamental examples: the classical Hilbert transform, and two new examples of Hilbert transforms over affine and universal covering groups. This vastly generalizes Fefferman's theorem to nontrigonometric and noncommutative scenarios, and confirms that Schur multipliers (matrix transformations by entrywise multiplication) share profound similarities with Euclidean Fourier multipliers –even in the lack of a Fourier transform– and complete for Lie groups a longstanding search.

Solvability of the LpDirichlet problem for the heat equation is equivalent to parabolic uniform rectifiability in the case of a parabolic Lipschitz graph

Authors: Simon Bortz (Universty of Alabama), Steve Hofmann (University of Missouri), José María Martell (ICMAT-CSIC) and Kaj Nyström (Uppsala University)
Source: Inventiones mathematicae. Volume 239, pages 165–217.
Date of Publication: January 2025.
Link

Review: A recent study solves a classical problem about the heat equation that has remained open for decades and is widely regarded as one of the central questions in the area. The problem can be described as follows: if we know how temperature is fixed along the boundary of a region whose shape may be irregular and even change over time, can we determine the temperature everywhere inside in a stable and well-controlled way?
For instance, in a piece of metal with a slightly rough surface whose geometry evolves with time, if some parts of its surface are heated and others cooled, heat diffuses into the interior according to the heat equation, but it is far from obvious whether irregularities of the boundary could amplify and produce pathological behaviour of the hat diffusion. Conversely, one may know that the temperature inside behaves in a stable and controlled way and ask whether this forces the piece of metal to have a boundary possessing some intrinsic geometric regularity.
The article published in Inventiones Mathematicae, entitled "Solvability of the L^p Dirichlet Problem for the Heat Equation is Equivalent to Parabolic Uniform Rectifiability in the Case of a Parabolic Lipschitz Graph" and authored by Simon Bortz (University of Alabama), Steve Hofmann (University of Missouri), José María Martell (ICMAT-CSIC) and Kaj Nyström (Uppsala University), studies precisely this question for domains whose boundary can be described as a Lipschitz graph of a function depending on space and time.
The authors show that analytic stability of heat diffusion inside such a domain is not merely influenced by the geometry of the boundary, but is in fact completely determined by it. More specifically, they prove that three conditions that had previously been understood only partially (solvability of the Dirichlet problem in Lebesgue spaces, quantitative control of caloric measure, which describes the behavior of the temperature inside the domain, and a geometric property known as parabolic uniform rectifiability) are actually equivalent.
In concrete terms, if the heat measure behaves comparably to the natural surface measure, then the boundary must possess a precise and quantifiable geometric structure: although it may appear irregular, it is irregular in a controlled and measurable way. Technically, this corresponds to the defining function of the boundary having the fractional time derivative of order 1/2 in a bounded mean oscillation space, a condition that turns out to be exactly the right geometric criterion.
Earlier work had shown that certain geometric assumptions guarantee solvability, but whether those assumptions were also necessary was unknown. By proving the full equivalence, this paper provides a complete characterization of which parabolic graph domains allow

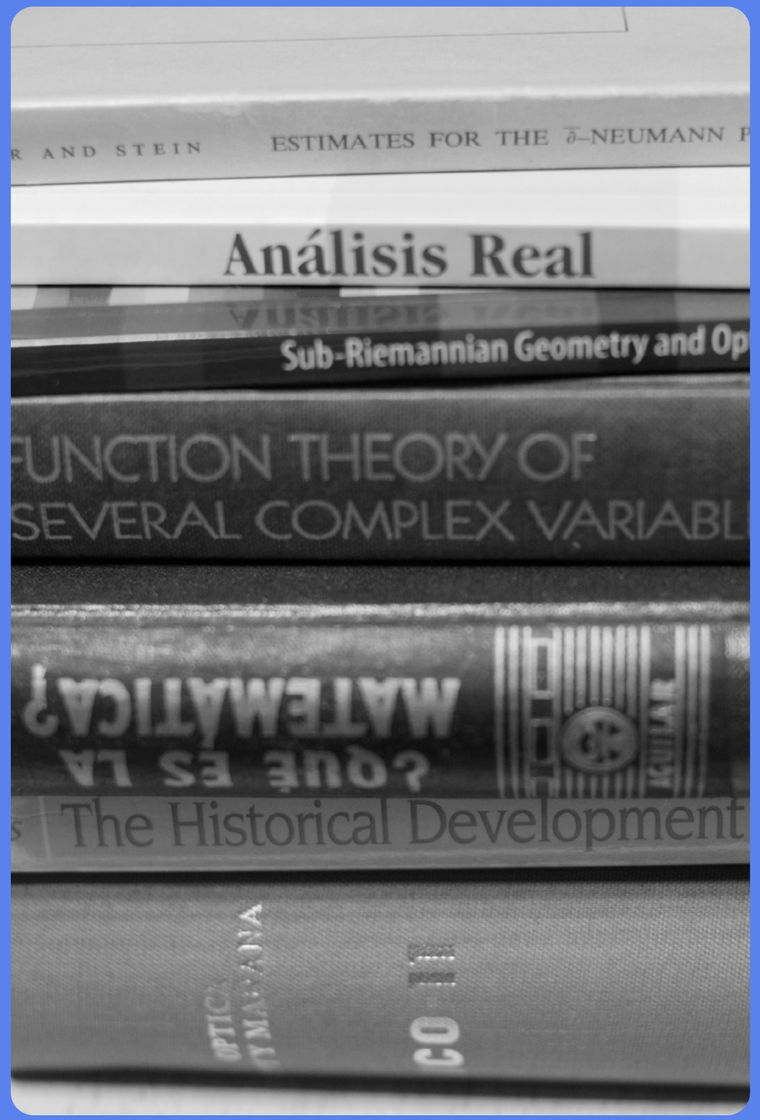
the Dirichlet problem for the heat equation to be solved, thereby closing a longstanding gap and completing a program initiated in foundational work of de John L. Lewis and Margaret A. M. Murray.
Conceptually, the proof introduces a strikingly original perspective: it analyzes the level sets of the Green function, which describes pointwise influence for the heat equation, treating them as extensions of the boundary itself and testing refined Littlewood–Paley-type estimates that measure oscillation across scales. These estimates make it possible to connect analytic behaviour, geometric structure, and boundary solvability within a single unified framework.
By establishing this definitive bridge between geometry, analysis, and heat diffusion, the work delivers a sharp structural theorem where previously only partial results were known, and is therefore widely viewed as a genuine breakthrough that sets a new benchmark for research in parabolic partial differential equations, harmonic analysis, and geometric measure theory.

Isolated steady solutions of the 3D Euler equations

Authors: Alberto Enciso (ICMAT, CSIC), Willi Kepplinger (Department of Mathematics, University of Vienna), Daniel Peralta-Salas (ICMAT, CSIC).
Source: Proceedings of the National Academy of Sciences 122 (12).
Date of Publication: 21 March 2025.
Link

Review: Steady states of an incompressible fluid describe situations in which the fluid moves permanently without changing over time: the flow pattern remains the same, even though the fluid particles are in motion. These states appear in numerous relevant physical contexts, such as stable ocean currents, persistent atmospheric vortices, or certain ideal flows used as models in aerodynamics. From a mathematical point of view, these flows are governed by the stationary Euler equations, which impose strong restrictions on the velocity of the fluid and its geometric structure.
A central aspect of their study is to determine the extent to which these states are stable or exceptional. To say that a steady state is isolated means that there are no other steady states arbitrarily close to it: small perturbations of the system do not give rise to new steady solutions. In physical terms, this would imply that the flow represents a particularly rigid configuration that cannot be smoothly deformed into other equilibrium solutions. However, in classical examples, such as known steady flows in three-dimensional space or in simple geometries, it is always possible to find continuous families of nearby solutions, suggesting a high degree of flexibility.
This apparent coexistence of flexibility and rigidity gives rise to a subtle and deeply mathematical interaction: on the one hand, the equations admit a wealth of solutions; on the other, these solutions must satisfy very strict geometric and dynamic constraints. A recent survey by Drivas and Elgindi highlighted this phenomenon by noting that none of the stationary states known to date are isolated, and by conjecturing that no sufficiently smooth stationary state can be isolated. The work reviewed here challenges this intuition and demonstrates that, in a broad class of compact three-dimensional Riemannian manifolds, there are incompressible flows that do admit isolated steady states, revealing a surprising new equilibrium between dynamic chaos and geometric structure.
The proof of this fact combines ideas from dynamical systems, which appear naturally because these isolated states have strongly chaotic dynamics, with techniques from spectral geometry and contact topology, which can be effectively used to analyze the steady Euler equations on carefully chosen Riemannian manifolds.

4.1. Books



ICMAT researchers published the following books during 2025:

Bălibanu, Ana; Bursztyn, Henrique; Laurent-Gengoux, Camille; Louis, Ruben; Ryvkin, Leonid (eds. Garcia-Fernandez, Mario; Iglesias Ponte, David; Miranda, Eva; Oms, Cédric; Rubio, Roberto), Advances in Poisson Geometry**, Birkhäuser.**

This book presents recent advances in topics related to Poisson geometry originating from lectures given at the “Poisson School” held in 2022 at the CRM in Barcelona. The purpose is to give both an introduction to this active field of research as well as highlight new trends in related topics. The texts cover both classical results, known to experts in the field, as well as recent and previously unpublished mathematical results.
Graduate students and early-stage researchers with basic knowledge in differential and symplectic geometry, together with established researchers that are keen to dive into this rapidly growing field of research, will find this book a useful resource.

Bullach, Dominik; Macías Castillo, Daniel (eds.), *Arithmetic of L-functions. Proceedings of an International Conference held at ICMAT, Madrid, May 2023***, European Mathematical Society Press.**

This book is the result of a conference titled ‘Arithmetic of L-functions’, held at ICMAT (Madrid) in May 2023. The conference aimed at bringing together researchers to discuss this central and vibrant area of modern number theory, whose roots trace back to the groundbreaking work of Dirichlet and Kummer in the nineteenth century. In the second half of the twentieth century, the subject was revolutionised by the formulation and study of ‘main conjectures’ in Iwasawa theory, the Birch and Swinnerton-Dyer conjecture, and the ‘Tamagawa number conjecture’ due to Bloch and Kato. Through such conjectures and related results, the properties of L-functions informed the development of arithmetic geometry.



Image: Ministerio de Ciencia, Innovación y Universidades

5. SEVERO OCHOA PROGRAMME

The Severo Ochoa Centres of Excellence and María de Maeztu Units of Excellence Programme from the Spanish Ministry of Science, Innovation and Universities recognises research centres and units that demonstrate outstanding scientific leadership and international impact, while maintaining strong connections with their social environment and the productive sector.

In April 2024, and for the fourth consecutive time, ICMAT was awarded the Severo Ochoa seal of excellence by the Ministry of Science, Innovation and Universities. This distinction places ICMAT among a very limited group of centres that have achieved this recognition four times to date, consolidating its position as a leading international research institute in mathematics.

Since October 2017, ICMAT has been a member of the Alliance of Severo Ochoa Centres and María de Maeztu Units of Excellence (SOMMa), which brings together more than 60 of the most competitive research centres and units in Spain, representing a community of over 11,900 researchers. ICMAT plays an active role in the governance of the Alliance, with its Director currently serving as Second Vice-President of SOMMa's Executive Committee.

Throughout 2025, the Severo Ochoa Programme played a central role in sustaining ICMAT's scientific activity and its strategy for talent development. The programme supported an intense schedule of scientific events, including conferences, workshops, distinguished lectures, colloquia, courses, schools and seminars, which together attracted approximately 1,000 visiting researchers. These activities reinforced ICMAT's role as an international hub for mathematical research and fostered collaboration across a broad range of areas.

The programme also facilitated research visits by ICMAT members and enabled the participation of more than 80 students, including master's students and final-year undergraduate students from the JAE School, coming from universities across Spain. These students attended scientific activities at ICMAT and undertook research stays under the supervision of Institute researchers, contributing to their early integration into the research environment.

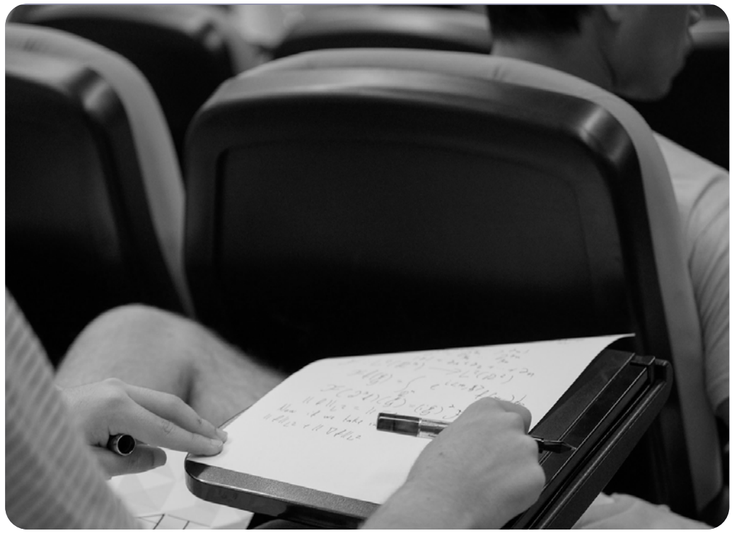
In parallel, ICMAT continued to strengthen its training and outreach initiatives. In 2025, the Institute launched the Mathematics Intensive Program (MIP) and continued the Pequeño Instituto de Matemáticas (PIM), which engages more than 150 secondary-school students who visit ICMAT on a weekly basis. The Institute also continued the INTRO-SO Grants, offering short research stays for undergraduate students under the supervision of ICMAT researchers, with 25 students participating during the year.

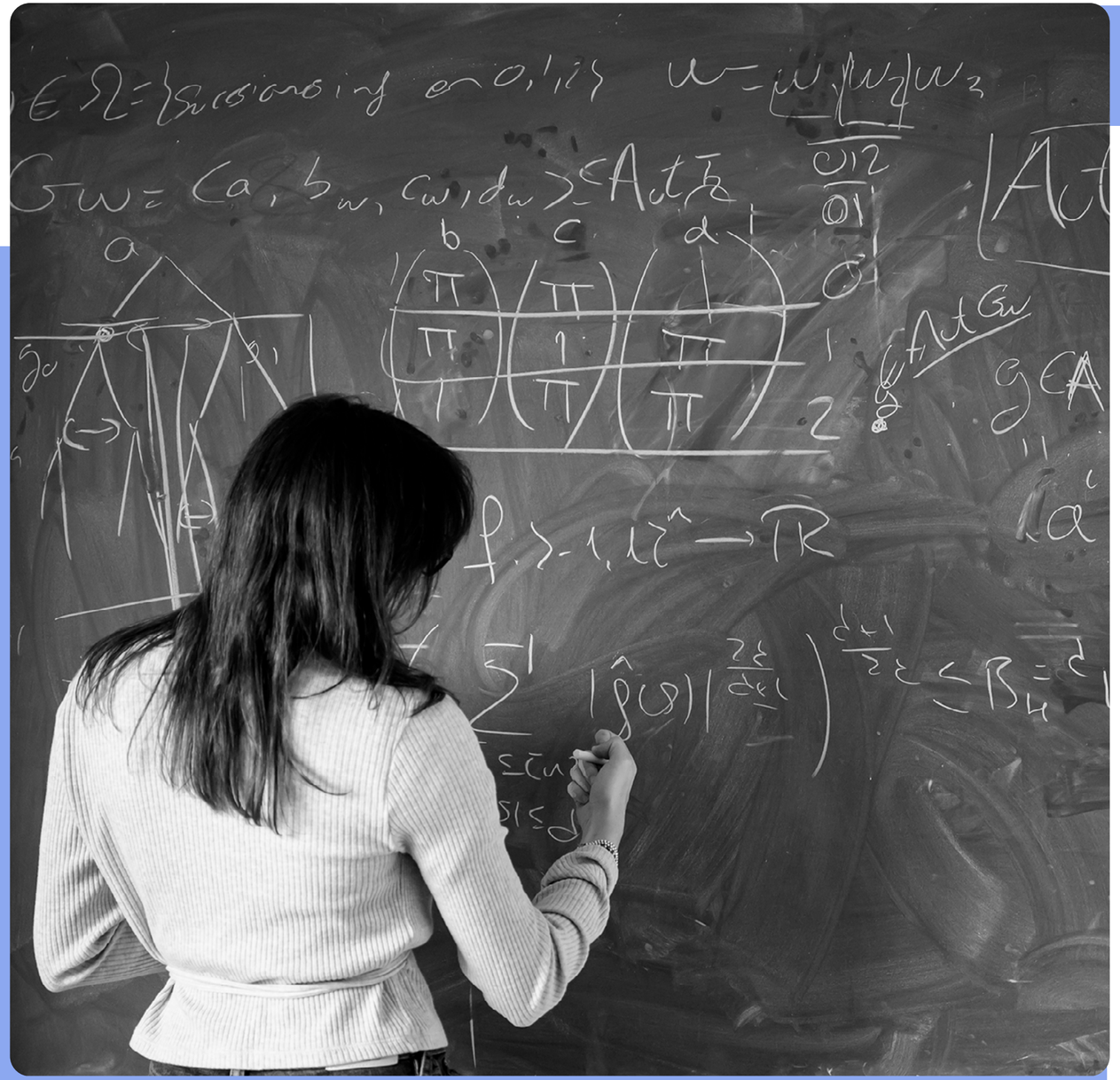
A cornerstone of the Severo Ochoa Programme at ICMAT is the Distinguished Professors and Laboratories Programme, currently in its fourth edition (2024–2028). Within this framework, a series of thematic laboratories are led by internationally renowned mathematicians, selected through a competitive international process. The chairs of the Severo Ochoa Laboratories are: Martin Bridson (University of Oxford, UK; Clay Mathematics Institute, USA) and Alan Reid (Rice University, USA); Ignacio Cirac (Max Planck Instituteof Quantum Optics, Germany); Charles Fefferman (Princeton University, USA); Nigel Hitchin (University of Oxford, UK) and Ngô Bảo Châu (University of Chicago, USA); Gilles Pisier (Texas A&M University, USA; Sorbonne Université, France) and Mikael de la Salle (Université de Lyon, France).

In addition, the programme includes a group of Distinguished Visiting Professors, whose role is to promote advanced research, mentoring and scientific exchange at the Institute. In 2025, these were: Bruno Anglès (Université de Caen Normandie, France); Elena Celledoni (Norwegian University of Science and Technology); Monika Ludwig (Technische Universität Wien, Austria); Eugenia Malinnikova (Stanford University, USA); Eva Miranda (Universitat Politècnica de Catalunya, Spain); and Eero Saksman (University of Helsinki, Finland).

Together, the Severo Ochoa Laboratories and Distinguished Professors generate dynamic local research clusters that attract a large number of international visitors, strengthen the scientific cohesion of ICMAT's research groups and reinforce the Institute's position as a key point of reference within the global mathematical community.

Finally, in 2025 ICMAT launched competitive calls for postdoctoral and predoctoral positions within the framework of the Severo Ochoa Programme. The postdoctoral call, including positions linked to Severo Ochoa Laboratories, attracted almost 700 expressions of interest, reflecting the Institute's strong international visibility and attractiveness. The predoctoral positions offered were successfully filled, with the selected candidates scheduled to begin their contracts in 2026.





6. RESEARCH PROJECTS

ICMAT research staff lead research projects that receive funding from different national and international sources. In total, in 2025 there have been more active research projects led by ICMAT research staff. The projects are listed below.

International Funding

European Funding

European Research Council Grants

Project	Code/Acronym	Reference	Principal Investigator	Start-final date
Quasiconformal Methods in Analysis and Applications	QUAMAP	ERC- Advanced Grant 834728	Kari Astala. ICMAT members: Daniel Faraco and Keith Rogers	01/09/2019 - 31/08/2025
Analysis of Geometry-Driven Phenomena in Fluid Mechanics, PDEs and Spectral Theory	FLUSPEC	ERC-Consolidator Grant 862341	Alberto Enciso	01/03/2021 - 28/02/2027

Societal Challenges Pillar

Project	Code/Acronym	Principal Investigator	Start-final date
A European “shield” against colorectal cancer based on novel, mor precise and affordable risk-based screening methods and viable policy pathways	ONCOSCREEN	David Ríos Insua	01/12/2022 - 30/11/2025

Other International Funding

Project	Code/Acronym	Principal Investigator	Start-final date
Robust Command and Control under Adversarially Perturbed Data	FA8655-21-1-7042	David Ríos Insua	22/09/2021 - 21/09/2025

National Funding

Public Funding

Grants for research projects

Project	Code/Acronym	Principal Investigator	Start-final date
Centros de Excelencia Severo Ochoa	CEX2023-001347-S	Diego Córdoba Gazolaz	01/04/2024 - 31/03/2028
Dinámica de fluidos incompresibles	PID2020-114703GB-I00	Ángel Castro and Diego Córdoba	01/09/2021 - 28/02/2025
Métodos Profinitos y Analíticos en Teoría de Grupos	PID2020-114032GB-I00	Andrei Jaikin	01/09/2021 - 31/08/2025
Methods and models for biomathematical applications	PID2020-112796RB-C21	Ana María Carpio	01/09/2021 - 31/08/2025
Espacios de Funciones y Técnicas de Acotación de Operadores en Análisis	PID2020-113048GB-I00	María Jesús Carro	01/09/2021 - 31/08/2025
Aplicaciones del análisis funcional en problemas de geometría y teoría de la información	PID2020-116398GB-I00	Pedro Tradacete	01/09/2021 - 31/08/2025
Herramientas matemáticas para observación de la tierra	PID2021-123348OB-I00	Ana Mª Mancho	01/09/2022 - 31/08/2025
Un nuevo paradigma para el aprendizaje automático adversario	PID2021-124662OB-I00	David Ríos	01/09/2022 - 31/08/2025
Análisis de Fourier con aplicaciones a teoría de medida geométrica y problemas inversos	PID2021-124195NB-C33	Keith Rogers	01/09/2022 - 31/08/2025

Project	Code/Acronym	Principal Investigator	Start-final date
Infinite groups from the algebraic, geometric, and combinatorial viewpoints	PID2021-126254NB-I00	Javier Aramayona and Concepción Martínez-Pérez	01/09/2022 - 31/08/2025
Análisis variacional y geometría aplicada a problemas inversos y mecánica	PID2021-124195NB-C32	Daniel Faraco and Luis Guijarro	01/09/2022 - 31/08/2025
Hacia una economía circular: tecnología digital disruptiva como herramienta para la innovación en el diseño y desarrollo de fármacos (DIGIDREV)	TED2021-129970B-C21	Nuria Eugenia Campillo Martín and David Ríos Insua	01/12/2022 - 30/09/2025
Modelización y simulación de electrolisis alcalina en configuración de Zero Gap	TED2021-131530B-I00	Marco Antonio Fontelos López	01/12/2022 - 31/05/2025
Red de Ecuaciones en Derivadas Parciales no Locales y Aplicaciones	RED2022-134784-T	Diego Córdoba Gazolaz	01/06/2023 - 31/05/2025
Geometría, Dinámica y Teoría de Campos	RED2022-134301-T	Daniel Peralta Salas	01/06/2023 - 31/05/2025
Red Temática de Geometría y Físicas	RED2022-134463-T	Oscar García Prada	01/06/2023 - 31/05/2025
Aspectos geométricos de teoría espectral e hidrodinámica	PID2022-136795NB-I00	Daniel Peralta Salas and Alberto Enciso Carrasco	01/09/2023 - 31/08/2026
Geometría de sistemas dinámicos: de la teoría a las aplicaciones	PID2022-137909NB-C21	David Martin de Diego	01/09/2023 - 31/08/2027
Fronteras del Análisis Armónico	PID2022-141354NB-I00	Javier Parcet Hernández and José María Martell Berrocal	01/09/2023 - 31/08/2027
Pares de Higgs, integrabilidad y métricas canónicas	PID2022-141387NB-C21	Oscar García Prada and Luis Álvarez Consul	01/09/2023 - 31/08/2026

Project	Code/Acronym	Principal Investigator	Start-final date
Simetrías e Invariantes en Geometría y Aritmética	PID2022-142024NB-I00	José Ignacio Burgos Gil and Daniel Macías	01/09/2023- 31/08/2027
Simetría espejo, álgebras de vértice y métricas canónicas	PID2022-141387NB-C22	Mario García Fernández	01/09/2023 - 31/8/2026
Simetría Espejo No-Kähler y Teoría de Gauge Superior	CNS2022-135784	Mario García Fernández	01/09/2023 - 31/08/2025
Teoria de Iwasawa no-conmutativa en característica positiva	CNS2023-145167	Daniel Macías Castillo	01/04/2024 - 30/06/2026
Geometria algebraica aritmética	PID2022-138916NB-I00	Enrique González and Orlando Villamayor	01/09/2023 - 31/08/2026
Dinámica asintotica y perturbaciones en ecuaciones en derivadas parciales	PID2022-137074NB-I00	Aníbal Rodríguez and Jose M Arrieta	01/09/2023 - 31/08/2026
EMOROBCARE	IASOMM24002	David Ríos Insua and Juan Antonio Rodríguez Aguilar	04/06/2024 - 28/02/2026
Sistema Remoto Integral de Monitorización, Detección y Predicción de Riesgos de Eventos Marinos Potencialmente Nocivos de Origen Natural o Antrópico en Áreas Off-Shore Destinadas a la Acuicultura	SIRENA	Ana Mª Mancho	22/07/2024 - 21/01/2026
Dinámica singular de fluidos incompresibles	PID2023-152878NB-I00	Diego Córdoba Gazolaz	01/09/2024 - 31/08/2027
Celestial mechanics, hydrodynamics and Turing machines	PCI2024-155062-2	Daniel Peralta Salas	01/11/2024 - 31/10/2027
Operator theory on free Banach spaces	PCI2024-155094-2	Pedro Tradacete	01/12/2024 - 30/11/2027

Project	Code/Acronym	Principal Investigator	Start-final date
Dinamica asintotica y perturbaciones en ecuaciones en derivadas parciales	PID2023-149451NA-100	María Medina de la Torre and Antonio Jesús Fernández Sánchez	01/09/2024 - 31/08/2024
EDPs no-lineales: flujos, desigualdades y geometría	PID2023-150166NB-I00	Matteo Bonforte and María del Mar González	01/09/2024 - 31/08/2027
EDP no locales en espacio y tiempo y aplicaciones a finanzas	PID2023-151120NA-I00	David Gómez Castro	01/09/2024 - 31/08/2027
Desarrollo de servicios transversales de inteligencia artificial	MMT24-CONEXIÓN IA-01	David Martín de Diego	20/11/2024 - 19/12/2028
SECURe artificIAl intelligence (MOMENTUM)	MMT24-ICMAT-01	David Ríos Insua	20/12/2024 - 19/12/2028
Langrangian and Hamiltonian field theories - Geometry, discretization, optimal control	PCI2024-155047-2	David Martín	31/12/2024 - 30/12/2027
Mapping class groups from above and below	PCI2024-155037-2	Javier Aramayona	31/12/2024 - 30/12/2027
Topology of Moduli Hodge bundles, G-Higgs bundles and character varieties of surface groups	PCI2024-155103-2	Óscar García Prada	31/12/2024 - 30/12/2027
Dinámica singular de fluidos incompresibles	PID2023-152878NB-I00	Diego Córdoba Gazolaz	01/09/2024 - 31/08/2027
Difusión no lineal: problemas locales y no locales	PID2023-146931NB-I00	Fernando Quirós	01/09/2024 - 31/08/2027

Project	Code/Acronym	Principal Investigator	Start-final date
EDPs no-lineales: flujos, desigualdades y geometría	PID2023-150166NB-I00	Maria del Mar Gonzalez and Matteo Bonforte	01/09/2024 - 31/08/2027
Las matemáticas de la teoría de información cuántica	PID2023-146758NB-I00	Carlos Palazuelos and David Pérez	01/09/2024 - 31/08/2027
Técnicas de perturbación singular en EDPs no lineales	PID2023-149451NA-I00	Antonio Fernández Sánchez and María Medina de la Torre	01/09/2024 - 31/08/2027
EDPs no locales en espacio y tiempo y aplicaciones a finanzas	PID2023-151120NA-I00	David Gómez Castro	01/09/2024 - 31/08/2027
Retículos de Banach, teoría geométrica de evaluaciones y aprendizaje automático	PID2024-162214NB-I00	Pedro Tradacete and Ignacio Villanueva	01/09/2025 - 31/08/2029
Espacios de funciones y técnicas de acotación de operadores en análisis	PID2024-155917NB-I00	María Jesús Carro and Javier Soria	01/09/2025 - 31/08/2029
Aritmética Combinatoria y análisis	PID2024-156180NB-I00	Fernando Chamizo and Pablo Candela	01/09/2025 - 31/08/2028
Grupos actuando en espacios de Cantor	PID2024-155800NB-C31	Javier Aramayona and Alejandra Garrido	01/09/2025 - 31/08/2029
Grupos y Álgebras de grupos	PID2024-155800NB-C33	Andrei Jaikin and Leo Margolis	01/09/2025 - 31/08/2029
Estabilidad en mecánica de fluidos incompresibles	PID2024-158418NB-I00	Angel Castro Martinez	01/09/2025 - 31/08/2028
Problemas Inversos y desigualdades	PID2024-156055NA-I00	María Ángeles García Ferrero	01/09/2025 - 31/08/2028
Haantjes geometry and integrable systems (HGIS)	PID2024-156610NB-I00	Piergiulio Tempesta	01/09/2025 - 31/08/2029

Project	Code/Acronym	Principal Investigator	Start-final date
Análisis y Geometría aplicada a problemas inversos y mecánica	PID2024-158664NB-C22	Keith Rogers	01/09/2025 - 31/08/2028
Categorias, grupoides y sus álgebras en teorías de campos y de la información	PID2024-160539NB-I00	Alberto Ibort Latre	01/09/2025 - 31/08/2028
Movimiento celular colectivo y matemáticas aplicadas a la biomedicina: simulación, análisis y problemas inversos	PID2024-155528OB-C21	Ana Carpio Rodríguez	01/09/2025 - 31/08/2029
Quantum Information Technologies Madrid	TEC-2024/COM-84-QUITEMAD-CM	David Pérez	01/01/2025 - 31/12/2028
Multiplicadores de Bochner-Riesz-Schur	EUR2025-164919	Javier Parcet	01/12/2025 - 30/11/2027
Coherencia en grupos y anillos de grupos	EUR2025-164928	Andrei Jaikin	01/12/2025 - 30/11/2027
Tiktoremas, un proyecto para llevar las matemáticas a TikTok	FCT-24-21348	Ágata Timón	01/07/2025 – 30/06/2026
Análisis y geometría aplicada a problemas inversos y mecánica	PID2024-158664NB-C22	Daniel Faraco and Luis Guijarro	01/09/2025 - 31/08/2028

Grants to recruit scientific personnel

Call	Funding Entity	Number of grants in effect in 2025
Formación de Profesorado Universitario	Ministerio de Ciencia, Innovación y Universidades (MICIU)	2
Formación de Investigadores Predoctorales	Ministerio de Ciencia, Innovación y Universidades (MICIU)	21
Programa Doctorado Industrial	Comunidad Autónoma de Madrid	1
Programa INVESTIGO	Comunidad Autónoma de Madrid	1
Programa Momentum	Agencia Estatal Consejo Superior Investigaciones Cientificas (CSIC)	2
Programas de doctorado	LaCaixa	5

Private Funding

Grants for research projects

Project	Programme	Principal Investigator	Start-final date
ZEREL DYNAMO	The Basement	David Ríos Insua	16/09/2023 - 31/05/2025
Instabilities in 2D incompressible fluids	Becas Leonardo 2023 BBVA Foundation	Ángel Castro	29/09/2023 - 29/09/2025
Development of a Training environment based on a reinforcement learning model in order to produce an intelligent training agent for Combat Aircraft pilots	Airbus Defence and Space SAU	David Ríos Insua	03/07/2024 - 02/03/2026
Desarrollo de funcionalidades de Intelligence Profiling usando analitíca predictiva avanzada	XEERPA MARKETING SOLUTIONS, SL	David Ríos Insua	01/10/2024 - 31/08/2025



7. SCIENTIFIC ACTIVITIES

Throughout 2025, there has been intense research activity, including approximately 9 conferences and workshops, 24 colloquia, 12 courses, 11 schools, and over 170 seminars. In total, more than 1050 visitors took part in these scientific events.

Workshops

In 2025, ICMAT hosted nine conferences and workshops. These meetings bring together experts from all over the world to share the latest advances in the frontiers of current research. A workshop usually includes several talks, courses and other scientific meetings.

Fluid mechanics at the ICMAT, 5-7 February

IX International Workshop on Information Geometry, Quantum Mechanics and Applications 2025 , 24-28 February

First Function Field days - Introductory lecture on Taelman's work on special L-values of Drinfeld modules , 10 April

First Function Field days, 14 April

Conference on Geometry at Large, an ICMAT-IMSA collaboration, 21-25 April

12th International Conference on Harmonic Analysis and Partial Differential Equations, 9-13 June

Extended special workshop of the Hitchin-Ngo Laboratory, 10-26 June

Groups in Madrid 2025, 25-26 September

Recent Trends in the Mathematics of Fluid Dynamics, 15-19 December







Distinguished Lectures

Distinguished lectures are a series of talks given by leading figures of international standing in mathematics. In 2025 the following lecture was held at ICMAT:

"Lifting problems past and present & Lifting and tensor products of operator algebras", Gilles Pisier (Sorbonne-Jussieu). 23 May



Special colloquia

Special colloquia are lectures given by internationally recognised researchers in which they present a research topic to a broad mathematical community.





Image: Laura Marcos/IFT

"Deep learning, structure preservation and shape analysis", Elena Celledoni (Norwegian University of Science and Technology and ICMAT-SO Distinguished Professor). 5 June

ICMAT-IFT Joint Colloquium: "Geometry of gauge theories in two dimensions", Oscar García Prada (ICMAT-CSIC). 12 December

Joint Mathematics Colloquium (ICMAT-UAM-UC3M-UCM)

The joint colloquia are conferences organised on an itinerant basis at ICMAT, UAM, UCM and UC3M. They bring researchers in mathematics of international relevance to share their latest results with other mathematicians, not strictly specialists in their field.

"Williams' conjecture holds for meteor graphs", Elizabeth Gillaspy (University of Montana), 27 January

"Partitions detect primes", Ken Ono (University of Virginia), 9 May

"Galois representations associated to Drinfeld modules", Richard Pink (ETH, Zurich), 13 June

"Special metrics in Kähler geometry", Eleonora Di Nezza (Università degli studi di Roma), 7 November

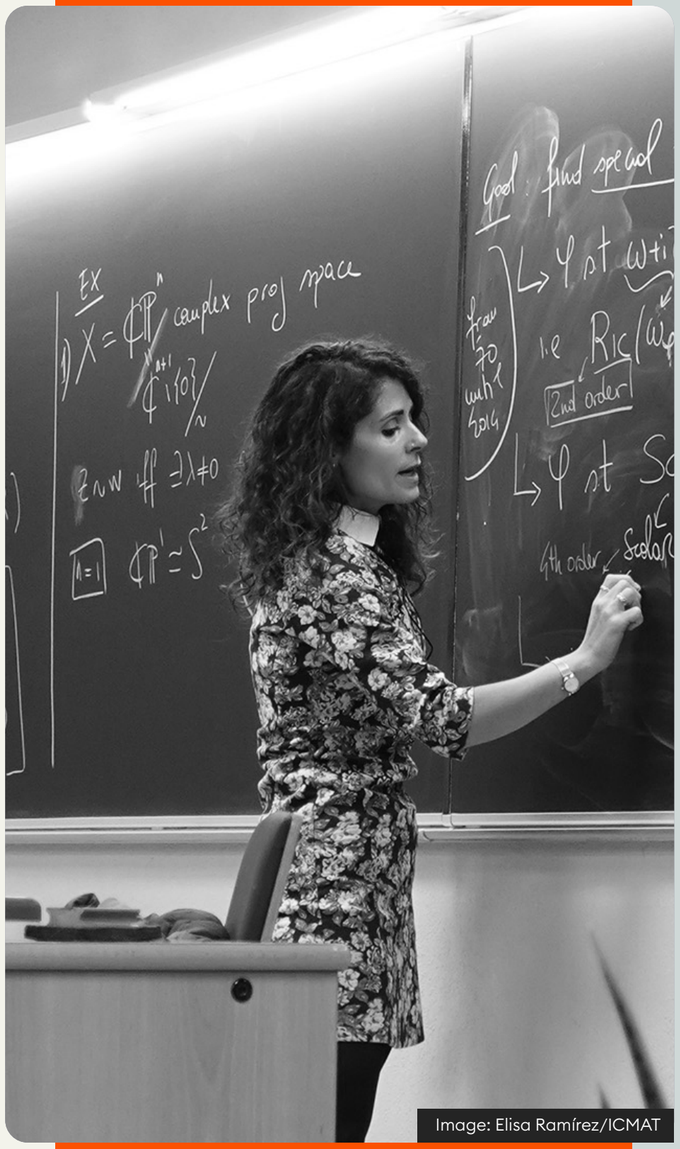


Image: Elisa Ramírez/ICMAT

Schools

Research schools are intensive programmes that aim to provide an introduction to a current research topic for pre and post-doctoral researchers in mathematics.

Primitive School on the Mapping Class Group.
12, 14, 19, 21, 26, 28 March

Advanced School on Mapping Class Groups, Surface Subgroups, Bundles, and Group Extensions.
5-9 May

RGAS Summer School on Perfectoid Techniques.
19-23 May

XVII International ICMAT Summer School on Geometry, Dynamics and Field theory.
23-27 June

JAE School of Mathematics 2025.
23 June – 4 July

Courses

A Brief Introduction to G2-Geometry, Andrés Julián Moreno Ospina (UNICAMP) (9 April & 16 April)

Vertex algebras, semi-infinite forms and the boson-fermion correspondence, Jethro Van Ekeren (IMPA).
22, 24, 27, 31 January and 5, 7 February

Canonical metrics in complex geometry - Part 1: Kahler geometry, Federico Giusti (ICMAT).
24, 28 February, 3, 7 March

Canonical metrics in complex geometry - Part 2: Non-Kahler geometry, Federico Giusti (ICMAT).
24 March, 4, 7, 11, April

Geometría de Stacks, Emilio Franco (ICMAT-UAM).
31 March, 7 April, 11 April

A Summer Tapas Invitation to Higher Structures in Symplectic and Poisson Geometry II, Alejandro Cabrera (UFRJ), Miquel Cueca (KU Leuven), Chenchang Zhu (University of Göttingen). 9 July

Nets in vector lattices and functional analysis, Youssef Azouzi (Université de Carthage, Tunisia). 3-6 November

The space of Kähler potentials , Eleonora Di Nezza (Tor Vergata). 4, 6, 11, 12 November

Flows of Geometric Structures, Andrés Julián Moreno Ospina (IMECC - Unicamp).
27 November, 4, 11, 18 December

Introductory Lecture - What is ... a toric sheaf?, Carl Tipler (Université de Bretagne Occidentale). 2 December

Seminars

Seminars (one-hour meetings in which researchers share their own results) are held every week at ICMAT in different areas:

- Analysis and Applications Seminar
- Analysis and PDEs Seminar
- Applied Mathematics Seminar
- Communtative Algebra-Algebraic and Aritmetic Geometry UAM-ICMAT Seminar
- DataLab Seminar
- Geometry Seminar
- Geometry, Mechanics and Control Seminar
- Group Theory Seminar
- Machine Learning Seminar
- Number Theory Seminar
- PDEs and Fluid Mechanics Seminar
- PDE UAM-ICMAT Seminar
- Q-Math seminar
- Other seminars

Joint Mathematics Junior Colloquium

The Junior Colloquium is an activity organised by pre-doctoral researchers, which aims to stablish links between young investigators in mathematics in the Community of Madrid, as well as to raise awareness of the various areas of research that they are developing. A session is held approximately every two weeks (usually on Wednesdays at 17:00h), taken place between ICMAT and UAM, in which there will be a talk and an informal discussion.

Working groups

Meetings where a scientific topic is discussed in a smaller setting.

De Picasso a Gromov - Separabilidad, casi-convexidad y la alternativa de Tits, Henrique Souza.
10, 17 January

Reading Groupoid. Every Tuesday from 7 October

Reading Group in Probabilistic Machine Learning.
Every 15 days from 5 November





8. TRAINING

ICMAT is committed to training new generations of researchers. At the doctoral level, PhD theses are supervised and research schools are organised (included in the Scientific Activities section); at university level, the JAE School for initiation to research is organised; and at pre-university level, ICMAT organises the Pequeño Instituto de Matemáticas (PIM).

Theses



17 researchers completed their PhD theses at ICMAT in 2025.

Banach lattices and free objects, Enrique García Sánchez

Advisor: Pedro Tradacete (ICMAT-CSIC)
Date: December 2025

Some results in diffusive partial differential equations, Joaquín Domínguez de Tena

Advisors: José María Arrieta Algarra and Aníbal Rodríguez Bernal (ICMAT-UCM)
Date: November 2025

The Complemented Subspace Problem in Banach lattices, David de Hevia

Advisor: Pedro Tradacete (ICMAT-CSIC)
Date: October 2025

Privacy via tensor network methods. Privacidad mediante métodos de redes tensoriales, José Ramón Pareja Monturiol

Advisors: David Pérez García (ICMAT-UCM) and Alejandro Pozas Kerstjens (UCM)
Date: October 2025

Topics on noncommutative Fourier multipliers, Jorge Pérez García

Advisors : Adrián M. González Pérez (UAM), Javier Parcet (ICMAT-CSIC)
Date : September 2025

Haantjes Geometry and Integrable Systems: A Tensorial Approach to Geometric Mechanics, Daniel Reyes Nozaleda

Advisor: Piergiulio Tempesta (ICMAT-UCM)
Date: July 2025

High-energy Eigenfunctions of the Laplacian: Localization Properties and Relation with Berry's Random Wave Model, Alba Dolores García Ruiz

Advisors: Alberto Enciso Carrasco (ICMAT-CSIC), Daniel Peralta-Salas (ICMAT-CSIC)
Date: July 2025

Espacios de preórdenes izquierdos de grupos , Ivan Chércoles Cuesta

Advisors: Yago Antolín Pichel (ICMAT-UCM)
Date: July 2025

Problems in elliptic and parabolic PDEs coming from probability, geometry and game theory, Irene Gonzálvez Martínez

Advisors: Fernando Quirós (ICMAT-UAM), Fernando Soria (ICMAT-UAM)
Date: June 2025

Elliptic and parabolic equations in rough domains , Pablo Hidalgo Palencia

Advisors: José María Martell Berrocal (ICMAT-CSIC)
Date: June 2025

On Some Isotopy Questions in 3-Dimensional Contact Topology , Dahyana Eugenia Farias Uncovich

Advisors: Eduardo Fernández Fuertes (UAM), Francisco Presas Mata (ICMAT-CSIC)
Date: June 2025

Rigidity results for the mapping class group, Rodrigo de Pool

Advisor: Javier Aramayona (ICMAT-CSIC)
Date: May 2025

Purely inseparable extensions of rings, Celia del Buey de Andrés

Advisor: Orlando Villamayor (ICMAT-UAM)
Date: April 2025

Moduli of Higher Connections and Holomorphic 2-Bundles, Roberto Téllez

Advisors: Luis Álvarez Cónsul (ICMAT-CSIC), Mario García Fernández (ICMAT-UAM)
Date: February 2025

Nonlocal Porous Medium Equations and a PDE approach to Machine Learning, Peio Ibarrondo Murguialday

Advisors: Matteo Bonforte (ICMAT-UAM), Davide Barbieri (ICMAT-UAM)
Date: February 2025

Shadowing and hiperbolicity for infinite dimensional dynamical systems, Carlos Roberto Takaessu Jr

Advisors: José M. Arrieta (UCM-ICMAT), Alexandre N. Carvalho
Date: January 2025

Solutions for the Muskat equation with quadratic growth at infinity, Omar Sánchez

Advisors: Ángel Castro (ICMAT-CSIC), Daniel Faraco (ICMAT-UAM)
Date: January 2025

Métodos matemáticos y computacionales en elastografía, Carolina Abugattas Chacoff

Advisor: Ana María Carpio Rodríguez (ICMAT-UCM)

Date: September 2025

Mathematics Intensive Programme (MIP)



In October 2025, ICMAT launched the Mathematics Intensive Programme (MIP), the first intensive training programme for undergraduate mathematics students in Spain. Through this initiative, Spain aligns itself with a long-standing tradition of excellence represented by elite institutions in other European countries, such as France's École Normale Supérieure (ENS) and the Scuola Normale Superiore in Pisa, which have served as training centres for some of the world's most outstanding mathematicians, including several Fields Medal recipients.

"The Mathematics Intensive Programme was conceived to provide a very small group of undergraduate students with exceptional mathematical ability with a high-level complementary education within a particularly stimulating academic environment", explains Javier Aramayona, Director of ICMAT.

In its first year, MIP welcomes four students who have recently begun their undergraduate studies in Mathematics in Madrid, selected from more than 70 applicants. The participants are Gonzalo San Vicente, enrolled in the double degree in Mathematics and Physics at the Complutense University of Madrid (UCM); Iván López Navarro, a Mathematics student at the Autonomous University of Madrid (UAM); Justo Juan Salcedo Otero, studying Mathematics at UCM and Physics at the National University of Distance Education (UNED); and Sofía Paz Chacón, a Mathematics student at the UAM.

Each participant is assigned an ICMAT researcher as a mentor for the duration of the four-year programme. The mentors for the current academic year are Diego Córdoba, Mario García Fernández, Andrei Jaikin and David Martín de Diego, all of whom are active researchers in different areas of mathematics. "Through regular meetings, recommended readings and ongoing guidance, the mentors foster each student's scientific curiosity", explain María Ángeles García-Ferrero (ICMAT-CSIC) and David Martín de Diego (ICMAT-CSIC), coordinators of the programme. Additional mentors will join the programme in subsequent years.

In addition to the mentoring component, MIP offers advanced thematic minicourses and complementary activities, which are also open, subject to prior registration, to other undergraduate Mathematics students. Each minicourse consists of three one-hour sessions held on Friday afternoons at ICMAT's premises.

The programme is free of charge for participating students and runs throughout the four years of their undergraduate degree. Upon completion, participants will receive a specific certificate issued by the CSIC recognising their participation in this programme of excellence.

Pequeño Instituto de Matemáticas (PIM)



From September 2025, 140 students aged between 12 and 18 once again meet every Friday of the school year to enjoy mathematics at Pequeño Instituto de Matemáticas (PIM) (Little Institute of Mathematics) of ICMAT. From 17:30 to 20:00, at the Institute's premises, the activity focuses on tackling, collaboratively, challenging mathematical problems that require more than simply applying a formula.

The project, free of charge for participants, began in the 2022-2023 academic year with the aim of providing an environment in which young people passionate about mathematics could develop their interest in the discipline by solving problems different from those usually presented in the classroom. "These are exercises that reflect the challenges STEM professionals face in real life and show the diverse and multifaceted nature of mathematics," explain the organisers. To face these challenges, students share ideas with each other and also with the teaching team, which consists mostly of mathematics researchers from the ICMAT and the Autonomous University of Madrid (UAM), as well as former students of previous editions of the PIM.

Another of the most notable aspects of the PIM is its human value: it is a space to connect people who share the same passion for mathematics.

JAE School



From 23 June to 4 July 2025, 86 final-year undergraduate and Master's students (30.4% of them women) had the chance to engage directly with cutting-edge research topics and professionals at the JAE School of Mathematics at ICMAT. "Over the course of these weeks, a fruitful interaction was established between top-level researchers and students who enjoy mathematics, in an exceptional environment," said the organisers.

Although the majority of the 2025 JAE School students came from Spanish universities (65% from Madrid, but also from Barcelona, Zaragoza, Granada, Santiago de Compostela, Alicante, Valladolid, Oviedo and Bilbao), this year's cohort also included students from Sorbonne University (France), Brown University (USA), Federal University of Minas Gerais (Brazil), Oxford and Heriot-Watt (both in the UK), the University of Bucharest (Hungary) and ETH Zürich (Switzerland).

The programme itself was also highly international: the six mini-courses were delivered by highly prestigious researchers from around the world. Each of these courses provided an accessible introduction to important research areas, tailored for undergraduate students.

In 2025, the School was organized by Daniel Peralta-Salas (ICMAT-CSIC) and Diego Córdoba (ICMAT-CSIC), director of the centre's Severo Ochoa programme.

Alongside the School, ICMAT also runs the 2025 Severo Ochoa Introductory Research Fellowships (INTRO-SO). Through this programme, 25 undergraduate students–and, exceptionally, Master's students, who also attend the JAE School–undertake a one-month training placement (between 9 June and 31 July 2025), supervised by a researcher at ICMAT. They work on a topic of their choice from a list of proposed subjects. The aim of these fellowships is to introduce participants to some of ICMAT's research lines and actively involve them in the Institute's scientific activity.

In 2025, the School was organized by Daniel Peralta-Salas (ICMAT-CSIC) and Diego Córdoba (ICMAT-CSIC), director of the centre's Severo Ochoa programme.



9. AWARDS AND DISTINCTIONS

In 2025 the excellence of the ICMAT's scientific staff has been recognised with various national and international awards and mentions.

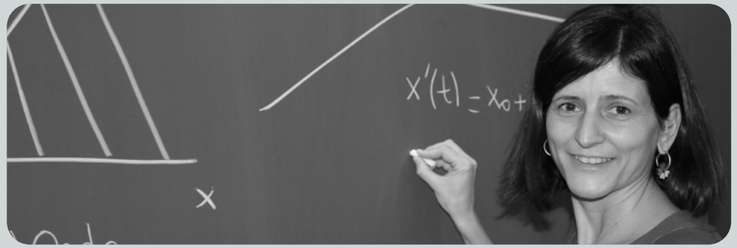
Javier Parcet, David Pérez García and Ágata Timón will participate in the International Congress of Matehmaticians (ICM) 2026



From 23 to 30 July 2026, the most important mathematical forum will be held in Philadelphia (USA): the International Congress of Mathematicians (ICM). The list of speakers includes ICMAT members: Javier Parcet, Research Professor at the Spanish National Research Council (CSIC) at ICMAT, and David Pérez García, Professor at the Complutense University of Madrid (UCM) and ICMAT member, who will be invited speakers in the Analysis and Mathematical Physics sections, respectively. In addition, Ágata Timón, Coordinator of the ICMAT Mathematical Culture Unit, will participate in a roundtable on public communication of mathematics.

More info

Ana Primo, Young Female Scientific Talent Award, by Mastercard and the Royal Academy of Sciences of Spain Foundation



On 11 February, Ana Primo, a member of ICMAT and associate professor at the Autonomous University of Madrid (UAM), received the Young Female Scientific Talent Award in the 'Mathematics' category, granted by Mastercard and the Royal Academy of Sciences of Spain Foundation (FRACE). Primo is an expert in partial and nonlinear differential equations.

For more info, read the interview with Primo

Nigel Hitchin receives the prestigious 2025 De Morgan Medal from the London Mathematical Society



Nigel J. Hitchin, Emeritus Professor at the University of Oxford and co-director of the Nigel Hitchin – Ngô Bảo Châu Laboratory at ICMAT, was awarded the 2025 De Morgan Medal by the London Mathematical Society, in recognition of his contributions to differential geometry and its connection with theoretical physics.

More info

Two researchers who completed their PhDs at ICMAT, first Spaniards to receive the Mathematical Council of the Americas Prize



Images: UC Davis and ICREA

The Mathematical Council of the Americas (MCA) awarded two of its five MCA 2025 Prizes to researchers who completed their PhDs at ICMAT: Javier Gómez Serrano, a researcher at Brown University (USA), an expert in partial differential equations; and Roger Casals, a researcher at the University of California, Davis (USA), a specialist in symplectic and contact topology. This is the first time a Spaniard has received this award, which recognises, every four years, the work of researchers at the mid-career stage who were trained in or are currently working in an American country.

More info

David Gómez-Castro receives the SeMA Prize for Best Article in SeMA Journal



Image: Courtesy of the researcher

The article 'Beginners guide to aggregation-diffusion equations', written by David Gómez Castro, Ramón y Cajal lecturer in UAM and ICMAT member, was recognised with the SeMA Award for Best Article in SeMA Journal in 2024. The Sociedad Española de Matemática Aplicada awards this prize from among all the works published in the SeMA Journal during the year prior to its announcement.

More info

Clara Torres Latorre and Eduardo Tablate, RSME-FBBVA Vicent Caselles Awards 2025





Images courtesy of the researchers

Eduardo Tablate, adjunct professor at CEU San Pablo University, received one of the Vicent Caselles awards, granted by the Spanish Royal Mathematical Society and the BBVA Foundation, for his thesis in group theory and functional analysis, developed in ICMAT under the supervision of Javier Parcet (ICMAT-CSIC) and José Conde (ICMAT-UAM).

Clara Torres Latorre, postdoctoral researcher in ICMAT, was also recognised with one of the Vicent Caselles awards for her thesis in partial differential equations, carried out at the University of Barcelona under the supervision of Xavier Ros Oton (UB, ICREA, CRM).

For more info, read the interview with Tablate and Torres.

Guillermo García Sánchez receives the 2023/2024 Extraordinary Doctorate Award, granted in November 2025 by the UPM



Image: Courtesy of the researcher

Guillermo García Sánchez, former doctorate student in ICMAT, received the 2023/2024 Extraordinary Doctorate Award, granted in November 2025 by the Polytechnic University of Madrid (UPM). García Sánchez developed his thesis in ICMAT under the supervision of Ana María Mancho (ICMAT-CSIC) in the field of transport in ocean flows.

More info



10. MATHEMATICAL CULTURE

The Mathematical Culture Unit (UCMAT), in collaboration with the Institute's scientific staff, develops a wide range of communication materials aimed at communicating both ICMAT's mathematical activities (new scientific results, events, visits by outstanding mathematicians or the awarding of grants and prizes) and mathematics in general to a wider audience.

These materials, delivered in 2025 through various formats and platforms, include +55 pieces (news articles, interviews and report) published on the ICMAT website, some of which are also distributed to the media as press releases, as well as videos. Within ICMAT's web content, two sections stand out in particular: ICMAT Alumni, that features profiles of researchers who completed their PhD theses at ICMAT and who currently have recognized academic careers, and Horizontes de las Matemáticas, a section presenting topics in advanced research, introduced by researchers invited to the Joint Mathematics Colloquium jointly organised by ICMAT, the Autonomous University of Madrid (UAM), the Complutense University of Madrid (UCM) and the Carlos III University of Madrid (UC3M).

Another communication channel of ICMAT is the ICMAT Newsletter: a monthly bulletin that provides updates on the centre's latest developments, including news, activities, projects, visitors, and more. Anyone interested can subscribe to the newsletter through this link.

The unit further extends its reach through active engagement on social media. ICMAT maintains a strong presence on major platforms, **including**: (as of January 2026) Facebook (34 000 followers), X (29 700 followers), Instagram (3411 followers), YouTube (5000 subscribers; 353 440 views), Linkedin (1816 followers) and BlueSky (801 subscribers).

ICMAT staff regularly collaborate with media outlets, either in response to specific requests from journalists or through initiatives developed by the Mathematical Culture Unit. In 2025, over 40 pieces mentioning ICMAT or its staff members have been published.

During 2025, a total of 11 articles were published in the 'Café y Teoremas' section, a collaboration with El País that ICMAT has maintained for the past ten years. The section will come to an end in early 2026. In parallel, during 2025 ICMAT launched two new monthly sections devoted to mathematics in mainstream media: "Dimensión fractal" in eldiario.es and "Entre teoremas" in ABC. The first article in each of these sections was published in December 2025.



OUTREACH ACTIVITIES

4º ESO+Empresa



ICMAT is participating in the Community of Madrid programme 4ºESO+Empresa (4th Grade Secondary Education + Company), which provides young students with the chance to carry out educational visits to companies and research centres. In 2025, 30 students were able to spend three days getting to know the daily activity of ICMAT, with the purpose of showing these students the type of work is done at the Institute and to stimulate scientific vocations. These students attended talks and wokshops given by ICMAT personnel, such as Javier Aramayona (ICMAT-CSIC), David Ríos (ICMAT-CSIC), Enrique García-Sánchez (ICMAT-CSIC), Pablo Hidalgo (ICMAT-CSIC), Ricardo Martínez de Madariaga (CFTMAT-CSIC), Mar González (ICMAT-UAM), Ana Primo (ICMAT-UAM), Juan Manuel López (ICMAT-CSIC) and Ana Bravo (ICMAT-UAM). They also enjoyed a scavenger hunt, organised by QED, UAM Mathematics student's association.

Date: 7, 8 and 9 April

Mathematics at the Residencia

Mathematics at the Residencia consists of a series of talks by internationally renowned speakers. It is organized by ICMAT in collaboration with the CSIC Vice-presidency of Organization and Scientific Culture (VACC) and the Residencia de Estudiantes of Madrid.

In 2025, the following talks were celebrated:

"Enigmas y patrones de los números primos. De Golbach a los primos gemelos", by Harald Helfgott (CNRS, Institut de Mathématiques de Jussieu, Paris VI/VII University)

Date: 30 June



Image: Residencia de Estudiantes

"¿Es la realidad como creemos? Matemáticas y cuántica para descifrarla", by Alberto Ibort (ICMAT-UC3M)

Date: 4 November

This activity, in addition to being part of Mathematics at the Residence series, was included in the celebrations of the International Year of Quantum Science and Technology 2025 and in the Science and Technology Week.



Image: Residencia de Estudiantes

European Researchers' Night

European Researcher's Night is aimed at bringing the general public closer to researchers in person in a festive and entertaining way in order to show the benefits they provide for society and their influence on daily life. Researchers' Night is associated with the European celebration of this event.

In 2025, the European Researchers' Night was celebrated on 26 September. ICMAT participated in the joint activity organized by the CSIC centres at Campus de Cantoblanco, entitled "El CSIC te llama esta noche". A large open fair has been organised in Fundación Espacio Telefónica to welcome people interested in learning about the science being done in these centres. There were workshops, scientific demonstrations, monologues and an exhibition (Escape-road: "A la búsqueda de las científicas Nobel y no Nobel"), on a wide range of research topics. The activity, as part of NIGHTMADRID, a science outreach project, coordinated by Fundación madri+d and funded by the European Union within the Horizon Europe Programme, under the Marie Skłodowska-Curie actions.

ICMAT organised two experimental workshops:

"Mathematics in motion: a glimpse into the world of fluids", given by Andrés Laín Sanclemente, José Antonio Lucas and Mencía Reborido, predoctoral researchers at ICMAT.

"The mathematics of electronic music", by Carlos García Meixide, predoctoral researcher at ICMAT.







Science Week

The Science and Technology Week is one of the leading events in social communication of science and technology held in Spain. ICMAT has participated in this scheme since 2009 by programming conferences and dissemination workshops addressed to all types of audiences. The main objective of these activities has been to improve the social perception of mathematics by revealing its surprising, unexpected and amusing features as well as those most closely related to society in general.

The Institute organised the following activities in 2025:

"**¿Es la realidad como creemos? Matemáticas y cuántica para descifrarla"**, by Alberto Ibort (ICMAT-UC3M)

Date: 4 November
Place: Residencia de Estudiantes de Madrid

This activity, in addition to being part of Science and Technology Week, is included in the celebrations of the International Year of Quantum Science and Technology 2025 and in the Mathematics at the Residence series.

"**From the path of a ball to the motion of waves**", by Ángel Castro (ICMAT-CSIC)

Date: 6 November
Place: Biblioteca José Saramago, Madrid

This activity was also part of the Aula Encuentros de Ciencia programme, a series of public outreach talks organised by the Asociación Cultura Sénior.

Initiative for Mathematics and the Arts

Iniciativa por las Matemáticas y las Artes (IMA – Initiative for Mathematics and the Arts) is a platform created with the aim of promoting joint activities between mathematics and the art. Within the framework of this initiative, ICMAT organised the following activities in 2025:

Theatre play 'Ada Byron: The Weaver of Numbers' and round-table discussion

To commemorate 8 March, International Women's Day, and 14 March, International Mathematics Day, the ICMAT and the Universidad Carlos III de Madrid (UC3M) organised this theatre play, followed by a round table discussion on a pioneering mathematician, Ada Lovelace, which was the starting point for reflecting on the evolution of the situation of women in this discipline.

Date: 5 March
Place: Auditorio Universidad Carlos III de Madrid, Campus de Leganés



An Invitation to Ethnomathematics

ICMAT launched an international working group dedicated to ethnomathematics in 2025. This is a discipline that unites mathematics, anthropology, arts, and other areas of the humanities. Its first activity included three lectures on some of these cultural manifestations: Inca quipus, house decoration in South Africa, Chokwe Sona drawings from Angola, or geometric ornamentation in Islamic art.

Speakers: Steven Bradlow (UIUC, Illinois), Antonio Costa (UNED, Madrid), Manuel de León (ICMAT, Madrid)

Date: 19 June
Place: ICMAT



11 February commemoration, International Day of Women and Girls in Science

ICMAT has joined in celebrating 11 February, International Day of Women and Girls in Science since 2018. The following activity was organised in 2025:

Workshop: 'Mathematics with a name of its own: Women who made history in mathematics', given by Alba García Ruiz (ICMAT-CSIC), for high school students.

Date: 12 February

More information in page 58 of this annual report.



May 12, Celebrating Women in Mathematics

ICMAT celebrated the international women in mathematics day in 2025 with a YouTube video in which María de la Paz Tirado Hernández (ICMAT-UAM) answered questions such as What is research in mathematics? What is the day-to-day work of someone who does it like? What kinds of problems are studied? What is it like to do a PhD?

More information in page 58 of this annual report.

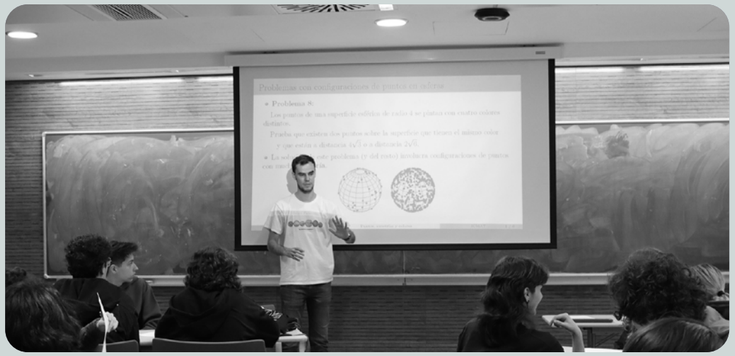


School visits

Every year, ICMAT receives visits from students from different educational levels, with the aim of showing them the centre's activities, the mathematics research career, the people who develop it, etc.

In April, ICMAT, together with IFT (Instituto de Física Teórica), organised a day of workshops and talks on physics and mathematics for gifted students in the Community of Madrid. On behalf of ICMAT, researchers Luis Álvarez Cónsul and Pablo Hidalgo, gave a talk and a workshop, respectively.





In June, students from the UAMMAT Summer Mathematics Camp visited ICMAT. Ana Bravo (ICMAT-UAM) and Alba García Ruiz (ICMAT-CSIC) gave a talk about ICMAT and research in mathematics and a workshop.





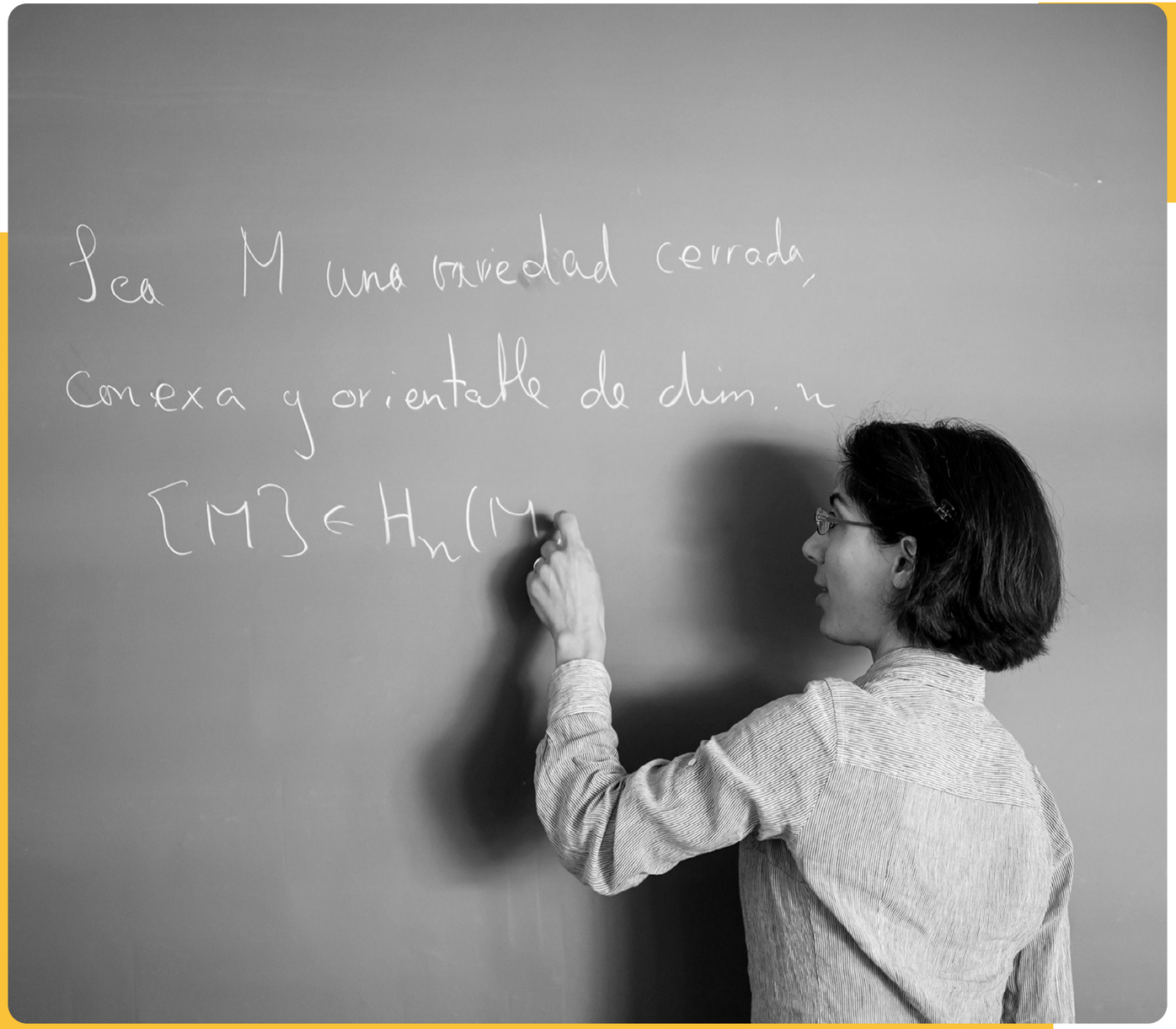
Science in Action

Science in Action is a competition based on innovative ideas to bring science closer to the general public. Those selected in the first phase present their proposals live in a grand finale that become a great celebration of science. Together with other scientific institutions, ICMAT supports this initiative financially and is part of the scientific jury that selects the finalists.

Audiovisual Communication

UCMAT produces and uploads videos (public lectures, interviews, outreach videos, institutional reports, dissemination of calls for proposals), on the ICMAT YouTube channel and on social media.





11. EQUALITY ACTIONS

*Since 2016 ICMAT has had an **Equality Committee,** which demonstrates its commitment to promoting inclusivity and diversity through its many programmes and collaborations. These initiatives not only celebrate the achievements of underrepresented groups in STEM, but also inspire future generations to pursue careers in science and mathematics.*

During 2025, the Equality Committee of ICMAT was composed by Ana Bravo (ICMAT-UAM), José M. Conde (UAM-ICMAT), María Ángeles García Ferrero (ICMAT-CSIC), David Martín de Diego (ICMAT-CSIC), Laura Moreno Iraola (ICMAT-CSIC), Yamilet Quintana (UC3M-ICMAT), Ágata Timón (ICMAT-CSIC) and Nuria Torrado (ICMAT-UAM). The committee was coordinated by Nuria Torrado until August and by María Ángeles García Ferrero from September.

Throughout the year, the Equality Committee organized and participated in a variety of initiatives aimed at promoting equality and diversity within the scientific community.

11 February, International Day of Women and Girls in Science



One of the highlights of the year was the celebration of the International Day of Women and Girls in Science on 11 February. As part of this celebration, the ICMAT welcomed more than 40 third-year high-school students who participated in the workshop "Women in their own right". Conducted by the predoctoral researcher Alba D. García Ruiz, the workshop introduced several Spanish women with remarkable contributions to mathematics in the past. In addition, the students participated in an interactive contest about what they have learnt.

On Monday, February 10, some participants from the Pequeño Instituto de Matemáticas (PIM) at ICMAT brought their love for mathematics to the II Fair of Women and Girls in Science, held at the Ministry of Education, Vocational Training, and Sports. Among others, they had the opportunity to converse with Pedro Sánchez, President of the Government of Spain, and Pilar Alegría, Minister of Education, Vocational Training, and Sports.

Moreover, Javier Aramayona (ICMAT-CSIC) delivered the talk "Maryam Mirzakhani, surfaces explorer" in a high-school for 15–17-year-old students. Eva Gallardo (ICMAT-UCM) was one of the speakers at the "I Am a Woman in STEAM" panel, organized by the Ayuntamiento de Las Rozas. In this event, professionals from various scientific fields shared their work and experiences as women dedicated to science with an audience of nearly 200 students from schools in Las Rozas (Madrid).

12 May, Celebrating Women in Mathematics

As part of the commemoration of the International Women in Mathematics Day, the ICMAT shared a video starred by María de la Paz Tirado Hernández, assistant professor at the UAM and member of the ICMAT. She shared her insights about what mathematical research entails or how mathematicians' daily life looks like. She also talked about her research on algebraic geometry.

STEMatEsElla Programme

Another major initiative supported by the committee was the fifth edition of the STEMatesElla mentoring programme, which took place during the first half of the year. This programme, organized by the Spanish Association of Executives and Counselors (EJE&CON) and the Royal Spanish Mathematical Society (RSME), in collaboration with ICMAT, Akermann International, and the Basque Center for Applied Mathematics (BCAM), connected female students in the final stages of their undergraduate or master's studies in STEM fields with professional women in science and business. The closing ceremony for this edition, along with the launch of the sixth edition, was held on 2026, 16th January at ICMAT. No subsequent edition has been launched and the program is paused by now.

Science by Women programme, Women for Africa Foundation

Through the Science by Women programme, of Women for Africa Foundation, ICMAT hosted Babel Raïssa Guemdjo Kamdem, a researcher from an African country selected as part of the tenth edition of the Science by Women programme launched in September 2024. During her six-month stay at ICMAT in 2025, she collaborated with the research group led by David Ríos on a project titled "Novelty Detection Using Kernel Null Foley-Sammon Transform." Halfway through her stay, she gave an interview in which she shared her work at ICMAT and the impact of this stay in her career.



The ICMAT has paused its participation in the programme for future editions.

Equality Intercenter Network CSIC

This network is integrated by the Equality Committees of ten CSIC Institutes located in the Campus of Excellence UAM+CSIC. The purpose of the network is to promote links between the CSIC Equality Groups on campus, to exchange recommendations and good practices and to organize several joint outreach activities, most notably the Escape-Road: A la búsqueda de las científicas Nobel y no Nobel. This activity presents a tour through the biography and work of several female scientists awarded with the Nobel Prize, and also with the Field Medal or the Abel Prize.

Participating CSIC centers: Centro de Biología Molecular "Severo Ochoa" (CBM), Instituto de Investigación en Ciencias de la Alimentación (CIAL), Centro Nacional de Biotecnología (CNB), Instituto de Ciencias Matemáticas (ICMAT), Instituto de Ciencia de Materiales de Madrid (ICMM), Instituto de Catálisis y Petroleoquímica (ICP), Instituto de Cerámica y Vidrio (ICV), Instituto de Física Teórica (IFT), Instituto de Investigaciones Biomédicas "Alberto Sols" (IIBM), Instituto de Micro y Nanoelectrónica (IMN).



12. CREDITS

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diciembre 2011 - marzo 2030