



Activity report

2022

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Introduction

José Antonio Lozano
Scientific Director

The year 2022 has been a restart in our lives. After almost two years of the pandemic, we have had to get used again to meet people in person, to come to the centre to work and to recover our lives before the pandemic. But after the pandemic, we are now more people than before and we had to start with most of the programs that were almost on standby like the visiting programs, courses, workshops, trips... This has been an important challenge for most of us.

This year we have reached many different achievements scientifically and also as an institution. From all of them, I would like to highlight two because of their relevance. On the first hand, the centre has been recognized with the Severo Ochoa award for the third time in a row. This is extremely difficult! We are the only research centre in the Basque Country which has achieved this. Furthermore, there are only 11 other research centres in Spain in all areas of knowledge which have been awarded three consecutive times by the Severo Ochoa. This achievement will provide stability to the centre for the next four years.

We have reached this milestone with the strong contribution of many people at BCAM. This is an example that shows what can be reached when all BCAM members and collaborators join their efforts in a joint initiative. I would like to thank Professor Luis Vega for scientifically coordinating this Severo Ochoa proposal.

The second achievement I would like to highlight is the addition of the Bilbao Council to the Board of Trustees of BCAM. This will strongly help us to put the centre at the forefront of Bilbao city, improving the knowledge the citizens have about the centre and making Bilbao “the city of mathematics”.

I would like to spend a few words of gratitude. I would like to thank all the people of BCAM who feel the centre as a part of them. Thank you very much to those that organise activities: conferences, talks, courses, light PhD seminars, and even chess contests. Those that contribute to communication and dissemination activities, knowledge transfer activities, and those that make this space strongly alive. I would like to add a special message of gratitude to our administrative staff, who carefully and patiently support our research activities and promote the centre.

Let's keep going with our motto: “let's write together the mathematics of the future”.



BCAM in numbers

2.1. Scientific outputs¹

- Number of indexed articles: 187
- Q1: 80,3%
- D1: 45,9%
- H index: 54
- 1663 selected documents are cited 5019 times in 2022 by 4090 documents.

2.2. Funding

- Total annual funding: 7,2 M€
- Basque Country: 3,6 M€
- Spain: 2,66 M€
- Europe: 0,63 M€
- Private & other: 0,31 M€

2.3. Grants in place

- 7 International public projects
- 2 ERC
- 1 FET
- 6 Marie Skłodowska-Curie
- 1 INTERREG POCTEFA
- 16 National public projects
- 17 Local public projects

¹ Year range: 2022. Data source: Scopus. Date exported: 19/12/22. First Quartile (Q1) Top 25% journals by Scimago ranking on 2020 (SJ2020). First Decile (D1) Top 10% journals by Scimago ranking on 2020 (SJ2020). The h-index: Hirsch JE. An index to quantify an individual's scientific research output. Proc Natl Acad Sci U S A. 2005 November 15; 102(46): 16569–16572. doi: 10.1073/pnas.0507655102

2.4. Training and knowledge transfer

- 10 defended Doctoral theses
- 55 ongoing Doctoral theses
- 46 ongoing Postdoctoral Trainees
- 8 ongoing Joint Positions

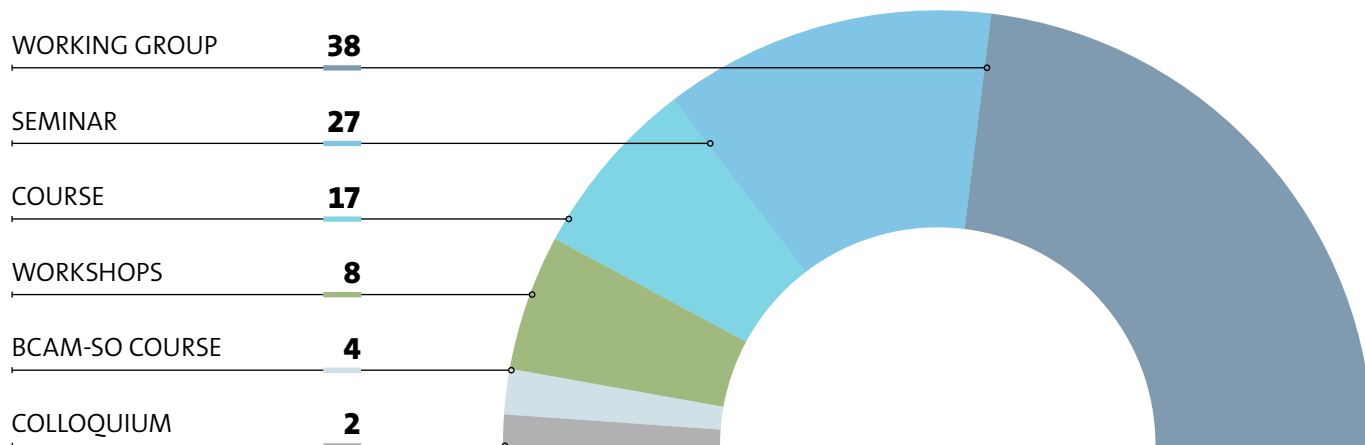
2.5. Personnel

- 148 research staff
- 15 administrative staff
- 26,6% women in BCAM
- 48 new researchers joined BCAM through the different calls
- 17 Visiting Fellows were received
- 31 people completed their internship at BCAM
- 132 visitors were received

2.6. Competitive individual grants

- 1 BCAM researcher has been awarded as an Ikerbasque Associate
- 1 BCAM researcher has been awarded a Juan de la Cierva Grant
- 1 BCAM researcher has been awarded a Ramón y Cajal Grant
- 2 BCAM researchers have been awarded a Junior Leader “La Caixa” grant & as an Ikerbasque Fellows
- 1 BCAM researcher has been awarded as an Ikerbasque Fellow

2.7. Scientific activities



2.8. Social media

T W I T T E R

FOLLOWERS	2028
TWEETS	427
IMPRESSIONS	214546
VISITS	99436
RETWEETS	656
LIKES	1495

L I N K E D I N

FOLLOWERS	2126
IMPRESSIONS	140189
REACTION	1600
SHARES	102

Y O U T U B E

SUBSCRIBERS	206
VEWS	3300
IMPRESSIONS	46600

Data source: Twitter, LinkedIn and Youtube.

Data exported: 31/12/2022.



People



BCAM's organization chart

GOVERNANCE

General Assembly

Steering Committee

Scientific Committee

Scientific Director

OPERATIONS

General Manager

BCAM management committee

BCAM Knowledge Transfer Unit

STAFF AREA

RESEARCH AREA

Project Manager

Research Area Coordinator

Data Science Unit Coordinator

Project Officer

Research Line / Group Leader

MSO Unit Coordinator

Communication Manager

Research Fellow

KTU Project Manager

IT Administrator

Post Doctoral Fellow

Knowledge Transfer Fellow

Management Assistant

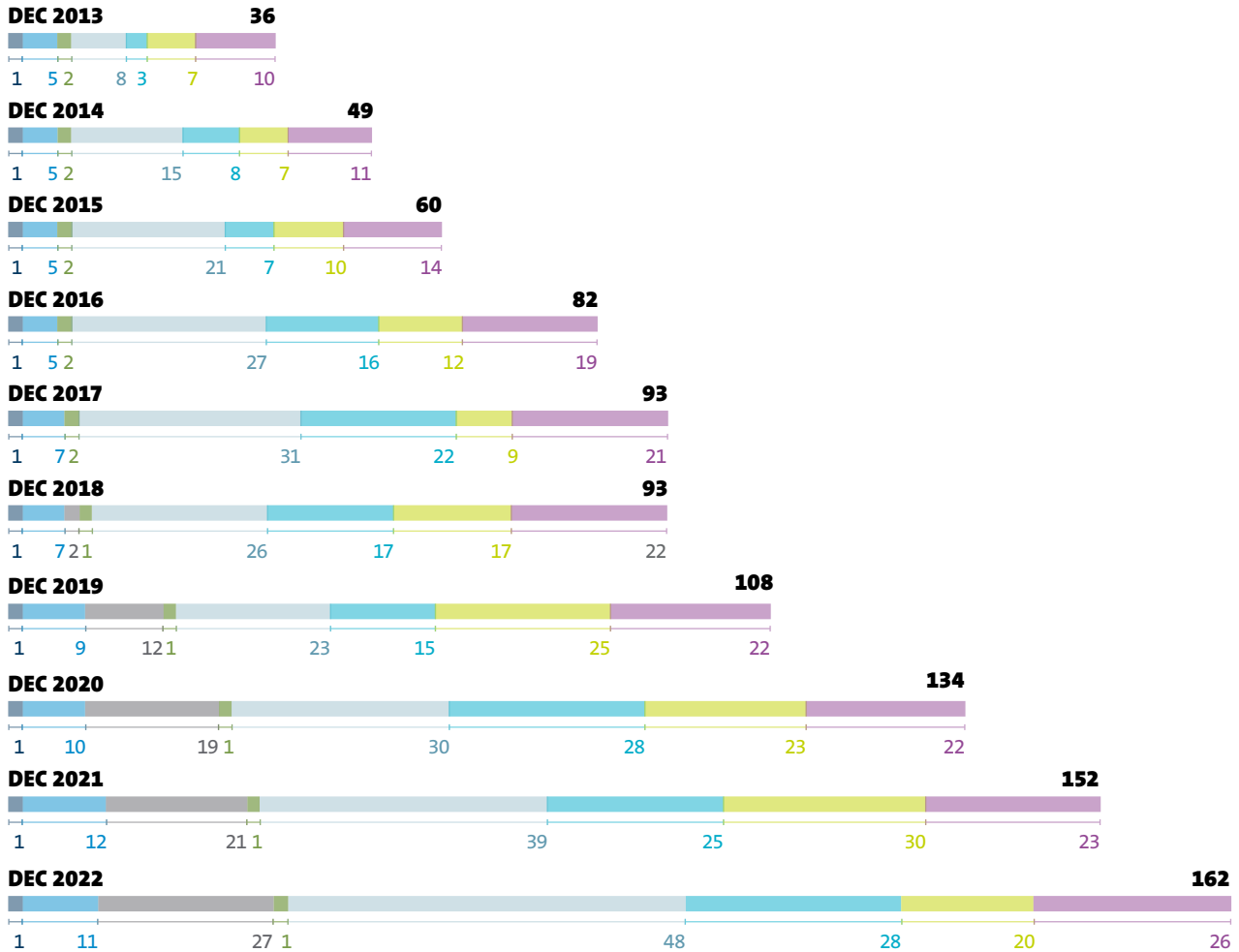
PhD Student

Research Technician

Administrative Assistant

Internships

Evolution of personnel




SCIENTIFIC DIRECTOR


STAFF MANAGEMENT


KTU RESEARCH TECHNICIANS


IT TECHNICIANS


PHD STUDENTS


POSTDOCTORAL FELLOWS

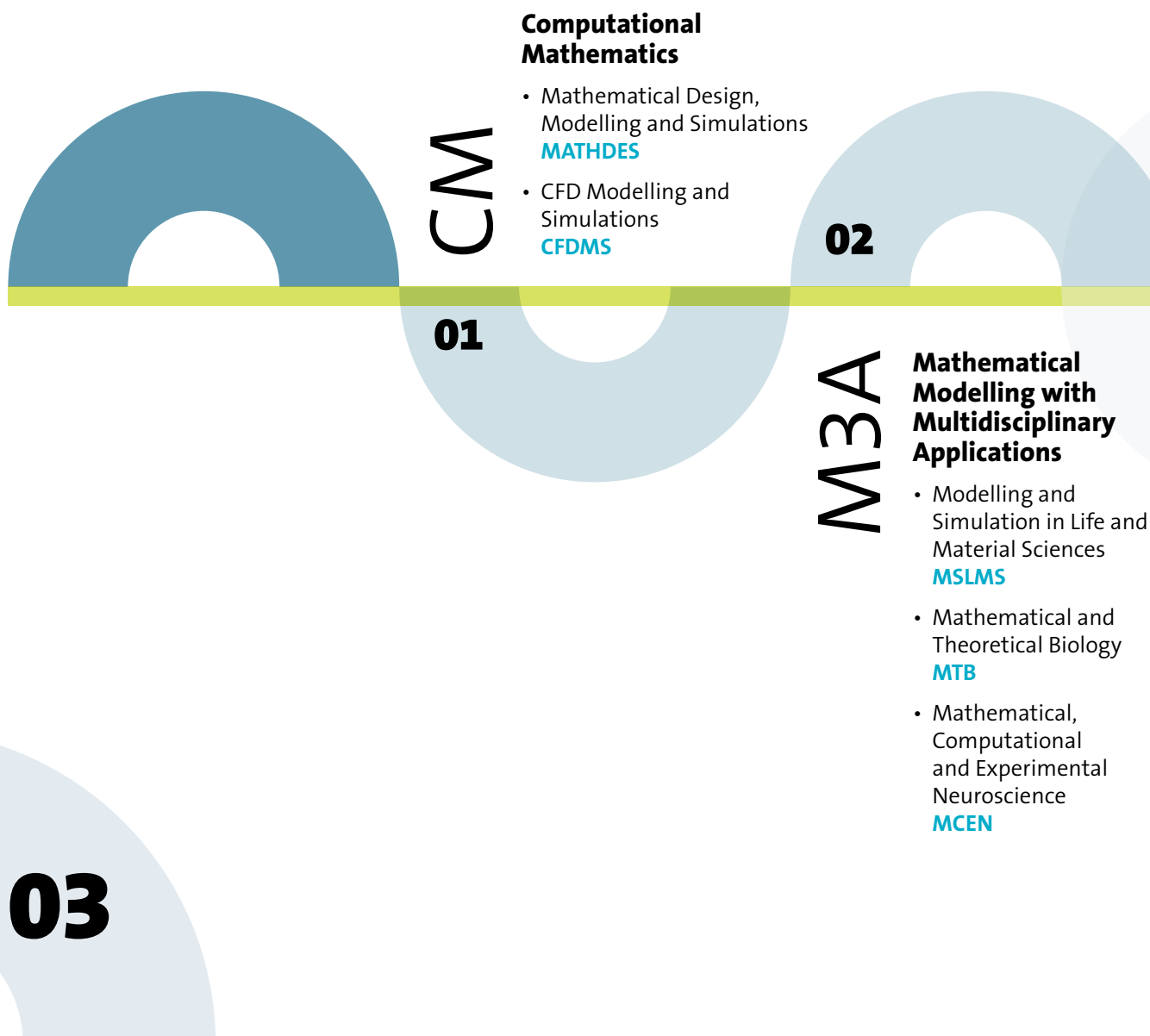

POSTDOCTORAL FELLOWS (SENIOR)


RESEARCH LINE LEADERS AND BCAM RESEARCHERS

3.1.

Research areas and lines

During 2022, 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.



MP

03

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 and Inverse Problems
HA
- Applied Analysis
AA

DS

05

Data Science and Artificial Intelligence

- Combinatorial Optimization
CO
- Applied Statistics
AS
- Machine Learning
ML

3.1.1.

BCAM research staff 2022





3.1.1.



Scientific director

	POSITION	RESEARCH AREA	RESEARCH LINE
Lozano Alonso, Jose Antonio	<i>Scientific Director</i>	DS	ML

Professors

		RESEARCH AREA	RESEARCH LINE
Akhmatskaya, Elena	<i>Ikerbasque Professor at BCAM</i>	M3A	MSLMS
Bru, Jean-Bernard	<i>Ikerbasque Professor at BCAM UPV/EHU</i>	MP	QM
Coello, Carlos A.	<i>Ikerbasque Professor at BCAM</i>	DS	CO
Ellero, Marco	<i>Ikerbasque Professor at BCAM</i>	CM	CFDMS
Fernandez de Bobadilla, Javier	<i>Ikerbasque Professor at BCAM</i>	MP	STAG
Pardo, David	<i>Ikerbasque Professor at BCAM UPV/EHU</i>	CM	MATHDES
Pérez, Carlos	<i>Ikerbasque Professor at BCAM UPV/EHU</i>	APDE	HA
Rodrigues, Serafim	<i>Ikerbasque Professor at BCAM</i>	M3A	MCEN
Vega, Luis	<i>UPV/EHU Professor & BCAM</i>	APDE	WAVE
Zarnescu, Arghir Dani	<i>Ikerbasque Professor at BCAM UPV/EHU</i>	APDE	APAN
Arostegui, Inmaculada	<i>UPV/EHU Professor linked to BCAM</i>	DS	AS
Barrio, Irantzu	<i>UPV/EHU Professor linked to BCAM</i>	DS	AS
Merino, María	<i>UPV/EHU Professor linked to BCAM</i>	DS	CO
Murua, Ander	<i>UPV/EHU Professor linked to BCAM</i>	CM	MATHDES
Sanz, Mikel	<i>UPV/EHU Professor linked to BCAM</i>	SP	QM

3.1.1.**Associate & Fellow Researchers**

		RESEARCH AREA	RESEARCH LINE
Aguiar, Maíra	<i>Ikerbasque Research Fellow & Research Line Leader</i>	M3A	MTB
Aguilera, Miguel	<i>Ikerbasque Research Fellow</i>	M3A	MCEN
Bartoñ, Michael	<i>Ikerbasque Research Associate & Ramon y Cajal Fellow</i>	CM	MATHDES
Lee, Dae-Jin	<i>BCAM Researcher & Research Line Leader</i>	DS	AS
Lucà, Renato	<i>Ikerbasque Research Fellow</i>	APDE	WAVE
Mazuelas, Santiago	<i>Ikerbasque Research & Ramon y Cajal Fellow</i>	DS	ML
Nava, Vincenzo	<i>BCAM Researcher</i>	CM	CFDMS
Pagnini, Gianni	<i>Ikerbasque Research Associate & Research Line Leader</i>	MP	SP
Perez, Pedro	<i>Ikerbasque Research Associate</i>	APDE	HA
Quadrianto, Novi	<i>Professor University of Sussex - Lab leader of the BCAM Severo Ochoa Strategic Lab on Trustworthy Machine Learning</i>	DS	ML
Roncal, Luz	<i>Ikerbasque Research Fellow</i>	APDE	HA
Serra, Joaquim	<i>Professor ETH Zürich - Lab leader of the BCAM Severo Ochoa Lab on Analysis of PDEs</i>	APDE	WAVE
Smirnov, Ilya	<i>Ikerbasque Research Fellow & Junior Leader</i>	MP	STAG
Urteaga, Iñigo	<i>Ikerbasque Research Fellow & Junior Leader</i>	DS	ML

Postdoctoral fellows

	RESEARCH AREA	RESEARCH LINE
Andrade, Hugo	MP	SP
Azevedo, Rodrigo	M3A	MCEN
Bakas, Odysseas	APDE	HA
Balboa, Florencio	CM	CFDMS
Barros de Souza, Danilo	M3A	MCEN
Carreño, Ander	DS	ML
Cortes, Henry Andres	M3A	MSLMS
Costa de Sousa, Mateus	APDE	HA
Coube, Sébastien	DS	AS
Eberle, Simon Andreas	APDE	WAVE
Epelde, Markel	MP	STAG
Fathnejat, Hamed	CM	MATHDES
Fernandez, Ana	CM	MATHDES
García, Fernando	DS	AS
Hashemian, Ali	CM	MATHDES
Geng, Zhiyuan	APDE	AA
Gidituri, Harinadha	CM	CFDMS
Gordaliza, Paula	DS	ML
Goswami, Kamal Nayan	M3A	MSLMS
Hernández, Dariel	CM	CFDMS
Inouzhe, Hristo	DS	AS
Kosz, Dariusz Mirosław	APDE	HA
Abedi, Mohammad Mahdi	CM	MATHDES
Moragues, Margarida	CM	CFDMS
Morelli, Simon	MP	QM
Moreno, Nicolas	CM	CFDMS

3.1.1.**Postdoctoral fellows**

	RESEARCH AREA	RESEARCH LINE
Muñoz, Judit	CM	MATHDES
Nieraeth, Zoe	APDE	HA
Dempsey, Róisín Mary	M3A	MCEN
Ousaadane, Abdessamad	CM	MATHDES
Pérez, Aritz	CM	ML
Ponce, Felipe Eduardo	APDE	HA
Garreta, Albert	MP	STAG
Rochera, David	CM	MATHDES
Saldaña, Fernando	M3A	MTB
Iakunin, Sergei	APDE	WAVE
Rincón, Mauricio	M3A	MSLMS
Senhaji, Kaoutar	DS	CO
Sharma, Smriti	CM	MATHDES
Shirazi, Abolfazl	DS	ML
Souto, Caetano	DS	AS
Steindorf, Vanessa	M3A	MTB
Stollenwerk, Nico	M3A	MTB
Strugaru, Magdalena	CM	MATHDES
Szarek, Tomasz Zachary	APDE	HA
Xingyu, Li	APDE	AA
Zohravi, Elnazossadat	CM	CFDMS

PhD Students

	RESEARCH AREA	RESEARCH LINE
Aldasoro, Marta	MP	STAG
Álvarez, Verónica	DS	ML
Anam, Vizda	M3A	MTB
Angerman, Peter	CM	CFMDS
Arza, Etor	DS	ML
Barrainkua, Ainhize	DS	ML
Benavides, Xabier	DS	ML
Bidaurrazaga, Arkaitz	DS	ML
Bondugula, Kartheek Reddy	DS	ML
Bonifazi, Giulio	M3A	MCEN
Camarasa, Miguel	APDE	WAVE
Cañizares, Manuel	APDE	HA
Caro, Felipe Vinicio	CM	MATHDES
Ceuca, Razvan-Dumitru	APDE	AA
Claros, Alejandro	APDE	HA
Dahlenburg, Marcus	MP	SP
Dancheva, Tamara	CM	MATHDES
de la Bodega, Javier	MP	STAG
De Lorenzo, Eduardo	MP	STAG
Pérez, Diana Marcela	DS	AS
Echeverría, Marina	M3A	MTB
Espinosa, Juan Carlos	DS	AS
Estadilla, Carlo Delfin Silverio	M3A	MTB
Florez, Mikel	APDE	HA
Gago, Imanol	DS	CO
Galán, Cristina	DS	AS
García, Ander	CM	CFDMS

3.1.1.**PhD
Students**

	RESEARCH AREA	RESEARCH LINE
Gardeazabal, Iker	APDE	HA
Gartzia, Eki	MP	STAG
Girier, Guillaume	M3A	MCEN
González, Jesús	CM	CFDMS
Gorostidi, Nicolás	CM	MATHDES
Hernández, Maria Alejandra	DS	AS
Martinez, Mario	DS	ML
Metraud, Nathan	MP	QM
Moreno, Daniela	CM	CFDMS
Nagar, Lorenzo	M3A	MSLMS
Parga, Martín	M3A	MSLMS
Rajain, Kanika	CM	MATHDES
Rodrigues, Kauê	MP	QM
Rodríguez, Oscar Alberto	CM	MATHDES
Segovia, José Ignacio	DS	ML
Uranga, Anton	M3A	MSLMS
Uriarte, Carlos	CM	MATHDES
Volpi, Michelangelo	M3A	MCEN
Zaballa, Onintze	DS	ML
Zaragoza, Juan	CM	CFDMS
Zumeta, Lore	DS	AS

Research Technicians

	RESEARCH AREA	RESEARCH LINE
Alberola, Enric	DS	ML
Blasco, Ruben	M3A	MTB
Casado, Ioar	DS	ML
Contreras, Ernesto	DS	ML
Coterillo, Raul	DS	ML
Cotillas, Mikel	DS	ML
Crespo, Alvaro	DS	AS
Danielewicz, Joanna	M3A	MCEN
Das, Bikram Kumar	M3A	MSLMS
Echevarrieta, Judith	DS	ML
Filippozzi, Lucia	DS	ML
García de Beristain, Imanol	CM	CFDMS
Gonzalez, Rodrigo	DS	ML
Guerrero, Bruno Valdemar	M3A	MTB
López De Castro, Marcos	MP	SP
Lopez, Gontzal	CM	CFDMS
Mampel, Jorge	MP	SP
Martin, Paula	DS	ML
Merino, Pablo	DS	ML
Monsalve, Abelardo Enrique	DS	AS
Olza, Alexander	DS	AS
Renteria, Jone	DS	AS
Rodriguez, Lander	DS	AS
Sebastian, Fernando	DS	AS
Srivastav, Akhil	M3A	MTB
Tahat, Amani	DS	AS
Tamuly Pranjali	CM	MATHDES

3.2.

BCAM Administrative Staff

Aguirre, Gorka	<i>Internship</i>
Benítez, Miguel Angel	<i>Project Manager</i>
Elejalde, Oriana	<i>Management Assistant</i>
Elespe, Irantzu	<i>Management Assistant</i>
Fuentes, Juner	<i>Internship</i>
Gómez, Lorea	<i>General Manager</i>
González, Ainara	<i>Project Manager</i>
Gutiérrez, Estibaliz	<i>Community Manager</i>
Hernández, Idoia	<i>Management Assistant</i>
Hernández, Olatz	<i>Community Manager</i>
Hurtado, Agurtzane	<i>Administrative Assistant</i>
Mena, Nerea	<i>Project Officer</i>
Sánchez, Endika	<i>IS/IT Manager</i>
Sojo, Asier	<i>Management Assistant</i>
Urresti, Álvaro	<i>Internship</i>

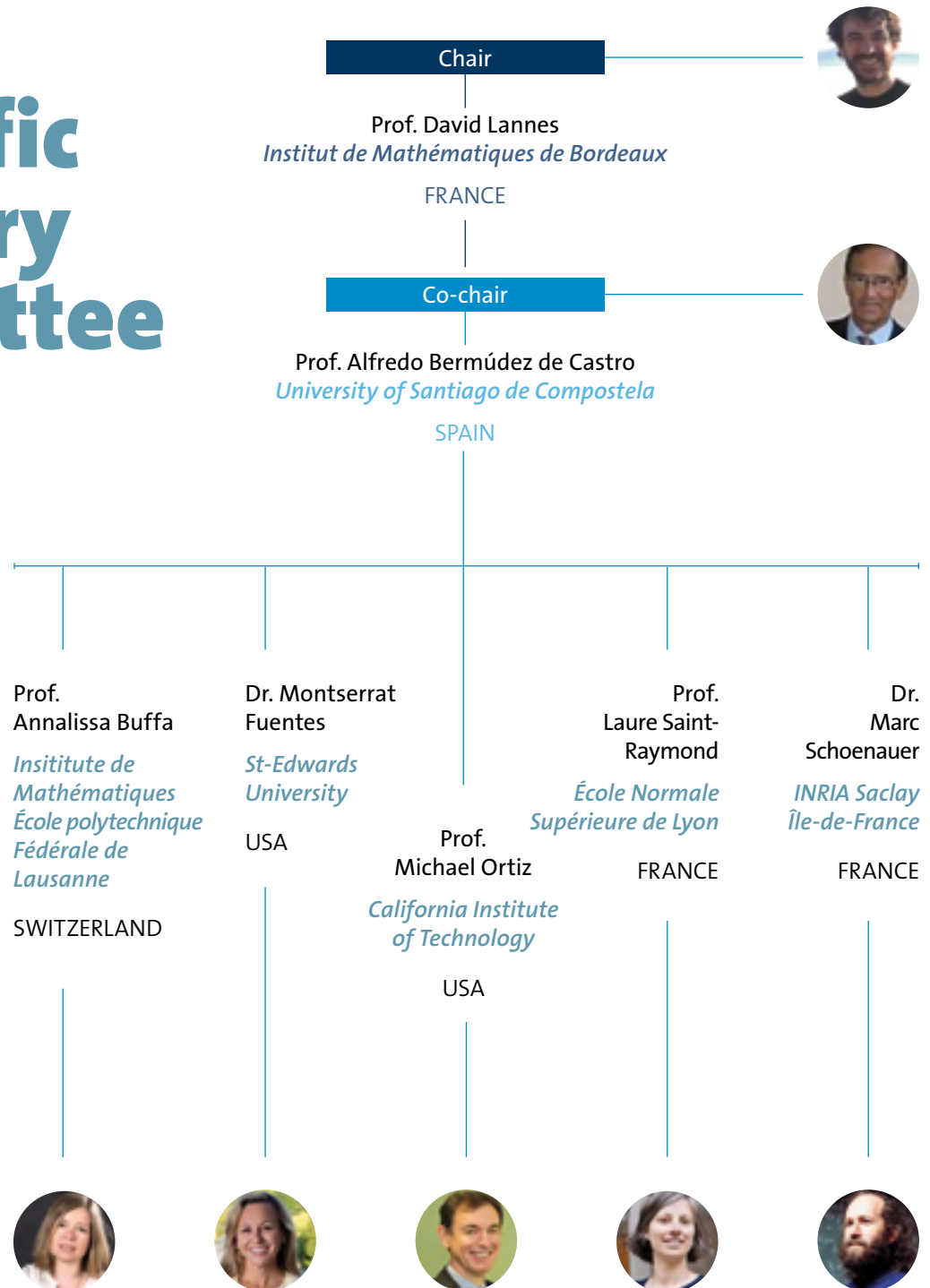
3.3.

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. The composition in 2022 is as follows:



3.4.

Women at BCAM



Magdalena Strugaru
Postdoctoral fellow

I fell in love with mathematics in primary school because it made me feel safe. Once I understood I could solve a problem by taking various paths, I found pleasure in identifying one solution and then checking it through a different approach. During my middle-grade years, I started to enjoy writing as well. While it did not offer me the same security, it allowed me to experience a different kind of creativity and to keep searching for rules, patterns, and structures, in other settings.

After high school, the growing interest in computer science in my country made me consider this field. The Faculty of Mathematics from Iasi, my hometown in Romania, was offering a relatively new - at that time - specialization, namely mathematics-informatics. Thinking that my first love would always support me when informatics could be tricky, I decided to give it a go. During the Master courses, at the University of Pau (France), I got captivated by the numerical approximation of PDEs, which I further explored during my Ph.D. project on numerical solutions for wave propagation problems.

After the Ph.D. defense, I accepted an offer at BCAM, convinced I would stay at most one year before moving to the USA. Fast forward 13 years: still at BCAM, in love with Euskadi, its people and its language. These years were far from a smooth research path. When our daughter was 6, health issues and family priorities pushed me to take two years off and reconsider my work-life balance and future professional life. In this uncertainty, BCAM offered me a Research Technician position, a fantastic opportunity to write in and about maths, supported by exceptional colleagues. My primary responsibility was coordinating and drafting regional, national, European, and international grant proposals. We received very good or excellent evaluations for all of them. In a nutshell, I learned and wrote about mathematics for myself, the research community, the European Commission and grant reviewers, children, and society at large. Most importantly, I found my place in the research world.

Motherhood taught me to be kind to myself and patient with my journey as a woman. The two-year withdrawal from research helped clarify my priorities and where I wanted to invest my time and energy. Eventually, my Research Technician position at BCAM proved that life offers opportunities tailored to individuals, not predetermined careers. Today, I enjoy doing research and writing (a lot) about applied mathematics as a postdoctoral fellow in an engaging team that innovates in artificial intelligence applied to PDEs. For the young girls and women passionate about mathematics or science in general who need to learn how to kindle that fire, I encourage you to honour your work, never stop learning, be kind to yourself, stay patient, and trust your journey. Lastly, keep your eyes, mind, and heart open to those extra-ordinary opportunities and the fantastic people that cross your lives.

3.4.



Diana Marcela Pérez
PhD Student

I have always felt very attracted to mathematics since I was in school. So when it was time to choose what I would do professionally, I did not hesitate about where to direct my life. I started studying Mathematics and Statistics programs simultaneously at two universities.

Finally, my path would be Statistics. In 2006, I graduated from this program at Universidad Nacional de Colombia (Sede Medellín). Four years later, I graduated from the Master's program in Statistics at the same University. Then I worked for two years as a statistician for private companies. One day, I got a call to work as a professor at Universidad de Antioquia (Colombia). I have to confess that I was scared to go to the academy because of all the challenges and responsibilities that this entails. However, after so many years in it, I think that once there, you hardly ever leave again. It is a job that traps you and involves you.

This world offers you a sea of possibilities to advance your professional and personal career that hardly any other sector offers you (even if it is not always well paid). In 2018 I could access one of the grants from the Spanish Government for a pre-doctoral contract with BCAM, where I arrived as the first Colombian female PhD student. At BCAM, I work under the supervision of a brilliant woman on spatio-temporal models for experiments in agriculture. I am proud of all this because I was thinking about the barriers/limitations/fears (which are nothing more than social prejudices) at that time. The first was starting a PhD at age 35 when all your peers are, on average, around 25 when they start. Then not feel competitive enough because you come from an underdeveloped country.

Finally, feeling vulnerable as a single woman facing an unknown world where I know absolutely no one (8123 km between Medellín and Bilbao!). I speak of these barriers in the past tense because living this experience has allowed me to discover that there are no limits other than those imposed on oneself and that there is nothing more satisfying than overcoming them. This is precisely what empowers women. To feel what strong and powerful we are!

My main research interest is in the area of Artificial Intelligence in particular problems related to statistics, data science, and machine learning. I am interested in the development of artificial intelligence techniques with theoretical guarantees to solve real-world problems. Specifically, I am working on regression and classification techniques based on online learning that adapts to varying underlying distributions. Currently, I am developing techniques with performance guarantees for supervised classification under concept drift and for lifelong learning.

I graduated in mathematics from the University of Salamanca in 2019. In July of that same year, I moved to BCAM for what I thought was going to be a 3-month internship. During the internship, I discovered what research was in a field that I liked, machine learning. During the internship, the idea to continue studying mathematics and research came to my mind. So, I decided to study for a master's degree in mathematical research and later start a PhD. Currently, I am in the third year of my PhD in the research area "Machine Learning" at BCAM.

Over the years, I have had the privilege of meeting women in the STEM world at different stages of their professional careers. I would like to thank all the women who share their stories and offer valuable insights to younger researchers. In particular, I would like to acknowledge the work of my primary school mathematics teacher for making me curious about mathematics. In addition, the support of my family, friends and researchers that I have encountered in my personal and professional life has been key to overcoming the obstacles and facing the challenges of the research world.

Lastly, I would like to say to girls who are considering a career in STEM that the important thing is to persevere and work hard. All work pays off and as Maryam Mirzakhani said: "The beauty of mathematics only shows itself to more patient followers."



Verónica Álvarez
PhD Student

3.5.

BATERA Mentoring Programme

BCAM's Mentoring Programme – BATERAs' objectives are to support young researchers in their reflection about career goals, competencies and professional options. Build an intergenerational network of professionals with an interest in supporting early-stage researchers to advance in their careers, promote synergies, cooperation and mutual enrichment between researchers favouring the exchange of knowledge and experiences.

Mentoring can help develop the capabilities of BCAM's PhD students by supporting and encouraging a learning organisation, knowledge transfer culture and succession planning.

What do the mentors and mentees think of the programme?

Miguel Aguilera

*Ikerbasque
Research Fellow*



I think that the combination of a doctoral student in the last stage of his thesis and someone who has just finished his postdoc phase has been very useful to solve doubts about how to approach the end of the thesis and the next steps.

Rodrigo Azevedo

*Postdoctoral
fellow*



Some students will definitely benefit from this interaction, mainly in time management and mid-term planning of their careers, as well as talking about the stress and frustration of the research process, which is always a common problem.

Dae-Jin Lee

*Group Leader of Applied
Statistics research line*



One of the main aspects is to create a positive atmosphere between the mentee and the mentor, for which the selection of partners is crucial.

In addition, a particular fact at BCAM is that throughout the year many postdocs from outside Bilbao come to the center.

The connection between PhD students and postdocs becomes stronger thanks to the mentoring program, thus generating a great academic, professional and personal exchange.

**Lorenzo Nagar**

*PhD Student
La Caixa
INPhINIT 2020*



I remark the importance of a good matching for the success of the programme.

Thanks to the previous established relationship and mutual confidence, the mentoring sessions turned out to be very helpful and were enriched by some literature provided by Dae-Jin.

Martin Parga

PhD Student



Now I have a better understanding of what's ahead and a person I can contact in case of doubts along that path.

Cristina Galán

PhD Student



I highly recommend mentoring programs to anyone looking to enhance their professional development or share their concerns or experiences.

Lore Zumeta

*PhD Student
Predoc Severo Ochoa
2018*



I found it positive to hear other researchers' experiences, and know how they addressed different situations or exchange views, as the research path is full of obstacles and ups and downs.

3.6.

Alumni & Former Members

The aim of the BCAM Alumni & Former Members network is to create a wide community among current and former PhD students and researchers. Therefore, they can continue learning from each other, find out about new job offers and research opportunities, and collaborate in promoting BCAM in an open, inclusive and international environment.

The BCAM Alumni & former members network will be addressed to former BCAM employees and PhD students that want to be aware of BCAM news, scientific activities and events of interest, courses, and seminars. The network will facilitate current and former researchers with easy access to visits and research to work on together. In this way, the network reinforces the BCAM community, the relationships between the people, and their scientific knowledge.





Álvaro Crespo

Internship at the Laboratory for Advanced Learning, Artificial Intelligence and Control, University of Houston

During my stay at BCAM I had the opportunity to work in two different branches within the centre. Firstly, I worked as an intern in Statistical Physics within the Mathematical Physics area, developing my master's thesis. Under the supervision of Gianni Pagnini, I took part in the study of the dynamics of forest fires. Later, I worked as a research technician at Applied Statistics, in the area of Data Science, under the supervision of Dae-Jin Lee. During this time, I worked in the mathematical modelling consultancy service, working on advising two Biscayan SMEs on obtaining value from their data in specific projects.

My time at BCAM has been very enriching. It has allowed me to get to know the world of research first hand as learning and working in different fields. What surprised me most was the good atmosphere in the centre and how pleasant it has been to work with all the people who are part of BCAM.



María Ángeles García-Ferrero

Assistant professor at the Faculty of Mathematics and Computer Science of the Universitat de Barcelona

BCAM is undoubtedly a great place for Analysis and PDE. When I arrived, the sanitary restrictions were still high, but by the time of my departure the center had recovered some normal face-to-face activity.

My most valuable memories of those months are the discussions with some of the researchers at BCAM, which were very supportive and mathematically enriching. I would also like to thank the Communication Team for encouraging me to participate in different activities and for their help.

Funding

Highlighted grants

101072732

**CINEMA Chemistry
Informed Machine
Learning in Emulsion
Polymerization Processes
and Products
(Horizon Europe)**

FUNDED BY

MSCA-2021-DN-01
Marie Skłodowska-Curie

DURATION

2023/01 - 2026/12

PI

Prof. Lozano, J.A.

The control of chemical reactors is a well-studied problem but is especially challenging in the case of polymerization reactors because many of the important characteristics of the polymer evolve continuously with time and cannot be measured directly online.

Aided by first-principles mathematical models of the polymerization process, CINEMA aims to address this problem by using machine learning to accelerate the prediction of the evolution of the polymerization such that reactors can be controlled on-line.

About the PI

Lozano, J.A. is the Scientific Director of BCAM since 2019 and Professor in the Department of Computer Science and Artificial Intelligence at the UPV/EHU since 2009. His research has focused, among other areas, on Artificial Intelligence and particularly in the fields of data analysis and combinatorial optimisation. He leads the Intelligent Systems Group research group since 2004 and BCAM's research line in Machine Learning since 2014. In his extensive career as a researcher, he has published more than a hundred articles in scientific journals receiving more than 15,000 citations, has supervised 22 doctoral theses and has written two books. In addition, his international prestige has led him to be associate editor of the most relevant journals in the field of Artificial Intelligence and to organise international conferences with the greatest impact in the field. In 2021 he was appointed the first and only Fellow of the Institute of Electrical and Electronic Engineering (IEEE) in the Basque Country.



PDC2022-133115-I00**B2F2 Be a Better digital Fire-Fighter****FUNDED BY**

Proyectos <<Pruebas de Concepto>> 2022 - National Research Agency (Agencia Estatal de Investigación)

DURATION

2022/12 - 2024/12

PI

Pi Dr. Pagnini, G.

DSSs are integrated web-based information systems that incorporate state-of-the-art structural functions as forest-fire simulators. The goal of the present project is the improvement of DSSs through the implementation in the wildfire simulator PROPAGATOR of the consistent statistical methods of ensemble forecasting and of the physically-based fire-spotting model derived within the projects Ensemble Forecasting for Predicting Wildfire Propagation (PID2019-107685RB-I00, 20202023) and Novel Method for Modelling Interface Propagation with Environmental and Engineering Applications (MTM2016-76016-R, 20172019). Actually, both the ensemble forecasting procedure and the fire-spotting modelling are not included yet in PROPAGATOR and, in general, they are widely not implemented yet in operative software tools. The exploitation of these results is in the form of products, services and other applications that are beneficial to Forest and Civil Protection agencies for wildfire managements, such that forest services could Be Better digital Fire-Fighters. In particular, PROPAGATOR is an operational cellular-automata based software code for simulating forest fires that is in daily use by some forest services and research staffs in Europe and, in the actual setting, it is at EU-TRL 9 (Technology Readiness Levels) - successful mission operations. The deliverable of the present proposal will be an updated fire-simulator PROPAGATOR such that the same users of PROPAGATOR are going to be the potential end-users of the achievements of this project. Beside the improvement of PROPAGATOR for its standard uses, the prediction systems for wildfire propagation will benefit of the probabilistic knowledge obtained by applying the ensemble forecast procedure for real-time estimation of wildfire perimeters when this estimation is based on crowdsourcing, e.g., through web-blog, twitter, WhatsApp In fact, the inaccuracy of such real-time data can be dealt in the same manner as the uncertainty is dealt by the ensemble forecasting.

About the PI

Pagnini, G. is the group leader of the Statistical Physics research line and an Ikerbasque Research Fellow. His scientific interests concern in a wide sense both turbulent dispersion and anomalous diffusion. For what concerns turbulent mixing, his research activities are devoted to the Lagrangian features of turbulence with applications to environmental problems and turbulent premixed combustion, as well as to fundamental issues. In particular, they are focused on the modelling of the absolute and the relative dispersion by means of nonlinear stochastic differential equations and on turbulent reacting flows by including the level-set method. For what concerns anomalous diffusion, his research activities are driven in the framework of Fractional Calculus and focused on the so-called fractional diffusion. In particular, they require tools and methods belonging to the integral transform theories and to the field of the so-called Special Functions and involve Lévy stable densities.



TED2021-132783B-I00**MATHEOLO Advanced Numerical Methods and Neural Networks for Structural Health Monitoring of Offshore Wind Platforms****FUNDED BY**

Proyectos de Transición Ecológica y Transición Digital 2021 - National Research Agency (Agencia Estatal de Investigación)

DURATION

2022/12 - 2024/12

PI

Dr. Nava, V.
Prof. Pardo, D.

The main goal of MATHEOLO is to bring a significant contribution to the ecological transition through reliable intelligent algorithms monitoring the structural health of offshore wind platforms, thus supporting the digital transition in the design and maintenance of the platforms. To achieve this goal, we envision two objectives: (a) to design and implement physics-informed DNN architectures, loss functions, and error control algorithms to efficiently approximate physically meaningful solutions for forward and inverse problems governed by PDEs, and (b) to apply and successfully interpret measurements for a reliable warning system for offshore wind platforms.

The research team is composed of five researchers specialists in the scientific disciplines represented in the project. The team brings together experts in complementary areas, making this project an interdisciplinary research project.

About the PI

Dr. Nava, V. received his B.Sc. and M.Sc. degrees in Civil Engineering from the Mediterranean University of Reggio Calabria (Italy). In 2009 he obtained a PhD in Maritime Engineering at the same university in collaboration with Rice University (Houston, USA). He also worked on a research project with BP America (Houston, USA) and as a lecturer and postdoctoral researcher at the Mediterranean University of Reggio Calabria (Italy) and at the Instituto Superior Técnico in Lisbon, Portugal. In 2013 he joined Tecnalia, first as a Marie Skłodowska-Curie fellow and then as a Senior Researcher, and since 2017 he has been working as a researcher in the field of offshore renewable energies at the Basque Center for Applied Mathematics (BCAM) and Tecnalia.

Pardo, D. is a Research Professor at Ikerbasque, the University of the Basque Country UPV/EHU, and the Basque Center for Applied Mathematics (BCAM) at the Simulation of Wave Propagation research line. He received the B.S. degree in mathematics from the University of The Basque Country, Spain, in 2000, and the M.S. and Ph.D. degrees in computational and applied mathematics from The University of Texas at Austin, in 2002 and 2004, respectively. His research interests include computational electromagnetics, petroleum-engineering applications (borehole simulations), adaptive finite-element and discontinuous Petrov-Galerkin methods, multigrid solvers, deep learning algorithms, and multiphysics and inverse problems.



4.1.

Competitive public funding

4.1.1.

European Commission - HORIZON 2020 - Excellence Pillar



4.1.1.1.

ERC (European Research Council)

STARTING GRANTS

- Call: ERCEA - Starting Grants 2019
 - Project: 851538 - BayesianGDPR (H2020)
Bayesian Models and Algorithms for Fairness and Transparency
 - Duration: 2021/03- 2025/03
 - PI: Quadrianto, N.
 - Beneficiaries: University of Sussex, BCAM
-
- Call: ERCEA - Starting Grants 2020
 - Project: 948029 - StableIF (H2020)
Stable interfaces: phase transitions, minimal surfaces, and free boundaries
 - Duration: 2021/09 - 2025/12
 - PI: Serra, J.
 - Beneficiaries: ETHZ, BCAM



4.1.1.2.

FET Open

- FETOPEN-01 2019
- Project: 862025 - ADAM² (H2020) - Analysis, Design, And Manufacturing using Microstructures.
- Funding: 356,740€
- Consortium: BCAM, Israel Institute of Technology (TECHNION), École Polytechnique Federale de Lausanne (EPFL), Universidad del País Vasco (UPV/EHU), Institut National de Recherche en Informatique et Automatique (INRIA), Technische Universität Wien (TUW), TRIMEK SA, STRATASYS LTD, HUTCHINSON SA, Seoul National University (SNU)
- Duration: 2020/01 - 2023/12
- PI: Bartoň, M.



4.1.1.3. MARIE SKŁODOWSKA-CURIE ACTIONS

RESEARCH NETWORKS (ITN) INNOVATE TRAINING NETWORKS

- Call: H2020-MSCA-ITN-2017
- Project: 764979 – ENABLE – European Network for Alloys Behaviour Law Enhancement
- Funding: 247,873€
- Consortium: Université de Bordeaux, Mines ParisTech, École Nationale d'Ingénieurs de Tarbes (ENIT), Luleå University of Technology, Universidad del País Vasco (UPV/EHU), Tecnalia, Safran, Sirris
- Duration: 2018/02- 2022/01
- PI: Bartoń, M.

- Call: H2020-MSCA-ITN 2020
- Project: 956325 - ASTROTECH (H2020) – Disruptive materials, technologies & approaches to unravel the role of Astrocytes in brain function and dysfunction: towards to Glial interfaces
- Funding: 250,905€
- Consortium: The Chancellor Masters and Scholars of the University of Cambridge (UCAM), Ustav Experimentální Medicíny Akademie Věd České Republiky Verejná Vědecká Instituce (UEM AVCR), Université D'Aix Marseille (AMU), Centre National De La Recherche Scientifique (CNRS), Instituto Nacional de Engenharia Biomedica (INEB), Universidad Degli Studio di Bari Aldo Moro (UNIBA), Fondazione Instituto Italiano di Tecnologia (IIT), Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC), Avanzare Innovacion Tecnologica (AVA), Optoceutics APS
- Duration: 2020/11 - 2024/10
- PI: de Pitta, M.

RESEARCH AND INNOVATION STAFF EXCHANGES (RISE)

- Call: H2020-MSCA-RISE-2017
- Project: 777778 – MATHROCKS – Multiscale Inversion of Porous Rock Physics using High-Performance Simulators: Bridging the Gap between Mathematics and Geophysics
- Funding: 202,500€ (BCAM)
- Consortium: UPV/EHU, INRIA, BSC-CNS, UPC, AGH UST, PUC Valparaíso, Curtin Univ., Univ. of Texas, Univ. Nacional de Colombia, PUC Chile, Univ. Central de Venezuela, Univ. de Buenos Aires, Macquarie Univ.
- Duration: 2018/04 - 2023/03
- PI: Hasemian, A.



4.1.1.4. INTERREG POCTEFA

- Call: 3^a
- Project: EFA212/16 PIXIL – Pyrenees Imaging eXperience: an International network
- Funding: 117,000€
- Consortium: Barcelona Supercomputing Center (BSC), Universitat de Barcelona, Institut National de Recherche en Informatique et en Automatique (INRIA), RealTimeSeismic, Pole Avenia
- Duration: 2019/09 - 2022/04
- PI: Hasemian, A.



4.1.2.

Spanish State Research Agency



4.1.2.1.

EXCELLENCE ACCREDITATION "SEVERO OCHOA"

- Centre of Excellence "Severo Ochoa" SEV-2017-0718
- Duration: 2018/06 - 2022/12
- Funded by: Spanish Government - AEI
- PI: Vega, L.
- Budget: 4,000,000€

4.1.2.2.

NATIONAL PLAN R&D 2021-2023

CALL	PROJECT	FUNDING	DURATION	PI
Proof of Concept Projects 2022	PDC2022-133115-I00 Be a Better digital Fire-Fighter	80,500€	2022/12 - 2024/11	Pagnini, G.

4.1.2.3

NATIONAL PLAN R&D 2017-2021

CALL	PROJECT	FUNDING	DURATION	PI
Projects R&D - No Orientada 2021	PID2021-125052GA-I00 Measuring ideals in a singularity	44,528.00€	2022/09-2025/08	Smirnov, I.
	PID2021-123034NB-I00 Spectral theory and PDE: Real and Fourier Analysis	135,520.00€	2022/01-2025/08	Renato, L Fanelli, L.
	PID2021-122156NB-I00 Harmonic analysis meets inverse problems	101,277.00€	2022/01-2024/11	Caro, P. Parissis, I.

CALL	PROJECT	FUNDING	DURATION	PI
Projects R&D&i - Challenges 2020	PID2020-115882RB-I00 New proposals for estimation, prediction and validation of semi-parametric models for the analysis of complex data with applications in Health and Climate Change	38,115€	2021/09- 2024/10	Lee, D-J.
	PID2020-117080RB-C55 Microscopic foundations of soft-matter experiments: computational nano-hydrodynamics	84,700€	2021/09- 2024/08	Ellero, M.
	PID2020-113156GB-I00 Harmonic Analysis and PDEs	61,710€	2021/09- 2024/08	Roncal, L. Pérez, C.
	PID2020-114189RB-I00 Liquid Crystals and interactions	22,869€	2021/09 - 2024/08	Zarnescu, A.
Projects R&D&i - Challenges 2019	PID2019-108111RB-I00 Real-time Inversion using Deep Learning Methods	136,004€	2020/06 - 2024/05	Pardo, D. Nava, V.
	PID2019-107685RB-I00 Ensemble forecasting for predicting wildfire propagation	46,343€	2020/06 - 2023/05	Pagnini, G.
	PID2019-104488RB-I00 Manufacturing of curved objects via Path-design of custom-shaped tools	136,004€	2020/06- 2023/05	Bartoñ, M. Calleja, A.

CALL	PROJECT	FUNDING	DURATION	PI
Call: Projects R&D - G. Conocimiento 2019	PID2019-104927GB-C22 Geometric numerical integrators for quantum problems, celestial mechanics and monte carlo	64,977€	2020/06- 2023/05	Akhmatskaya, E. Murua, A.
	PID2019-105058GA-I00 Unifying data processing via probabilistic transformations	40,656€	2020/06 - 2023/05	Mazuelas, S.
Projects R&D&i - G. Conocimiento 2018	PGC2018-094522-B-I00 Mathematical and numerical analysis of some partial differential equations and their applications	142,780€	2019/01 - 2021/12	Vega, L. Cuesta, C.
Projects R&D&i - Challenges 2018	PGC2018-094528-B-I00 Interplays between Harmonic Analysis and Inverse Problems	57,717€	2019/01 - 2021/12	Caro, P. Parissis, I.
	RTI2018-094595-B-I00 Virtual Rheological Analysis of Complex Shear Thickening Fluids	41,140€	2019/01 - 2021/06	Ellero, M.
Scientific equipment for research	RTI2018-093860-B-C21 Development of novel mathematical and experimental methodologies to control neuronal activity and dissect spatio-temporal neuronal codes	35,332€	2019/01 - 2022/09	Rodrigues, S.

4.1.2.4.

ARTIFICIAL INTELLIGENCE R&D MISSIONS 2021 PROGRAMME

PROJECT	FUNDING	DURATION	PI
MIA.2021.M04.0008 IA4TES - Inteligencia Artificial para la Transición Energética Sostenible	686,868€	2022/01 - 2024/10	Mazuelas, S. Nava, V.

4.1.3.

Basque Country



4.1.3.1.

BERC PROGRAMME 2022-2025

- Duration: 2022/01 - 2025/12
- Funded by: Basque Government
- PI: Lozano, JA.
- Budget: 5,394,481€



4.1.3.2. ELKARTEK

PROJECT	FUNDING	DURATION	PI
KK-2022/00090 KONFLOT - Co-Design of floating renewable energy controllers	88,660.00€	2022/03-2023/12	Pérez, A.
KK-2022/00110 SoslAMet - Sustainable Smart Technologies for the Future of the Metal Sector	113,600.00€	2022/03-2023/12	Ellero, M.
KK-2022/00119 EGIA - EdGe technologies for Industrial distributed AI applications	66,316.50€	2022/03-2023/12	Pérez, A.
KK-2022/00100 CHARGER+ - New Generation of Electric Vehicle Charging Points with Autonomous and Collaborative Functionalities and Zero Impact	93,264.69€	2022/03-2023/12	Mazuelas, S.
KK-2022/00052 KAIROS - Predictive digitisation of the long-term behaviour of polymeric composite materials. Using AI, physics-based modelling and test acceleration methodologies	133,537.97€	2022/03-2023/12	Ellero, M.
KK-2022/00006 M-KONTAK - Investigation of Metal-to-Metal Contact Phenomena in High Pressure H2 Technologies	67,280.13€	2022/03-2023/12	Akhmatskaya, E.
KK-2021/00026 B-Ind5G - Federated Experimentation Infrastructure for applications Industry 4.0	60,379€	2021/03 - 2022/12	Mazuelas, S.
KK-2021/00048 ExpertIA - Evolution of industrial process modelling and control: advanced models combining expert knowledge with AI techniques in design and development	44,726€	2021/03 - 2022/12	Nava, V.
KK-2021/00091 REMEDY - Real Time Control and Embedded Security	64,676€	2021/07 - 2022/12	Rojas-Delgado, J.
KK-2021/00123 AUTOEV@L - Technology evolution for multi-vehicle automation and evaluation of highly automated driving functions	71,440€	2021/03 - 2022/12	Mazuelas, S.
KK-2021/00064 CICe21 - Research on Material Models and Components for The Future Generation of Generation of Batteries in Mobility	53,629€	2021/03 - 2022/12	Akhmatskaya, E.
KK-2021/00022 ICME - Integrated Computational Materials Engineering	77,490 €	2021/03- 2022/12	Akhmatskaya, E.



4.1.3.3.
BIZKAIA PROVINCIAL COUNCIL

PROJECT	FUNDING	DURATION	PI
6/12/TT/2022/00006 MATH4SPORTS - Modelización matemática para la industria deportiva: salud y rendimiento	151,328.94€	2022/07 - 2024/06	Lee, D-J.
6/12/TT/2021/00009 Optimización del proceso de fusión de aluminio a través de tecnología matemática	42,060.07€	2022/01 - 2023/06	Ellero, M.



4.2.

Private funding



AXA RESEARCH FUND

- Call: Mitigating risk in the wake of the COVID-19 pandemic
- Project: Early Prognosis of COVID-19 Infections via Machine Learning
- Funding: 230,000€
- Duration: 2020/10 - 2023/09
- PI: Mazuelas, S.

4.2.1.

Private Individual Grants

4.2.1.1.

LA CAIXA - Inphinit grants and Junior Leader Programme

LA CAIXA	LA CAIXA SEVERO OCHOA	INPHINIT PROGRAMME	JUNIOR LEADER PROGRAMME
	2017 Bonifazi, G. Grant: 321,300€	2020 Nagar, L. Grant: 305,500€	2018 de Pitta, M. Grant: 298,500€
			2018 Balboa, F. Grant: 297,900€
			2021 Smirnov, I. Grant: 297,900€
			2022 Urteaga, I. Grant: 297,900€

4.3.

Individual grants

4.3.1.

European Commission - H2020 – Excellence Pillar



EUROPEAN COMMISSION - H2020 - EXCELLENCE PILLAR



INDIVIDUAL FELLOWSHIPS EUROPEAN FELLOWSHIPS (IF-SF)



INDIVIDUAL FELLOWSHIPS - GLOBAL FELLOWSHIPS (IF-GF)

H2020-MSCA-IF-SF-2018

Project:

832332-MinSOL-PDEs (H2020) - Minimal solutions to nonlinear systems of PDEs

Grant: 160,932€

Duration:

2019/12 - 2022/04

PI:

Zarnescu, A.
Smyrnelis, P.

H2020-MSCA-IF-GF 2018

Project:

842536 - AEROSIMULAT (H2020) - High performance aerodynamics and aeroacoustics simulations of the new generation of high-speed gas turbines via high-order Galerking methods

Grant: 245,732€

Duration:

2020/09 - 2023/08

PI:

Moragues, M.

H2020-MSCA-IF-SF-2020

Project:

101021893 - ViBRheo (H2020) - Design of a Virtual Blood Rheometer for Thrombotic Process Characterization

Grant: 172,932€

Duration:

2022/01 - 2023/09

PI:

Ellero, M.
Moreno, N.

H2020-MSCA-IF-GF 2020

Project:

101017984 - GEODPG (H2020) - Space-time DPG methods for partial-differential equations with geophysical applications

Grant: 263,732€

Duration:

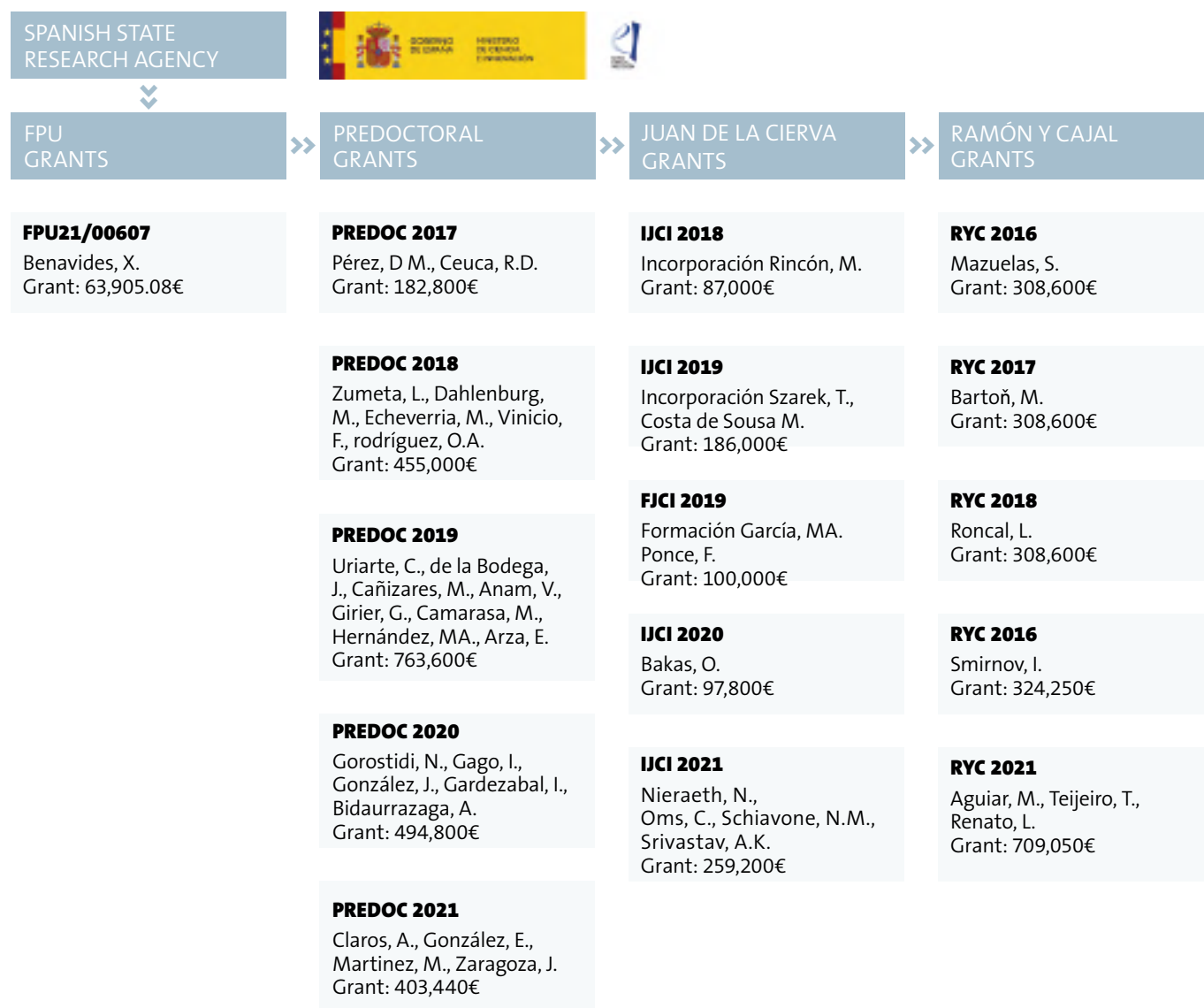
2022/01 - 2024/12

PI:

Pardo, D.
Muñoz, J.

4.3.2.

Spanish State Research Agency



4.3.3.

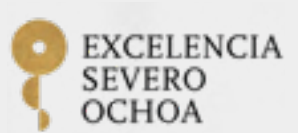
Basque Government



4.4.

Funding institutions

Distinctions



HR EXCELLENCE IN RESEARCH

Public funding institutions



ikerbasque
Basque Foundation for Science



Bizkaia
foru aldundia
diputación foral



Scientific activities

BCAM-SO Course Program

During 2022 BCAM has continued with the first edition of BCAM – Severo Ocho Course Program in Pure Mathematics and has started the second one with a wider offer of courses and more lectures:

- Harmonic Analysis by Ioannis Parisis (Ikerbasque & UPV/EHU), Luz Roncal (BCAM - Ikerbasque), Mateus Costa de Sousa (BCAM)
- Classical tools in differential topology by Pablo Portilla (Université de Lille)
- Introducción a la geometría simpléctica by Marisa Fernández (UPV/EHU)

BCAM Courses

Trough Courses program, BCAM is working on the training for PhD Student and research staff at the centre. This year BCAM has reinforced this work with 14 courses organised by members of the BCAM team and given by them and collaborators from other institutes:

- Anderson localization for random Schrödinger operators by Sylvain Zalczer (BCAM)
- Multiobjective Optimization using Metaheuristics by Carlos A. Coello (BCAM-Ikerbasque-CINVESTAV-IPN)
- Diophantine Approximation through the Mass Transference Principle by Felipe Ponce Vanegas (BCAM)
- Mathematical Models in Epidemiology by Maira Aguiar, Nicole Cusimano, Damián Knopoff, Nico Stollenwerk, Vanessa Steindorf, Fernando Saldaña, Akhil Srivastav and Carlo Estadilla (BCAM)





- C*-Algebra and Mathematical Foundations of Quantum Statistical Mechanics by Jean-Berard Bru (BCAM-Ikerbasque-UPV/EHU)
- Topics in Geometric Measure Theory: Lipschitz Functions and Rectifiable Sets by Zhiyuan Geng (BCAM)
- Non-uniqueness of weak solutions and existence of dissipative solutions for the Euler equations by Giorgio Cialdea (BCAM)
- Recent trends in deep learning research, and their possible applications on deep data-driven computing by Artzai Picón (Tecnalia-UPV/EHU) and Aitor Álvarez-Gila (Tecnalia-Universitat Autònoma de Barcelona)
- Convergence of stochastic integrals and their applications by Scott Hottovy (USNA)
- Applied Algebraic Quantum Theory by Peter beim Graben (BCCN)
- Bellman Functions: The dynamic programming point of view by Guillermo Rey (UAM)
- Hypocoercivity and Convergence of Kinetic Equations by Xingyu Li (BCAM)
- Dynamic modeling and statistical inference in the life sciences: philosophical and practical perspectives by Johannes Jaeger (Complexity Science Hub), Veronica Grieneisen (Cardiff University), Kepa Ruiz-Mirazo and Jose M.G. Vilar (Biofisika Institutua - UPV/EHU), Ivan Coluzza (BCMaterials), Daniele De Martino (Biofisika Institutua), Miguel Aguilera and Caetano Souto-Maior (BCAM)

Colloquiums

BCAM collaborates closely with the university in various activities, including the colloquiums, which once again this year are being held jointly:

- 12th Math Colloquium BCAM-UPV/EHU
 - Classification and width of (hollow) lattice polytope by Francisco Santos (University of Cantabria)
 - The Tits Alternative by Serge Cantat (University of Rennes)
- 13th Math Colloquium BCAM-UPV/EHU
 - Invariants of flows on singular spaces by Jose Seade (UNAM)
 - Spectral results and open problems for Dirac-Coulomb operators with general charge distributions by Maria Jesus Esteban (University of Paris)



Seminars

BCAM seminars program is aimed at training BCAM's scientific staff, exchange knowledge with the academic, industrial and business scientific community and to disseminate the very diverse applicability of mathematics.



Light PhD seminars: This seminar series is organized by BCAM PhD students to promote a knowledge exchange space adapted to their needs. This space is dedicated to help PhD students improve their communication skills, especially their public presentations, in preparation for the defense of their thesis.

- Advances in Streaming Novelty Detection by Ander Carreño
- Curve-guided multi-pass 5-axis CNC flank milling of free-form surfaces using conical tools by Kanika Rajain

- Fire-spotting modelling in wildfire simulations. Motivation, state of the art and test over a real case by Marcos Lopez de Castro
- Dirichlet processes in machine learning: From theory to practice by Ioar Casado
- Cubic microlattices embedded in nematic liquid crystals: a Landau-de Gennes study by Razvan Ceuca
- New mathematical tools for calculating gravitational dynamics in planetary systems and other N-body problems by David M. Hernández (Yale University)
- Towards a converse to Schur's criterion by Anthony Carbery (University of Edinburgh)
- Extraordinarily corrupt or statistically commonplace? A hierarchical bayesian view of experimental science by Caetano Souto Maior (BCAM)
- An information theoretical approach to nonequilibrium neural computation by Miguel Aguilera (University of Sussex)
- Elementary geometric measure theory ideas in data science by Alex Iosevich (University of Rochester)

Scientific seminars: In this series, BCAM collaborating researchers of reputed experience in their field and BCAM members offer talks in a wide range of topics.

- Machine Learning and Automation for Predictive Synthetic Biology by Hector Garcia Martin (Berkeley Lab)
- Nonlinear dynamics of interacting microbubble contrast agents: bifurcations, multistability and synchronization by Dmitry Sinelshchikov (HSE University)
- Some sharp null-form type estimates for the Klein-Gordon equation by Shobu Shiraki (Saitama University)

- From Monte Carlo to neural networks approximations of boundary value problems by Iulian Cimpian (University of Bucharest and "Simion Stoilow" Institute)
- Multidegrees at the crossroads of algebra, geometry, and combinatorics by Yairon Cid-Ruiz (KU Leuven)
- Incorporating biotic information in Species Distribution Models: a coregionalised approach by David V. Conesa (Universitat de Valencia)
- On distributionally robust optimization for multistage multiscale mixed integer linear problems under uncertainty by Laureano Escudero (Universidad Rey Juan Carlos)
- Optimization of the design and operation of multi-energy systems by Lorenzo Pilotti (BCAM)
- Nonlinear differential equations with a quadratic nonlinearity and their stochastic duals by Reinaldo García García (Universidad de Navarra)
- Extraordinarily corrupt or statistically commonplace? Reproducibility crises may stem from a lack of understanding of outcome probabilities (A hierarchical bayesian view of experimental science) by Caetano Souto Maior

Women Scientific Seminar

BCAM has introduced new seminar program to promote and raise awareness about the work of women researchers, that is why in 2022 has started BCAM Women Scientific Seminar and the first of many has been:

- Modeling and Reinforcement Learning-Based Control for Thermal and Disease Transmission Dynamics Problems by Christina Schenk (IMDEA Materials)distributions by Maria Jesus Esteban (University of Paris)





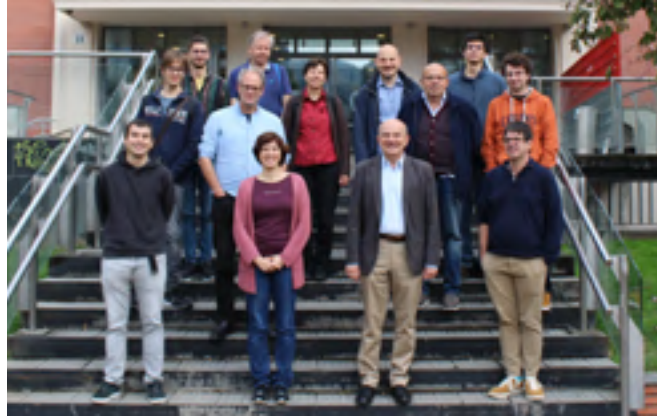
Workshops and Conferences

Aimed at complementary training and the establishment of the state of the art in specific areas of mathematical research and the establishment and development of new dynamics of collaboration and research with companies and industries that want to apply the mathematical models that BCAM can develop.

- PIXIL Workshop: Present and future of geothermal energy in Spain and France
- Dynamical Systems Applied to Biology and Natural Science - DSABNS 2022
- ERCOM Meeting 2022
- Artificial Intelligence for the Fight Against COVID-19 Workshop (AI4FA)
- Computational methods and tool for complex suspensions (CMCS)
- Hydronamics of Wave Energy Converters (HYWEC) 2022
- The Mathematics of Machine Learning Workshop (MML)
- Covid-19 in Euskadi and Catalunya: dealing with a pandemic from a biostatistical perspective
- ENLIGHT-TRANSMATH meeting: building networks in Harmonic Analysis and PDEs
- Wildfires: Mathematical, Physical and Statistical investigations

Working Groups

APDE research line, with the aim of expanding knowledge in the area, has organized 39 Joint BCAM-UPV/EHU Analysis and PDE working group session together with UPV/EHU colleagues.



Participation in Congresses and visits to other research center

With the aim of broadening knowledge and improving and developing the research work carried out at BCAM, the centre's researchers visit collaborators in other entities both locally and abroad. During 2022, the BCAM team has visited entities such as Ikerlan, CFAA, BSCS, BC3, Hospital de Galdakao, Hospital Oncológico or Spanish entities such as UAB, ULL, IHCantabria, UAM, UV, among others.

At the international level, the research team has moved to the Sorbonne Paris Nord University, Princeton University, University of Helsinki, University of Athens, University of Verona, University of Bordeaux, University of Sussex, Lund University, UAIC Iasi, BMW, University of Antioquia, ETH Zurich, Insittuto Superior Tecnico, Paris-est Creteil University, among others.

Finally, BCAM researchers participate in and attend congresses and workshops, not only to broaden their knowledge, but also to be able to develop new working relationships:

JANUARY 2022

- Congreso Bienal de la RSME
- ENABLE workshop

FEBRUARY 2022

- Hausdorff School: PDE's in Fluid Mechanics
- 14th meeting of the GDR DynQua
- XXIII-Simposio Internacional de Métodos Matemáticos Aplicados a las Ciencias

MARCH 2022

- SIAM PDE 2022
- Probabilistic Modelling in Genomics 2022

APRIL 2022

- Copenhagen School of Stochastic Programming
- Analysis of Fluid and Elastic Bodies Interactions
- Course and Workshop on Solving PDEs with Deep Learning
Jean-Morlet Chair 2022 - Workshop: Analysis of Nematic Liquid Crystal Flows
- Annual European Rheology Conference (AERC 2022)
- II Jornada Cantábrica de EDPs
- Wind Europe Annual Event 2022



MAY 2022

- FGP22
- ICFBR2022
- Fifth International Workshop on Zeta Functions in Algebra and Geometry
- GMP 2022
- II Jornadas de Ciencia de los Datos e IA
- FOWT 2022
- Workshop on Singularities in Algebraic Geometry
- 42ND VI-HPS TUNING WORKSHOP (POP COE)
- IEEE ICASSP 2022
- INdAM Workshop II
- EGU22
- IPMS 2022
- EOSC General Assambly
- 100 UMI – 800 UNIPD
- XVIII Edición de la Conferencia Española de Biometría (CEB Madrid 2022)
- EARCO 2022
- EUSPEN International Conference 2022

JUNE 2022

- ECCOMAS 2022
- 11th International Conference on Harmonic Analysis and Partial Differential Equations
- EAGE ANNUAL 2022
- SEIO 2022
- ESI 2022
- Harmonic Analysis and related topics
- AIME 22
- Third Italian Meeting on Probability and Mathematical Statistics
- 31BIEMH
- CS 2022
- SFMC 2022
- EACA 2022
- HYP 2022
- ICCS 2022
- Fourier Analysis @ 200
- ICMASC
- SPM 2022
- Ninth Biennial SPSP 2022

JULY 2022

- EURO 2022
- ESMC
- III Portuguese Meeting on Biomathematics
- Real Analysis, Harmonic Analysis and Applications
- Symposium on Geometry Processing
- Dirac Equations Conference
- XV Summer School UPC
- GECCO 2022
- IBC 2022
- WCB 2022
- Graduate Summer School in Algorithmic Fairness MIC 2022
- ICML 2022
- IWSM 2022
- CEDYA 2022
- Summer school in Analysis and PDE
- CINBIO V Annual Meeting
- WCCM-APCOM2022
- SMC Local Cohomology



AUGUST 2022

- Inverse Problems in Analysis and Geometry Conference
- North American School of Information Theory
- COLLAS
- International School on Complexity - XVII Course Stochastic Forecasting in Complex Systems
- SIAM NWCS 2022
- SEE Annual Meeting

SEPTEMBER 2022

- Physics of Biological Systems: From Emergent Collective behaviors to Functional Materials Summer School
- CIME Mathematical modeling for epidemiology: analysis, simulation and forecasting
- CCAIM Summer School
- IWOTA 2022
- CMN 2022
- CSGG 2022
- Summer School on Motivic Integration
- EFMC14
- SMPS 2022
- VI Jornadas Cientificas de Estudiantes de la SEB
- Probability and Analysis 2022
- 35th M. Smoluchowski Symposium
- ISMC 2022
- EDS 2022
EITN Fall School in Computational Neuroscience
- Summer School on Active Matter and Complex Media, Cargese 2022
- SIAM MDS 2022
- Jóvenes Investigadores 2022
- Leuven Lectures on Singularities

OCTOBER 2022

- IBA 2022
- Minres 2022
- EUSQUTECH 2022
- IBERIAN EOSC Workshop
- TGF 2022
- RECSI 2022
IberoSing International Workshop 2022
- 2nd HARMONIC ANALYSIS WORKSHOP IN SEOUL

NOVEMBER 2022

- 100xciencia.6
- EAWE 2022
- IGA 2022
- AMATS 2022
- Renew 2022
- BYMATH 2022
- IX ICFR 2022
- HOPER Bogotá 2022
- MRS 2022 Fall meeting
- IEEE ICDM 2022
- NeurIPS 2022

DECEMBER 2022

- Escuela de Invierno de Análisis
- SOMACHI 2022
- II Encuentro RSME-UMA
- Inverse Days 2022
- CMStatistics 2022

Highlighted publications



5-axis Double-flank CNC Machining of Spiral Bevel Gears Via Custom-shaped Tools. Part II: Physical Validations and Experiments

Computational Mathematics

Mathematical Design, Modelling and Simulations MATHDES

We proposed new methodology for 5-axis flank CNC machining, called double-flank. Spiral bevel gears admit this approach where the tool has tangential contact with the material block on two sides. The proposed approach is validated by physical experiments using a custom-shaped tool specifically designed for a particular gear. The benefit of this approach is shown in the semifinishing stage, where it outperforms traditional ball end milling by an order of magnitude in terms of machining time.

2022. *The International Journal of Advanced Manufacturing Technology*, 119 (3-4), pp.1647-1658.

- Escudero, G.G.
- Bo, P.
- González-Barrio, H.
- Calleja-Ochoa, A.
- Barton, M.
- de Lacalle, L.N.L.

Hydrodynamics of Spike Proteins Dictate a Transport-affinity Competition for SARS-CoV-2 and Other Enveloped Viruses

Computational Mathematics

CFD Modelling and Simulation

By using mesoscopic-hydrodynamic simulations we have studied numerically the flow effects induced by different morphologies on the overall diffusive transport of several viruses. Many viruses, such as SARS-CoV-2 or Influenza, possess envelopes decorated with surface proteins (a.k.a. spikes). Depending on the virus type, a large variability is present in the surface-proteins number, morphology and reactivity, which remains generally unexplained. In this work we have postulated the relevance of hydrodynamic interactions in the viral infectivity of enveloped viruses and proposed micro-rheological characterization as a platform for virus differentiation. Our results revealed that the diffusional mechanism of SARS-CoV-2 is strongly influenced by the size and distribution of its spikes. Finally, we have proposed and validated a universal mechanism to explain the link between optimal virion structure and maximal infectivity for many virus families.

Sci Rep 12, 11080 (2022).
www.doi.org/10.1038/s41598-022-14884-6

- Moreno, N.
- Moreno-Chaparro, D.
- Usabiaga, F.B.
- Ellero, M.

On the Interfacial Lithium Dynamics in $\text{Li}_7\text{La}_3\text{Zr}_2\text{O}_{12}$: poly(ethylene oxide) (LiTFSI) Composite Polymer-ceramic Solid Electrolytes Under Strong Polymer Phase Confinement

Mathematical Modelling with Multidisciplinary Applications – M3A
Modelling and Simulation in Life and Materials Sciences MSLMS

Unlocking the full potential of composite solid electrolytes (CSEs), which comprise a polymer matrix and ceramic particles, is key to enabling safer and more energy dense battery technologies. Using our novel approach for multiscale modelling of advanced battery materials (it combines Density Functional Theory, enhanced sampling, ML optimization and experiment) we explained Li^+ diffusion through ceramic/polymer interfaces and proposed practical strategies for enhancing the CSE performance.

Journal of Colloid and Interface Science (2022) 623, 870-882
doi: 10.1016/j.jcis.2022.05.069.

- Bonilla, M. R.
- García Daza, F. A.
- Cortés, H. A.
- Carrasco, J.
- Akhmatskaya, E.

Modelling Secondary Infections with Temporary Immunity and Disease Enhancement Factor: Mechanics for Complex Dynamics in Simple Epidemiological Models

Mathematical Modelling with Multidisciplinary Applications – M3A
Mathematical and Theoretical Biology MTB

We study a basic SIR–SIR model without strain structure of pathogens. Capturing differences between primary and secondary infections, temporary immunity after a primary infection and disease enhancement in a subsequent infection are considered to investigate to which extent these biological mechanisms can generate complex behavior in simple epidemiological models. Rich dynamical structures are identified, including new bifurcations structures never described in dengue fever epidemiology.

2022. Chaos, Solitons & Fractals 164:112709.
www.doi.org/10.1016/j.chaos.2022.112709

- Steindorf, V.
- Srivastav, A.K.
- Stollenwerk, N.
- Kooi, B.W.
- Aguiar, M.

Classification of Bursting Patterns: A Tale of Two Ducks

Mathematical Modelling with Multidisciplinary Applications · M3A
Mathematical, Computational and Experimental neuroscience MCEN

We have mathematically derived an extended classification of bursting patterns in models of excitable cells, in collaboration with John Rinzel (Courant Institute of Mathematical Sciences, New York, USA) and Mathieu Desroches (Inria, France). Our extended classification includes a new class of bursting systems in multiple-timescale systems of dimension at least four, with (at least) two fast and (at least) two slow variables. Our results reveal the importance of the slow singular dynamics, in complement to the fast singular dynamics, when classifying complex oscillations, with application to unexplained experimental data.

*PLoS Computational
Biology 18(2):
e1009752, 2022.*

- **Desroches, M.**
- **Rinzel, J.**
- **Rodrigues, S.**

Large Deviations in Weakly Interacting Fermions: Generating Functions as Gaussian Berezin Integrals and Bounds on Large Pfaffians

Mathematical Physics · MP
Quantum Mechanics QM

The convergence of perturbation expansions in non-relativistic fermionic constructive quantum field theory at weak coupling is ensured if the matrix entries of the covariance and the interparticle interaction decay sufficiently fast and if certain Pfaffians can be bounded efficiently. We derive in this paper more general covariances while establishing such properties in a very general framework. This paper will thus serve as a stepping stone towards a mathematically rigorous theory of weakly interacting fermion systems at equilibrium that will be applicable in multiple scenarios.

*Rev. Math. Phys. 34(1)
(2022) 2150034 (73 pp).*

- **Bru, J.-B.**
- **Aza, N. J. B.**
- **de Siqueira Pedra, W.**
- **Müssnich, L.**

Anomalous Diffusion Originated by Two Markovian Hopping-trap Mechanisms

Mathematical Physics · MP
Statistical Physics SP

A model based on two co-existing Markovian hopping-trap mechanisms is derived for anomalous diffusion. This result proves that two relaxation times are enough for generating all the “anomalous” features of the process, in opposition to the long-standing paradigm in the field based indeed on the need of a broad distribution of relaxation times. It provides also an argument for fractional diffusion as a mathematical tool for bridging two co-existing equilibrium states in a disordered medium.

Math. Theor., 55,
224012 (2022)

- Vitali S.
- Paradisi P.
- Pagnini G.
- J. Phys. A

Moderately Discontinuous Homology

Mathematical Physics · MP
Singularity Theory and Algebraic Geometry STAG

Homology Theory, dating back from fundamental work of Poincaré, is one of the main tools to study topological properties of spaces. Since its inception it has become a cornerstone in geometry and topology, pervading nearby areas ranging from analysis and arithmetics. It is very useful for the study of degenerating families of smooth objects acquiring singularities at special parameters, and there is an already classical topological theory in this direction. In the recent years the attention is shifting to the study of metric aspects of degenerations. Homology only captures topological phenomena, so it loses the metric information. In this paper we lay the foundations of an enrichment of homology theory which is able to capture meaningful metric information and is suited to study metric degenerations in analytic geometry.

Pure Appl. Math 75
Issue 10, (2022), 2123-
2200

- Fernández-Bobadilla, J.
- Heinze, S.
- Pe-Pereira, M.
- Sampaio, J. E.

Convergence over Fractals for the Periodic Schrödinger Equation

Analysis of Partial Differential Equations APDE

Linear and Non -Linear Waves WAVE

In this publication we study the Sobolev regularity necessary to have pointwise convergence to the initial datum for periodic solutions of the Schrodinger equation over sets of full fractal (Hausdorff) measure. This is a classic and profound problem of harmonic analysis. Here we provide new counterexamples and positive results and we establish a link with the Talbot effect, which is an important physical phenomenon in the study of turbulence in dispersive PDEs and fluid mechanics.

Analysis and PDEs,
15(7), 1775--1805,
2022,
[doi.org/10.2140/
apde.2022.15.1775](https://doi.org/10.2140/apde.2022.15.1775)

- Eceizabarrena, D.
- Lucà, R.

Asymptotic behavior of the interface for entire vector minimizers in phase transitions

Analysis of Partial Differential Equations APDE

Applied Analysis AA

We study entire and locally-minimizing solutions for a vectorial problem. The specific potential we study allows for non-standard and intriguing behavior of the minimizers, which are, over large regions, identically equal to some zeroes of the potential. This can be regarded as a model where the zeros of the potential represent the phases of a substance which can exist in several, equally preferred, phases. We establish estimates showing how the phases can coexist in the entire space.

J. Funct. Anal. 283
(2022), no. 6,

- Alikakos, N.-D.
- Geng, Z.
- Zarnescu, A.

Polynomial Averages and Pointwise Ergodic Theorems on Nilpotent Groups

Analysis of Partial Differential Equations APDE

Harmonic Analysis HA

The authors establish pointwise almost everywhere convergence for ergodic averages along polynomial sequences in nilpotent groups of step two of measure-preserving transformations on σ -finite measure spaces. They also establish corresponding maximal inequalities on L^p for $1 < p \leq \infty$ and ρ -variational inequalities on L^2 for $2 < p < \infty$. This gives an affirmative answer to the classical Furstenberg-Bergelson-Leibman conjecture in the linear case for all polynomial ergodic averages in discrete nilpotent groups of step two.

*Inventiones
Mathematicae
arxiv.org
abs/2112.03322*

- Ionescu, A-D.
- Magyar, A.
- Mirek, M.
- Szarek, T. Z.

Minimax Classification under Concept Drift with Multidimensional Adaptation and Performance Guarantees

Data Science DS

Machine Learning ML

The paper includes artificial intelligence techniques that learn to predict the energy consumed, adapting to changes in consumption patterns. Learning and prediction techniques are proposed and their performance is experimentally evaluated in multiple scenarios. In particular, we develop adaptive online learning techniques that update model parameters recurrently, and sequential prediction techniques that obtain probabilistic forecasts using the most recent parameters. The method is evaluated using datasets corresponding to regions that have different sizes and show varying consumption patterns over time. The results show that the proposed method can improve the performance of existing techniques in a wide range of scenarios.

*International
Conference on Machine
Learning (ICML 2022).
Pages: 486-499.*

- Álvarez, V.
- Mazuelas S.
- Lozano, J. A.

Multidimensional Adaptive P-Splines with Application to Neurons' Activity Studies

Data Science DS
Applied Statistics AS

The receptive field (RF) of a visual neuron can be mapped using different techniques, however, raw RF maps are usually noisy and have sharp transitions in space and time, making their analysis challenging. This work presents a novel anisotropic locally adaptive P-spline model based on the "Separation of Overlapping Precision matrices" method which provides fast and efficient computations. Overall, this work addresses an important problem in neuroscience and our solution can have broad applications in other fields where spatiotemporal smoothing is required.

*Biometrics. 2022
Sep 5. doi: 10.1111/
biom.13755. Epub
ahead of print. PMID:
36062852.*

- **Rodríguez-Álvarez, MX.**
- **Durbán, M.**
- **Eilers, P.H.C.**
- **Lee, D-J.**
- **Gonzalez, F.**

On the Construction of Pareto-compliant Combined Indicators

Data Science DS
Combinatorial Optimization CO

Currently, an open research area is related to finding new Pareto-compliant indicators whose preferences are different from those of the hypervolume indicator. In some recent work, we proposed a theoretical basis to combine existing weakly Pareto-compliant indicators with at least one being Pareto-compliant, such that the resulting combined indicator is Pareto-compliant as well. Most importantly, we were able to show that the combination of Pareto-compliant quality indicators with weakly Pareto-compliant indicators leads to indicators that inherit properties of the weakly compliant indicators in terms of optimal point distributions.

*Evolutionary
Computation, Vol. 30,
No. 3, pp. 381-408, Fall
2022.*

- **Falcón-Cardona, J.G.**
- **Emmerich, M.T.M**
- **Coello Coello, C.A.**

Severo Ochoa Joint Research Lab Program

Luis Vega

*Principal Investigator of
Severo Ochoa Excellence
Accreditation and Group
Leader of Linear and
Non-Linear Waves (WAVE)
research line.*

The Basque Center for Applied Mathematics is the first Basque centre to receive this recognition for the third time and consecutively after having achieved its previous accreditations in the 2013 and 2017 calls.

The Severo Ochoa centre of excellence accreditation is a recognition by the State Research Agency, part of the Ministry of Science, Innovation and Universities. Is the highest recognition for centres of excellence in Spain and is awarded after a rigorous evaluation process carried out by international scientific committees. Numerous high-level centres have competed for this distinction, which recognises the international relevance of the scientific research carried out and the global interest of the proposed work programme for the next four years.

Luis Vega, Principal Investigator of the accreditation, assures that the success of BCAM is based on "the strong synergies between the lines of research and the commitment of the BCAM team" to work together towards a common scientific objective: to consolidate an interdisciplinary system capable of tackling the challenges of Mathematics in a broad way, uniting Mathematics, Engineering and Science.

The objectives of the Strategic Plan 2022-2025 are aligned with BCAM's vision as: i) putting mathematics at the service of society, ii) a cutting-edge research environment with special attention to multidisciplinary disciplines, iii) a pole of attraction for talent, iv) a training school, v) connected to the world, vi) a centre for experimental and scientific computing, vii) a model of knowledge transfer, viii) promoting the image of mathematics. The Plan will be led by the research team of guarantors, with the collaboration of researchers linked to the Basque Foundation for Science, Ikerbasque, and the University of the Basque Country UPV/EHU and international researchers.

This accreditation will strengthen our centre and contribute to transferring research in Applied Mathematics to other scientific, technological and industrial agents. This achievement would not have been possible without the collaboration of BCAM members and the centres and institutions in our environment.

At BCAM we will continue to work to demonstrate that mathematics and science, in general, are fundamental tools for the development of society.



Severo Ochoa Joint Research Labs

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.

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.

01. 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.

02. To contribute to BCAM projects on mathematical modelling applied to health.

03. Explore the connection between pure/applied mathematics and new research topics in collaboration with BCAM research areas.

04. Strengthen contacts within the international scientific community.

05. To provide specialized training to the members of the centre.



EXCELLENZA
VINCITORI
2010

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.

The Lab on Trustworthy Machine Learning: In collaboration with Prof. Novi Quadrianto- University of Sussex-BCAM. ERC Starting grant 2020 on Bayesian Models and Algorithms for Fairness and Transparency. The laboratory is co-led by Prof. Jose Antonio Lozano, BCAM Scientific Director who coordinates the area of Data Science and Artificial Intelligence.

During this time they have been working mainly on two topics. The first topic is to consider fairness in those problems where the distribution that generated the data changes with the time. For instance, in the examples of credit assignment, it is possible that the typology of clients changes with the time or the criteria to assign credits. The question is then how to modify the classifier taking into account the new sample and, at the same time, guarantee fairness.

A second topic is how to carry out a better evaluation of fairness models. Usually, these models are evaluated with just an average and a standard deviation value. We have developed a new Bayesian method that allows to produce a probability distribution over each evaluation measure (accuracy and/or fairness matrix). In this way, the evaluation of the results of the algorithms is much more robust as it considers the uncertainty about the results.

In terms of activities, the Laboratory co-supervised the PhD thesis of Ainhize Barrainkua, a Horizon Europe RIA project on “It takes two to tango: a synergistic approach to human-machine decision making” has been approved and another proposal (ERC proof of concept) is currently under review.



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.

Lab on Modelling with Partial Differential Equations in Mathematical Biology In collaboration with Prof. Jose Antonio Carrillo. Mathematical Institute Oxford University. ERC Advanced Grant 2019 on nonlocal PDEs for complex particle dynamics: phase transitions, patterns and synchronization. The laboratory is co-led by Prof. Elena Akhmatskaya, Ikerbasque Professor at BCAM who coordinates the area of mathematical modelling with multidisciplinary applications.

The main objective of this strategic lab was to advance in understanding different techniques for parameter estimation and identifiability of models in mathematical biology based on aggregation-diffusion PDEs. In this direction, together with Gissell Estrada, now in Oxford, they have advanced to identify the right error functionals to be used in the PDE setting. They started to implement these ideas based on different standard optimization methods. Bayesian parameter estimation using Hamiltonian MonteCarlo is the next natural step and the results hopefully will be seen in the next year. Elena put me in contact with the group of Amanda Sierra at Achucarro in fall 2021. Since then another front of research has opened. The group of Amanda Sierra at Achucarro together with Carrillo's PhD student Carles Falco and the ERC PDRA Duncan Martinson in Oxford have developed an ODE model from scratch for the migration and proliferation of microglia in early stages of brain development. This population model has been fitted and parametrized by MonteCarlo chain numerical methods of the PINTS library in Oxford, and now it is being used for prediction in experiments at Achucarro.

This activity has a lot of potential for further interactions with the Achucarro lab. Very initial scientific discussions with S. Rodrigues and M. Desroches took place to identify common interests and potential research topics in computational neuroscience.



**Joint
Research
Lab**
ETH Zurich

The “BCAM Severo Ochoa Strategic Lab Analysis of PDEs” is held together with Prof. Joaquim Serra at ETH Zürich.

Lab on Analysis of PDEs: In collaboration with Prof. Joaquim Serra. ETH Zurich. ERC Starting grant 2020 on Stable Interfaces: phase transitions, minimal surfaces, and free boundaries. The laboratory is co-led by Prof. Luis Vega, coordinator of the APDE research area.

The Laboratory is focused on two objectives. The first main objective is in the direction of the Dirac equation. The starting point is a paper by Arrizabalaga et al. which is a relevant step forward in the resolution of MIT bag model problem about the optimal way to confine relativistic particles. One of the consequences of this work is that there are still some basic questions in 2d that have to be understood first to be able to solve the problem in 3d. The progress in this direction is in the analogous 2d problem. One of them uses classical results of holomorphic functions while the other one uses techniques of variational calculus.

The second main objective is to catalyse the progress made by several BCAM researchers in the use of Machine Learning techniques for the numerical resolution of PDEs. The recent success of these techniques raises theoretical problems of mathematical analysis of the first magnitude. Finding the precise statement of these problems and addressing the solutions to some of them are the objectives. The Lab will also count on this with F. De La Hoz (member of HADE team) and A. Barcnas (expert in Control Theory), both young associated professors at UPV/EHU.

ETH zürich

(bcam)
basque center for applied mathematics

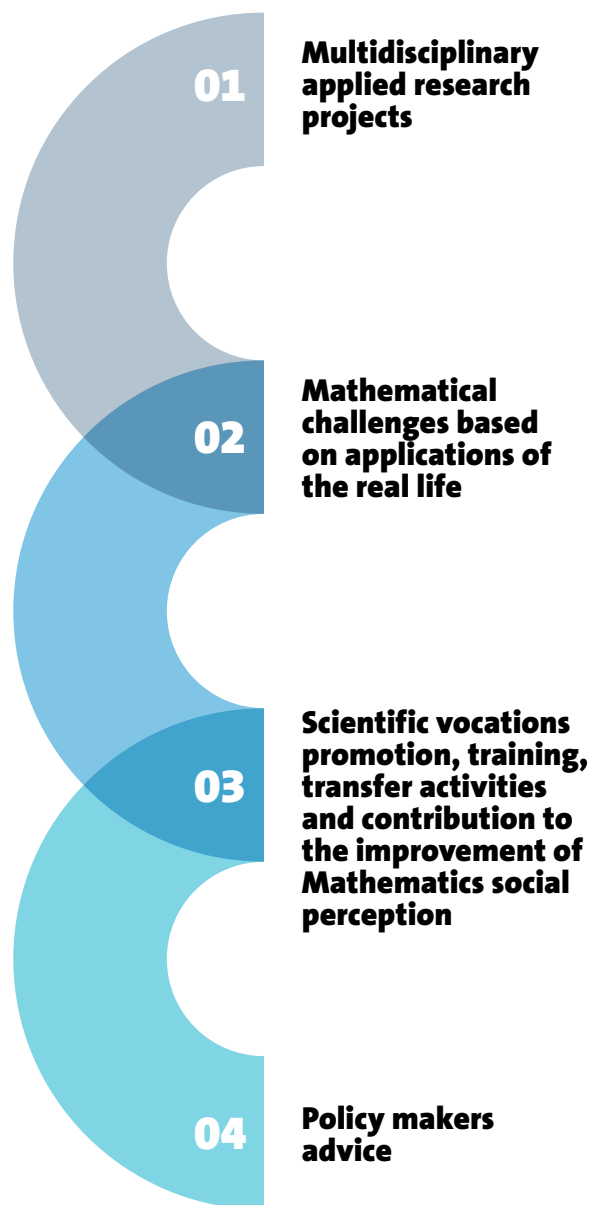





Knowledge Transfer Unit



Objectives



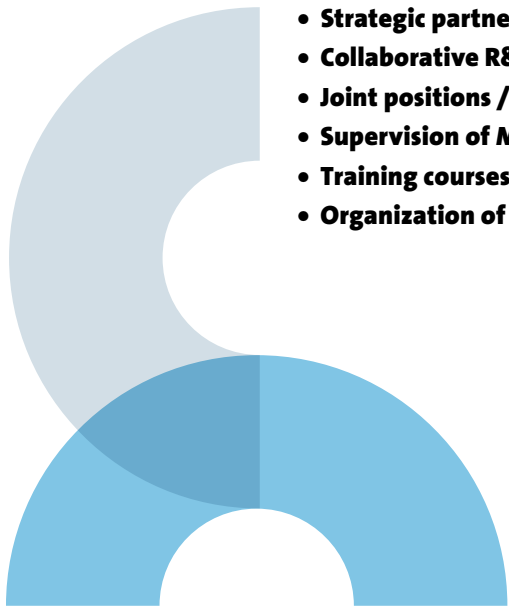


One of BCAM's most important missions is to spread knowledge and technology in the industry and the society in general.

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.

These are the collaboration models:

- 
- **Strategic partnerships**
 - **Collaborative R&D&I projects**
 - **Joint positions / research teams**
 - **Supervision of Master and PhD Students**
 - **Training courses**
 - **Organization of dissemination activities**

Ongoing projects



RUNNEA

Project

Mathematical modelling for predicting the performance of recreational runners

Goal

Development and implementation of Artificial Intelligence and Machine Learning tools for monitoring and improving the physical fitness of Runnea Academy users



illycaffè spa
Trieste Italy

Project

Mathematical model for simulation espresso coffee extraction at mesoscopic scale

Goal

Development of mesoscopic particle-simulation methods to better understand the mesoscopic extraction kinetics and morphologically characterization of the ground coffee microstructure



Oxcitas

Project

Mathematical modelling applied to the ageing process

Goal

Development of quantitative tools based on Machine Learning to estimate biological age through biomarkers related to blood analysis



Basque Government

Project

Development and implementation of a territorial classification system to evaluate the risks of arbovirolosis infections in the Basque Country

Goal

To develop a territorial classification system to identify the risk of arboviral infections transmitted by Aedes mosquitoes in the Basque Country

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.

The launch of the JRL-ORE seeks to strengthen the research links between the parties in order to take advantage of synergies between them and to reach critical masses in the agreed scientific and technological areas. It aims to increase the level of the research results in terms of their impact on the business world and society in general.

The activity of the Joint Research Laboratory on Offshore Renewable Energy covers eight technologies or areas of knowledge: Power & Energy Systems, Applied Mathematics/Data Analytics, Power Electronics, Control Engineering, Materials, Marine Geology, Fluid Dynamics and Mechanics. Transversally to the technologies, the Lab developed six product or service categories on which they focus the research efforts and which we make available to the industry.

The JRL-ORE Lab covers all stages of the offshore renewable energies process. From the initial phases, with the generation of innovative concepts, research and selection of innovative materials and mathematical models designed to optimize the useful life and reduce costs, through the implementation of floating structures and offshore renewable systems, test campaigns in laboratory and open sea and finally the grid integration of offshore renewable energies.

Some of the Offshore Renewable Energy projects are LIFE50+ (H2020-LCE-2014-1-640741), OPERA (H2020-LCE-2015-1-654444), VALID (H2020-LC-SC3-2020-101006927), MATHEO (Elkartek 2019) and KONFLOT (Elkartek 2022). The Lab members are also involved in the Master in Renewable Energy in the Marine Environment (REM PLUS) and leading the ICOE-OEE 2022 and EWTEC23 conferences.

Link to the lab: www.jrl-ore.com

tecnalia Inspiring Business

UPV/EHU
Universidad del País Vasco Euskal Herriko Unibertsitatea

bcam
Basque center for applied mathematics



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:**
Time series, conceived as a sequence of data points sorted in time order, prevail as a data structure in many different application areas. In particular, JRL-AI focuses on similarity measures for online settings, namely, data-intensive scenarios where computational resources are stringently limited and thereby, similarity measures must be computed in an incremental fashion.
- **Stream Learning:**
An increasing number of applications are based on training data continuously available (stream learning), and applied to real scenarios, such as mobile phones, sensor networks, industrial process controls and intelligent user interfaces, among others.
- **Optimization:**
The team that composes the JRL has a wide experience in the design and development of both heuristics and metaheuristics, specifically in those that fall inside the bio-inspired paradigm.
- **Lifelong Machine Learning:**
Lifelong Machine Learning (LML), also known as Lifelong Learning or Continual Learning or Continuous Learning, is an emerging paradigm that has gained momentum in the last years mainly for two main reasons: on the one hand, LML is closer to the human learning process and it considers the world in a more realistic way:
- **Adversarial Machine Learning:**
Adversarial Machine Learning (AML) is an emerging research field that blends together machine learning and cybersecurity. In order to prevent models from being fooled, new learning algorithms must be carefully designed to minimize their vulnerability. To this end, the JRL is lately conducting research towards proposing new learning procedures that are robust against adversarial inputs.

These topics have an impact on the different applications fields, such as Intelligent Transport Systems, Industry 4.0, Social Networks, Energy and Cybersecurity.

Link to the lab: www.jrlab.science

tecnalia Inspiring Business

UPV/EHU
Universidad del País Vasco Euskal Herriko Unibertsitatea

(bcam)
basque center for applied mathematics

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. LTCs were created to provide an institutional framework for research teams from the Basque country and from Bordeaux working together. This framework supports trans-border research communities, which involve young and senior researchers, students, and technicians that can move from one lab to the other without boundaries and share a common vision and action agendas. TRANSMATH is a project created in 2017 for mathematics to work in the specific subject of:

- a) Cutting edge research in the classical fields of mathematics: Geometry, Algebra, Analysis of PDEs, etc.
- b) Modeling and simulation, in particular in the applications to environment and health-related issues.
- c) Data Science.

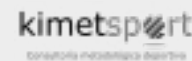
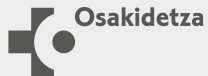
During 2022, the Transmath Laboratory has co-supervised 2 PhD Students and organised the ENLIGHT-TRANSMATH Meeting: building networks in Harmonic Analysis and PDEs Workshop. The workshop aimed to bring together researchers in mathematics from several institutions of the consortium, but also from related institutions, and to obtain first-hand knowledge of their research. The ultimate goal was to foster new interactions among researchers of the ENLIGHT consortium and beyond. Moreover, the short-term objective is to foster collaboration with JRL-AI (Joint Research Laboratory on Artificial Intelligence).



Joint positions



Knowledge transfer collaborators



Media and outreach activities

Since the beginning, BCAM has been working to bring mathematics closer to society. It continues to work to publicize the work of the centre and the work of research, working on the gender perspective and encouraging STEAM vocations.

To show the value of maths, BCAM participates in different activities to communicate and disseminate about them and in 2022 has participated in:

First Lego League

FIRST LEGO League Euskadi is an international educational program in which more than 560,000 schoolchildren aged between 6 and 16 from 110 countries around the world participate. Its aim is to awake young people's interest in science and technology. Through fun, group learning experiences with real thematic challenges, skills in the scientific and digital world are developed and values such as discovery, innovation, inclusion and teamwork are promoted.

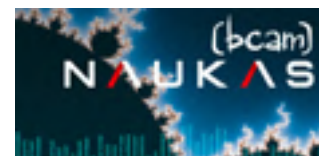


This year Imanol Gago participated giving the talk to bring the young people closer to the collaboration that BCAM is carrying out together with Basque Health Service, whose aim is to find the optimal distribution of ambulances in the Basque Country using mathematics.

BCAM – Naukas Pi Day

With the aim of bringing the fascinating nature of mathematics closer to them and to make known, among other things, the properties and applications of the number Pi in everyday life.

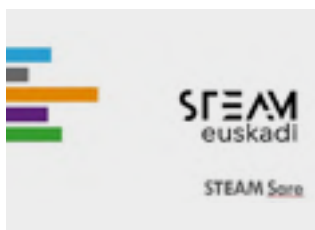
In 2022, María Ángeles Garía-Ferrero and Nicolás Moreno take part, in Mathematical images and Tell me who you are and I'll tell you how you move (A story based on viral facts, any resemblance to reality is pure science) talks respectively.



Steam Sare

First time taking part in 2021, 2022 BCAM has officially become a member of the network composed of schools, companies and scientific-technological agents. The programme works to promote STEAM education in the Basque Country through many different activities, offers the students a real context in science, maths o technology and shows the labour reality, the diversity of professional profiles and the richness of the Basque industrial fabric.

In the framework of Steam Sare, Innobasque



and Elhuyar Fundazioa have organized Career guidance meetings to help high school students in their educational and professional choices, showing the diversity of STEM professions through direct contact with STEM professionals and inspiring vocations in STEM fields, with a special focus on girls. Verónica Álvarez has participated in the activity talking with students about her academic and professional background and sharing her personal motivations and interests to carry out the work she does.

Mathematics in everyday life

Together with UPV/EHU and RSME (Royal Spanish Mathematical Society), BCAM organize a series of scientific dissemination talks in Spanish and Basque that aim to bring mathematics and its reality closer to society in general in an entertaining but rigorous way.

This time Carlos Uriarte, PhD Student, has been in Bidebarrieta giving a talk about Differential equations to explain the world and artificial neural networks to solve them.



Incubator of Probes and Experiments

In 2022, and as in previous editions, the jury of the competition was made up of members of BCAM's Applied Statistics group, including Dae-Jin Lee and members of his group. The aim of this activity is to promote the teaching and learning of Statistics, Probability and Operations Research at non-university educational levels, as well as to broaden students' knowledge and skills in this field, so students can see the importance and usefulness of Statistics in real life and as a fundamental tool in practically all sciences.



BBK Zientzia Irekia European Researchers Night

The event promoted by BBK whose main objective is to make knowledge of STEM professions and creativity available to everyone in order to increase scientific and technological vocations from an early age.

In 2022, join the event with the participation of Nicolás Moreno, who has given a talk about how viruses move and how mathematical models help us to understand them.

It is an event held in more than 370 cities across the continent and is funded by the European Commission under the Marie Skłodowska-Curie Actions (MSCA) - an initiative to promote scientific careers in Europe - which is part of Horizon Europe, the European Union's Framework Programme for Research and Innovation.

Its main objectives are to bring closer researchers and the general public, so that their work and the benefits they bring to society are known and to promote the scientific career among students by eliminating gender barriers.

The participation of BCAM has been made through Dae-Jin Lee and Kanika Rajain. Dae-Jin has given a talk about how through the analysis and

visualization of data from public sources, different graphs that scientists use to study the evidence of climate change will be shown, and Kanika about applications of mathematics in the real world.



matematika mugaz best

2) - functions. The total energy below is
$$u^2 = \frac{1}{2} \int_{\mathbb{R}} [f(y)|u_t(y,t)|^2 + v(y)|u_y(y,t)|^2] dy$$

(matematika mugaz bestalde) the follow
where unknown is the vector valued fun

$(w(y,t), \tilde{w}(y,t)) := (\sqrt{f(y)} u_t(y,t), \sqrt{v(y)} u_y(y,t))$
used in time:

$\begin{pmatrix} u(y,t) \\ w(y,t) \end{pmatrix}, (y) \in \mathbb{R}, t \geq 0$, where $u := \begin{pmatrix} u \\ v \end{pmatrix}$

$(w(y,0), \tilde{w}(y,0)) = (w^0(y), \tilde{w}^0(y)) = (\sqrt{f(y)} u^0(y), \sqrt{v(y)} d^0(y))$

$c) = c(y)$ and $d(y) = \begin{pmatrix} \sqrt{f(y)} \\ \sqrt{v(y)} \end{pmatrix} (y)$

$c) \int_{\mathbb{R}} |y|^d |e^{i \cdot} - the d-dimensional$
 $y \pm t:$

$= \frac{1}{2} (u^0(y+t) + u^0(y-t)) + \frac{1}{2} \int_{y-t}^{y+t} u^0(y) dy$

1) $\int_{\mathbb{R}} |y|^d |e^{i \cdot} - the d-dimensional$



$(y) \in \mathbb{R}, t \geq 0$

BCAM in the media

To make BCAM's work known to society, the appearance in the media helps the message reach more people. This year we can highlight the following appearances:

Third Severo Ochoa accreditation of excellence:

BCAM has been recognized as a “Severo Ochoa” centre of excellence by the State Research Agency, part of the Ministry of Science and Innovation. It thus becomes the first Basque centre to receive this recognition for the third time and consecutively after having achieved its previous accreditations in the 2013 and 2017 calls. This accreditation is the highest recognition for centres of excellence in Spain.

Bilbao City Council new member of BCAM:

In 2022 Bilbao Council has become a new partner of BCAM, and in this way it has joined Ikerbasque, Innobasque, UPV/EHU, the Provincial Council of Bizkaia and Petronor Innovación S.L. to BCAM's Executive Committee, with the aim to jointly promote projects to retain, attract and link talent to the city of Bilbao, as a driving force for progress and innovation, as well as to strengthen scientific dissemination activities in the urban environment.

National Research Awards ceremony:

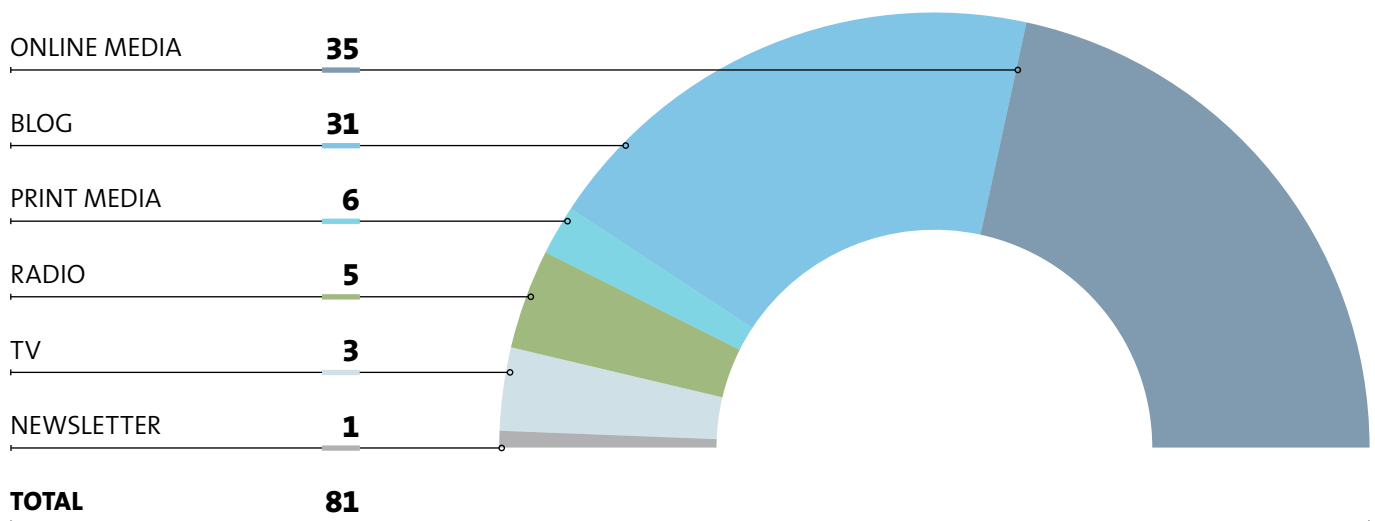
Luis Vega was awarded with the National Research Award in the field of mathematics in 2021, and in 2022 Ministry of Science and Innovation organized the presentation of awards with the participation of the awards in Barcelona. These awards are the most important recognition in Spain in the field of scientific research, a recognition the recognition of the long career of Luis Vega.

BCAM-Naukas Pi day:

The event takes place the 14 March with different activities for the general public and with the aim of bringing mathematics closer to them and to make known, among other things, the properties and applications of the number Pi in everyday life.



BCAM appearances in media



Gender balance actions

BCAM works on giving a gender perspective to every action so as to eliminate inequalities and promote effective and real equality between women and men in the international area. To do so, BCAM works on different initiatives to promote women's research and foster the interest of younger girls in STEAM vocations. In 2022, BCAM took part in the following initiatives:

01

Lore Zumeta, PhD Student at Applied Statistics research line, participated at Gymkana: La ciencia de datos, Mary Eleanor Spear organized by uc3m



02

BCAM participated in the activities proposed in the "11F - International Day of Women and Girls in Science" framework



03

Judit Muñoz, postdoctoral fellow at the Mathematical Design, Modeling and Simulations - MATHDES research line, gave a virtual talk at IES Cruces to 200 students of in the 11F framework



04

Maria Angeles Garcia-Ferrero, postdoctoral fellow at the Linear and Non-Linear Waves research line, gave a talk in Centro San Luis in the 11F framework



“The beauty of mathematics only shows itself to more patient followers”

Maryam Mirzakhani



05

Collaboration with Women for Africa Foundation (FMxA) to host the researcher Corine Laureda Sinsin from University Felix Houphouët Boigny in Benin Republic (Africa), for six months in the “Science by Woman” programme.



06

Maria Angeles Garcia-Ferrero, postdoctoral fellow at the Linear and Non-Linear Waves research line, participated in the “Mesa Redonda” about #MujeresQueTransforman: La presencia femenina en las carreras STEM organized by Afi Escuela de Finanzas.



07

BCAM joined “Emakumeak Zientzian” initiative, its aim is to make women in science more visible, to break with the generally male roles attributed to scientific and technical activities, and to promote scientific careers among girls and adolescents.



08

BCAM initiated the “BCAM Women Scientific Seminars”. This initiative is aimed to give visibility to the work of female mathematicians in the dissemination of their research work.



Networks and agreements

Networks, joint labs and platforms

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:



Strategic & institutional networks



ERCOM
European Research Centers on Mathematics
www.euro-math-soc.eu/committee/ercom



EWM
European Women in Mathematics
www.europeanwomeninmaths.org



SOMMA
The 'Severo Ochoa' Centers and 'Maria de Maeztu' Units of Excellence Alliance
www.somma.es



REM
Strategic Network in Mathematics
www.institucionales.us.es/remimus

02

Joint Research Labs



LTC-TRANSMATH

Joint Transborder
Laboratory in Mathematics
www.transmath.org/en



Joint Research Lab on Offshore Renewable Energy (JRL-ORE)

www.jrl-ore.com



Joint Research Lab on Artificial Intelligence (JRL-AI)

www.somma.es



Aulas BCAM – UPV/EHU in Leioa and Donostia / San Sebastián

03

Thematic networks & platforms



MATH-IN

Spanish Network of
Mathematics and Industry
www.math-in.net



BIOSTATNET

National Network of
Biostatistics
www.biostatnet.com



CLISYNE

Clinical Systems
Neuroscience
www.clisyne.org



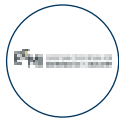
PET MSO-ED

Spanish Platform for
Modelling, Simulation and
Optimization Technologies
in a Digital Environment
[www.math-in.net/?q=es/
content/pet-mso-ed](http://www.math-in.net/?q=es/content/pet-mso-ed)



04

Associations & consortiums



ECMI
European Consortium for
Mathematics in Industry
www.ecmiindmath.org



EOSC
European Open Science Cloud
www.eosc-portal.eu



BAIC
Basque Artificial
Intelligence Center
www.baic.eus/es



BCSC
Basque CyberSecurity Centre
www.basquecybersecurity.eus



BDIH
Basque Digital Innovation Hub
www.basqueindustry.spri.eus/es/basque-digital-innovation-hub



EU-MATHS-IN
European Service Network of
Mathematics for Industry and
Innovation
www.eu-maths-in.eu



BAT
B Accelerator Tower
www.bacceleratoretower.com



INNOLAB
Bilbao
www.ilb.eus/en



EARMA
European Association of Research
Managers and Administrators
www.earma.org

Societies

We are institutional members of the following societies:



EMS
European Mathematical Society
www.euromathsoc.org



RSME
Real Sociedad Matemática Española – RSME
www.rsme.es



SEMA
Sociedad Española de Matemática Aplicada
www.sema.org.es



2022







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