BASQUE CENTER FOR APPLIED MATHEMATICS

Activity Report

2025

basque center for applied mathematics

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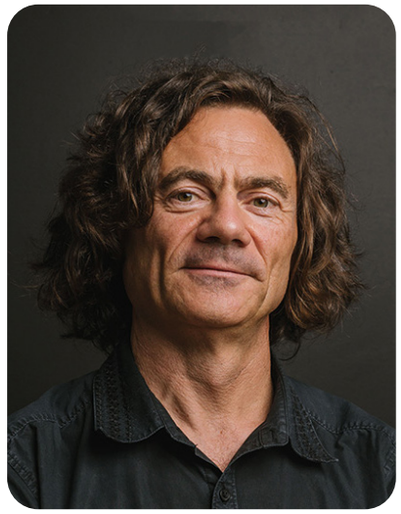
2025

Index

01

Introduction

A LETTER FORM OUR DIRECTOR



Jose A. Lozano

SCIENTIFIC DIRECTOR

Progress in mathematics is rarely linear; it is the result of sustained collective effort, strategic vision, and the patience to explore complex ideas. As Maryam Mirzakhani so eloquently stated, “The beauty of mathematics only shows itself to more patient followers.” This spirit continues to guide the Basque Center for Applied Mathematics (BCAM) as we reflect on the year 2025, a year marked not only by scientific excellence but also by careful preparation for the future.

During 2025, BCAM further consolidated its position as an international reference in applied mathematics and interdisciplinary research. The Centre’s researchers produced high-impact results across a wide range of areas, including fundamental mathematics, artificial intelligence, and mathematical modeling, with publications in leading journals and conferences such as Annals of Mathematics, Nature Communications, and Science. These results reflect both the depth of our core mathematical research and its strong connections to other scientific domains.

Internationalisation has remained a key pillar of BCAM’s activity, closely aligned with regional strategic priorities. A clear example is the launch of the BCAM Severo Ochoa Strategic Lab on Quantum Mathematics, an international joint research lab developed together with leading researchers from institutions such as the University of Milan and the University of Pisa. This initiative strengthens BCAM’s international presence in quantum mathematics while contributing directly to the Basque Quantum (BasQ) Strategy, providing the fundamental mathematical foundations required for the development of a robust and internationally connected quantum ecosystem in the Basque Country.

The year has also been marked by the continued strengthening of talent, leadership, and scientific quality at BCAM. Targeted recruitment actions through competitive international programmes, including ATRAE, have contributed to consolidating key research lines and ensuring their long-term development. In parallel, the excellence of BCAM’s research has been acknowledged through prestigious national and international awards across several fields, reflecting both methodological innovation and interdisciplinary impact. Doctoral training has remained a central pillar of the Centre’s mission, with a record number of PhD theses successfully defended during 2025, further reinforcing BCAM’s role in shaping future scientific talent.

A defining milestone of 2025 has been the design of the BCAM Strategic Plan for the period 2026–2029. Developed through an open and participatory process involving principal investigators, postdoctoral researchers, and PhD students, this plan sets a renewed scientific roadmap based on strong mathematical foundations and the synergistic integration of advanced modelling, artificial intelligence, and high-performance computing. It places special emphasis on fostering synergies across research areas, strengthening the applied dimension of BCAM’s activity, and aligning the Centre with Basque and European strategic priorities.

This forward-looking vision reinforces BCAM’s commitment to knowledge transfer and societal impact, with mathematical developments applied to areas such as health, energy, materials, neuroscience, quantum technologies, and Industry 4.0, in close collaboration with public institutions and industry.

None of these achievements would be possible without the people who sustain BCAM every day. I would like to express my sincere gratitude to our researchers, to all those involved in scientific activities, training, outreach, and knowledge transfer, and especially to our administrative and technical staff for their essential and continuous support.

With a strong year behind us and a clear strategic roadmap ahead, BCAM looks to the future with confidence and ambition.

Let’s keep writing together the mathematics for the future.

02

BCAM In Numbers

THE YEAR AT A GLANCE

2.1 SCIENTIFIC OUTPUTS

159 No. OF INDEXED ARTICLES

66 H INDEX

81,3% Q1

42,7% D1

1.974 BCAM DOCUMENTS ARE CITED 45.577 TIMES UNTIL 2025

2.2 GRANTS IN PLACE

15

INTERNATIONAL PROJECTS

8 MARIE SKŁODOWSKA-CURIE

4 ERC

2 HE CLUSTER 4 (DIGITAL, INDUSTRY & SPACE)

1 H2020/ HORIZONTE EUROPA

11 NATIONAL PUBLIC PROJECTS

8 REGIONAL PUBLIC PROJECTS

1 PRIVATE PROJECT

2.3 PERSONNEL

137 PEOPLE AT BCAM

14 ADMINISTRATIVE STAFF

24,3% WOMEN

\+

123 VISITORS

16 NEW RESEARCHERS

10 VISITING FELLOWS

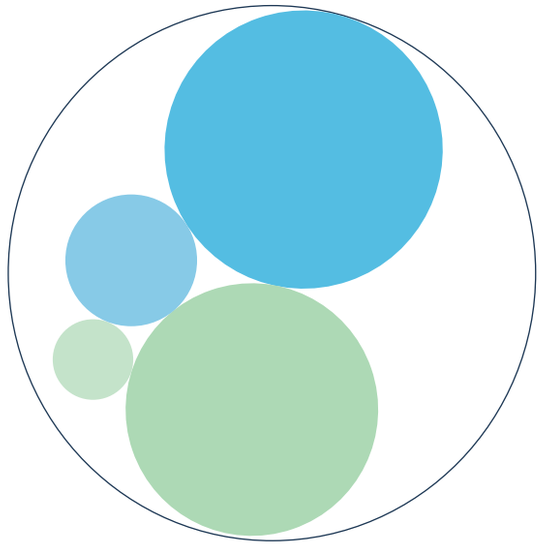
23 INTERNS

2.4 FUNDING

TOTAL ANNUAL FUNDING

7,18 M€

3,39M€	BASQUE COUNTRY
2,8M€	SPAIN
0,7M€	EUROPE
0,29M€	PRIVATE & OTHER



2.5 TRAINING AND KNOWLEDGE TRANSFER

17 DEFENDED DOCTORAL THESES

38 ONGOING DOCTORAL THESES

27 ONGOING POSTDOCTORAL TRAINEES

3 ONGOING JOINT POSITIONS

2.6 SCIENTIFIC ACTIVITIES AND DISSEMINATION

SEMINARS 52

BCAM COURSE 5

BCAM SO COURSE 2

WORKSHOPS 7

COLLOQUIUM 6

SUMMER SCHOOLS 2

DISSEMINATION ACTIVITIES 14

750

MATEMATIKAHRIAK SCHOOL VISITS: AROUND 750 STUDENTS HAVE HAD THE OPPORTUNITY TO LEARN ABOUT BCAM AND GET CLOSER TO MATHEMATICAL RESEARCH

2.7 MEDIA

2,309
FOLLOWERS

4,061
FOLLOWERS

393
SUBSCRIBERS

5,293 YOUTUBE VIEWS

Data source: Hootsuite, Twitter, LinkedIn and Youtube. Data exported: 31/12/2025.

178
TOTAL BCAM APPEARANCES IN THE MEDIA

6 TV

31 PRINT MEDIA

81 ONLINE PRESS

37 RADIO

23 BLOGS + WEBSITES


MUSIKA KLASIKOA 2025eko ekaina BILBAO 27

Luca Fanelli, doctor en piano y matemáticas, director artístico del concurso musical 'Villa de Bilbao' y profesor de investigación Ikerbasque en la EHU y BCAM

"La música ha influido e influye mucho en las matemáticas"

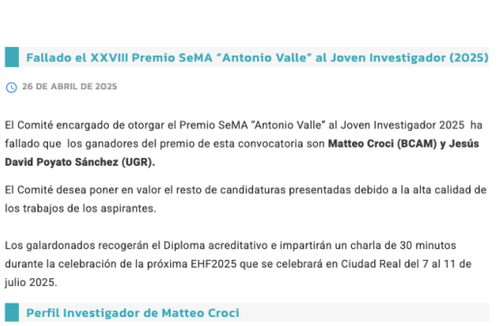
"Apostaría porque la música vuelva a tener un papel importante en los colegios, pero es difícil"


SER

Sociedad

Zer gertatuko litzateke adimen artifizialak gauzak azkarrago edo fidagarriago gogoratuko balitu?

Nazioarteko ikertzaile lantalde batek "Sare nueronal kurbatuak" izeneko adimen artifizialeko ereduen klase berri bat garatu du



EL CORREO

Ciencia

El experto en IA José Antonio Lozano, Premio Euskadi de Investigación 2024

El catedrático de Ciencia de la Computación ha realizado destacadas aportaciones en el campo de la salud, colaborando con el Gobierno vasco en la pandemia. Director del BCAM, también ha trabajado con el Athletic en la prevención de lesiones


as

Fútbol

ATHLETIC

San Mamés, bajo control

Estudian a las multitudes en el estadio para la gestión de la movilidad en eventos masivos.

VINCENT WEST

Alfonso Herrán
Coordinador Delegación País Vasco

Investigadores del Basque Center for Applied Mathematics-BCAM **han desarrollado una innovadora herramienta computacional para estudiar y optimizar la movilidad de peatones en eventos masivos** y han analizado el comportamiento de las multitudes con dicho fin con el estadio de fútbol de San Mamés como referencia.

Fallado el XXVIII Premio SeMA "Antonio Valle" al Joven Investigador (2025)

26 DE ABRIL DE 2025

El Comité encargado de otorgar el Premio SeMA "Antonio Valle" al Joven Investigador 2025 ha fallado que los ganadores del premio de esta convocatoria son **Matteo Croci (BCAM) y Jesús David Poyato Sánchez (UGR).**

El Comité desea poner en valor el resto de candidaturas presentadas debido a la alta calidad de los trabajos de los aspirantes.

Los galardonados recogerán el Diploma acreditativo e impartirán un charla de 30 minutos durante la celebración de la próxima EHF2025 que se celebrará en Ciudad Real del 7 al 11 de julio 2025.

Perfil Investigador de Matteo Croci

Matteo Croci es profesor investigador Ramón y Cajal en BCAM (Bilbao) desde el año 2024. Defendió su tesis titulada: "Multilevel Monte Carlo Methods for Uncertainly Quantification in Brain Simulations" en la Universidad de Oxford en el año 2020 bajo la dirección de los profesores P. E. Farrel y M. B. Giles.

Matteo obtuvo el premio Lexlie fox Prize in Numerical Analysis (segunda posición) en el año 2023. Previamente había obtenido el

campusa Noticias de la Universidad del País Vasco

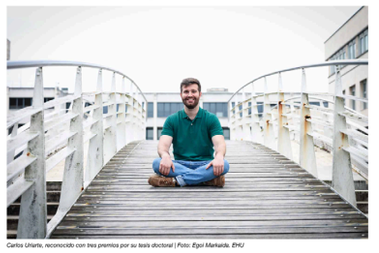
EHU

NOTICIAS CATHEDRA CRÓNICA REPORTAJES INVESTIGACIÓN PHOTOCAMPUS AGENDA

EUSKARA | ESPAÑOL | ENGLISH

Carlos Uriarte, reconocido con tres prestigiosos premios por su tesis doctoral

Su investigación sobre la utilización de inteligencia artificial en simulaciones computacionales recibe un triple reconocimiento internacional



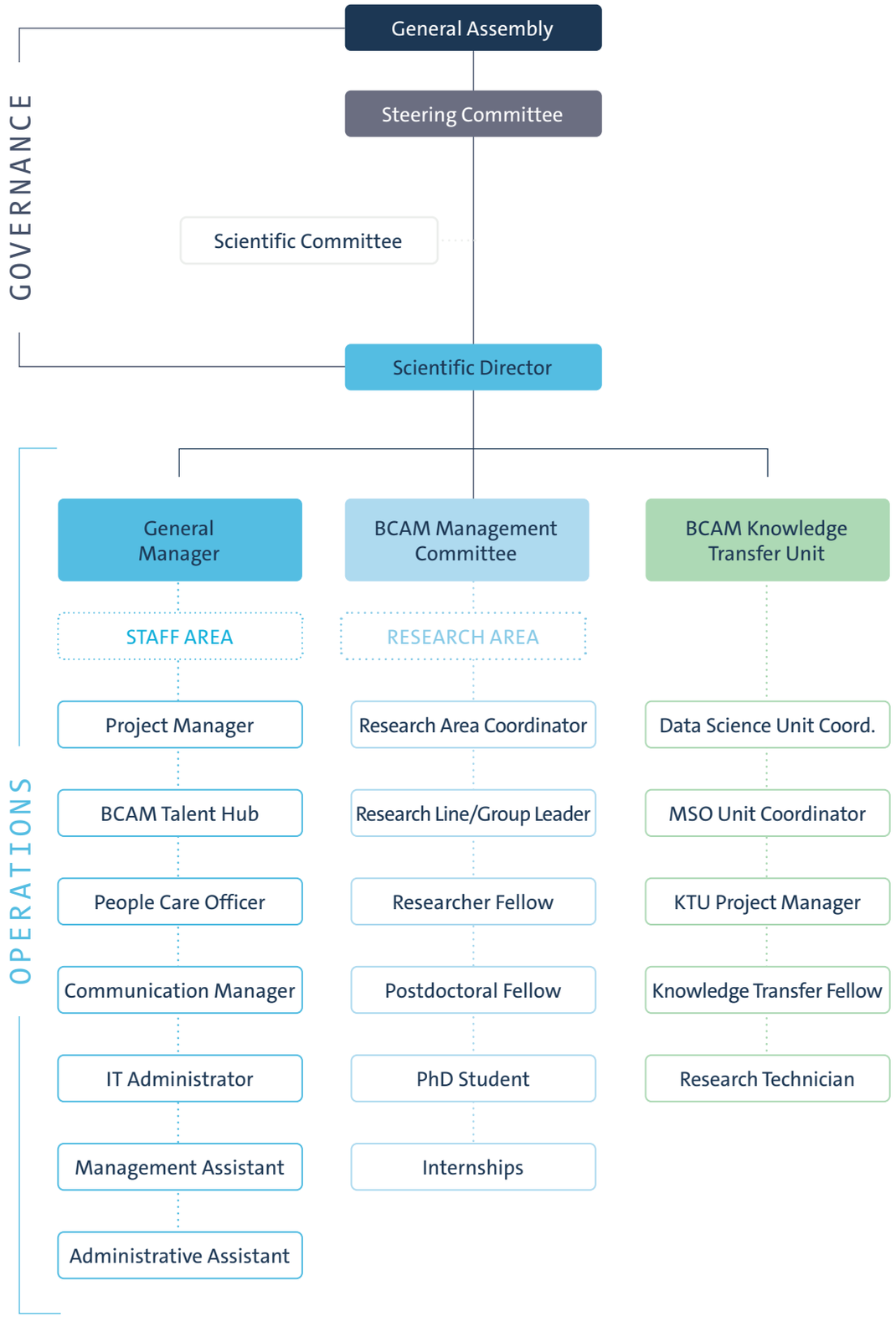
Carlos Uriarte, reconocido con tres premios por su tesis doctoral | Foto: Egoi Markaida. EHU

Carlos Uriarte (Getxo 1996), doctor en Matemáticas por la Universidad del País Vasco (EHU), ha sido distinguido recientemente con el premio a la mejor tesis doctoral de 2024 por tres destacadas instituciones científicas: la Comunidad Europea de Métodos Computacionales en Ciencias Aplicadas ECCOMAS, la Sociedad Española de Matemática Aplicada SEMA y la Sociedad Española de Métodos Numéricos en Ingeniería SEMNI. La coincidencia de estas tres entidades al premiar un mismo trabajo no es habitual y refleja el reconocimiento que está recibiendo el Programa de Doctorado en Matemática y Estadística de la Facultad de Ciencia y Tecnología de la EHU.

03 People

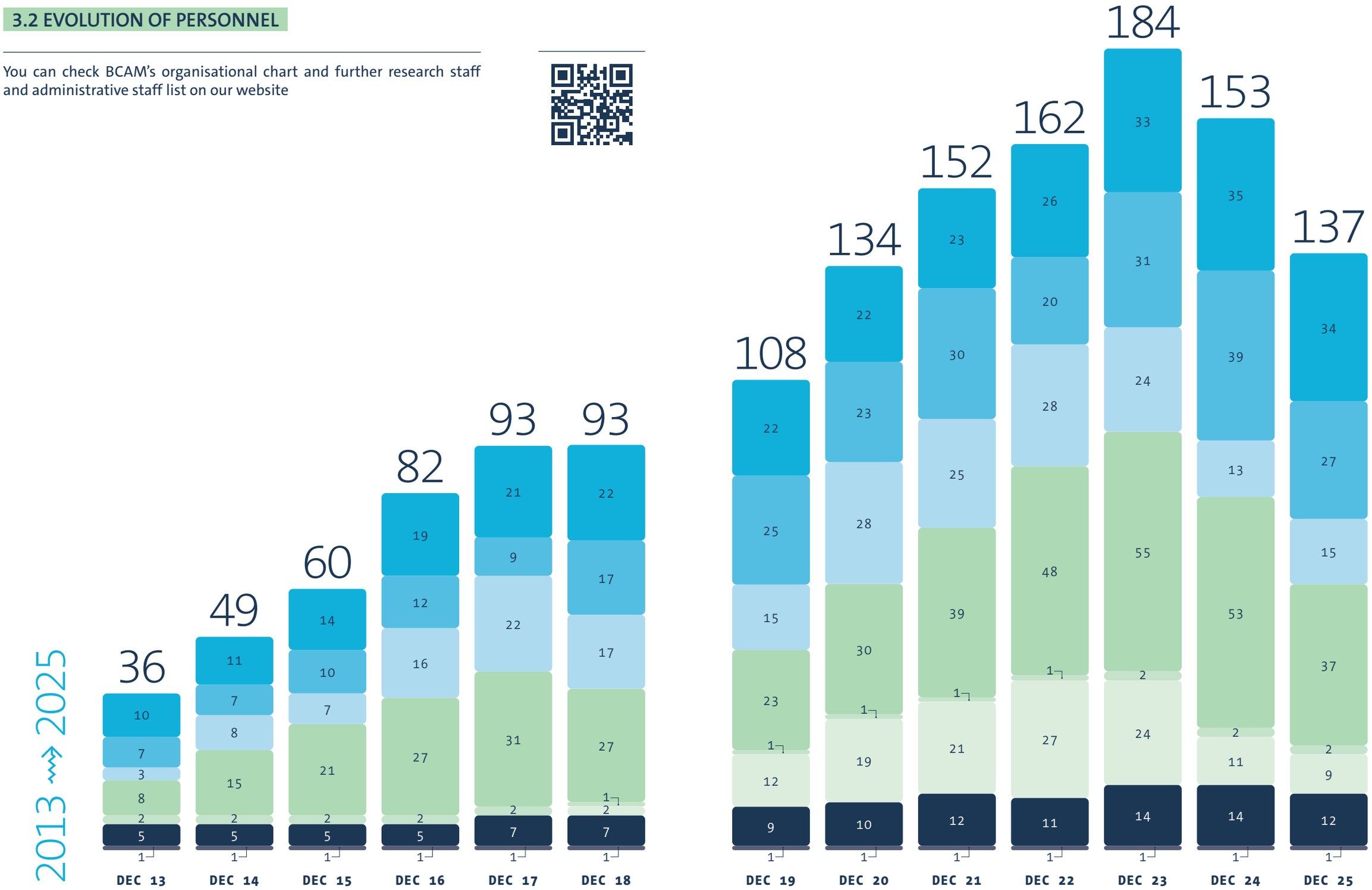
WHO IS BEHIND BCAM?

3.1 BCAM'S ORGANIZATIONAL CHART



3.2 EVOLUTION OF PERSONNEL

You can check BCAM's organisational chart and further research staff and administrative staff list on our website



3.3 RESEARCH AREAS AND LINES

During 2025, BCAM continues to develop its research through the established research groups and lines of research, organised thematically in 5 areas in relation to its scientific field.

01 CM
Computational Mathematics

- Mathematical Design, Modelling and Simulations MATHDES
- CFD Modelling and Simulations CFDMS

02 M3A
Mathematical Modelling with Multidisciplinary Applications

- Modelling and Simulation in Life and Material Sciences MSLMS
- Mathematical and Theoretical Biology MTB
- Mathematical, Computational and Experimental Neuroscience MCEN

03 MP
Mathematical Physics

- Quantum Mechanics QM
- Statistical Physics SP
- Singularity Theory and Algebraic Geometry STAG

04 APDE
Analysis of Partial Differential Equations

- Linear and Non-Linear Waves WAVE
- Harmonic Analysis HA
- Applied Analysis AA

05 DS
Data Science and Artificial Intelligence

- Combinatorial Optimization CO
- Computational and Applied Statistics CAS
- Machine Learning ML

3.4 BCAM SCIENTIFIC ADVISORY COMMITTEE

The Scientific Committee is an external and strategic advisory council of BCAM made up of internationally recognised researchers in mathematics. They provide an independent view of BCAM's researchers and activities. This committee meets once a year to monitor the development of the centre's strategic plan, provide advice on different topics and validate the results obtained.

Prof. David Lannes

CHAIR

Institut de Mathématiques de Bordeaux,
Bordeaux, FRANCE

DIRECTOR OF RESEARCH AT THE CNRS

Prof. Annalisa Buffa

Institute de Mathématiques - Ecole polytechnique Fédérale de Lausanne
Lausanne, SWITZERLAND

CHAIR OF NUMERICAL MODELLING AND SIMULATION (MNS)

Prof. Montserrat Fuentes

St. Edward's University
Austin, Texas, USA

PRESIDENT

Prof. Laure Saint-Raymond

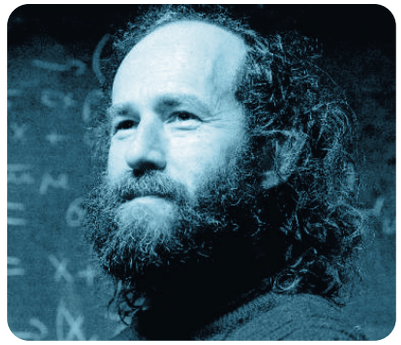
UMPA, ENS de Lyon
Lyon, FRANCE

PROFESSOR

Prof. Jesús María Sanz Serna

Royal Academy of Sciences of Spain and Carlos III University of Madrid
Madrid, SPAIN

ACADEMICIAN AND FORMER PRESIDENT OF THE ROYAL ACADEMY OF SCIENCES OF SPAIN AND APPLIED MATHEMATICS PROFESSOR



Prof. Marc Shoenauer

INRIA Saclay - Île-de-France
Orsay Cedex, FRANCE

DEPUTY RESEARCH DIRECTOR AT INRIA
CO-HEAD (WITH MICHÈLE SEBAG) OF PROJECT-TEAM TAU

Prof. Jan Philip Solovej

University of Copenhagen
Copenhagen, DENMARK

CHAIR OF NUMERICAL MODELLING AND SIMULATION (MNS)

04 Funding

WHO IS BEHIND BCAM?

You can check BCAM's research projects on our website

HIGHLIGHTED PROJECTS

FermiMath

THE MATHEMATICS OF INTERACTING FERMIONS

HE-101040991

The quantum many-body problem presents us with a baffling variety of phenomena whose mathematical understanding is just leaving infancy. One of the most prominent examples is the behavior of electrons in condensed matter: surprisingly, despite the presence of strong interactions between particles in the microscopic Schroedinger equation, on a macroscopic level one observes almost non-interacting particles. Moreover, some properties even turn out to be universal, i.e. do not depend on the details of the microscopic equation at all. Fermi liquid theory has been phenomenologically developed as an emergent theory to describe these correlation effects in systems of interacting fermionic particles. The first goal of this project is a rigorous derivation of Fermi liquid theory from the Schroedinger equation. My approach will be based on the analysis of high-density scaling limits. While the analysis of scaling limits has been tremendously successful in the last years for bosonic systems, in fermionic systems it has been restricted to the derivation of mean-field theories. Recently I have developed an approximate bosonization for three-dimensional systems which can be rigorously applied in high-density scaling limits. This is one of the few tools that permit an analysis beyond mean-field theory, enabling us now to describe correlations without relying on perturbation theory. The second goal is to show that one-dimensional systems can be analyzed similarly but display a very different behavior called Luttinger liquid, demonstrating that the approach allows to distinguish Fermi from non-Fermi liquids. Thus I will not only provide a unified justification of the non-interacting electron approximation in two and more dimensions, but also pave a new way to and partially resolve the classification problem of the fermionic phase diagram.

FUNDED BY

European Union's Horizon Europe research and innovation program under the European Research Council (ERC)

DURATION

2025/08 – 2027/04

PI

Prof. Benedikter, N. the European Research Council (ERC)

ABOUT THE PI

Niels Benedikter is a Professor of Mathematical Physics at the University of Milan (Statale). The focus of his work is on the mathematically rigorous derivation of effective theories for quantum many-body systems. Examples are the Gross-Pitaevskii and Bogoliubov theories of Bose-Einstein condensates, Hartree-Fock theory for fermionic many-body systems, spin wave theory for the ferromagnetic Heisenberg model, and the random phase approximation describing emergent bosonic excitations in the Fermi gas.

Since August 2025, Benedikter also leads the BCAM Severo Ochoa Strategic Lab on Quantum Mathematics at BCAM.

SWEATHEART

MART WEARABLES FOR TAILORED HEALTH AND EXERCISE ASSESSMENT OF REAL-TIME TRAINING

HE-101202439

FUNDED BY

MSCA- Individual Fellowship 2024

DURATION

2025/07 – 2027/06

PI

Dr. De Giovanni, E.

In the context of the EU “Healthier Together” initiative, the main objectives include reducing the significant health burden of Non-Communicable Diseases (NCDs), especially cardiorespiratory (CR) ones, and improving the overall health and well-being of the community. As several CR diseases manifest during extreme exercise, there is a need to monitor these conditions and tailor the exercise regimens to the specific subject’s CR profile. The goal of SWEATHEART is to create an energy-efficient embedded wearable system to continuously monitor CR parameters during high-intensity exercise and exercise-induced phenomena in elite athletes, whose profile is the most suited. It will use accurate wearable sensors in real-world training sessions to tailor exercise prescriptions and prevent overreaching and cardiorespiratory issues. To achieve the goal, SWEATHEART will follow three objectives: 1) Detect the CR parameters in real-time using an optimal set of non-invasive and low-cost wearable sensors and emerging computing techniques; 2) Detect fatigue and overreaching derived by extreme exercise based on the extracted CR parameters; 3) Design an energy-efficient embedded system for tailored exercise prescription based on the CR parameters and overreaching. The project requires multidisciplinary involvement of different parties. The host institution and the supervisor have extensive knowledge of mathematical and statistical modeling and machine learning methodologies. Moreover, their collaborations with sports clubs and the supervisor’s start-up experience will enhance the project results and the researchers’s future career development. The secondment institution specializes in exercise physiology and has long-lasting experience in data protocol design. The applicant contributes to the system-level design of embedded wearable sensors for biomedical applications. The hosts and applicant will mutually benefit from the project outcomes and the newly formed collaborations.

ABOUT THE PI

Elisabetta De Giovanni is a Marie Skłodowska-Curie Postdoctoral Fellow at the Basque Center for Applied Mathematics (BCAM) in Bilbao, Spain, focusing on developing energy-efficient wearable systems to monitor cardiorespiratory effects during high-intensity exercise. She holds a master’s degree in Bioengineering from the University of Pavia and earned her PhD in Electrical Engineering from École Polytechnique Fédérale de Lausanne (EPFL, Switzerland) in 2021, specializing in adaptive ultra-low power wearable sensors for health monitoring. After a year-long career break in 2022, she worked as a postdoctoral fellow at the University of Salento, developing intelligent IoT solutions for health, sport, and safety. Her research career has a multidisciplinary approach integrating Bioengineering and Electrical Engineering, with mathematical modeling, computer science, and physiology. She has collaborated with multi-international academic and industrial partners, such as Bilbao Kirolak (Spain), the Institute of Sports Sciences of the University of Lausanne (Switzerland), the Salento Biomedical District (Italy), and the International Academy of Sport Science and Technology (Switzerland), among others. Elisabetta has authored multiple articles in top journals and conferences, received over 150 citations, and peer-reviewed various articles for international journals.

SIPOCAG

SINGULARITIES IN POSITIVE-CHARACTERISTIC ALGEBRAIC GEOMETRY

HE-101202625

FUNDED BY

MSCA- Individual Fellowship 2024

GRANT DATE

2025/02

PI

Dr. Mallory, D.

SIPOCAG aims to understand and classify singularities occurring in positive-characteristic from two points of view: First, to understand the indecomposable summands arising via the Frobenius morphism of a ring or a variety, and second, to understand the relation between the theory of arc/jet schemes and the “standard” singularities of positive-characteristic commutative algebra. Towards the first objective, given a ring R in characteristic p, one obtains a new module by restricting scalars along the Frobenius self-map on R. The properties of resulting module reflect the singularities of R; for example, Kunz showed that this module is flat if and only if R is regular. I seek to understand what the indecomposable summands of this module tell us about R, especially as one restricts scalars along higher iterates of the Frobenius. In particular, SIPOCAG focuses on the question of how many different isomorphism classes of indecomposables show up in this process: I propose to understand when this number is finite, and what the types and nature of the summands tell us about the ring R. Towards the second objective, the arc scheme of a variety X and its truncation, the jet schemes, are moduli spaces of infinitesimal curves on X, and have proved useful in studying singularities in birational geometry. However, the relation between the arc/jet schemes and the usual notions of singularities in commutative algebra, such as F-purity, remains unknown. SIPOCAG will characterize such classes of singularities via the study of their arc/jet schemes, and leverage these connections to better understand the behavior of these singularities. Finally, I propose to develop useful new computational tools for working with concrete examples of the preceding two phenomena, which will be useful not only for SIPOCAG but also to many other researchers. These goals will be approached by combining my existing geometric approach to these topics with the algebraic expertise of the host.

ABOUT THE PI

Devlin Mallory is a Postdoctoral Fellow at BCAM, in the Singularity Theory and Algebraic Geometry group. He studies algebraic geometry and commutative algebra. Recently, I’ve been thinking about positivity properties of tangent bundles of Fano manifolds in relation to differential properties of their section rings, and connections to positive characteristic phenomena such as finite F-representation type. Mallory is also interested in applications of arc spaces to the study of singularities.

Previous to this, he was a Postdoctoral Fellow at the University of Utah, and before that he was a graduate student at the University of Michigan. His adviser was Mircea Mustață.

FUNDING INSTITUTIONS

Distinctions

EXCELENCIA SEVERO OCHOA

HR EXCELLENCE IN RESEARCH

Public Funding Institutions

EUSKO JAURLARITZA GOBIERNO VASCO

ikerbasque Basque Foundation for Science

Bizkaia foru aldundia diputación foral

European Commission

05 Highlighted Publications

THE YEAR AT A GLANCE

COMPUTATIONAL MATHEMATICS

Gabor-enhanced physics-informed neural networks for fast simulations of acoustic wavefields

MATHEMATICAL DESIGN, MODELLING AND SIMULATIONS

Physics-Informed Neural Networks (PINNs) applied to the Helmholtz equation suffer from low-frequency bias in high-frequency wavefield modelling. To address this, a simplified Gabor-PINN framework incorporating trainable Gabor basis functions is proposed to capture oscillatory behaviour. Unlike previous methods, this approach learns a non-linear mapping to a custom Gabor coordinate system. This absorbs key parameters, reducing computational complexity and eliminating manual tuning. Additionally, the framework efficiently integrates Perfectly Matched Layers (PML) into the training process. Numerical experiments show that this method achieves faster convergence, higher accuracy, and greater robustness than traditional PINNs and prior Gabor-based approaches. Crucially, the advancement lies not in increasing architectural complexity, but in absorbing it into the learned coordinate transformation. The code is publicly available.

Journal of Neural Networks, Volume 193, 2025, 107978, ISSN 0893-6080,
https://doi.org/10.1016/j.neunet.2025.107978

AUTHORS

Abedi, MM. | Pardo, D. | Alkhalifah, T.

Smoothed Dissipative Particle Dynamics for Mesoscale Advection-Diffusion-Reaction Problems

CFD MODELLING AND SIMULATION

Smoothed dissipative particle dynamics (SDPD) is a widely used particle-based method for modeling soft matter systems at mesoscopic and macroscopic scales, offering thermodynamic consistency and direct control over the fluid's transport properties. Here, we present an SDPD model that incorporates the transport of reactants on scales smaller than the discretizing particles, including the evolution of compositional fields. The proposed methodology is well-suited for modeling complex systems governed by advection-diffusion-reaction (ADR) dynamics. Implemented in Large-scale Atomic/Molecular Massively Parallel Simulator, the model is validated using a range of benchmark problems spanning diffusion-dominated, reaction-dominated, and coupled ADR regimes. Our simulation results demonstrate that the implemented SDPD model effectively captures complex behaviors, such as Turing pattern formation. The proposed model holds promise for applications across various fields, including biology, chemistry, materials science, and environmental engineering.

Journal of Chemical Physics, 2025 Nov 7;163(17):174105.
doi: 10.1063/5.0295983.

AUTHORS

Echeverría-Ferrero, M. |
Moreno, N. | Ellero, M.

MATHEMATICAL MODELLING WITH MULTIDISCIPLINARY APPLICATIONS

DMC matters: the role of dimethyl carbonate in SEI formation on oxygen functionalized anodes

MODELLING AND SIMULATION IN LIFE AND MATERIALS SCIENCES

We present novel computational methods for studying Li-ion dynamics in the technologically significant solid electrolyte materials Ga0.15/Scy-LLZO. Combining a specifically designed DFT-based force field and an advanced hybrid Monte Carlo with molecular dynamics simulations, we systematically examine the material's transport properties for a range of cationic concentrations. In addition, we introduce innovative post-processing data mining clustering techniques which help shed light on conductivity mechanisms, providing key insights for advanced electrolyte design.

AUTHORS

Das, B. K. | Cortés, H. A. | Rincón Bonilla, M. | Yang, M. | Carrasco, J. | Akhmatskaya. E.

Journal of Materials Chemistry A, 2025, 13, 27557 DOI: 10.1039/D5TA02003D

Evaluating the risk of mosquito-borne diseases in non-endemic regions: A dynamic modeling approach

MATHEMATICAL AND THEORETICAL BIOLOGY

Mosquito-borne diseases are spreading into temperate zones, raising concerns about local outbreaks driven by imported cases. Using stochastic methods, we developed a vector-host model to estimate the risk of import-driven autochthonous outbreaks in non-endemic regions. The model explores key factors such as imported cases and vector abundance. Our analysis shows that mosquito population abundance significantly affects the probability and timing of outbreaks. Even with moderate mosquito populations, isolated or clustered outbreaks can be triggered, highlighting the importance of monitoring vector abundance for effective public health planning and interventions.

AUTHORS

Stollenwerk, N. | Mateus, L. | Steindorf, V. | Guerrero, B.V. | Blasco-Aguado, R. | Cevidanes, A. | Bidaurrazaga Van-Dierdonck, J. | Aguiar, M.

https://doi.org/10.1016/j.matcom.2025.04.026.

Explosive neural networks via higher-order interactions in curved statistical manifolds

MATHEMATICAL, COMPUTATIONAL AND EXPERIMENTAL NEUROSCIENCE

Higher-order interactions underlie complex phenomena in systems such as biological and artificial neural networks, but their study is challenging due to the scarcity of tractable models. By leveraging a generalisation of the maximum entropy principle, we introduce curved neural networks as a class of models with a limited number of parameters that are particularly well-suited for studying higher-order phenomena. Through exact mean-field descriptions, we show that these curved neural networks implement a self-regulating annealing process that can accelerate memory retrieval, leading to explosive order-disorder phase transitions with multi-stability and hysteresis effects. Moreover, by analytically exploring their memory-retrieval capacity using the replica trick, we demonstrate that these networks can enhance memory capacity and robustness of retrieval over classical associative-memory networks. Overall, the proposed framework provides parsimonious models amenable to analytical study, revealing higher-order phenomena in complex networks.

AUTHORS

Aguilera, M. | Morales, P.A. | Rosas, F.E. | Shimazaki, H.

Nature Communications 16, 6511 (2025). https://doi.org/10.1038/s41467-025-61475-w

MATHEMATICAL PHYSICS

Non-linear operator-valued elliptic flows with application to quantum field theory

QUANTUM MECHANICS (QM)

This study investigates a novel system of non-linear differential equations on operator spaces, a highly challenging and underdeveloped mathematical field. The authors demonstrate that this system possesses a unique solution for all times, specifically within the Schatten norm topology. Crucially, the system exhibits remarkable ellipticity properties that are essential for proving its infinite-time limit under relatively weak initial hypotheses. This system serves as the elliptic counterpart to a hyperbolic flow previously used in quantum field theory to diagonalise quadratic bosonic Hamiltonians. In a similar manner, the asymptotics of this new elliptic flow can be applied to diagonalise Hamiltonians that are quadratic in the fermionic field. This approach yields new explicit expressions and key properties for these pivotal Hamiltonians, offering significant contributions to both quantum field theory and quantum statistical mechanics.

AUTHORS

Bru J-B. | Metraud, N.

Journal de Mathématiques Pures et Appliquées, Volume 195, 2025, 103657, ISSN 0021-7824, https://doi.org/10.1016/j.matpur.2025.103657.

Fire-spotting modelling in operational wildfire simulators based on Cellular Automata: A comparison study

STATISTICAL PHYSICS

The molecular motion in heterogeneous media displays anomalous diffusion by the mean-squared displacement X2(t) =2Dt . Motivated by experiments reporting populations of the anomalous diffusion parameters and D, we aim to disentangle their respective contributions to the observed variability when this last is due to a true population of these parameters and when it arises due to finite-duration recordings. We introduce estimators of the anomalous diffusion parameters on the basis of the time-averaged mean squared displacement and study their statistical properties. By using a copula approach, we derive a formula for the joint density function of their estimations conditioned on their actual values. The methodology introduced is indeed universal, it is valid for any Gaussian process and can be applied to any quadratic time-averaged statistics. We also explain the experimentally reported relation D exp(c1+c2) for which we provide the exact expression. We finally compare our findings to numerical simulations of the fractional Brownian motion and quantify their accuracy by using the Hellinger distance.

AUTHORS

Lanoiselée, Y. | Pagnini G. | Wylomanska A.

Physical Review Letters, 135, 137101 (2025), https://doi.org/10.1103/y5pn-5ynd

Hodge modules and cobordism classes

SINGULARITY THEORY AND ALGEBRAIC GEOMETRY

We show that the cobordism class of a polarization of Hodge module defines a natural transformation from the Grothendieck group of Hodge modules to the cobordism group of self-dual bounded complexes with real coefficients and constructible cohomology sheaves in a compatible way with push-forward by proper morphisms. This implies a new proof of the well-definedness of the natural transformation from the Grothendieck group of varieties over a given variety to the above cobordism group (with real coefficients). As a corollary, we get a slight extension of a conjecture of Brasselet, Schürmann and Yokura, showing that in the Q -homologically isolated singularity case, the homology L-class which is the specialization of the Hirzebruch class coincides with the intersection complex L-class defined by Goresky, MacPherson, and others if and only if the sum of the reduced modified Euler–Hodge signatures of the stalks of the shifted intersection complex vanishes. Here Hodge signature uses a polarization of Hodge structure, and it does not seem easy to define it by a purely topological method.

AUTHORS

Fernández de Bobadilla, J. | Pallarés, I. | Saito, M.

Journal of the European Mathematical Society 27 (2025), no. 2, pp. 773–800, DOI 10.4171/JEMS/1387

ANALYSIS OF PARTIAL DIFFERENTIAL EQUATIONS

Complete classification of global solutions to the obstacle problem

LINEAR AND NON-LINEAR WAVES

The characterization of global solutions to the obstacle problems in R^N, or equivalently of null quadrature domains, has been studied for more than 90 years. In this paper, we give a conclusive answer to this problem by proving the following long-standing conjecture: The coincidence set of a global solution to the obstacle problem is either a half-space, an ellipsoid, a paraboloid, or a cylinder with an ellipsoid or a paraboloid as base.

AUTHORS

Eberle, S. | Figalli, A. | Weiss, G.S

Annals of Mathematics, 201(1), pp. 167-224. 2025. DOI: 10.4007/annals.2025.201.1.3

The hydrostatic Lagrangian approach to the compressible primitive equations

HARMONIC ANALYSIS

This article develops the hydrostatic Lagrangian approach to the compressible primitive equations. A fundamental aspect in the analysis is the investigation of the compressible hydrostatic Lamé and Stokes operators. Local strong well-posedness for large data and global strong well-posedness for small data are established under various assumptions on the pressure law, both in the presence and absence of gravity.

AUTHORS

Hieber, M. | Iida, Y. | Roy, A. | Zöchling, T.

Mathematische Annalen, 2025, Volume 286, Issue 9, 2024, 110375, ISSN 0022-236, https://doi.org/10.1016/j.jfa.2024.110375.

Poisson transform and unipotent complex geometry

APPLIED ANALYSIS

Our concern is with Riemannian symmetric spaces $Z = G/K$ of the non-compact type and more precisely with the Poisson transform $\mathscr{P}_\lambda$ which maps generalized functions on the boundary ∂Z to λ-eigenfunctions on Z. Special emphasis is given to a maximal unipotent group $N < G$ which naturally acts on both Z and ∂Z. The N-orbits on Z are parametrized by a torus $A = (\mathbb{R}_{>0})^r < G$ (Iwasawa) and letting the level $a \in A$ tend to 0 on a ray we retrieve N via $\lim_{a\to 0} Na$ as an open dense orbit in ∂Z (Bruhat). For positive parameters λ the Poisson transform $\mathscr{P}_\lambda$ is defined and injective for functions $f \in L^2(N)$ and we give a novel characterization of $\mathscr{P}_\lambda(L^2(N))$ in terms of complex analysis. For that we view eigenfunctions $\phi = \mathscr{P}_\lambda(f)$ as families $(\phi_a)_{a\in A}$ of functions on the N-orbits, i.e. $\phi_a(n) = \phi(na)$ for $n \in N$. The general theory then tells us that there is a tube domain $\mathscr{T} = N\exp(i\Lambda) \subset N_{\mathbb{C}}$ such that each ϕ_a extends to a holomorphic function on the scaled tube $\mathscr{T}_a = N\exp(i\,\mathrm{Ad}(a)\Lambda)$. We define a class of N-invariant weight functions $\mathbf{w}_\lambda$ on the tube $\mathscr{T}$, rescale them for every $a \in A$ to a weight $\mathbf{w}_{\lambda,a}$ on $\mathscr{T}_a$, and show that each ϕ_a lies in the L^2-weighted Bergman space $\mathscr{B}(\mathscr{T}_a, \mathbf{w}_{\lambda,a}) := \mathscr{O}(\mathscr{T}_a) \cap L^2(\mathscr{T}_a, \mathbf{w}_{\lambda,a})$. The main result of the article then describes $\mathscr{P}_\lambda(L^2(N))$ as those eigenfunctions ϕ for which $\phi_a \in \mathscr{B}(\mathscr{T}_a, \mathbf{w}_{\lambda,a})$ and

$$\|\phi\| := \sup_{a\in A} a^{\mathrm{Re}\ \lambda-2\rho}\|\phi_a\|_{\mathscr{B}_{a,\lambda}} < \infty$$

AUTHORS

Gimperlein, H. | Krötz, B. | Roncal, L. | Thangavelu, S.

Journal of Functional Analysis, Volume 288, Issue 3, 2025, 110742, ISSN 0022-1236, https://doi.org/10.1016/j.jfa.2024.110742.

DATA SCIENCE & ARTIFICIAL INTELLIGENCE

A Constrained Learning-Based Competitive S warm Optimizer for Large-Scale Multiobjective Optimization

COMBINATORIAL OPTIMIZATION

Competitive Swarm Optimisers (CSOs) are a prominent paradigm for solving large-scale multiobjective optimisation problems (LMOPs). However, traditional pairwise random competition (PRC) can limit performance: poor-quality winner particles hinder loser particle learning, and stochastic perturbations slow down convergence speed. To address these issues, this article proposes a constrained learning-based CSO (CL-CSO). Firstly, CL-CSO uses reference vectors to divide the original objective space into several subregions. Secondly, it introduces a constrained learning strategy—comprising intra-subregion and cross-subregion learning—ensuring loser particles only learn from winners in their own or neighbouring subregions. Furthermore, a Gaussian model-assisted evolutionary strategy is implemented to enhance the diversity and quality of winner particles. Consequently, both particle learning and overall convergence speed are significantly enhanced. Experimental results on benchmark LMOPs (with up to 5,000 decision variables) and real-world instance selection problems demonstrate that CL-CSO outperforms several competitive algorithms.

AUTHORS

Li,Y. | Li, L. | Lin, Q. | Ming, Z. | Leung, V. C. M. | Coello Coello C. A.

IEEE Transactions on Cybernetics, vol. 56, no. 1, pp. 148-161, Jan. 2026, doi: 10.1109/TCYB.2025.3612091

Modelling in-hospital length of stay: A comparison of linear and ensemble models for competing risk analysis

APPLIED STATISTICS

This study assessed cost-sensitive ordinal AI-ML strategies for predicting SARS-CoV-2 pneumonia severity using data from 1,548 patients across four Spanish hospitals. A model using 148 features, ordinal decomposition, cost-based re-sampling, and Histogram-based Gradient Boosting outperformed five clinical severity scores and a standard AI-ML baseline. It achieved 68.1% accuracy and 0.802 AUC. The research highlights the effectiveness and rarity of combining ordinal classification with cost sensitivity in clinical prognosis tasks.

PLOS ONE 20(8): e0322101. https://doi.org/10.1371/journal.pone.0322101

AUTHORS

Espinosa-Moreno, J.C. | García-García, F. | Mas-Bilbao, N. | García-Gutiérrez, S. | Legarreta-Olabarrieta, M. J. | Lee D-J.

Reliable Programmatic Weak Supervision With Confidence Intervals for Label Probabilities

MACHINE LEARNING

The accurate labeling of datasets is often both costly and time-consuming. Given an unlabeled dataset, programmatic weak supervision obtains probabilistic predictions for the labels by leveraging multiple weak labeling functions (LFs) that provide rough guesses for labels. Weak LFs commonly provide guesses with assorted types and unknown interdependences that can result in unreliable predictions. Furthermore, existing techniques for programmatic weak supervision cannot provide assessments for the reliability of the probabilistic predictions for labels. This paper presents a methodology for programmatic weak supervision that can provide confidence intervals for label probabilities and obtain more reliable predictions. In particular, the methods proposed use uncertainty sets of distributions that encapsulate the information provided by LFs with unrestricted behavior and typology. Experiments on multiple benchmark datasets show the improvement of the presented methods over the state-of-the-art and the practicality of the confidence intervals presented.

IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 47, no. 12, pp. 11534-11547, Dec. 2025, doi: 10.1109/TPAMI.2025.3597508.

AUTHORS

Álvarez, V. | Mazuelas, S., An, S. | Dasgupta, S.

06 Severo Ochoa Joint Research Lab Program

This initiative is part of the actions promoted by BCAM thanks to the accreditation of “Severo Ochoa Centre of Excellence” granted by the Ministry of Science and Innovation through the State Research Agency and that BCAM has for the period 2023-2027.

- ---→ **To promote collaborative research on hot topics** such as machine learning methods and PDEs, Elliptic and Dispersive PDEs and their relation with Geometry and Fluid Mechanics and thus strengthen the centre’s research areas and generate synergies.
- ---→ **To contribute to BCAM projects** on mathematical modelling applied to health.
- ---→ **Explore the connection between pure/applied mathematics and new research topics** in collaboration with BCAM research areas.
- ---→ **Strengthen contacts** within the international scientific community.
- ---→ **To provide specialized training** for the members of the centre.

This program highlights the importance of international collaboration between research centres and universities, as well as the strengthening that this can mean for the centre’s lines of research and its international positioning. The agreement will materialize through different activities such as the joint supervision of postdoctoral researchers or visits to the centre and joint participation in scientific activities.

BCAM SEVERO OCHOA STRATEGIC LABS

Joint Research Lab

U. SUSSEX

The “BCAM Severo Ochoa Strategic Lab on Trustworthy Machine Learning” is held together with Prof. Novi Quadrianto at the University of Sussex and co-led by Jose A. Lozan, Scientific Director of BCAM and coordinator of the Data Science and Artificial Intelligence research area.

Joint Research Lab

U. OXFORD

The “BCAM Severo Ochoa Strategic Lab on Modelling with Partial Differential Equations in Mathematical Biology” is held together with Prof. Jose Antonio Carrillo at Mathematical Institute, Oxford University and co-led by Prof. Elena Akhmatskaya, Ikerbasque Professor at BCAM who coordinates the area of Mathematical Modelling with Multidisciplinary Applications.

Joint Research Lab

ETH ZURICH

The “BCAM Severo Ochoa Strategic Lab on Analysis of PDEs” is held in collaboration with Prof. Joaquim Serra from ETH Zurich. The laboratory is co-led by Prof. Luis Vega, coordinator of the APDE research area.

Joint Research Lab

RÉNYI INSITUTE

The “BCAM Severo Ochoa Strategic Lab on Singularity Theory” is held together with Prof. Andras Némethi (Renyi Institute Budapest), Prof. Duco van Straten (Mainz University) Prof. Nero Budur (KU Leuven). The laboratory is co-led by Prof. Javier Fernández de Bobadilla, Ikerbasque Professor at BCAM and research

Joint Research Lab

MILAN AND U. PISA

The “BCAM Severo Ochoa Strategic Lab on Quantum Mathematics” is held together with Prof. Niels Benedikter (University of Milan, Department of Mathematics “Federigo Enriques”), Dr. Chiara Boccato (University of Pisa, Department of Mathematics), and Prof. Serena Cenatiempo (Gran Sasso Science Institute, Mathematics Division). The laboratory is co-led by Prof. Jean-Bernard Bru, Ikerbasque Professor, UPV/EHU, and group leader at BCAM of the Quantum Mechanics research group.

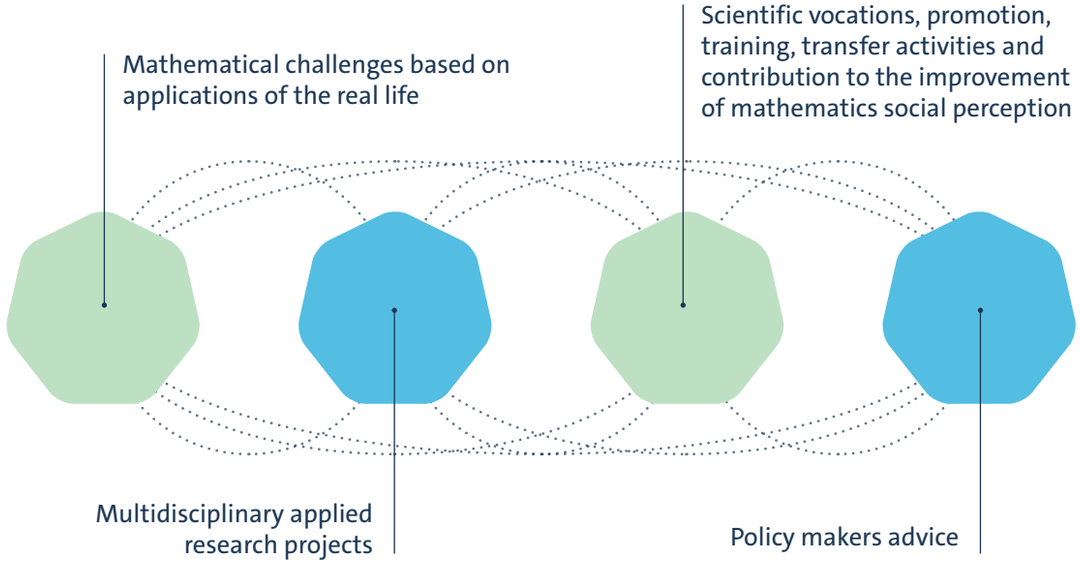
Joint Research Lab

MATHEMATICAL MATERIAL SCIENCE

The “BCAM Severo Ochoa Strategic Lab on Mathematical Material Science” is established in collaboration with Prof. Filip Rindler at the University of Warwick and BCAM - Ikerbasque Prof. Arghir Zarnescu.

07 Knowledge Transfer Unit [KTU]

The aim of BCAM Knowledge Transfer Unit is structured around four main objectives:



One of BCAM's most important missions is to spread knowledge and technology in the industry and the society in general.

It is critical for the Basque Center for Applied Mathematics to transfer the obtained research results to sectors as biosciences, health, energy, advanced manufacturing, telecommunications and transport, including local, national and international entities.

For that purpose, BCAM offers expertise in many research fields to SMEs and large industrial groups, and supports the creation of new companies.

COLLABORATION MODELS

01. Strategic partnerships
02. Collaborative R&D&I projects
03. Joint positions / research teams
03. Supervision of Master and PhD Students
04. Training courses
05. Organization of dissemination activities

PRIVATE FUNDING ONGOING PROJECTS

Goal-directed behavior and the origin of life

This study explores the hypothesis that non-living systems exhibit “goal-directed behaviour” (GDB), a trait vital for persistence and growth.

It posits that GDB is as fundamental to the origin of life as metabolism, addressing a major gap in current scientific research.

The project will develop a formal theory, testing it through active droplets, chemical networks, and digital whole-cell models.

Ultimately, it aims to redefine abiogenesis and establish benchmarks for understanding agency in both protobiological and living systems.

JOHN TEMPLETON FOUNDATION

JOINT POSITIONS

VERSES

Tekniker

QUANTUM MADS

JOINT RESEARCH LABS

Joint Research Laboratory on Offshore Renewable Energy

Tecnalia-UPV/EHU-BCAM

The Joint Research Laboratory on Offshore Renewable Energy is composed of researchers from TECNALIA, UPV/EHU and BCAM.

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Joint Research Laboratory on Artificial Intelligence

Tecnalia-UPV/EHU-BCAM

The Joint Research Lab team is composed of fully collaborative and open-minded researchers. The research areas of the JRL-AI are: Time Series Analysis, Stream Learning, Optimization, Lifelong Machine Learning, Adversarial Machine Learning.

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Transmath

Transborder Laboratory for Mathematics and its Applications

The Laboratories for Trans-border Cooperation (LTCs) are a formula for collaboration that have been developed since 2015 in the frame of the Campus Euskampus-Bordeaux. TRANSMATH is a project created in 2017 for mathematics to work in the specific subject of: 1) cutting edge research in the classical fields of mathematics: ge,etru, algebra, analysis of PDEs, etc., 2) modeling and simulation, in particular in the applications to environment and health releated issues, and 3) data science.

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AULAS BCAM-EHU LEIOA AND DONOSTIA

AULA bcam UPV/EHU

The Aula BCAM-EHU promote, among others, joint participation in R&D projects in an open framework of topics of common interest between the UPV/EHU and the Basque Center for Applied Mathematics. Furthermore, it will favour the development of a professional career in BCAM of the students who participate in the activities of the Aula. It will jointly produce scientific-technological publications to disseminate the results of the collaborative research activity.

08 Gender balance actions

GENDER ACTIVITIES

BCAM is dedicated to integrating a gender lens into all its endeavors, striving to eradicate disparities and advance genuine equality between genders on a global scale. In pursuit of this mission, BCAM engages in various initiatives aimed at advancing women's contributions in research and cultivating the enthusiasm of young girls for STEM careers. In 2025, BCAM actively participated in the following endeavor:

EMAKUMEAK ZIENTZIAN

BCAM participates in Emakumeak Zientzian, an initiative that promotes, organises, develops, presents and executes an extensive programme of activities around 11 February. This proposal aims to make women scientists visible, break down stereotypes and encourage scientific vocations. BCAM hosted visits to the centre (offered by Leire Garmendia, PhD student); researchers from the centre visited schools and collaborated in the dissemination of the activities.

BE ZIENTZIA

Science fair in collaboration with Achucarro, BC3 and BCMaterials. More than 200 primary and secondary school pupils from Bilbao took part in it through different txokos organised by the 4 BERC centres.

FBBVA AWARDS 2025

María Merino (BCAM - EHU researcher) among those honored at SEIO - FBBVA Awards 2025

The team composed of María Merino Maestre (BCAM - EHU Researcher / Combinatorial Optimization), José A. Lozano (Scientific Director of BCAM and Full Professor at EHU), Gorka Kobeaga (CDM Consultores), and Jairo Rojas-Delgado (Archlet) was awarded for their exceptional methodological contribution. Their article entitled "A revisited branch-and-cut algorithm for large-scale orienteering problems", published in the European Journal of Operational Research, sets a new standard in computational efficiency and solution quality for orienteering problems.

ECCOMAS PHD AWARDS

Kanika Rajain (Postdoc Fellow), selected as SEMA Nominee for the 2025 ECCOMAS PhD Awards

The Spanish Society for Applied Mathematics (SEMA) has officially chosen Kanika Rajain's (Postdoctoral Fellow / Mathematical Design, Modelling and Simulations) doctoral thesis as a candidate for the prestigious ECCOMAS Awards for the Two Best PhD Theses in 2025.

Kanika defended her thesis, "5-Axis Computer Numerically Controlled (CNC) Flank Milling of Free-Form Surfaces Using Straight and Custom-Shaped Tools", under the supervision Michael Barton (Group Leader.Ikerbasque Research Associate Professor Mathematical Design, Modelling and Simulations) on January 2025.

MATEMATIKHA/ RIAK

Back in 2024 BCAM won , through its initiative MATEMATIKHARIAK, the Special Mention of Gender in the fourth edition of the STEAM Euskadi Sariak Awards, in the category of 'STEAM education initiatives promoted by socioeconomic entities'. These awards are organized by the Department of Education of the Basque Government in collaboration with the Basque Innovation Agency-Innobasque, within the STEAM Euskadi Strategy. The initiative has welcomed 750 student with the special focus in enlightening the interest for science in young girls.

SCIE-FUNDACIÓN BBVA AWARDS

BCAM's postdoc researcher Verónica Álvarez Castro, awarded as one of the Young Researchers in Computer Science in the SCIE-Fundación BBVA Awards

Verónica Álvarez Castro, Postdoc Fellow in BCAM's Machine Learning line, currently at the Massachusetts Institute of Technology (USA), has been awarded as one of the Young Researchers in Computer Science in the The Research Awards of the Scientific Society of Computer Science of Spain (SCIE)-Fundación BBVA

The jury of these awards has taken into account her contributions to machine learning in the field of adaptation to temporal changes, both in its most fundamental aspects and in its application to specific problems such as energy consumption prediction.

The Research Awards of the Scientific Society of Computer Science of Spain (SCIE)-BBVA Foundation recognize the excellence of the most outstanding scientists in our country in the field of computer science.

09 HRS4R Strategy at BCAM

A NEW STRATEGIC PHASE FOR HR MANAGEMENT

Since endorsing the European Charter for Researchers in 2008, BCAM has consistently aligned its management with international excellence standards. In 2024, the centre transitioned into a new strategic phase with the implementation of the 2024–2027 Action Plan under the HRS4R framework.

NEW HR LOGO COMMITTEE

A key milestone this year was the creation of the HR Logo Committee, a body designed to supervise policy compliance and ensure that all HR actions directly support the institution's long-term objectives through rigorous monitoring and evaluation.

2024 marked the launch of the BCAM Talent Hub, a dedicated office centralising the centre's recruitment strategy. This hub integrates internship programmes, international doctoral calls, and senior talent attraction in partnership with Ikerbasque.

2025 TRAINING AGENDA

Complementing this, in 2025, the centre's training agenda saw significant activity:

In the framework of BCAM's Training Plan, we started a collaboration with Deusto University for teaching at Mathematics Bachelor. Also, we held a targeted session in Equality in November was delivered to foster a more equitable and effectively managed research environment. The fourth edition of the Batera Mentoring Programme provided bespoke career guidance for early-career researchers and we renewed the perspective and we added training sessions for mentors and mentees.

4th Edition of the Batera Mentoring Programme

NEW Collaboration with Deusto University

INCLUSIVE CULTURE

BCAM's dedication to an inclusive culture was formalised this year through the development of the Decalogue on Inclusive Communication, ensuring diversity and empathy remain core to the centre's internal and external dialogue.

GENDER EQUALITY, STEAM & KNOWLEDGE TRANSFER

The institution also maintained a strong presence in the scientific community through, gender equality, with active participation in Emakumeak Zientzian by being in the coordinator group of the initiative, and the WomenXAfrica Foundation, promoting female leadership and global collaboration and in STEAM with the 'Matematikhariak' initiative, that was awarded the STEAM Euskadi seal with a special mention for gender perspective. In knowledge transfer,we launched the BCAM Podcast and joined the BBK Kuna Kideak alliance underscore BCAM's role in promoting the UN Sustainable Development Goals (SDG 9) within the Bizkaia region.

STEAM EUSKADI SEAL — Awarded to the 'Matematikhariak' initiative, with a special mention for gender perspective.

NEW — BCAM Podcast launched

SDG9 — Promoted through the BBK Kuna Kideak alliance

COMMUNITY ENGAGEMENT

Beyond the laboratory, the centre reinforced team cohesion and visibility within the local community, notably through participation in Bilbao's Business Race, promoting a healthy work-life balance and a collaborative spirit among staff. In addition, we participate in Bilbao Metropoli 30 to reflect on the future of the Bilbao metropolitan area, and its fundamental task is to foster a shared, long-term vision for Metropolitan Bilbao. Currently, it has more than 140 associated public entities, companies, universities, technology and educational centres, and social organisations representing different sectors of the metropolis.

In 2025, we have maintained our commitment to the HR Excellence in Research award until 2028, when the strategy of the centre will be reevaluated.

HR LOGO UNTIL 2028 — BCAM maintains its HR Excellence in Research award, with the centre's strategy set for reevaluation in 2028.

HR EXCELLENCE IN RESEARCH

Central to this has been the introduction of BCAM Breaks, where staff gather twice a month for coffee and conversation, fostering stronger professional and personal ties. And also celebrate international days, for example Pie Day or Halloween, making different activities during the week for researchers and staff to participate in. Additionally, our annual Winter Cocktail was enriched this year by a guided tour of Bilbao, offering a wonderful cultural experience for the whole team.

"Fostering stronger professional and personal ties."

Twice a month, staff gather for BCAM Breaks — coffee and conversation that strengthen the sense of community at the centre.

Additionally, we have continued our collaboration with the food bank collection. BCAM participates in this initiative annually, with staff volunteering their time as well as providing a collection point for donated products.

10 Networks and agreements

Being a multidisciplinary centre, collaboration between institutions and researchers is fundamental for the Basque Center for Applied Mathematics. Currently, BCAM belongs to some of the most important national and international networks in its field. We organized our participation in these networks and consortiums in the following way:

1. STRATEGIC & INSTITUTIONAL NETWORKS

ERCOM
European Research Centers on Mathematics

EWM
European Women in Mathematics

SOMMA
The 'Severo Ochoa' Centers and 'Maria de Maeztu' Units of Excellence Alliance

REM
Strategic Network in Mathematics

2. JOINT RESEARCH LABS & PLATFORMS

LTC-TRANSMATH
Joint Transborder Laboratory in Mathematics

JRL-ORE
Joint Research Lab on Offshore Renewable Energy

JRL-AI
Joint Research Lab on Artificial Intelligence

"AULAS" BCAM
UPV/EHU in Leioa and Donostia-San Sebastián

3. THEMATIC NETWORKS

MATH-IN
Spanish Network of Mathematics and Industry

BIOSTATNET
National Network of Biostatistics

CLISYNE
Clinical Systems Neuroscience

PET MSO-ED
Spanish Platform for Modelling, Simulation and Optimization Technologies in a Digital Environment

RGAS
Algebraic Geometry and Theory of Singularities

4. ASSOCIATIONS & CONSORTIUMS

ECMI
European Consortium for Mathematics in Industry

EOSC
European Open Science Cloud

BAIC
Basque Artificial Intelligence Center

BCSC
Basque CyberSecurity Centre

BDIH
Basque Digital Innovation Hub

EU-MATHS-IN
European Service Network of Mathematics for Industry and Innovation

BAT
B Accelerator Tower

INNOLAB
INNOLAB Bilbao

EARMA
European Association of Research Managers and Administrators

SOCIETIES

We are institutional members of:

EMS
European Mathematical Society

RSME
Real Sociedad Matemática Española

SEMA
Sociedad Española de Matemática Aplicada

AGREEMENTS

See next page →

AGREEMENTS

01 BASQUE COUNTRY

- Ayuntamiento de Bilbao
- OSI Araba & BioAraba
- CIC bioGUNE
- DANOBAT GROUP
- EITB
- Emergencias Osakidetza
- GHI Hornos Industriales
- Hawk Biosystems
- Ikerbasque
- Ikerbasque (IBM)
- Innovation Data Space Iberdrola
- INSERTEC
- Nautilus
- OSI Barrualde Galdakao + BIOEF
- Tecnalia - JRL A2I
- JRU UPV-Tecnalia-BCAM
- Aula BCAM Donosti

02. NATIONAL

- Pint of Science
- UAM (Universidad Autónoma de Madrid)
- UNIVERSIDAD COMPLUTENSE DE MADRID
- Convenio De Cooperación Educativa Entre La Universidad De Oviedo Y Bcam (Basque Center For Applied Mathematics) Para La Realización De Prácticas Externas De Estudiantes Universitarios
- Univ. Salamanca. Cooperacion Educativa
- Universidad Politécnica de Madrid
- Universidad de Zaragoza
- Universitat rovira i virgili
- UPNA

03. INTERNATIONAL

- Alfred Renyi
- Instituto de Ciências Matemáticas e de Computação
- Pontificia Universidad Católica de Valparaíso
- Univ. Tuebingen
- Universidad Nacional de Colombia
- Univ. Sussex
- University of Trento
- University of Trieste
- Bilateral agreement between University of Warwick & BCAM
- VERSES

Contact

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Universidad del País Vasco
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Petronor
Innovación


Bilbao
UDALA
AYUNTAMIENTO


HR EXCELLENCE IN RESEARCH


EXCELENCIA
SEVERO
OCHOA