CRMatemàtica
MONTHLY NEWSLETTER
Nº45
May 2026

What Memory Has to Balance

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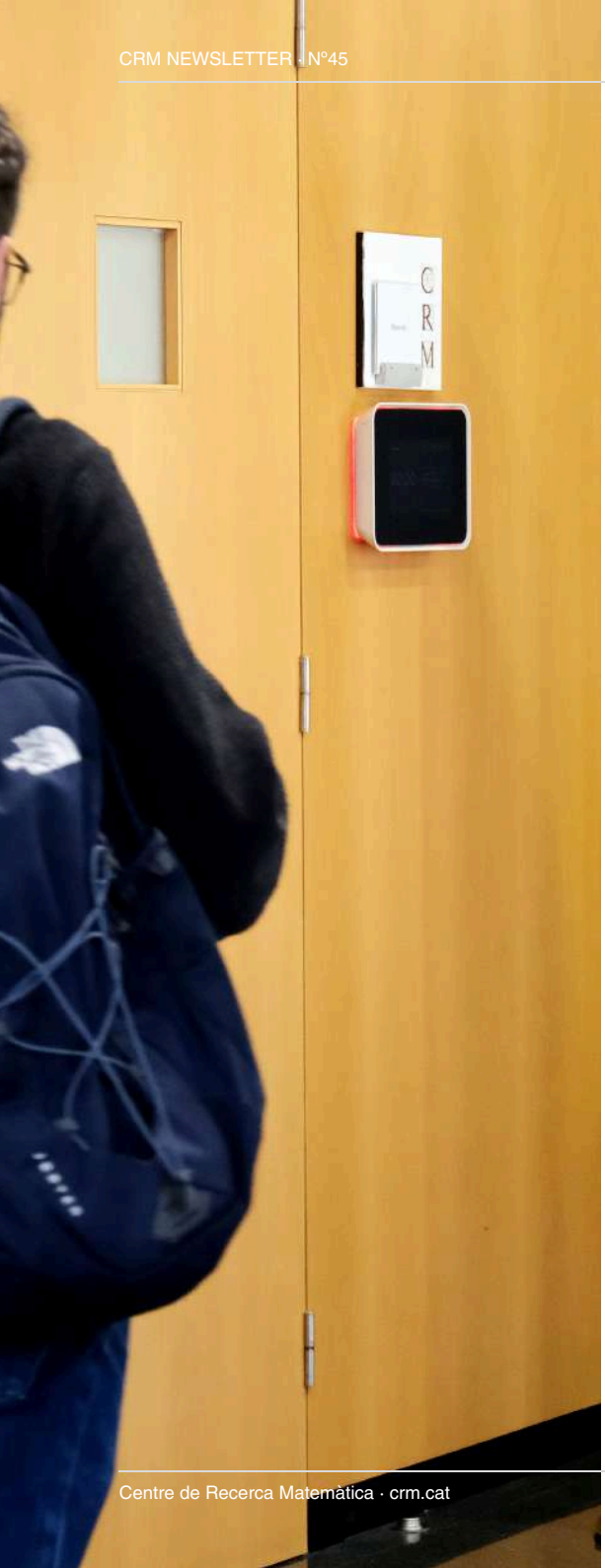


May, in one piece

The maths this month was preoccupied with not falling apart. The month around it made no such effort.

The neuroscience group worked out what keeps a neural circuit from either freezing solid or dissolving into noise, which is more than most of us manage by a Friday afternoon. Xavier Ros-Oton, with Maria Colombo and Xavier Fernández-Real, established exactly how smooth the solutions to an awkward free-boundary problem are allowed to be, and not a degree smoother. A BGSMath course spent six sessions getting an orderly temperature and pressure out of particles that do nothing all day but collide at random.

Jezabel Curbelo collected the National Research Award from Felipe VI at the Palau de Pedralbes, where the King made the case for backing science by citing a Catalan inventor whose submarine never made it past the prototype for lack of backing. Four mathematicians from the centre, Tere M-Seara, Eva Miranda, Núria Fagella and Marta Mazzocco, made this year's ranking of women researchers in Spain. And three CRM researchers spent an evening in two Sabadell bars explaining brains, graphs and mountain risk to people who had come in for a pint.

The blog kept stranger company. A French mathematician who never existed and once nearly got his inventor shot in Finland. The number 67, and the teenagers who will not stop yelling it at fast-food counters. And George Pólya, so mortified at running into the same student twice on a country walk that he went home and turned the awkwardness into a theorem.

Ahead: summer schools, more or less without a gap. A couple of the registration deadlines have already passed. Sorry.

— CRM Comm & Outreach

LATEST NEWS

RESEARCH · NEUROSCIENCE

A Brain That Won't Sit Still

Two papers from the CRM's neuroscience group come at memory from opposite ends. One asks why the brain's record of a sound keeps changing when nothing else does. The other asks what stops a learning network from seizing up. Both land in the same place.

You notice rain on the window, reach for the umbrella by the door, and leave. An input arrived, an output followed. That, roughly, is what a memory system is for, and most of the time it runs without you watching it.

It can break in two directions. It can stop listening, so you take the umbrella every day, rain or no rain. Or nothing new sticks, each thing you learn painting over the last, and you reach the door having forgotten where you were going. Two papers from the Computational and Mathematical Neuroscience group at the CRM, both out this spring, work the two edges of that problem.

Record the same neurons in a mouse's auditory cortex day after day, playing the same sound, and

the response won't hold still. The cells active on Monday are not the cells active on Friday. This is representational drift, and until two-photon imaging let researchers track individual neurons across weeks, nobody could see it. A brain at rest was assumed to be a brain at rest. It isn't.

Jens-Bastian Eppler and his co-authors traced the drift to two ingredients pulling against each other: a steady churn of random change at the synapses, and Hebbian learning reining it in. Neurons that fire together wire together, as Donald Hebb put it in 1949. Take either ingredient out of the model and the data stops fitting.

Gloria Cecchini and Alex Roxin came at it from the other side. In their model the network is driven by its inputs, the way a real neuron is driven by the cells feeding into it, and Hebbian learning on its own sends it off a cliff. Cells with more connections fire more, which strengthens those connections, which makes them fire more still. Within a few steps the busiest cells take over and the network gives the same answer to everything. The umbrella, every morning.

Their fix is a kind of inhibition tuned to each neuron's own incoming wiring. Switch it on and the runaway stops. The network stays sensitive to what arrives, and it holds more memories, for longer, into the bargain. It still forgets in the end. A feedforward network of finite size always does. The forgetting just slows to a rate that's worth having.

Read together, the two papers reach the same verdict. Hebbian learning alone doesn't quite work; it needs something pushing back, noise in one case, inhibition in the other.

"DRIFT ISN'T SEPARATE FROM LEARNING. IT IS LEARNING. AT SOME POINT SOMETHING HAS TO GIVE WAY, AND OLDER REPRESENTATIONS GET OVERWRITTEN."

Eppler, J.-B., Lai, T., Aschauer, D., Rumpel, S., & Kaschube, M. (2026). *Representational drift reflects ongoing balancing of stochastic changes by Hebbian learning*. PNAS, 123(5). https://doi.org/10.1073/pnas.2503046123

Cecchini, G., & Roxin, A. (2026). *Locally balanced inhibition allows for robust learning of input-output associations in feedforward networks with Hebbian plasticity*. Journal of Computational Neuroscience. https://doi.org/10.1007/s10827-026-00932-x

Read the full article →

AWARD

Jezabel Curbelo Receives the National Research Award

Jezabel Curbelo, full professor at the UPC and researcher at the CRM, received the 2025 National Research Award in the María Andresa Casamayor category from King Felipe VI at the Palau de Pedralbes. The prize recognises her work in fluid dynamics applied to geophysics.

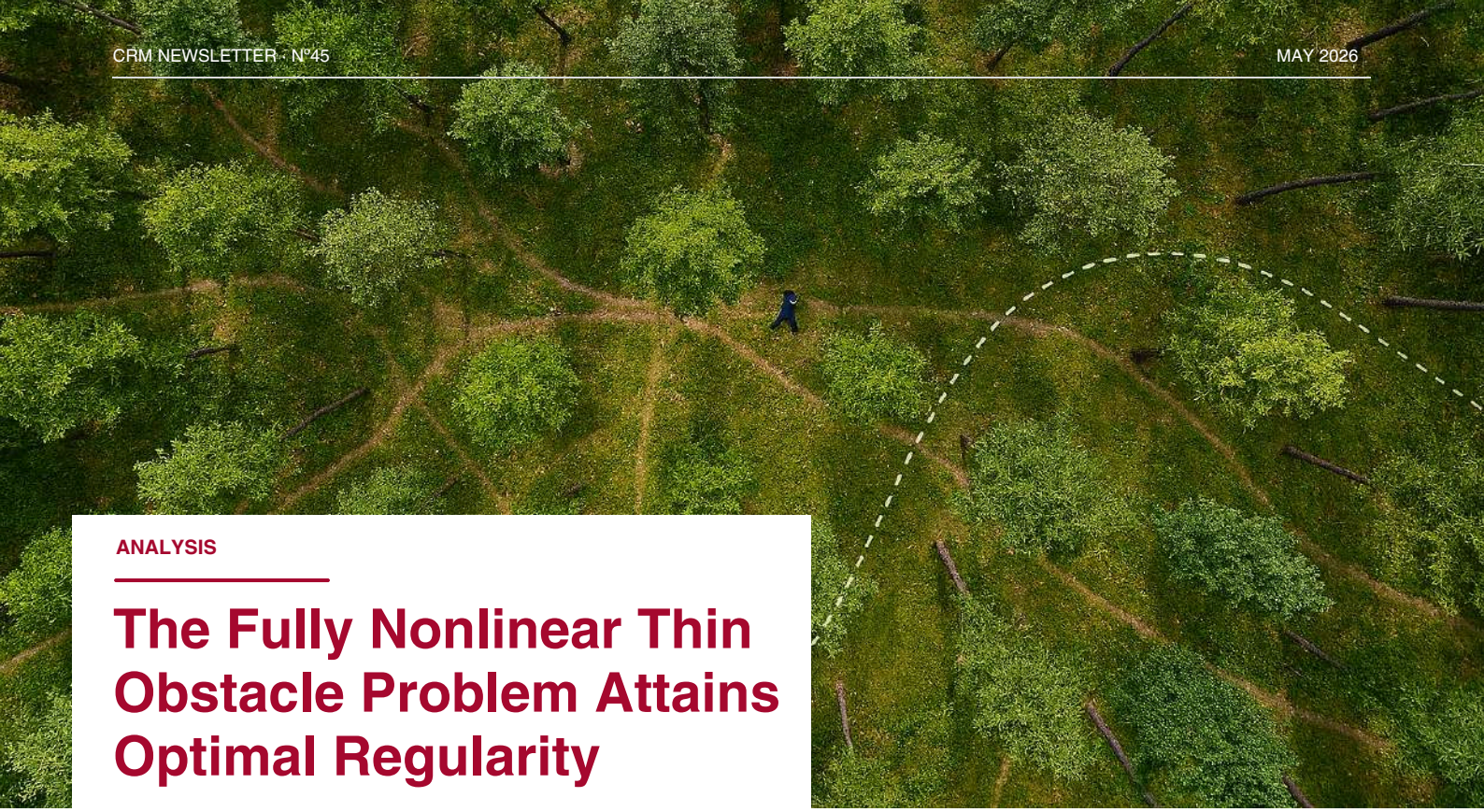
On 4 May, twenty researchers were called up at the Palau de Pedralbes to collect the National Research Awards from King Felipe VI. Jezabel Curbelo was among them. Full professor at the Universitat Politècnica de Catalunya and researcher at the CRM, she took the award for young researchers in the María Andresa Casamayor category, mathematics and ICT, for her work in the fluid dynamics of geophysical systems.

The Ministry of Science, Innovation and Universities handed out twenty awards this year, half of them to researchers based in Catalonia. Ten went to senior figures, ten to researchers under forty, and each carries 30,000 euros. In his address the King argued that scientific talent has to be accompanied and sustained, not only praised, and reached for an uncomfortable example: Narcís Monturiol, the nineteenth-century Catalan inventor whose submarine never made it past the prototype for want of money.

"IT IS A GREAT JOY. IT IS AN HONOUR TO SEE THE WORK CARRIED OUT OVER THESE YEARS RECOGNISED, AND A SOURCE OF MOTIVATION TO KEEP MOVING FORWARD."

Curbelo studies how fluids move on the scale of the planet: the atmosphere, the ocean, and the Earth's interior. She currently leads CLaCos, a Ramón Areces-funded project that reads signals of climate change out of atmospheric and oceanic flows by following the geometry of particle trajectories.

Read the full article →



ANALYSIS

The Fully Nonlinear Thin Obstacle Problem Attains Optimal Regularity

A new theorem settles how regular the solutions to a hard class of free-boundary problems can be. "Optimal regularity for the fully nonlinear thin obstacle problem," by Maria Colombo, Xavier Fernández-Real and Xavier Ros-Oton, appears in the Journal of the European Mathematical Society

Press a stretched elastic sheet down onto a bump. Part of it lies flat against the bump, part lifts away and floats free, and somewhere there is a line where the two regions meet. That line is a free boundary. The mathematics of free boundaries is the study of how a solution behaves right at the point where it stops being free to do as it likes.

The thin obstacle problem, also called the Signorini problem, is a stricter version. The barrier does not fill the whole region; it sits on a lower-dimensional slice, so the solution only feels it from certain directions. That small change makes the behaviour near the boundary surprisingly delicate.

The hardest case is the fully nonlinear one, where the governing equation depends on the second derivatives of the solution in a nonlinear way. The usual machinery for these problems, monotonicity formulas above all, stops working. Solutions were known to be reasonably regular. How regular, at best, was open.

A paper by Maria Colombo and Xavier Fernández-Real, both at EPFL, and Xavier Ros-Oton, at ICREA, the Universitat de Barcelona and the CRM, answers it. There is an optimal degree of smoothness, an exponent set by the operator itself, and the solutions reach it on both sides of the obstacle. In general it cannot be pushed any further.

The interesting part, for Ros-Oton, is the why. The same regularity had been known for the classical thin obstacle problem for decades, but every proof leaned on properties peculiar to that one model. The new result holds across a large family of thin free-boundary problems, and in doing so it hands over a fresh proof even for the classical case that everyone thought was settled.

Maria Colombo, Xavier Fernández-Real, Xavier Ros-Oton, *Optimal regularity for the fully nonlinear thin obstacle problem*. J. Eur. Math. Soc. 27 (2025), no. 9, pp. 3793–3840
DOI 10.4171/JEMS/1445

"THE OPTIMAL REGULARITY FOR THE THIN OBSTACLE PROBLEM HAD BEEN KNOWN FOR DECADES, BUT ALL KNOWN PROOFS STRONGLY USED VERY SPECIFIC PROPERTIES OF THAT MODEL. OUR RESULT SHOWS THAT THE SAME REGULARITY HOLDS FOR A VERY LARGE CLASS OF PROBLEMS."

Read the full article →

LIFE AT CRM

Mathematics in the Bars of Sabadell

For one evening in May, two Sabadell bars doubled as lecture halls. Three CRM researchers took part in Pint of Science, fielding questions on the brain, on graph theory and on the mathematics of mountain risk from an audience that was, by then, a few drinks in.

On 20 May, three researchers from the CRM took their work to two bars in Sabadell and explained it to whoever had turned up for a drink. The occasion was Pint of Science Sabadell 2026, the local leg of a festival that drags research out of the seminar room and into the pub.

Jens-Bastian Eppler spoke on why the brain sorts the world into categories before you have had time to decide anything, and how those categories shift with the situation: shown an animal, the brain often cares less about the species than about whether it is going to bite.

Tássio Naia talked about graphs by way of the Oberwolfach problem, how to seat a crowd at round tables over several dinners so that everyone ends up next to everyone else exactly once. David Romero, who runs the CRM's Knowledge Transfer Unit, presented

work from the cross-border NeuroMunt project on how people weigh risk in the mountains, reading EEG signals through the mathematics of complexity. Rescues in Catalonia's natural areas are up by about a fifth since the pandemic.

Science in a bar usually leans on the fields with easy stories to tell, biology and physics. Mathematics is the rarer guest. Three of them on the Sabadell bill put it on the menu, somewhere between the antimicrobial peptides and the energy communities.

Pint of Science began in 2013 with two neuroscientists in London and now runs in 27 countries. Spain's eleventh edition this year reached 114 towns and cities; Sabadell's second put on 43 talks across three bars, a different language in each one every night.

Read the full article →

RECOGNITION

Four CRM Mathematicians in the 2026 Ranking of Women Researchers in SpaiN

Four mathematicians affiliated with the CRM appear in the 2026 edition of the Ranking of Spanish and Spain-based Women Researchers, published this April: Tere M-Seara, Eva Miranda, Núria Fagella and Marta Mazzocco. The ranking lists women researchers working in Spain by public bibliometric indicators.

Read the full article →

BGSMATH · COURSE

An Introductory Course to the Boltzmann Equation

From 28 April to 14 May, the Faculty of Mathematics at the Universitat de Barcelona ran a BGSMath course on the Boltzmann equation, taught over six sessions by Gissell Estrada (UPC–CRM) and Xavier Ros-Oton (ICREA–UB–CRM). The equation comes out of a single question: how do billions of particles, each colliding at random, add up to something as steady as a temperature or a pressure?

Read the full article →

CALENDAR OF **ACTIVITIES**

COLLOQUIUM

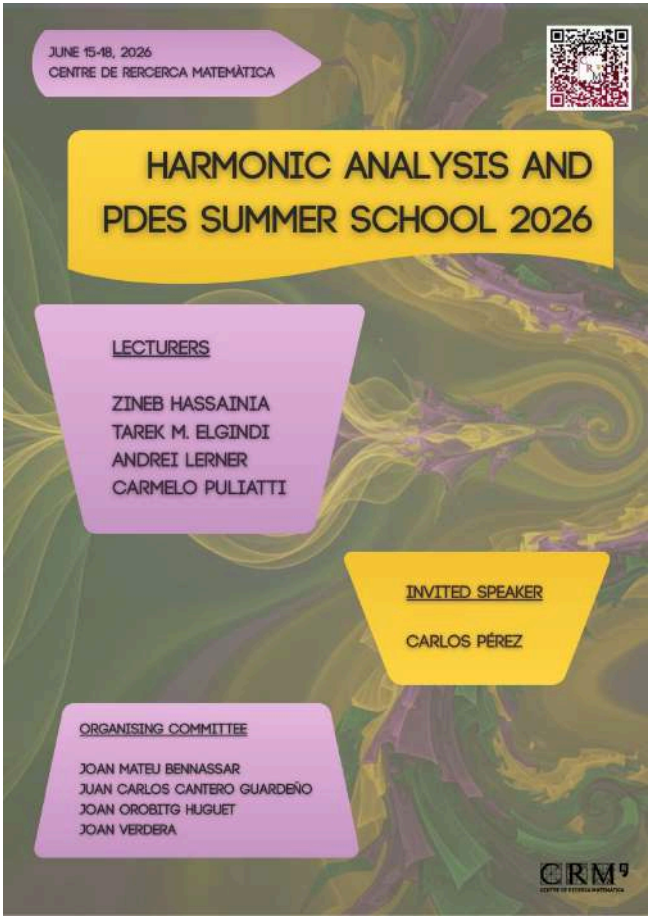
Hypatia Colloquium 2026

WHEN June 08–11, 2026

WHERE CRM / Institut d'Estudis Catalans (IEC)

Colloquium registration deadline: 4 June 2026

+Info →



SUMMER SCHOOL

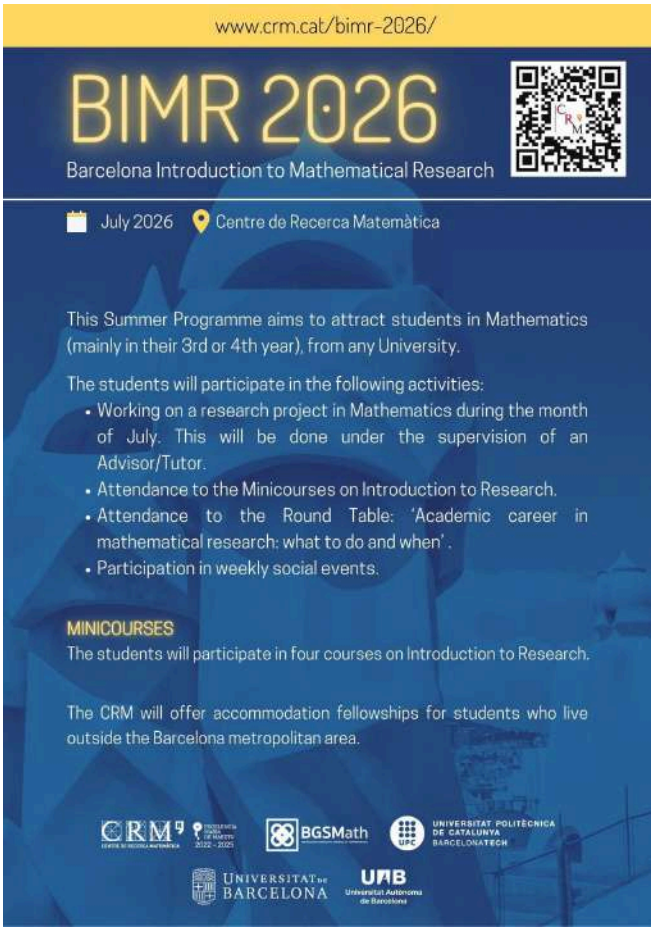
Harmonic Analysis and PDE's Summer School

WHEN June 15–18, 2026

WHERE Centre de Recerca Matemàtica (CRM)

Registration deadline: 1 June 2026

+Info →



RESEARCH PROGRAMME

BIMR 2026 – Barcelona Introduction to Mathematical Research

WHEN June 29 – July 24, 2026
WHERE Centre de Recerca Matemàtica (CRM)
Registration deadline 21 / 06 / 2026

+Info →

SUMMER SCHOOL

22nd School on Interactions between Dynamical Systems and PDE's (JISD 2026)

WHEN June 29 – July 03, 2026
WHERE Centre de Recerca Matemàtica (CRM)
Registration deadline: 12/06/2026

+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 June 2026

+Info →

FROM THE BLOG

El Gegant del π

HISTORY OF MATHEMATICS

How to Stumble on a Theorem

George Pólya wrote one of the most famous books ever published on how to think. How to Solve It (1945) lays out four tidy steps for cracking a problem. His own most celebrated theorem came from none of them. Around 1920, walking in the woods outside Zürich, Pólya kept crossing paths with one of his students and the student's girlfriend, again and again, until he felt like he was spying on them. He went home mortified and asked whether two wanderers were, in some sense, fated to meet. The answer became the recurrence theorem for random walks: on a flat grid an aimless walker returns home with probability one, but lift the grid into three dimensions and the odds of ever getting back drop to about a third. A drunk man finds his way home; a drunk bird is lost forever.

Read more →

CREATIVE WRITING

Eigenvalue Day

One of the blog's "Mathematical Days" stories, and just as coy about what it is really doing. A sailor wakes on a boat, plays two chords on an accordion, and dreams of a red village across a moving bridge. Aboard, a single chord makes a glass tremble and a crewmate dance; another turns the boat towards an island that appears on no map. By the time the sailor crosses the bridge from the dream and reaches a harbour full of people dressed exactly like him, the story has quietly walked the reader through eigenvalues and eigenvectors without once saying the words. You can read it as a dream and never notice the algebra. That is the point.

Read more →

MATHEMATICAL FICTION

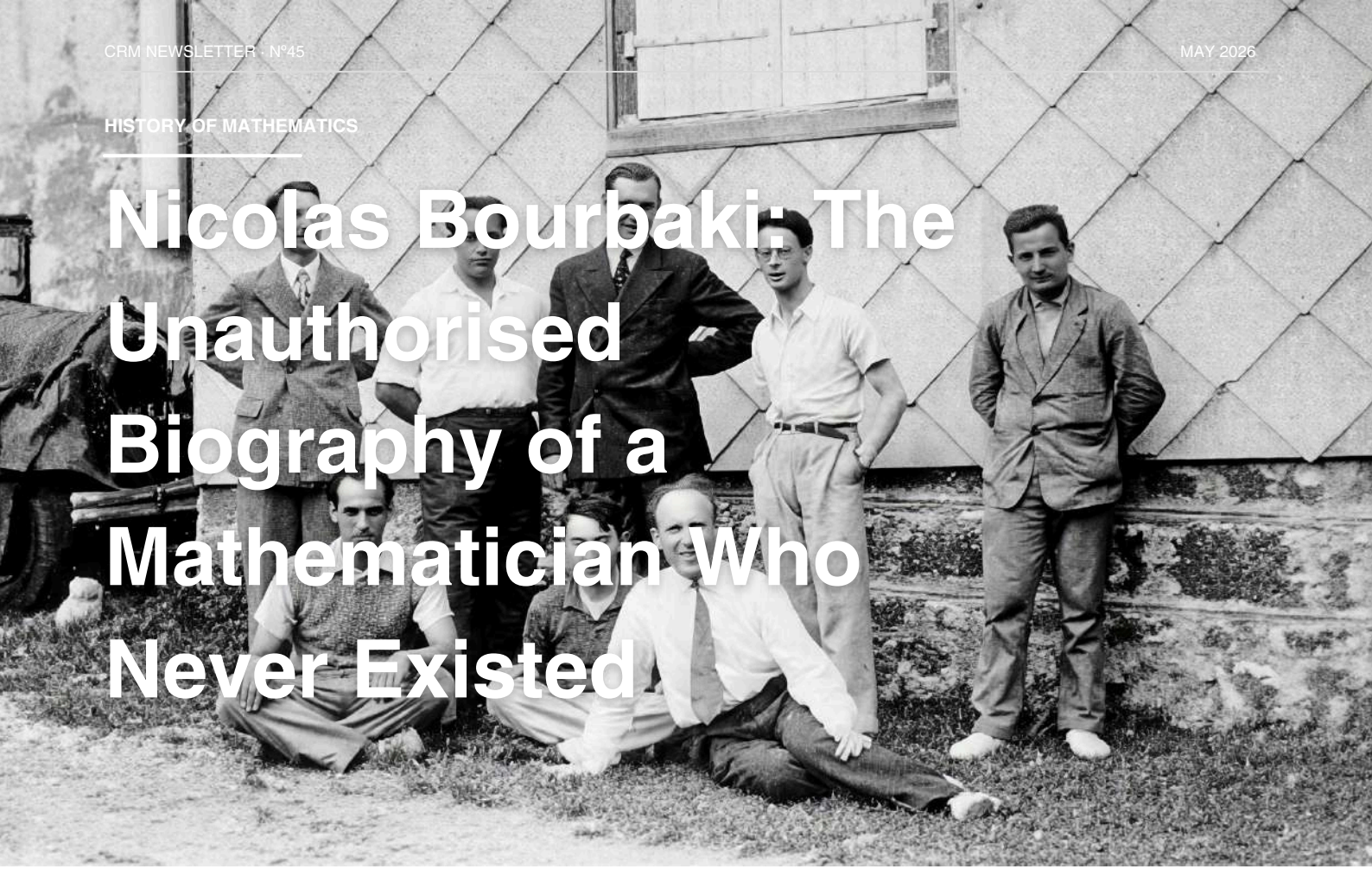
Go Round the World, and a Graph Brings You Back to El Born

The thirteenth instalment of the blog's running saga of mathematical stories. Three friends are scattered across Barcelona, one by the beach at Bogatell, one at the Escola Industrial, one on a street called carrer de la Jota, decoding clues out of alphabet soup and a message in a bottle. To find each other they have to get back to El Born, and the fastest way to do it becomes a problem about graphs: treat the city as a network, mark each friend as a node, and find the shortest edges to the meeting point. The title is a pun on the Catalan saying roda el món i torna al Born, go round the world and come back to the Born. The mathematics is real; the plot does the explaining.

Read more →

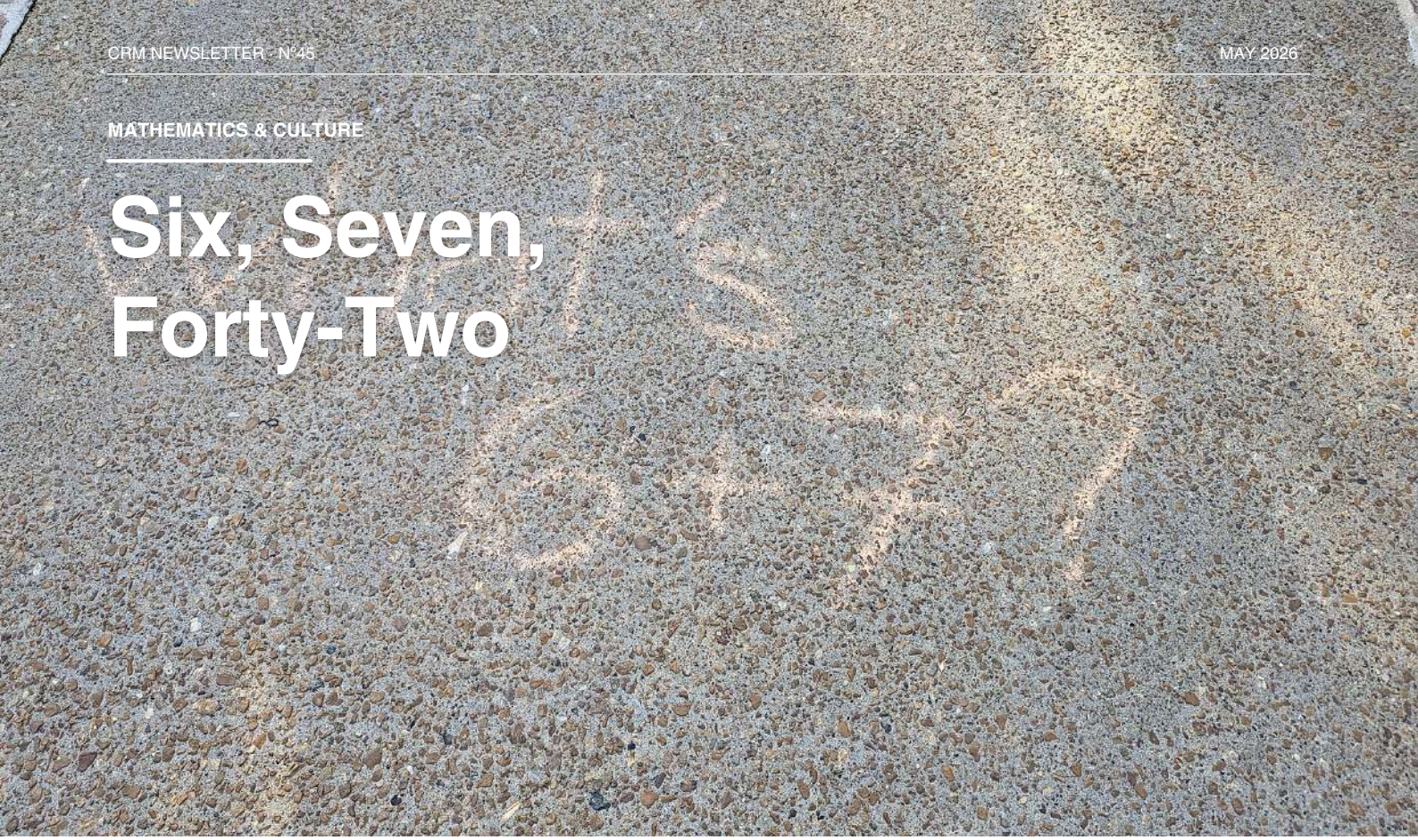
HISTORY OF MATHEMATICS

Nicolas Bourbaki: The Unauthorised Biography of a Mathematician Who Never Existed



Paris, 1935: a paper arrives at the Academy of Sciences from a reclusive mathematician named Nicolas Bourbaki, who lives on the outskirts of the city and passes his time at cards. The paper is accepted. The author does not exist. Bourbaki was the collective pseudonym of a group of young French mathematicians, André Weil and Henri Cartan among them, who had met in a Paris café in 1934 to fix the way analysis was taught and ended up trying to rebuild the whole of mathematics from the ground up. The post follows the joke and the work it carried: a fictional homeland called Poldavia, a near-execution in Finland, three congresses a year, the rule that members had to leave at fifty, and a series of textbooks that has now passed six thousand pages and gave us the symbol for the empty set.

Read more →



MATHEMATICS & CULTURE

Six, Seven, Forty-Two

A drill-rap meme about the number 67 spread far enough last year that the In-N-Out burger chain stopped reading order number 67 out loud, worn down by the scene teenagers made every time. The phrase means nothing; a Swedish language institute added it to its dictionary defined as "a meaningless expression." The post takes the meme seriously anyway. Seven is the number people pick most often when asked for a random one between one and ten, and a 1976 Yale experiment put it at 28 per cent. Six is a perfect number, equal to both the sum and the product of its own divisors. Six times seven is forty-two, which Douglas Adams made the answer to life, the universe and everything. And 67 itself turns out to be a prime that keeps surfacing where mathematicians least expect it.

Read more →

PHD DIARY

A Community Experience Inside the MSCA-COFUND TOUCH Programme

Alexandra Antoniadou is a PhD researcher in the CRM's Computational and Mathematical Neuroscience group, where she studies how working memory declines with age, supervised by Klaus Wimmer. She arrived sideways: an engineering degree in Thessaloniki, then a master's in systems neuroscience in Crete. In this interview she talks about doing a doctorate inside the Marie Skłodowska-Curie TOUCH programme, which trains 24 doctoral candidates across the mental-health research community around the UAB. What drew her in was the size of the thing, a cohort large enough that the isolation a PhD can bring is harder to fall into, and the mix of disciplines that comes with it. She is candid about the cost too: the pull of an over-busy research city, and the work of learning to talk openly about what is not going well.

Read more →

OPEN CALLS

Postdoctoral Researcher (Ref. 2026-06-P04632)

Deadline: 2 June 2026

CENTRE DE RECERCA MATEMÀTICA

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