MATH AmSud

2024 call for proposal approved projects

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Bruhat intervals

The main objective of this project is to strengthen collaboration between researchers from South America and France, focusing on several problems that revolve around the combinatorics of Bruhat intervals. The research team is made up of researchers from very diverse fields, including Algebraic Combinatorics, Representation Theory, Convex Geometry, Algebraic Geometry among others. This project represents a valuable opportunity to combine our expertise and efforts to unravel the mysteries behind Bruhat intervals. Moreover, we intend to foster the involvement of graduate students and young researchers in the project by facilitating meetings and research stays abroad.

This project aims to deepen our understanding of the Bruhat order of a Coxeter system. This order arises naturally in the study of Schubert varieties and representations of algebraic groups. The cornerstone of this project lies in the observation that for affine Weyl groups, the Bruhat order is closely connected to Euclidean geometry. A manifestation of this connection is evident in the results presented in the preprint "On the size of Bruhat intervals", where we (three researchers involved in this project along with a Ph.D. student associated with another researcher) establish a relationship between the size of a Bruhat interval and the geometry of polytopes.

During the project we will focus on the following kind of problems:
1.To study the isomorphism type of Bruhat intervals.
2.To determine the size of Bruhat intervals.
3.To count lattice points in orbit polytopes.
4.To study the computational complexity of counting elements in Bruhat intervals.

Project coordinators

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CHA2MAN

Stochasticity & Chaos in Multiscale Phenomena

Goal 1 : To propose stochastic models accounting for uncertainties in multiscale fluids.
Goal 2 : To analyze dynamical systems at the boundary of chaos.
Goal 3 : To explore complex dynamics with uncertainties.

The CHA2MAN project aims to address the complex behaviors of multiscale dynamical systems by incorporating stochastic perturbations to account for inherent uncertainties and randomness. This approach serves as a regularization mechanism when deterministic models fall short. To this aim, CHA2MAN integrates perspectives from two mathematical disciplines: stochastic modeling and analysis and the study of complex dynamical systems to address specific multiscale phenomena, with chaotic behaviors.

Project coordinators

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EXPLORE-SDE

Explosions for non-markovian and related stochastic differential equations

In this proposal, we are interested in studying explosion criteria and numerical schemes for non-Markovian stochastic differential equations (SDE). Specifically, we propose to work on three main topics. The first one consists of studying explosion criteria for stochastic differential equations with Markovian switching and additive noise derived from a non-Markovian process such as fractional Brownian motion. We plan to develop a numerical scheme to approximate the explosion time. The second part of the proposal consists of studying a class of stochastic functional differential equations. We plan to study explosion criteria as well as a numerical scheme to approximate the explosion time. The third part deals with the study of the characterization of the random time of explosion from a statistical perspective and the estimation of parameters in a nonlinear AR model with fractional Brownian motion noise, which can be considered as a statistical model derived from a stochastic functional differential equation.

Project coordinators

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NETGAN
New trends in geometric analysis

The main goal in this research project is to develop innovative methods to further investigate and classify objects of interest in Geometric Analysis.

Specifically, they will address the following problems:
1.Classify solutions of the Allen-Cahn equation with low Morse index.
2.Classify submanifolds of constant mean curvature and codimension 2 (in the sense of Almgren) in Euclidean space.
3.Determine if planes through the origin are the only free boundary minimal surfaces of index one in the three-dimensional Schwarzschild manifold.
4.Investigate whether hyperplanes through the origin are the only stable free boundary minimal hypersurfaces in the n-dimensional Schwarzschild manifold for n between 4 and 7.
5.Classify static metrics in zero and positive cosmological constant.
6.Construction of high-complexity Neumann solutions of Allen-Cahn type equation in a ball.
7.Study the rigidity and symmetry properties of Neumann solutions with Allen-Cahn type nonlinearities with low complexity
8.Constructing annular domains in cohomogeneity-one manifolds that support a solution to the Serrin problem through the bifurcation theory of PDEs.
9.Prove index estimates for constant mean curvature surfaces in hyperbolic space in terms of topological invariants, and consider the same problem in higher dimensions.
10.Investigate the existence of stable non-compact surfaces in H2 x R with constant mean curvature greater than 1/2.
11.Study the bubbling phenomena for the prescribed curvature flow on surfaces with boundaries.
12.Conduct blow-up analysis of conformal metrics on the annulus with prescribed Gaussian and geodesic curvatures.
13.Investigate the functional Scal/lambda_1 acting on the space of metrics on the sphere and characterize the stationary metrics for this functional under appropriate conditions.
14. Given a closed orientable surface S, study the question of existence and geometric characterization of maximizers of the 1-width in the space of hyperbolic metrics on S.
15. Find explicit examples of maximizers of the 1-width in the space of hyperbolic metrics on S in the case of low genus.
16.Prove the existence of infinitely many minimal surfaces with free boundary on asymptotically flat manifolds and convex boundary on

Project coordinators

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NPAAG

Geometry and Arithmetics of Algebraic Varieties of Non-Positive Curvature

The present project aims to forge a collaborative network spanning Chile, France, and Uruguay, leveraging the expertise of various mathematics sub-communities within Algebraic Geometry across institutions in Chile and Uruguay.

The logistical framework of our project revolves around three key scientific events scheduled over the two-year period. These events serve as guiding pillars for the travel arrangements, emphasizing extended stays to foster collaboration and to explore new research lines at the interface of the main topics of expertise of the already existing communities. With the aim to improve their initial training and complete their knowledge, with the aspiration of fostering new perennial collaborations between Latin America and Europe beyond the end of the project, we prioritize funding for Junior Researchers and students. To achieve this, they have made significant efforts to secure external funding opportunities to maximize the number of supported missions for the participants.

The scientific core of the project is focused on the study of properties of projective algebraic varieties whose canonical class is either trivial or anti-ample (Calabi-Yau varieties and Fano varieties), along with their variants in an arithmetic context. Taken separately, these directions are classic topics in algebraic geometry and many of the participants to the project are already involved in fruitful collaborations with researchers in France within their respective sub-communities.

The goal is to unite these communities under a single effort, encouraging the dissemination of ideas and techniques specific to each community to others through the exchanges between the participants, to foster the emergence of new lines of research at their interfaces.

Project coordinators

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SGP

Symmetries in Geometry and Physics

The project proposes a collaboration among six countries to advance the study of geometric structures on differentiable manifolds, moduli space geometry, algebraic geometry and topology, and their connections with mathematical physics, especially quantum mechanics and general relativity. In the field of differential geometry, this project will concentrate on studying homogeneous geometric structures on homogeneous manifolds.

This will include a focus on (locally conformally) Kahler manifolds and their odd-dimensional counterparts, Sasakian spaces. Additionally, they plan to investigate Calabi-Yau manifolds with torsion, particularly examining their analytical properties in relation to heat flows. Their contributions to mathematical physics will be centered around supermembrane theories and super-gravities, and their interactions with algebraic geometry and topology.

Through this project, we aim to advance these areas of study, contributing to the broader fields of Geometry, Topology, and Mathematical Physics, in line with current research trends.

Project coordinators

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SiJaVol

Statistical inference for Jacobi and Volterra models: Applications in Genetic and Finance

The central theme of this collaborative project is the study and development of statistical inference in the Jacobi and Volterra process, both for the Brownian case and for fractional Brownian motion. The Latin American team has worked on the small time approximation for the Jacobi process, known in genetics as Wright-Fisher diffusion, used to model the variation in the allele frequency. By means of stochastic calculation techniques, an analytical expression of the density is obtained.

The French team has further developed its work on the Volterra process, studying Stochastic Volterra Equations (SVEs) of convolution type, including the case of rough trajectories, i.e., $H < 1/2$. For both processes, the objective is to extend results to the fractional case, with $1/2 < H < 1$, as well as to study approximations of the densities, thus developing a theory of parameter estimation for this process. Both teams possess the requisite tools for approximating densities, thereby enabling the alliance through this collaborative project to delve more deeply into these problems or extend them to other stochastic processes.

Project coordinators

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XPAND

Expansiveness in Dynamics and applications: expanding the French-Latin american collaboration

MATH AmSud

Expansiveness in dynamical systems has long been a captivating research topic. The class of expansive systems encompasses diverse behaviors (from “very structured” till “completely chaotic”) while enabling us to find significant results within this class.

This research project focuses on several aspects of expansiveness and its applications in various contexts and for various group actions. These include the study of topological, algebraic, combinatorial and geometric properties of subshifts; the study of actions of groups of real numbers in geometric spaces of number theory origin; thermodynamical aspects of expansiveness, among others. We have classified the questions we will tackle in the following interconnected topics of research:

- the study of expansive/nonexpansive properties of subspaces;
- variations on expansiveness and their applications in discrete and continuous group actions;
- Applications to centralizers, cellular automata and measures;
- Expansiveness and high complexity systems
- Beyond finite alphabets.

The research team possesses expertise across all these areas. This project aims to synthesize this knowledge to address general problems related to expansivity and look for applications in other related fields, such as theoretical computer science, combinatorics, etc.. Furthermore, by combining diverse expertise, perspectives, and ideas, we seek to solve both classical and emerging challenges in the theory of dynamical systems.

To achieve our research goals, we aim to bring together leading researchers from Brazil, Chile, Peru, and France, who specialize in distinct subareas of dynamical systems. By strengthening existing collaborations and forging new ones among these countries, we plan to develop scientific exchanges that will yield significant results in this field.

This project will promote student training through co-supervision among partners, facilitating research visits and exchanges. We also plan to promote the exchange of postdocs and early-career researchers between France and the South American institutions.

Moreover, we will organize two conferences and a research school to teach the classical aspects of dynamical systems and disseminate the new findings and advancements made by our group. This school will focus on students and early career researchers. Simultaneously, the research school will serve as a gathering point for all members of our research group. Finally, two scientific meetings are planned, bringing together members of the team and other specialists.

Project coordinators

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