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Reading a Boundary at Every Scale

ALSO IN THIS ISSUE

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BARCCSYN: 117 neuroscientists at the IEC
The golden ratio in a K-pop hit
Messi, and the maths of the World Cup

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June, in the heat

The heat wave reached Spain before most of the summer schools did.

June in Barcelona was hot and crowded, people arriving for courses and colloquia while the rest of the city left for the coast. Two of them arrived with new titles: Eva Miranda and Xavier Tolsa were both elected to Spain's Royal Academy of Sciences within a month of each other, into the same mathematics section from opposite ends of the subject. Tolsa's election came alongside the month's deepest result, a higher-dimensional version of Carleson's ε^2 conjecture, published with Ian Fleschler and Michele Villa in *Inventiones*.

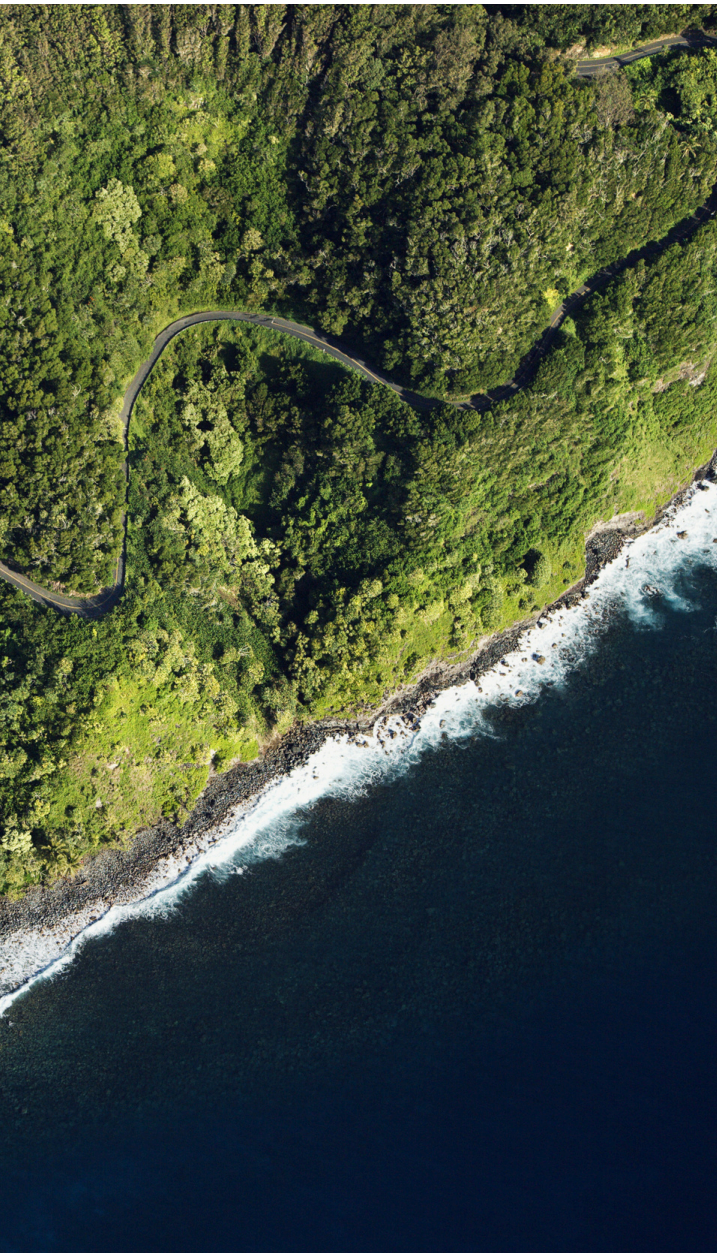
The summer schools filled the building. Hypatia spent four days on the mathematics of living systems, the Harmonic Analysis and PDEs school ran from fluids to the geometry of boundaries, and BARCCSYN brought 117 neuroscientists to the IEC.

The blog, meanwhile, went to the cinema and the stadium: the topology of a horror-game maze, the golden ratio in a K-pop hit, the geometry of Messi at a World Cup.

Best read somewhere with a fan.

— CRM Comm & Outreach

LATEST NEWS



RESEARCH · ANALYSIS

Reading a Boundary at Every Scale

Ian Fleschler, Xavier Tolsa and Michele Villa have carried Carleson's ε^2 conjecture into higher dimensions, settling when a rough boundary has a tangent. "Carleson's ε^2-conjecture in higher dimensions" appears in Inventiones Mathematicae.

Zoom in on a single point of a jagged boundary and ask a plain question: how far is it from looking like a straight line? Carleson's coefficient measures exactly that, at one scale, the deviation from flatness in a small disc of radius r around the point. Now do it at every scale at once, shrinking r towards zero, and add up the squares. Carleson's ε^2 conjecture says that wherever this running total comes out finite, the boundary has a genuine tangent there, and wherever it diverges, it does not. The two sets are the same, give or take something negligible.

In the plane, this was settled in earlier work. The open question was what happens in higher dimensions, and the answer was not a matter of turning a crank. The planar coefficient breaks: in

higher dimensions it can read zero even where a surface is visibly curved. Connectivity, which does a lot of quiet work in the plane, stops being enough to pin the geometry down.

Ian Fleschler (Princeton), Xavier Tolsa (ICREA, UAB and the CRM) and Michele Villa (Ikerbasque and UPV/EHU) get around this by changing what gets measured. Instead of one curve's deviation, their coefficients track how two disjoint sets carve up a sphere at each scale, and how close that division sits to the one a flat hyperplane would make. From there they prove two things. First, the set where the new square function stays finite is rectifiable, meaning that away from a negligible part it can be covered by smooth pieces. Second, under a mild condition on the sets, the full characterisation: an exact integral test for whether a point is a true tangent point.

The planar case comes out improved as a by-product, the sort of thing that tends to happen when a problem is finally understood rather than merely solved. The paper closes on a list of open questions, on slicing, on higher codimension, on how all of this talks to harmonic measure, which is one way of saying the subject is far from finished.

ADD UP HOW FAR A BOUNDARY STRAYS FROM STRAIGHT, AT EVERY SCALE AT ONCE. WHERE THE TOTAL STAYS FINITE, THERE IS A TANGENT.

Fleschler, I., Tolsa, X. & Villa, M. *Carleson's ε^2-conjecture in higher dimensions*. Invent. math. 241, 207–307 (2025). https://doi.org/10.1007/s00222-025-01337-w

Read the full article →

HONOUR

Eva Miranda and Xavier Tolsa Elected to the Royal Academy of Sciences

Within a month of each other, Eva Miranda and Xavier Tolsa have been elected to the Mathematics section of Spain's Royal Academy of Exact, Physical and Natural Sciences, entering from opposite ends of the subject.

The plenary of Spain's Royal Academy of Exact, Physical and Natural Sciences has elected Eva Miranda (UPC, CRM) a corresponding academic in geometry and topology, with the appointment announced on 3 June. It follows the election of Xavier Tolsa (ICREA, UAB, CRM) to the same mathematics section about a month earlier. Two researchers from the CRM community into the national academy inside thirty days, from different parts of the map.

Miranda is a full professor at the UPC, where she directs the Laboratory of Geometry and Dynamical Systems. She works in symplectic and contact geometry and in dynamical systems, and lately in fluid mechanics: with Robert Cardona, Daniel Peralta-Salas and Francisco Presas she built solutions to Euler's equations able to simulate a universal computer, which showed that some questions about how such flows behave are undecidable, beyond the reach of any algorithm. The construction settled a

problem posed earlier by Cristopher Moore. In July she receives the inaugural Agnes Szanto Medal at the Foundations of Computational Mathematics conference in Vienna.

Tolsa is an ICREA research professor at the UAB, working in harmonic analysis and geometric measure theory. His characterisation of the sets removable for bounded analytic functions resolved the Painlevé problem, open since the nineteenth century, and in 2025 he settled a higher-dimensional case of a conjecture of Carleson, the result this issue opens with. He presented the work at the Academy on 2 June and will give a plenary lecture at the International Congress of Mathematicians in Philadelphia later this year.

The Academy was founded in 1847 and advises the Spanish government on scientific matters. Its membership is capped at 72 numerary and 144 corresponding academics across three sections. Miranda and Tolsa enter the same one from its far corners, geometry on the one side, analysis on the other.

Read the full article →

EVENT · NEUROSCIENCE

BARCCSYN 2026 Gathers Barcelona's Neuroscience Community

The fourteenth BARCCSYN meeting brought 117 researchers to the Institut d'Estudis Catalans for two days of computational, cognitive and systems neuroscience: eleven talks, three keynotes, sixty-three posters.

For fourteen years BARCCSYN has done one stubborn thing: put the people who build models of the brain in the same room as the people who record from it, and see what comes of it. The fourteenth edition ran on 28 and 29 May in the Prat de la Riba room of the Institut d'Estudis Catalans, with 117 registered participants. It is organised by the CRM with the computational neuroscience section shared by the Catalan societies of biology and mathematics, and this year's committee paired Jens-Bastian Eppler and Alexandre Hyafil, from the CRM, with Hernando Martínez Vergara and Indre Pileckyte, from IDIBAPS.

Eleven short talks and sixty-three posters filled the two days around three keynotes. Raoul-Martin

Memmesheimer (Bonn) opened with a memory model that runs against the usual picture: rather than memories sitting in fixed assemblies of strongly wired neurons, his assemblies remodel completely over time, cells swapped in and out as the network churns, the memory holding precisely because that drift is what consolidates it. Sara Mederos (Hospital del Mar) closed with the circuits behind decisions under threat, in mice trained to stop fleeing an overhead shape that imitates a predator, tracing how higher visual areas teach the animal to override the instinct.

The CRM came in force, with talks from Gloria Cecchini, Alexandre Garcia-Duran and Lluís Hernández and eight posters across the two sessions. Eppler's, on how network structure holds neural representations steady while they drift, sat a few metres from Memmesheimer's keynote making much the same case from the other direction.

The closing prizes went to IDIBAPS: best talk to Melanie Tschiersch, on how prefrontal and parietal activity line up during working memory, and the two poster prizes to Thomas Morvan and Caterina Barezzi. The format has not changed in fourteen years, two rooms, a long coffee break, a wall of posters, and it still does its job.

PUT THE PEOPLE WHO BUILD MODELS OF THE BRAIN IN THE SAME ROOM AS THE PEOPLE WHO RECORD FROM IT, AND SEE WHAT COMES OF IT.

Read the full article →

SUMMER SCHOOL

Hypatia 2026: Modelling Life, Sharing Ideas

From 8 to 11 June the CRM hosted the Hypatia Graduate Summer School, four days of advanced training for young researchers built around the mathematics of living systems. Two courses anchored the week: Gissell Estrada (UPC–CRM) and Tomás Alarcón (ICREA–CRM) on partial differential equations for biology, from cellular dynamics to collective behaviour, and Giulia Laura Celora (Oxford) on how modelling explains self-organisation, the business of keeping order in a living thing, with examples running from embryonic development to cancer. Between sessions the school screened Gifted and used it to argue about what talent is and how it gets recognised. Hypatia runs with a particular eye on the visibility of young women in mathematics.

Read the full article →

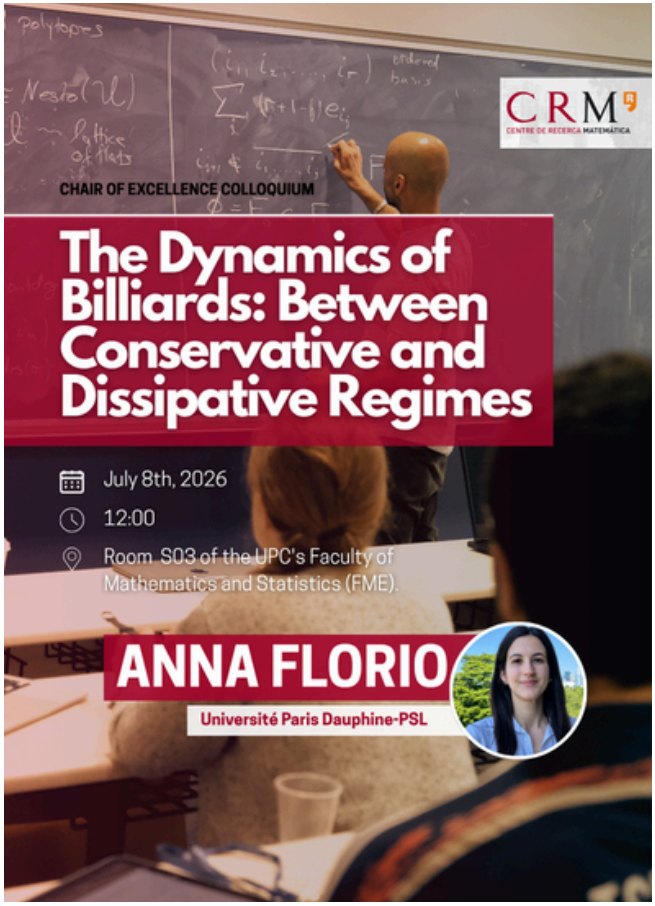
SUMMER SCHOOL

Harmonic Analysis and PDEs at the CRM

From 15 to 18 June the CRM Auditorium held the Harmonic Analysis and PDEs Summer School, four mini-courses running across the week so each built as a connected argument instead of a one-off talk. The thread tying them together was the analysis of singular integrals, reaching from a rotating blob of fluid to the ragged edge of a region in the plane. Two courses took on the incompressible Euler equations: Zineb Hassainia (NYU Abu Dhabi) on vortex patches and leapfrogging rings, Tarek Elgindi (Duke) on how smooth solutions can blow up in finite time. Andrei Lerner laid out his resolution of Muckenhoupt's 1980 C_p conjecture, and Carmelo Puliatti connected harmonic measure to the shape of a boundary. Carlos Pérez gave the invited lecture. Around forty people came, from nine countries across three continents. The organising committee came from the UAB: Joan Mateu, Juan Carlos Cantero, Joan Orobitg and Joan Verdera.

Read the full article →

CALENDAR OF **ACTIVITIES**



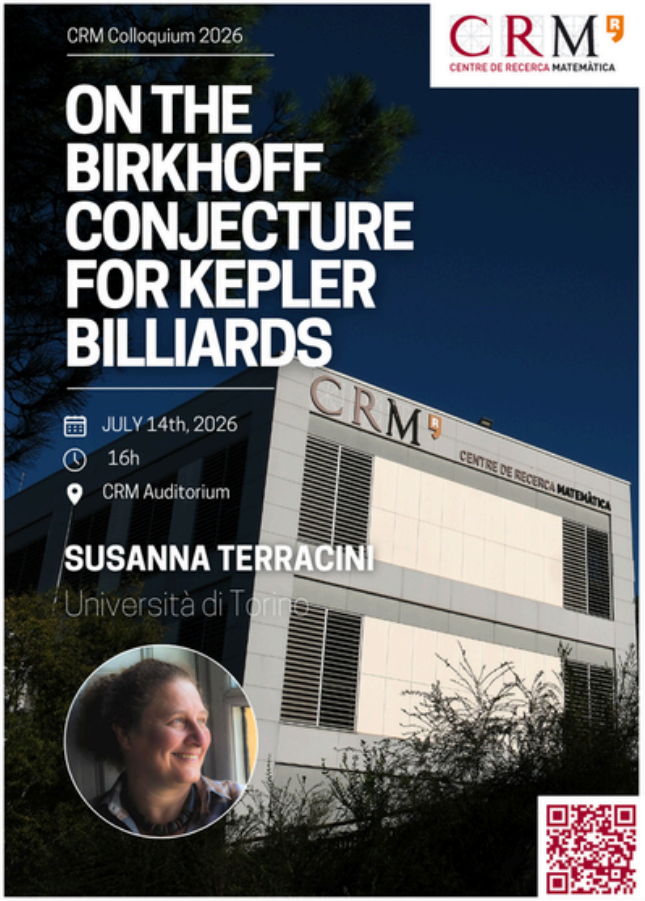
COLLOQUIUM

The Dynamics of Billiards: Between Conservative and Dissipative Regimes

Anna Florio
CEREMADE, Université Paris-Dauphine PSL

WHEN July 08, 2026
WHERE Universitat Politècnica de Catalunya

+Info →



COLLOQUIUM

On the Birkhoff conjecture for Kepler billiards

Susanna Terracini
Università di Torino

WHEN July 14, 2026
WHERE Centre de Recerca Matemàtica (CRM)

+Info →

JUNIOR MEETING

BMS-BGSMath Junior Meeting

WHEN September 02–04, 2026
WHERE Centre de Recerca Matemàtica (CRM)

Registration deadline: 17 July 2026

+Info →

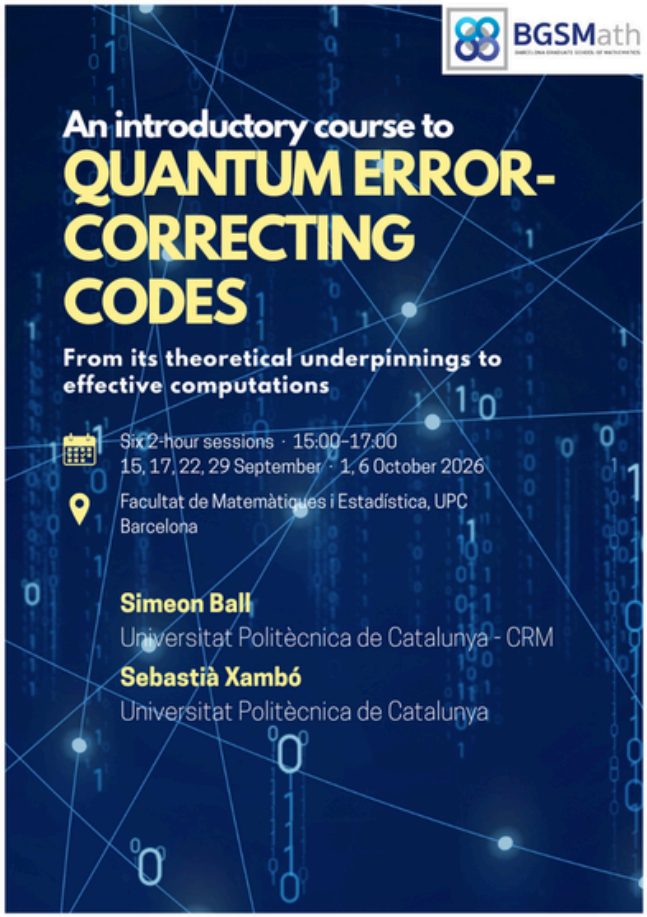
WORKSHOP

Barcelona Workshop on Kinetic and Macroscopic Models in Biology with Friends II

WHEN September 07–10, 2026
WHERE Institut d'Estudis Catalans (IEC)

Registration deadline: 17 July 2026

+Info →



BGSMATH COURSE

An Introductory Course to Quantum Error-Correcting Codes: From Theoretical Underpinnings to Effective Computations

WHEN September 15 – October 06, 2026
WHERE Universitat Politècnica de Catalunya

Registration deadline: 13 September 2026

+Info →

RESEARCH PROGRAMME

IRP on Analysis of Free Boundary Problems

WHEN October 19 – December 04, 2026
WHERE Centre de Recerca Matemàtica (CRM)

Advanced Course registration deadline: 2 October 2026

Workshop registration deadline: 12 October 2026

+Info →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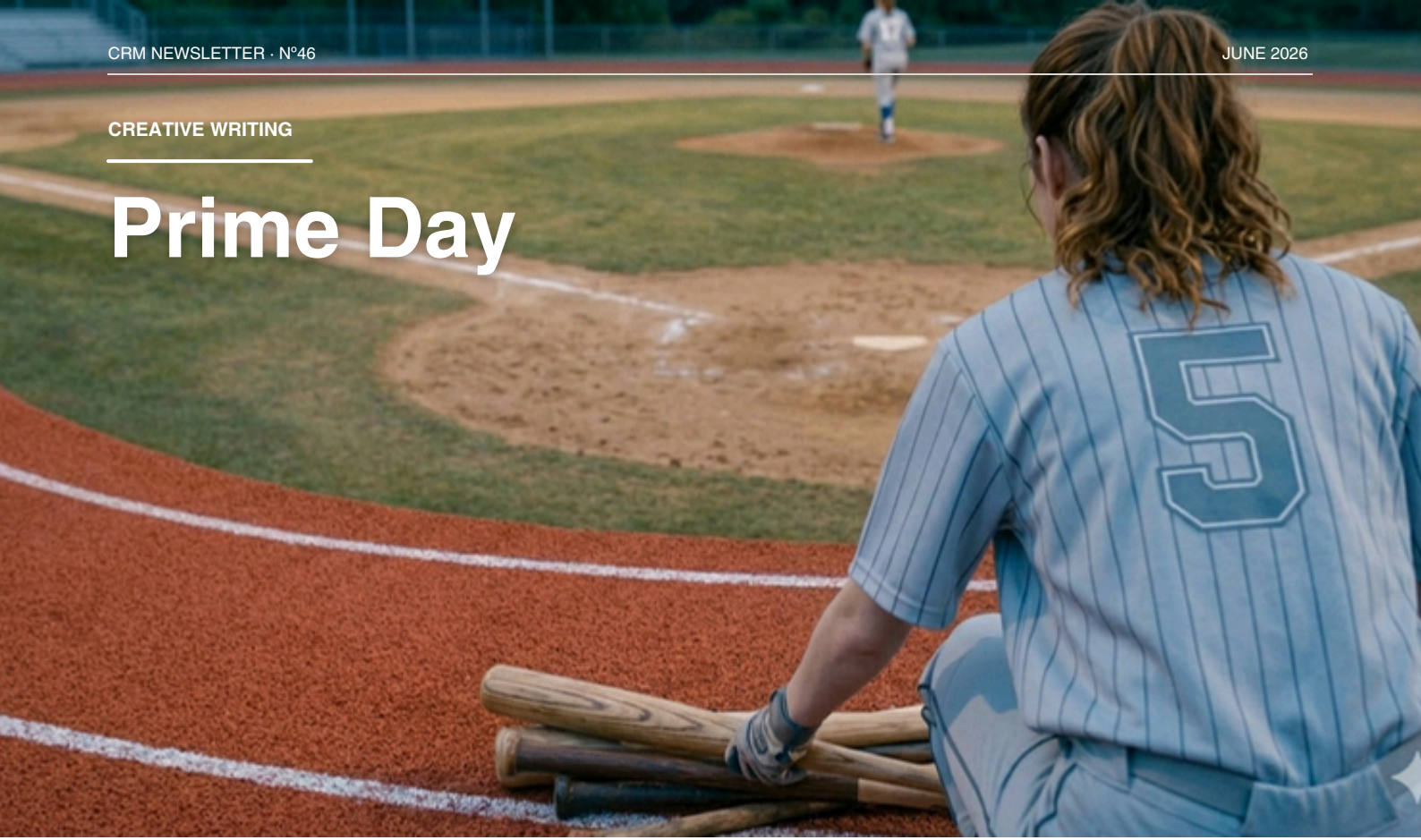
Challenges in group-level statistical inference:

FROM THE BLOG

El Gegant del π



CREATIVE WRITING

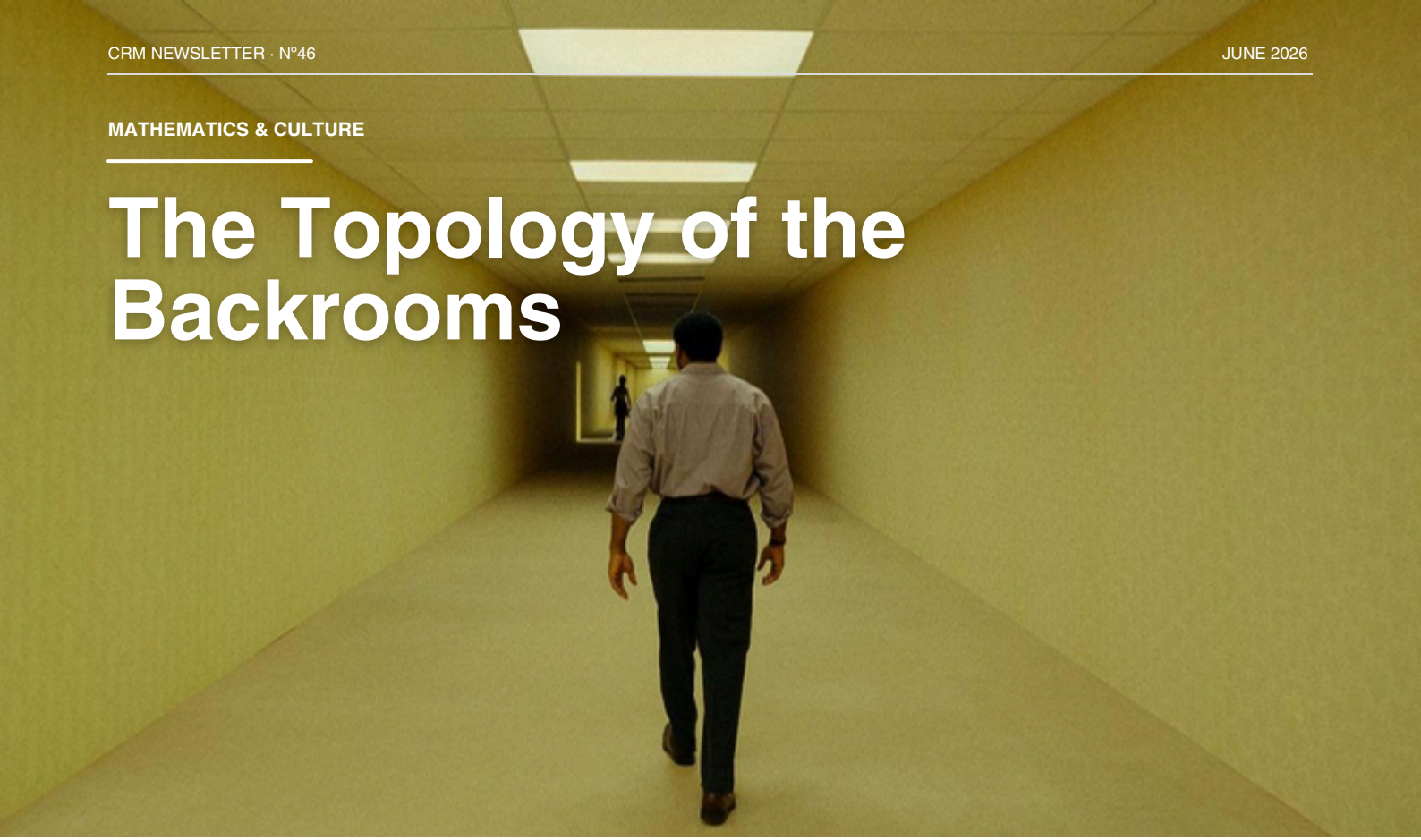
Prime Day

Another of the blog's "Days", told entirely in numbers you only notice once someone points them out. A softball player narrates an ordinary day: she wakes at 7:11:13, eats 2 pieces of fruit and 5 hazelnuts, runs 109 steps one way and 113 the other, rests for 17 minutes and 19 seconds while a teammate brags about a 41-line poem. Bus 67 home, 73 per cent battery before bed. Every figure in the day is a prime, which a friend on the phone finally spots when the narrator can't. You can read it straight through as a slightly odd Tuesday and miss the whole thing, which is the joke.

Read more →

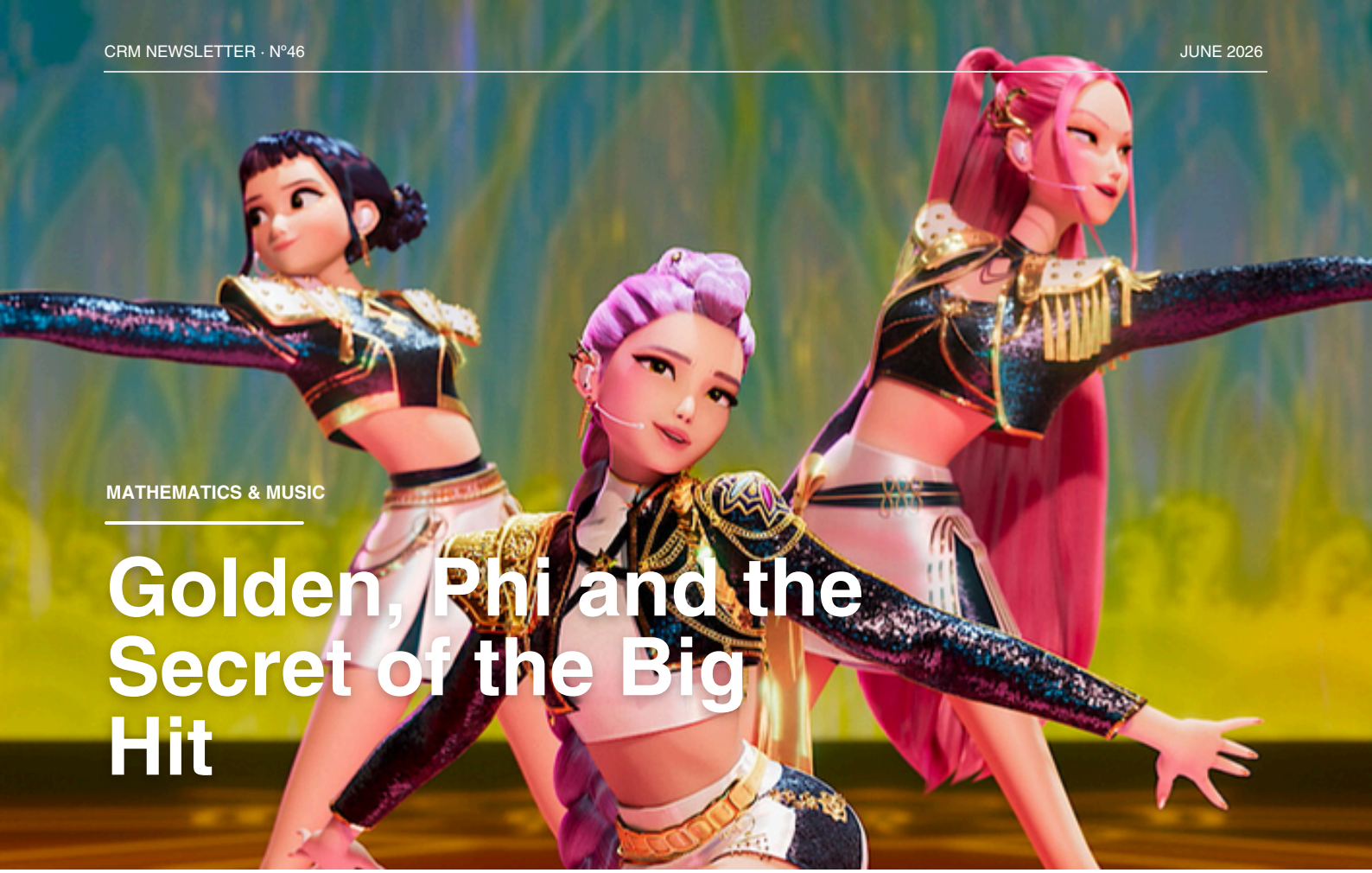
MATHEMATICS & CULTURE

The Topology of the Backrooms



The Backrooms, the internet's favourite horror setting, is an endless run of identical empty yellow office rooms you fall into by slipping through reality at the wrong spot. People keep calling the place "non-Euclidean", and the post's argument is that they have it backwards. Locally the geometry is flat and ordinary: right angles, straight walls, zero curvature everywhere. What breaks is the global topology, the quiet agreement that a building has to fit inside one continuous chunk of space. From there the piece runs through mazes and labyrinths as graphs, the duality between corridors and walls, the matrix-tree theorem (a 10×10 grid hides more than 10^{39} possible layouts), and the Betti number that explains why keeping one hand on the wall stops saving you. Borges saw it coming.

Read more →

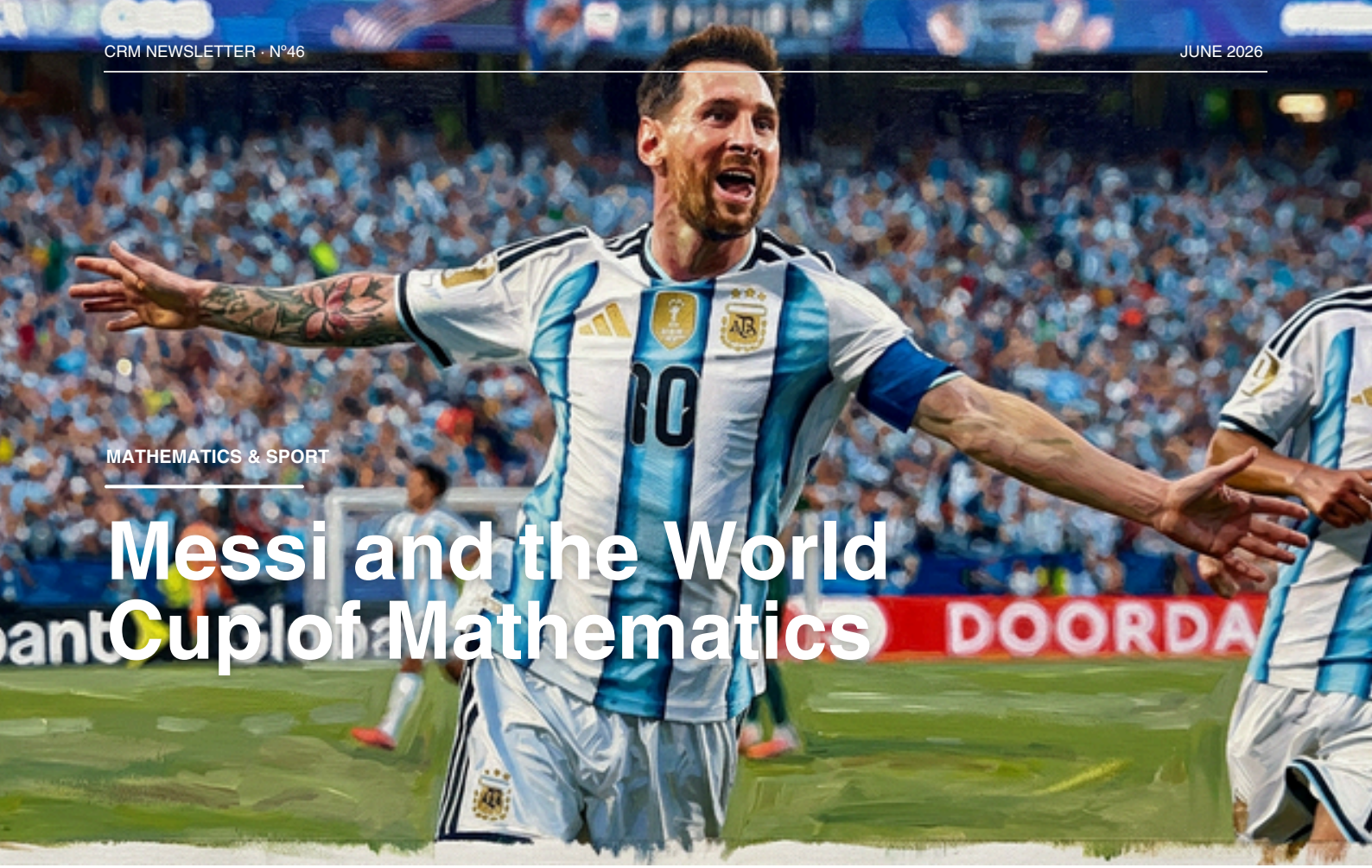


MATHEMATICS & MUSIC

Golden, Phi and the Secret of the Big Hit

The most-watched original on Netflix this year is an animated film about a K-pop girl group who moonlight as demon hunters, and its big song, "Golden", has a number hiding in it: 1.618, the golden ratio. There's a parlour trick where you multiply a song's length by 0.618 and land on its emotional peak, and it works suspiciously often, mostly because pop songs are stuffed with choruses. "Golden" does the opposite. At its golden point the music drops out of the chorus into a fragile bridge, the moment the heroine's composure cracks. The post is honest about how much of this is real and how much we paint on afterwards: the Parthenon doesn't fit the golden rectangle, the nautilus doesn't spiral by phi. Sunflowers, though, genuinely do, because phi is the one number that refuses to line up.

Read more →

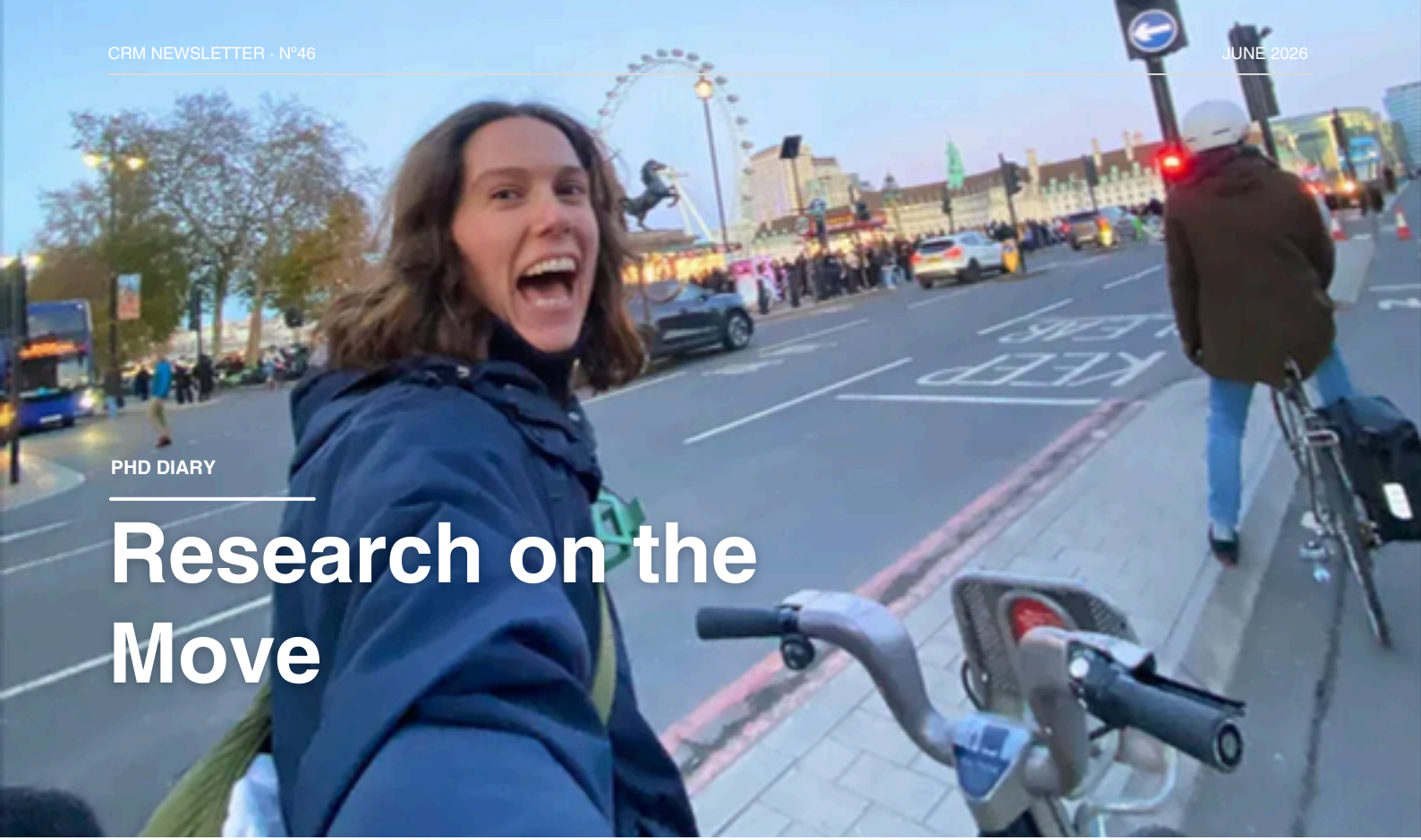


MATHEMATICS & SPORT

Messi and the World Cup of Mathematics

With the World Cup on, the blog watched Messi put three past Algeria (the goalkeeper was Zidane's son) and then went looking for the mathematics underneath. There's a lot of it. Niels Bohr kept goal for a Copenhagen club and once let a ball roll in while he worked a problem on the goalpost; his brother Harald won Olympic silver in 1908 before becoming one of the great mathematicians of his generation. A football is a truncated icosahedron obeying Euler's formula, until this year's ball traded it for a rounded tetrahedron with fewer symmetries and a stranger flight. A CRM study once worked out, for a team playing high up in Johannesburg, how to choose a ball that punishes the opponent. And Messi's third goal was a Voronoi diagram opening in real time, the defence forgetting him just as the space did.

Read more →



PHD DIARY

Research on the Move

Lucía Arancibia is near the end of her PhD in the CRM's neuroscience group, working with Klaus Wimmer and Alex Hyafil on how the brain integrates evidence over space and time to reach a decision. She got there by moving: biomedical engineering in Madrid, an Erasmus in Graz where she first met brain computation, a master's at Imperial College, a research job at the Instituto Cajal, then Barcelona. This instalment of the diary is about mobility, the part nobody puts on a CV. The practical side she has down; the goodbyes she doesn't. She's candid about the cost, including a Chicago stay that fell through when US science funding was cut, and about learning to be comfortable not understanding things. Her advice to anyone starting out: ask everything, and don't worry about looking lost.

Read more →

OPEN CALLS

International Programme for Research in Groups (IP4RG)

Permanent call

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