2025 chapter ICMC SUMMER MEETING

03-05 FEBRUARY | **SÃO CARLOS - SP BRAZIL**

SCIENTIFIC COMMITTEE

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ICMC USP/Brasil

LIST OF SESSIONS

- *Free Boundaries problems and related topics*
- *Nonlinear Dynamical Systems*
- *Conservation Laws and Transport Equations*
- *Domain perturbation for PDEs and applications*
- *Integral and Functional Differential Equations*
- *Dispersive Equations*
- *Elliptic Equations*
- *Linear Partial Differential Equations*
- *Harmonic Analysis and Related Topics*
- *Dynamical Systems via Ordinary Differential Equations*

Plenary Lectures | **Special Sessions** | **Poster Sessions**

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Welcome

It is a pleasure to welcome you to the *ICMC Summer Meeting on Differential Equations - 2025 Chapter* and to São Carlos. We wish you a pleasant stay and that you enjoy the meetings.

Scientific committee

Denis Bonheure (Université Libre de Bruxelles/Belgium)

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Local organizing committee

Alessandra Aparecida Verri (UFSCar/Brazil)

Ederson Moreira dos Santos (USP/Brazil)

Evandro Raimundo da Silva (ICMC USP/Brazil)

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Paulo Leandro Dattori da Silva (USP/Brazil)

Vera Lúcia Carbone (UFSCar/Brazil)

Session Organizers

Jean Silva (UFMG/Brazil) & Gerardo Jonatan Huaroto Cardenas (UFAL/Brazil): Conservation Laws and Transport Equations.

Marcia A. G. Scialom (UNICAMP/Brazil) & Mahendra Panthee (UNICAMP/Brazil): Dispersive Equations.

Marcone C. Pereira (USP/Brazil) & Alessandra Verri (UFSCar/Brazil): Domain Perturbation for PDEs and Applications.

Ederson Moreira dos Santos (USP/Brazil) & Gustavo Ferron Madeira (UFSCar/Brazil): Elliptic Equations.

João Vitor da Silva (UNICAMP/Brazil) & Disson dos Prazeres (UFS/Brazil): Free Boundaries Problems and Related Topics.

Guilherme da Silva (USP/Brasil), Tiago Picon (USP/Brazil) & Charles Ferreira dos Santos (USP/Brazil): Harmonic Analysis and Related Topics.

Jaqueline G. Mesquita (UnB/Brazil), Pierluigi Benevieri (USP/Brazil) & Fernanda Andrade da Silva (USP/Brazil): Integral and Functional Differential Equations.

Bruno de Lessa Victor (UFSC/Brasil) & Nicholas Braun Rodrigues (UFSCar/Brasil): Linear Partial Differential Equations.

Juliana Fernandes da Silva Pimentel (UFRJ/Brazil), Maykel Boldrin Belluzi (UFSCar/Brazil) & Phillipo Lappicy (Universidad Complutense de Madrid/Spain): Nonlinear Dynamical Systems.

Alex Carlucci Rezende (UFSCar/Brazil) & Tiago Carvalho (USP/Brazil): Dynamical Systems via Ordinary Differential Equations.

Address

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ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS 2025 CHAPTER

Maps

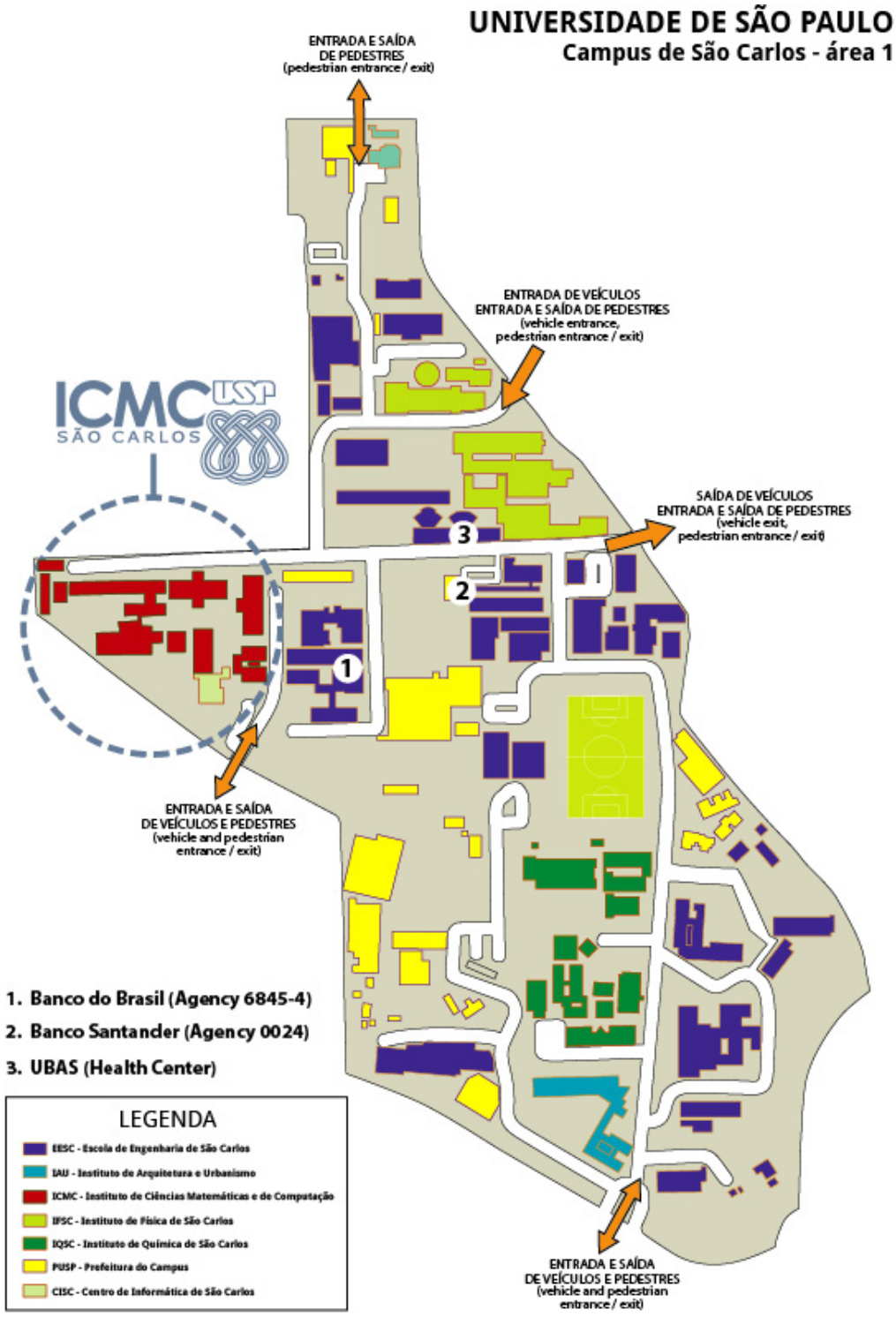

Figure 1: Campus map

Figure 2: ICMC map

ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS 2025 CHAPTER

General Information

Conference site

The meeting will take place at Buildings 4, 5 and 6. These buildings are indicated in the map on page 6.

Plenary talks and Session on Nonlinear Dynamical Systems will take place at the Auditorium (Building 6).

Session "Dynamical Systems via Ordinary Differential Equations" will take place in room 4001 (Building 4). All other sessions will take place in Building 5.

Poster session will take place at the Ground floor of the Library.

The Coffee Room is on the ground floor of the Library (1, map on page 6).

Registration

The registrations will be made in the following schedule:

Sunday, February 02^{nd}: From 16:00 to 18:00 in the entrance of the ICMC Auditorium (Building 6).

Monday, January 03^{rd}: From 08:00 to 08:40 in the entrance of the ICMC Auditorium (Building 6).

Those who cannot register on Sunday or Monday can also do it during the week at any time.

We will provide you with a badge at registration. Please wear your badge at the event to access the event rooms.

The Events Office will set up a help desk at the entrance of the Auditorium and will be at your disposal for any questions and information, also the Events Office (3, map on page 6) will be at your disposal.

Registration Fees

Student Fee: R$ 100,00 (reais).

Regular Fee: R$ 200,00 (reais).

Financial support

The financial support from the local organizing committee will be available on Monday, February 03, from 11:30 to 13:30 and on Tuesday, February 04, from 11:30 to 12:30, at the help desk at the entrance of the Auditorium (Building 6, map on page 6). In order to receive your support, it is mandatory to completely fill out the on-line registration form available at `summer.icmc.usp.br/user_summer/` .

Meals and refreshments

There are several restaurants near the campus. A selection of restaurants, coffee shops, and hotels next to ICMC (walk distance) can be found at `https://icmc.usp.br/e/e0f70`.

Social events

Tuesday, February 04: Photo of the meeting at 11:30 at ICMC.

Tuesday, February 04: Conference Dinner at 20:00 at Barone Restaurant.

Health emergencies

In case of accidents or health emergencies call 192 (SAMU).

Money exchanges

In case you need to exchange your money, we recommend:

• Confidence Câmbio at Shopping Center Iguatemi. The working hours are from 10:00 to 20:00 (Mon-Fri) and from 10:00 to 18:00 (Sat).

• JIS Câmbio at 1931, São Sebastião Street. The working hours are from 09:30 to 17:30 (Mon-Fri).

Smoking

Smoking is prohibited inside any of the ICMC buildings also in the canteen and on the ground floor of the library.

Computer and wireless LAN use

The University provides access to wireless internet connection via **eduroam**. If you do not possess an eduroam account you can access another of our wireless connection through the following steps:

1. Enable wireless on your device.
2. Join the ICMC-GUEST wireless network.
3. Open a browser and try to visit any website.
4. You will be redirected to a login page. Enter the login and password as follows:

   User Name: summer2025

   Password: 2025summer
5. You may freely browse the internet after logging in. You may occasionally need to re-authenticate using the above procedure.

Contents

ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS 2025 CHAPTER

Plenary Lectures

Plenary Lectures

Solutions to elliptic systems in a competitive regime

Angela Pistoia

La Sapienza Università di Roma

I will present some old and new results concerning existence of positive solutions to a class of systems of PDE's arising in the study of Bose-Einstein condensates in the whole euclidean space in presence of a competitive regime.

The role of homogeneity in functional inequalities and PDEs

Anibal Rodriguez Bernal

U. Complutense, Madrid

We show that many important inequalities and estimates in functional analysis and PDEs stem naturally from homogeneity properties of the norms involved and can be easily interpreted in terms of the regularity of the function spaces that appear in them.

Flipping one sided regularity via a Harnack approach

Diego Moreira

Universidade Federal do Ceará

In this talk we discuss some recent advances on the regularity theory of non linear elliptic problems showing that weak Harnack type arguments allow the passage from one-side regularity to full regularity in Hölder and Sobolev spaces. As a particular case of these phenomena, we can identify the Caffarelli, Kohn, Nirenberg and Spruck theorem (in the 80s), as well as, some more recent regularity results obtained in collaboration with Alessio Figalli (ETH) and Ederson Braga (UFC) both on the regularity of semiconvex supersolutions of uniformly elliptic equations. This problem has some motivations linked to free boundary problems as well. If time permits, I will point out some open problems.

Geometric Analysis of Spectral Partition Problems with measure constraints

Hugo Tavares

Universidade de Lisboa

In this talk, we discuss a class of spectral partition problems with a measure constraint inside a given box $\Omega \subset \mathbb{R}^N$. More concretely, we consider the problem

$$\inf \left\{ \sum_{i=1}^{k} \lambda_1(\omega_i) \;\middle|\; \omega_1, \dots, \omega_k \subset \Omega \text{ nonempty open sets, } \omega_i \cap \omega_j = \emptyset \text{ for all } i \neq j, \text{ and } \sum_{i=1}^{k} |\omega_i| \leq a \right\},$$

which is a prototypical situation of a shape optimization problem involving partitions with spectral costs.

We establish the existence of an optimal *open* partition $(\omega_1^*, \dots, \omega_k^*)$ that saturates the measure constraint, showing that the corresponding eigenfunctions are locally Lipschitz continuous, and obtain

some qualitative properties for the partition. Then, we provide a full regularity result for the associate free boundary $\cup_i \partial\omega_i^*$, for a particular solution.

The talk is based in two works, one joint with Ederson Moreira dos Santos (ICMC-USP), Pêdra Andrade and Makson Santos (IST-Lisboa), the other in collaboration with Dario Mazzoleni (Pavia) and Makson Santos. We will also show some numerical simulations performed by Pedro Antunes (IST-Lisboa), which lead to some open problems and support some conjectures.

Stabilization and Optimal Control of a 3-D fluid-structure interactions with a weak damping.

Irena Lasiecka

Memphis

We consider an interface problem consisting of a 3 D- fluid equation interacting with a 3 -D dynamic elasticity. The interface is moving according to the speed of the fluid. The PDE system is modeled by system of partial differential equations describing motion of an elastic body inside an incompressible fluid. The fluid is governed by Navier-Stokes equation while the structure is represented by the system of dynamic elasticity with weak dissipation. The interface between the two environments undergoes oscillations which lead to moving frame configuration, the latter giving rise to a quasilinear system.

For such structures, control problems corresponding to minimization of vorticity/hydrodynamic pressure subject to constraints or minimization of drag are discussed. The problem is motivated by applications arising in bio-mechanics, aeroelasticity and industrial processes. In the presence of weak damping affecting the solid, the control-to-observation map is proved global-so that the size of the data can be chosen uniformly in time. This allows consideration of an infinite time horizon optimal control problem. The latter depends critically on the estimates obtained in joint work with M. Ignatova, I. Kukavica and A. Tuffaha in the case of 3-D fluid structure interaction. These estimates are further developed in the study of *finite horizon* optimal control problem in a joint work with L. Bociu and A. Tuffaha, and most recently expanded to an *infinite horizon* optimization.

Justifying linearization for boundary homogenization on grill-type walls

Maria-Eugenia Pérez-Martínez

Universidad de Cantabria

Rapidly alternating Winkler-Robin type boundary conditions appear naturally in foundation models for engineering constructions, where strong reactions concentrated in small regions may occur. These reactions may be represented by a nonlinear monotonic vector function of the displacements. A homogenization process is required to save numerical computations, and also, often a linearization process is performed in order to simplify the model. However, the linearization may be wrong or it may not be justified. We provide techniques that justify both the averaged boundary conditions and the linearization process for certain relations between the period, sizes of the reaction regions and reaction coefficients. We deal with the elasticity operator but the technique applies to other operators and/or geometrical configurations such as those appearing in diffusion processes for inhomogeneous porous media with nonlinear Robin boundary conditions on the boundary of the cavities. We provide a review of different linear and nonlinear homogenized models, analyzing the cases where non periodicity could be allowed. The talk is based on joint works [1-4] and some recent works in progress.

[1] D. Gómez, M. Lobo, M.-E. Pérez-Martínez and E. Sanchez-Palencia: Homogenization in perforated domains: a Stokes grill and an adsorption process, Appl. Anal. 97(16): 2893 – 2919, 2018.

[2] D. Gómez, S.A. Nazarov and M.-E. Pérez-Martínez: Asymptotics for spectral problems with rapidly alternating boundary conditions on a strainer Winkler foundation. J. Elasticity. 142, 89-120, 2020.

[3] D. Gómez and M.-E Pérez-Martínez: Averaged reaction for nonlinear boundary conditions on a grill-type Winkler foundation. Math. Model. Anal., 29(4):694-713, 2024.

[4] M.-E. Pérez-Martínez. Homogenization for alternating boundary conditions with large reaction terms concentrated in small regions. In: Emerging problems in the homogenization of Partial Differential Equations. pp. 37-57 ICIAM2019 SEMA SIMAI Springer Ser. 10, 2021.

Nonlinear heat equations on groups and beyond

Michael Ruzhansky

Ghent University and QMUL

In this talk we will give an overview of our recent works concerning the Fujita exponent for semilinear heat equations in different settings, in the generality of unimodular Lie groups and beyond.

Stability results for viscoelastic models

Valéria Neves Domingos Cavalcanti

Universidade Estadual de Maringá

We are concerned with the global existence as well as the asymptotic behaviour of some viscoelastic evolution models. In the presence of viscoelastic effects given by a memory term with past history, we establish the global existence of solutions and the uniform decay rates of those solutions.
We observe that the origin of modern viscoelasticity traces back to the works of Boltzman [1, 2] and Volterra [3, 4].

[1] L.E. Boltzmann, Zur Theorie der elastischen Nachwirkung, Wien. Ber. 70 (1874), 275–306.

[2] L.E. Boltzmann, Zur Theorie der elastischen Nachwirkung, Wien. Ber. 5 (1878), 430–432.

[3] V. Volterra, Sur les équations intégro-différentielles et leurs applications, Acta Math., 35 (1912) 295-356.

[4] V. Volterra, Leçons sur les fonctions de lignes, Gauthier-Villars, Paris, 1913.

The Dirichlet Problem for Elliptic Operators without Maximum Principle

Wolfgang Arendt, Tom ter Elst, Manfred Sauter

Ulm University

We investigate the Dirichlet problem with respect to an elliptic operator under the sole hypothesis that 0 is not a Dirichlet eigenvalue. In this situation the weak maximum principle may be violated. Nonetheless the Dirichlet problem is well posed, whenever the underlying domain is Wiener regular; i.e. if the Dirichlet problem is well posed for the Laplacian. If the domain is not Wiener regular, Perron introduced a weak solution. This notion of solution depends strongly on the maximum principle and

is defined as the supremum of sub solutions. We define the "Perron solution" in a different way under our general hypotheses and give several quite different characterizations of this solution. The most important one, formulated in terms of Sobolev spaces is even new for the Laplacian. The talk is based on the article: W. Arendt, A.F.M. ter Elst: The Dirichlet Problem for elliptic operators without maximum principle. Math. Ann. 390 (2024), 763-810

ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS 2025 CHAPTER

Thematic Sessions

Conservation Laws and Transport Equations

Organizer: Jean Silva (UFMG/Brazil) & Gerardo Jonatan Huaroto Cardenas (UFAL/Brazil)

Quantitative particle approximation of nonlinear stochastic Fokker-Planck equations with singular kernel

Alexandre Batista de Souza, Christian Olivera, Josué Knorst

Unicamp

We derive quantitative estimates for large stochastic systems of interacting particles perturbed by both idiosyncratic and environmental noises, as well as singular kernels. We prove that the (mollified) empirical process converges to the solution of the nonlinear stochastic Fokker-Planck equation. The proof is based on Itô's formula for H_q^1-valued process, commutator estimates, and some estimations for the regularization of the empirical measure. Moreover, we show that the aforementioned equation admits a unique strong solution in the probabilistic sense. Our results cover several classical models such as the stochastic 2d Navier-Stokes equation, in vorticity form, the stochastic Burgers equation, and the parabolic-elliptic Keller-Segel equation. The talk is based on joint work with Christian Olivera and Josué Knorst (arXiv:2412.05950).

On local well-posedness of the stochastic incompressible density-dependent Euler equations

Claudia Espitia, Christian Olivera, David Mollinedo

Unicamp

We study the stochastic inhomogeneous incompressible Euler equations in the whole space R3. We show the existence and pathwise uniqueness of local solutions with a multiplicative stochastic noise. Our approach is based on reducing our problem to a random problem and some estimations for type transport equations.

Weak solutions of the compressible Poisson-Nernst-Planck-Navier-Stokes equations

Daniel Marroquin, Dehua Wang

Universidade Federal do Rio de Janeiro

We consider the compressible Poisson-Nernst-Planck-Navier-Stokes (PNPNS) system of equations, which models the transport of charged particles, under the influence of the self-consistent electrostatic potential, in a compressible fluid.

We study the equations posed on a smooth bounded spatial domain of R3 and consider a set of boundary conditions motivated by physical considerations. Then we investigate the existence and properties of global weak solutions for the initial/boundary value problem, without restrictions on the size of the initial data. This is a joint work with Dehua Wang.

Nonlinear evolution equations and relaxation time for a parametric family of zero-range processes

Fábio Júlio da Silva Valentim, Freddy Hernández-Romero, Milton Jara
UFES

In this talk, I will present a family of zero-range processes to establish a connection between the results obtained in [Landim (1996), Morris (2006)] and [Nagahata (2010)]. Each process in this family is associated with a nonlinear evolution equation, called the hydrodynamic equation, and a useful tool to rigorously deduce this is the relaxation time. I will begin with a heuristic argument to estimate the order of the relaxation time for a general zero-range process in terms of its partition function. Next, I will introduce a parametric family of partition functions as solutions to a specific ordinary differential equation. By analyzing the asymptotic behavior of the coefficients in the power series expansion of these partition functions, we derive the corresponding family of rate functions. Finally, I will present numerical evidence, obtained through deterministic iterative methods and Monte Carlo simulations, to confirm the order of the relaxation time for these processes.

Beyond DiPerna-Lions & Ambrosio: a Lagrangian approach to transport/continuity equations

Henrique Borrin de Souza
UNICAMP

In this presentation, we shall explore the theory developed after DiPerna-Lions (Invent. Math., 1989) and Ambrosio (Invent. Math., 2004), where they study solutions satisfying the so called "renormalization property". Loosely speaking, the aforementioned property states that composition of smooth functions with solutions of the transport equation are also solutions. For vector fields satisfying it, existence, uniqueness and stability of solutions of transport/continuity equation, and as a byproduct we have well-posedness of the associated flow.

Despite the renormalization property holding for $W^{1,p}$ (or more generally BV) vector fields, the property is quite rigid and many closely related spaces to BV do not satisfy it. Therefore, a new approach was developed by Crippa-DeLellis (Crelle, 2008) by first obtaining a well-posed flow for $W^{1,p}$ vector fields and then constructing a Lagrangian solution for the transport/continuity equations. The space for which the technique is applicable was further extended and now is much greater than BV with the very recent result of Nguyen (ARMA, 2021).

We shall give the broad strokes of the technique, highlighting the major results so far and commenting on new results by the author and their advisor Marcelo Santos with applications on Vlasov-Maxwell system and the generalized SQG equations.

The limit behavior of some families of variational multiscale problems in the ergodic settings.

Jean Silva
Universidade Federal de Minas Gerais

In this talk, we will combine the gamma convergence techniques with techniques of two-scale convergence to give a characterization of the stochastic homogenization problem of a family of variational multiscale problems where the integral functionals are random pertubations accomplished by stochastic diffeomorphisms(called stochastic deformations) of stationary functions.

Asymptotic Decay of Besicovitch Almost Periodic Solutions to Stochastic Scalar Conservation Laws

João Fernando Nariyoshi, Hermano Frid, Yachun Li, Jin Rui
Universidade de São Paulo

We are interested in the Cauchy problem for a stochastic conservation law with rough flux in the class of Besicovitch almost periodic functions. First, we demonstrate that the problem is well-posed provided that the Lions-Perthame-Souganidis notion of pathwise entropy solution is adapted for this context. Then, we extend a theorem by Gess and Souganidis to study the asymptotic decay of these almost periodic solutions to their mean value.

This is joint work with Hermano Frid (University of São Paulo - Ribeirão Preto), Yachun Li (Shanghai Jiao Tong) and Jin Rui (Shanghai Jiao Tong). The author has been supported by the Pró-Reitoria de Pesquisa e Inovação of the University of São Paulo through the "Programa de Apoio a Novos Docentes" (Grant 22.1.09345.01.2).

Viscosity Solutions of first order Hamilton-Jacobi Equations

Jomar Ferreira Ramos Junior, Jean Carlos da Silva
UFMG

In this talk, we introduces the concept of viscosity solutions for first order Hamilton-Jacobi equations. Initially, the need for this new solution concept is motivated by demonstrating, through examples, the limitations of classical and weak solutions in the specific context of Hamilton-Jacobi equations. Subsequently, the main classical results of the theory related to partial differential equations are briefly discussed, including the existence, uniqueness, and stability of viscosity solutions. Finally, the study highlights the significance of this concept in the modern analysis of nonlinear differential equations.

Study of H-measure Support

Luís Fernando Salvino
Universidade Federal de Minas Gerais

This study deals with the characterization of the H-measure support corresponding to a sequence of bounded Young measures $(\nu_x^k)_{k\in\mathbb{N}}$ that satisfies the inequality

$$\operatorname{div}\left(\int_p^\infty sgn(\lambda-p)(f(kx,\lambda)-f(kx,p))\,d\nu_x^k(\lambda)\right)\leq 0 \text{ em } \mathcal{D}'(U),\forall p\in \boldsymbol{R}.$$

Solvability of the stochastic hyperbolic Keller-Segel model

Nikolai V. Chemetov, Kush Kinra, Fernanda Cipriano
Universidade de São Paulo

This talk is concerned with the solvability of the stochastic hyperbolic Keller-Segel model on R^2 with an infinite dimensional multiplicative noise andintegrable initial data. The model is composed of a stochastic nonlinear hyperbolic conservation law and an elliptic equation.

We present a method based on the kinetic theory and the stochastic compactness arguments. We apply the stochastic Jakubowski-Skorokhod representation theorem to show the existence of a stochastic weak entropy solution.

Fernanda Cipriano and Kush Kinra (Universidade Nova de Lisboa, Portugal).

[1] N.V. Chemetov, Nonlinear hyperbolic-elliptic systems in the bounded domain. Communications on pure and applied analysis, v. 10, (2011) 1079-1096.

[2] L.K. Arruda, N.V. Chemetov, F.Cipriano, Solvability of the Stochastic Degasperis-Procesi Equation. J.Dynamics and Differential Equations, 35(1) (2023), 523-542.

[3] N.V.Chemetov, F. Cipriano, Weak solution for stochastic Degasperis-Procesiequation. J. Differential Equations, Vol. 382 (15) (2024), 1-49.

Existence of weak solutions to obstacle problems for a quasilinear unidimensional wave equation

Wladimir Neves, João-Paulo Dias, José-Francisco Rodrigues

Universidade Federal do Rio de Janeiro

By applying compensated compactness in the viscosity method with suitable penalisations, we prove the existence of a weak solution for the one obstacle problem for a class of quasilinear wave equations in one space dimension, extending previous results obtained in the linear case, as well as for a two obstacle problem, which is novel in the hyperbolic case. In contrast with the linear case, in a strict quasilinear case one has a weak regularity estimate and, by interpolation, we obtain a continuous solution, which satisfies also a weak entropy condition in the free domain where the string is not in contact with the obstacles.

Domain Perturbation for PDEs and Applications

Organizer: Alessandra Verri (UFSCar/Brazil) & Marcone C. Pereira (USP/Brazil)

Dirichlet's Laplacian in a straight, stretched and locally twisted waveguide

Diana Carolina Suarez Bello, Alessandra Verri
Universidade Federal de São Carlos

In this seminar we will present results based on the study of the Dirichlet's Laplacian operator spectrum in a straight, stretched and locally twisted waveguide. We will show sufficient conditions that imply the existence of discrete spectrum of the operator in this type of domains.

Dynamics of parabolic equations in domains with a small hole

Elaine Andressa Tavares de Lima, German Lozada Cruz
Universidade de São Paulo

In this lecture we will see the asymptotic dynamics for a class of semilinear parabolic problems with Dirichlet boundary conditions in domains with a small hole of size proportional to a positive parameter ϵ. In other words, we prove that the family of attractors behaves continuously as $\epsilon \to 0$. We will also provide the convergence rates in terms of the parameter.

Homogenization of the heat equation in a time-oscillatory moving thin domain

Jean Carlos Nakasato, Tatsu-Hiko Miura
University of São Paulo

We study the asymptotic behavior of solutions of the heat equation in a time oscillatory thin domain. We start by determining estimates of solutions in the perturbed domain and then find the effective problem. This is a joint work with Tatsu-Hiko Miura (University of Hirosaki).

On eigenvalue generic properties of the Laplace-Neumann operator

José N. V. Gomes, Marcus A. M. Marrocos
UFSCAR - Departamento de Matemática

We establish the existence of analytic curves of eigenvalues for the Laplace-Neumann operator through an analytic variation of the metric of a compact Riemannian manifold M with boundary by means of a new approach rather than Kato's method for unbounded operators. We obtain an expression for the derivative of the curve of eigenvalues, which is used as a device to prove that the eigenvalues of the Laplace-Neumann operator are generically simple in the space of all C^k Riemannian metrics on M. This implies the existence of a residual set of metrics in this space, which make the spectrum of the Laplace-Neumann operator simple. We also give a precise information about the complementary of this residual set, as well as about the structure of the set of the deformation of a Riemannian metric which preserves double eigenvalues.

Partial Differential Equations in Thin Domains

Marcone C. Pereira
Universidade de São Paulo

In this talk, we will explore results related to parabolic and elliptic equations defined in thin domains. We will begin by examining the pioneering work of Hale and Raugel (JDE, 1992) in the context of parabolic equations. From there, we will move to more recent developments where Homogenization Theory plays a crucial role in analyzing the asymptotic behavior of solutions as a domain in Euclidean space degenerates into an interval.

Eigenvalue asymptotics for two dimensional magnetic Dirac operators

Pablo Miranda, Vincent Bruneau
Universidad de Santiago de Chile

In this talk, we present results on the eigenvalue distribution for perturbed magnetic Dirac operators in two dimensions. We consider compactly supported perturbations and derive thirdorder asymptotic formulas that incorporate a geometric property of the perturbation's support. Notably, our approach allows us to consider some perturbations that do not necessarily have fixed sign, which is one the main novelties of our work. This is part of a joint work together with Vincent Bruneau.

Elliptic semilinear problems in thin domains defined by non-negative functions

Patrícia Neves de Araújo, Marcone Corrêa Pereira, Jean Carlos Nakasato
Universidade de São Paulo

In this work, we investigate the behavior of the solutions of a semilinear elliptic equation posed in a thin domain with an outward peak given by a nonnegative function. We apply standard methods from asymptotic analysis and thin domains to show the strong convergence of the solutions of the linear problem and determine its rate of convergence. We also derive conditions under which the linear limit equation has a compact resolvent in order to analyze the semilinear equation. We obtain upper and lower semicontinuity of the solutions and establish the rate of convergence under appropriated conditions on the geometry of the thin domain.

On the upper semicontinuity of global attractors of parabolic equations with dynamic boundary conditions

Pedro T. P. Lopes, Leonardo Pires
Universidade de São Paulo

Using form methods and analytic semigroup theory, we show how to prove the existence and upper semi-continuity of global attractors of a family of parabolic and elliptic second-order elliptic equations with dynamic boundary conditions. We consider perturbations of the coefficients as well as perturbations of the domains.

Free Boundaries Problems and Related Topics

Organizer: João Vitor da Silva (UNICAMP/Brazil) & Disson dos Prazeres (UFS/Brazil)

Global Sobolev fractional regularity for fully nonlinear elliptic equations

Claudemir Alcantara, Makson Santos
Pontifícia Universidade Católica do Rio de Janeiro

We investigate fractional regularity estimates up to the boundary for solutions to fully nonlinear elliptic equations with measurable coefficients. Specifically, under the assumption of uniform ellipticity of the operator, we demonstrate that viscosity solutions to a second-order operator satisfy a fractional Laplacian equation. This result implies that the solutions are globally of class $W^{1+\varepsilon,p}$ with appropriate estimates. Consequently, these solutions exhibit differentiability of order strictly greater than one without requiring any additional assumptions regarding the operator, such as convexity or concavity.

On fractional quasilinear equations with elliptic degeneracy

Disson dos Prazeres
Universidade Federal de Sergipe

In this talk, we present a systematic approach to investigate the existence, multiplicity, and local gradient regularity of solutions for nonlocal quasilinear equations with local gradient degeneracy. Our method involves an interactive geometric argument that interplays with the uniqueness property for the corresponding homogeneous problem, leading with gradient Hölder regularity estimates. This approach is intrinsically developed for nonlocal scenarios, where uniqueness holds for the local homogeneous problem.

Free boundary problem with oscillatory singularities

Ginaldo de Santana Sá, Damião Araújo, Eduardo Teixeira, José Miguel Urbano
Universidade Estadual de Campinas

In this talk, we investigate a class of free boundary problems with oscillatory singularities within stochastic materials. Our main result yields sharp regularity estimates along the free boundary, provided the power of the singularity varies in a Dini continuous fashion below a certain threshold. We also reveal an interesting repelling estimate preventing the free boundary from touching the region where the singularity power oscillates above the threshold.

Sharp regularity for weighted quasilinear elliptic models of p-Laplacian type

João Vitor da Silva, Disson S. dos Prazeres, Gleydson C. Ricarte, Ginaldo S. Sá
Universidade Estadual de Campinas

In this Lecture, we obtain sharp and improved regularity estimates for weak solutions of weighted quasilinear elliptic models of Hardy-Hénon-type, featuring an explicit regularity exponent depending only on universal parameters. We also establish higher regularity estimates and non-degeneracy

properties in some specific scenarios, providing further geometric insights into such solutions. Our regularity estimates both enhance and, to some extent, extend the results arising from the $C^{p'}$ conjecture for the p-Laplacian with a bounded source term. Finally, our results are noteworthy, even in the simplest model case governed by the p-Laplacian with regular coefficients:

$$\div\left(|\nabla u|^{p-2}\mathfrak{A}(|x|)\nabla u\right) = |x|^{\alpha}u_{+}^{m}(x) \quad \text{in} \quad B_1$$

under suitable assumptions on the data, with possibly singular weight $\mathfrak{h}(|x|) = |x|^{\alpha}$, which includes the Matukuma and Batt– Faltenbacher–Horst's equations as toy models.

This is a joint work with Disson dos Prazeres (UFS-Brazil), Gleydson C. Ricarte (UFC-Brazil), and Ginaldo S de Sá (Unicamp-Brazil).

The geometry of free boundaries in PDE

Julio Cesar Correa Hoyos, Disson dos Prazeres

UERJ

Free boundary problems naturally arise in phenomena such as ice melting and iron behavior under abrupt temperature changes during forging (quenching). These problems can be formulated as seeking a pair (Ω, u), where Ω represents the domain and u is a function satisfying a specific partial differential equation (PDE) in Ω.

Understanding the domain's geometry is a crucial yet challenging aspect, with open questions dating back to the 1980s. This lecture will cover some classical results in the linear and nonlinear scenarios. Key differences between this scenarios will be discussed, highlighting the challenges of the nonlinear case and compare the methods in each case. This comparison unveils some geometric results in the nonlinear case.

Weighted Lorentz Estimates for the Obstacle Problem with Oblique Boundary Conditions

Junior da Silva Bessa, Gleydson Chaves Ricarte

Universidade Estadual de Campinas

In this talk, we will be interested in studying the obstacle problem for fully nonlinear elliptic models with an oblique tangential derivative condition on the boundary. Specifically, we will examine the following model:

$$\begin{cases} F(D^2u, Du, u, x) \leq f(x) & \text{in} \quad \Omega \\ (F(D^2u, Du, u, x) - f)(u - \psi) = 0 & \text{in} \quad \Omega \\ u(x) \geq \psi(x) & \text{in} \quad \Omega \\ \beta \cdot Du + \gamma u = g(x) & \text{on} \quad \partial\Omega, \end{cases} \tag{1}$$

under the framework of Weighted Lorentz spaces. Here, we consider a bounded domain $\Omega \subset \mathbb{R}^n$ ($n \geq 2$) with boundary $\partial\Omega$ and obstacle ψ. Assuming suitable conditions on the source term f, boundary data β, γ, g, and weakened convexity of the operator F, we establish Weighted Lorentz-Sobolev estimates for solutions of (1).

The Existence of Solutions and their Asymptotic Behavior to a Weakly Coupled Logistic System

Mayra Soares, Liliane de Almeida Maia, Haoyu Li
University of Brasilia

We study the weakly coupled elliptic system of logistic type in the form of

$$\begin{cases} -\Delta u = \lambda_1 u - u^3 + \beta u v^2 \text{ in } \Omega, \\ -\Delta v = \lambda_2 v - v^3 + \beta u^2 v \text{ in } \Omega, \\ u, v \in H_0^1(\Omega), \end{cases} \tag{2}$$

where $\Omega \subset \mathbb{R}^N$ is a bounded domain with $N \geq 2$. We say the system is competitive if $\beta < 0$ and cooperative if $\beta > 0$, $\beta \in \mathbb{R}$, $\lambda_1(\Omega) < \lambda_1 \leq \lambda_2$.

We prove the existence of solutions to the problem (2) in different frameworks depending on the information we have about the parameter β. Furthermore, we analyze the asymptotic behavior of such solutions as $\beta \to 0$ or $\beta \to \pm\infty$.

A two-phase problem with a degenerate operator in Orlicz-Sobolev spaces

Pedro Fellype da Silva Pontes, Minbo Yang
ZJNU - Zhejiang Normal University - China

In this talk we will discuss about two-phase problem equipped with the Φ-Laplacian operator, where $\Phi(s) = e^{s^2} - 1$. We obtain the existence, boundedness, and Log-Lipschitz regularity of the minimizers of the energy functional associated to the two-phase problem. Furthermore, we also prove that the phase change free boundaries of the minimizers possess a finite perimeter.

An L^∞-estimate for solutions to p-Laplacian type equations using an obstacle approach

Romário Tomilhero Frias, João Vitor da Silva, Elzon Cézar Bezerra Júnior
UNICAMP

In this talk, we will address a version of the L^∞-estimate for weak solutions of $p-$Laplacian type equations of the form

$$-\operatorname{div} \mathfrak{a}(x, \nabla u) = f(x) \quad \text{in} \quad \Omega,$$

where $1 < p < \infty$, $\Omega \subset \mathbb{R}^n$ $(n \geqslant 2)$ is a suitable domain (possibly unbounded with finite measure), $f \in L^q(\Omega)$ with $q > \frac{n}{p}$ and $q \geq \frac{p}{p-1}$ and $\mathfrak{a} : \Omega \times \mathbb{R}^n \to \mathbb{R}^n$ is a continuous vector field satisfying certain structural properties. Unlike the non-variational scenario, our approach is based on analyzing an obstacle problem associated with our equation and exploring its intrinsic qualitative properties.

Porosity of the free boundary in a minimum problem

Yuwei Hu, Jun Zheng
Unicamp

Given a bounded domain $\Omega \subset \mathbb{R}^N (N \geq 2)$, a positive constant λ, and functions q, $h \in L^\infty(\Omega)$, we study geometric properties of non-negative minimizers of the minimum problem

$$\mathcal{J}(u) = \int_\Omega \left(A(|\nabla u|) + qF\left(u^+\right) + hu + \lambda \chi_{\{u>0\}} \right) \mathrm{d}x \to \min$$

over certain class $\mathcal{K}$ in the framework of Orlicz-Sobolev spaces, where u^+ denotes the positive part of u, $\chi_{\{\cdot\}}$ is the standard characteristic function, and the functions A and F satisfy the structural conditions of Lieberman-Tolksdorf's type. In particular, F is allowed to grow with a subcritical exponent. By using the technique of blow-up and the Harnack's inequality, we firstly prove the non-degeneracy of non-negative minimizers near the free boundary $\Gamma^+ := \partial\{u > 0\} \cap \Omega$, then show that the free boundary Γ^+ is locally porous. Furthermore, we also show that the set $\{u > 0\}$ has a uniformly positive density.

Integral and Functional Differential Equations

Organizer: Jaqueline G. Mesquita (UnB/Brazil), Pierluigi Benevieri (USP/Brazil) & Fernanda Andrade da Silva (USP/Brazil)

Two positive solutions for a second-order nonlinear problem with mixed boundary conditions

Adriano Peixoto

Universidade de São Paulo

In this work, we prove the existence of two positive solutions of a second-order nonlinear problem with mixed boundary conditions. The proof of our main result relies on Mawhin's coincidence degree.

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Gronwall inequality for Stieltjes integrals

Claudio A. Gallegos, Ignacio Márquez Albés, Antonín Slavík

Universidad de Chile

In this talk, we will discuss about a new Gronwall inequality for Stieltjes integrals (Kurzweil and Lebesgue) [1]. This new theorem improves several existing results and has a simple proof derived from the quotient rule for Stieltjes integrals [2]. Moreover, we will present a uniqueness theorem for measure differential equations.

This research was supported by ANID/FONDECYT postdoctorado No 3220147.

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Regulated functions with values in Banach space and variable time-scales

Dana Frankova
Czech Academy of Sciences

We deal with regulated functions with values in Banach space, which are defined on real line and on variable time-scales, with a focus on compactness.

Stability of Nicholson's blowflies equation

Fernanda Andrade da Silva, Marcia Federson, Everaldo Bonotto
Universidade de São Paulo

In this work we deal with a new class of equations, called generalized stochastic equations (we write GSEs for short), whose solutions are described by the Kurzweil-belated integral. The idea of this integral is to use be-lated partial divisions and adapt the classic Kurzweil integral so that it not only it contains the Itô-Henstock integral but it also provides a general setting for many stochastic equations.

Functional differential equations have motivated many mathematical and applied statistical researches. Indeed, many realistic models must include some of the past history of the state of the system, and this, in turn, leads to time delay. In epidemiological and ecological mathematical models, uncertainty in the inter- actions between individuals of population and/or higher-frequency environmental noises develop stochasticity. One of the major problems in ecology is the population dynamics of the Australian sheep blowfly model by Nicholson's blowflies equation. Motivated by these features, we discuss stability of this equation subject to stochastic perturbations through GSEs.

Mixed Cost Function and State Constrains Optimal Control Problems

Hugo Leiva
Yachay Tech

This work advances the understanding of Pontryagin's maximum principle within the realm of optimal control problems, particularly those involving constraints on state variables and a mixed cost function—comprising a term evaluated at the final state of the trajectory along with an integral term. We explore the application of the Dubovitskii-Milyutin theory in depth, utilizing conic approximations around key components, such as the objective function, the system of differential equations, and constraints on both control and state variables. Notably, we observe that the adjoint equation associated with the problem undergoes modifications in the differential equation and the initial data. Additionally, we incorporate two very important Optimal Control problems as examples: The epidemic model (SIR Model), optimal control problem at the onset of a new viral outbreak, and The Moon-landing Problem(MLP) to illustrate the practical implications of our findings, demonstrating both the theoretical constructs and their real-world relevance.

A competitive chemostat model with time-dependent delays

Jaqueline Godoy Mesquita, Teresa Faria
Universidade de Brasília

In this work, a non-autonomous chemostat model with time-dependent delays modelling n microorganisms in competition is derived and studied. Under very mild general conditions on the coefficients

and time-varying delays, we investigate the extinction of all the species and, in the case of a periodic system, the existence of nontrivial and nonnegative periodic solutions. For the model with a simple microorganism, a criterion for the uniform persistence is established, which also implies the global attractivity of any positive solution. In this way, a criterion for the existence, uniqueness and global attractivity of a positive periodic solution is derived. These results largely generalize and enhance recent achievements in the literature. This is a joint work with Teresa Faria.

Periodicity on Time Scales

Martin Bohner, Jaqueline Mesquita, Sabrina Streipert
Missouri University of Science and Technology

We introduce a novel definition of periodicity on arbitrary time scales, dependent on a strictly increasing and differentiable function ν. After providing crucial properties of ν-periodic functions, such as the translation invariance of integrals of periodic functions, we apply the concept of ν-periodicity to linear dynamic equations. We provide necessary and sufficient conditions for a linear dynamic equation to have a ν-periodic solution and discuss its uniqueness.

Delay-differential equations in the limit of large delay

Matthias Wolfrum
WIAS Berlin

In this lecture, I will review results on delay-differential equations (DDEs) with large delay. The limit of the delay time tending to infinity is a singular limit and leads to dynamics on different time scales. We present specific asymptotic methods to capture the the scaling of the different time scales. In this way, we will be able to understand and calculate qualitatively different parts of the spectrum at equilibria and describe the corresponding instabilities. Then, we will show how Floquet spectra of periodic solutions can be treated in similar way. Finally, we will present recent results on solutions with localized structures DDEs with large delay. We show how in the limit of large delay such solutions can be described as homoclinic solutions of a desingularized problem. Then we use concepts from classical homoclinic bifurcation theory to understand the instabilities and bifurcations of such solutions. We present examples of such dynamics from applied problems, including DDE models for optoelectronic devices and neuronal systems.

Multiparameter bifurcation problems for ordinary differential equations

Robert Skiba, Daniel Strzelecki, Nils Waterstraat
Nicolaus Copernicus University in Torun

In this talk, we will present an approach to studying the following problem:

$$\begin{cases} \dot{x}(t) = f(t, x(t), \lambda), \\ \lim\limits_{t \to \pm\infty} x(t) = 0, \end{cases} \tag{3}$$

where Λ is a compact metric space, and $f : \mathbb{R} \times \mathbb{R}^d \times \Lambda \to \mathbb{R}^d$ satisfies the condition $f(t, 0, \lambda) = 0$ for all $(t, \lambda) \in \mathbb{R} \times \Lambda$. This assumption ensures that, for any parameter $\lambda \in \Lambda$, the constant function $x(t) \equiv 0$ is a solution of (3). Consequently, our goal is to identify nontrivial solutions, i.e., pairs

$(x(\cdot), \lambda)$ such that $x(\cdot) \neq 0$.

To this end, we will demonstrate how to establish the existence of so-called bifurcation points for (3). Recall that a point $\lambda^* \in \Lambda$ is called a **bifurcation point** for the homoclinic solutions of (3) if there exists a sequence of pairs $(x_n(\cdot), \lambda_n)$ such that $x_n(\cdot) \neq 0$ solves $\lambda_n \to \lambda^*$, and $x_n \to 0$ in an appropriate sense. The set of all such parameters λ^* is denoted by $\mathcal{BIF}(\Lambda)$.

We will present conditions under which the set $\mathcal{BIF}(\Lambda)$ is non-empty and discuss its topological properties. Specifically, we will investigate how bifurcation phenomena are influenced by the structure of Λ and the behaviour of the function f.

Our approach draws upon tools from functional analysis, dynamical systems, and algebraic topology, collectively providing a robust framework for addressing these questions.

[1] V. Anagnostopoulou, C. Pötzsche, M. Rasmussen, Nonautonomous Bifurcation Theory: Concepts and Tools, Frontiers in Applied Dynamical Systems: Reviews and Tutorials 10, Springer, Cham, 2023.

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A thermoelastic system with small delays

To Fu Ma

Universidade de Brasília

An interesting paper by Nicaise and Pignotti [1, 5] showed that a damped wave equation $u_{tt} - \Delta u + \alpha u_t = 0$, with additional delay term $\beta u_t(t-\tau)$ is still exponentially stable, provided $|\beta| < \alpha$. Later, analogous results were proved, replacing frictional damping αu_t by a fading memory dissipation, provided β is small enough (see [2, 3, 4]). In the present talk, we show that a sole thermal dissipation can also drives the system exponentially to zero, provided β is small enough. We shall present the results in a framework for Timoshenko beams and discuss the existence of global attractors.

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Nonlinear Dynamical Systems

Organizer: Juliana Fernandes S. Pimentel (UFRJ/Brazil), Maykel Boldrin Belluzi (USP/Brazil) & Phillipo Lappicy (UFRJ/Brazil)

Asymptoptic behaviour of a SIR model with random diffusion and trasmission coefficient

Alexandre N. Oliveira Sousa, Tomás Caraballo, Paulo N. Seminário Huertas, Javier López-de-La-Cruz
Universidade Federal de Santa Catarina

We investigate a SIR model incorporating reinfection, vital dynamics, and a randomly varying transmission coefficient. Additionally, we consider the model with a random diffusion as our linear operator Our study establishes the existence of exponential attractors and explores the conditions determining whether the disease is eradicated or persists in an endemic state.

Existence and stability of pullback exponential attractors for a nonautonomous semilinear evolution equation of second order

Arthur Cunha, Vinícius Azevedo, Everaldo Bonotto, Marcelo Nascimento
Universidade Federal da Bahia - UFBA

We consider a nonautonomous semilinear evolution problem that models some sort of propagation problem in nonlinear elastic rods and nonlinear ion-acoustic waves. We investigate the existence and stability of a family of pullback exponential attractors for our problem under suitable growth and dissipativeness conditions. Moreover, we also prove the upper and lower semicontinuity of this family of pullback exponential attractors. As a particular case, we obtain the existence of the pullback attractor in an appropriate space, we prove its upper semicontinuity and, lastly, we obtain a regularity result of this pullback attractor.

Evans function, parity and nonautonomous bifurcation

Christian Pötzsche
Institut für Mathematik, Universität Klagenfurt, Austria

This is a joint work with Iacopo Longo (Imperial College, London, UK) and Robert Skiba (Uniwersytet Miko laja Kopernika w Toruniu, Poland).

We provide an approachable and yet flexible sufficient condition for the bifurcation of bounded entire solutions to nonautonomous ordinary differential equations. This requires to relate the parity [1], which is a crucial tool in the abstract bifurcation theory of nonlinear Fredholm operators to the Evans function [3], an established concept for the stability analysis of traveling waves to evolutionary differential equations.

We illustrate that isolated zeros of the Evans function imply that critical spectral intervals of the Sacker-Sell (dichotomy) spectrum split, while sign changes of the Evans function are sufficient for local and global bifurcations of whole continua of bounded entire solutions.

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Robustness of the exponential dichotomy

Estefani M. Moreira, Alexandre N. Carvalho, Phillipo Lappicy, Alexandre N. Oliveira-Sousa
Universidade de São Paulo

In this talk, we will prove that exponential dichotomies are preserved under small perturbations. Our proof does not require the discretization of the perturbated process and, as a consequence, it is more direct.

Critical transitions and early-warning signals for concave and d-concave nonautonomous scalar differential equations

Iacopo P. Longo, Jesús Dueñas, Rafael Obaya
Imperial College London

We investigate nonautonomous saddle-node bifurcations for nonautonomous concave and d-concave scalar differential equations subjected to an asymptotically constant variation of a parameter. We show that finite-time Lyapunov exponents calculated along a locally pullback attractive solution are efficient indicators (early-warning signals) for a bifurcation. The develop theory has significant implications for the study of critical transitions, also known as tipping points. For instance, we highlight applications to simple models in population dynamics.

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Study of the spread of infectious diseases: SIR models incorporating vital dynamics, reinfection, and random transmission coefficient

Javier López-de-la-Cruz

Universidad Politécnica de Madrid

Epidemics have influenced the humanity over history, bringing about consequences as catastrophic as the ones caused by wars and causing extinctions of entire populations. Apart from the human losses, epidemics also have important social consequences and have a huge negative impact on the economy.

Many infectious diseases, which have caused epidemics over history, are not eradicated yet and new ones are arising over the years. Hence, it is essential to set up mathematical models to describe the evolution of the diseases and then understand their evolution and make decisions to control the spread of the disease as soon as possible, trying to minimize the consequences.

The first known paper about mathematical modeling of epidemics was published in 1760 (see [1]), where D. Bernoulli studied the spread of smallpox by means of a system of ordinary differential equations. However, the study of mathematical models in Epidemiology was not developed until the very beginning of the twentieth century, when W. H. Hamer formulated in 1906 a discrete mathematical model to describe the transmission of measles (see [2]). Afterward, in 1911, R. Ross provided a mathematical model to predict the spread of an outbreak of malaria (see [3]), where he proved that it was enough to partially reduce the population of mosquitoes to eradicate the epidemics.

Nevertheless, in 1927 Kermack and McKendrick established a mathematical model to describe the spread of an infectious disease (see [4]) which has been the base of mathematical epidemiology ever since. This classical model, called SIR, is a compartmental model, i.e., it divides the population into three groups. The first group contains the susceptible individuals (S), people who are not infected but can contract the disease when contacting an infected. The second group contains the infected individuals (I). The third group contains the recovered individuals (R), people who are recovered with immunity or who pass away because of the disease.

Unfortunately, the classical SIR model assumes strong restrictions. For instance, it assumes that the total population is constant. However, sometimes infectious diseases do not disappear quickly (as the COVID-19), then the size of the population usually varies due to external factors. Another important restriction is to assume that every infected individual either recovers with immunity or passes away, which is not the case with the COVID-19.

To set up more realistic models and avoid the drawbacks pointed out above, in this talk (based on [5]) we will introduce vital dynamics and reinfection in the classical SIR model. Nevertheless, we will go further and we will also perturb randomly some parameters, as the transmission coefficient, motivated by facts observed in real epidemics. After presenting carefully the resulting models, given by differential systems, we will investigate the dynamics of the disease by means of the theory of random dynamical systems, which will allow us to find conditions under which the disease either is eradicated or becomes endemic. Apart from that we will interpret the results from the biological point of view. Finally, we will illustrate the theoretical results with several numerical simulations.

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Global existence and asymptotic behaviour for diffusive Hamilton-Jacobi equations with Neumann boundary conditions

Joaquín Domínguez-de-Tena, Philippe Souplet

ICMAT-Universidad Complutense de Madrid

We will present recent results on the diffusive Hamilton-Jacobi equation $u_t - \Delta u = |\nabla u|^p$, an important model in stochastic control. This equation has been extensively studied in the whole space or in bounded domains with Dirichlet boundary conditions, where gradient blow-up phenomena can occur in finite time. However, there are few studies addressing the case of Neumann boundary conditions. In this talk, we focus on the global existence and asymptotic behaviour of solutions for the Neumann problem with Lipschitz data, improving some previous results. Time permitting, we will also discuss generalizations for other non-linearities. The results presented are based on joint work with Philippe Souplet.

On Bifurcation from Infinity: A Compactification Approach

Juliana Fernandes, Phillipo Lappicy, José Maria Arrieta

Universidade Federal do Rio de Janeiro

We will introduce a compactification method that has been successfully applied in various contexts, such as in non-dissipative reaction-diffusion equations, where it provides a clear framework for studying unbounded solutions, their stability, and related phenomena like heteroclinic orbits. After discussing the general application of this method in broader settings, we will focus on its specific use in the context of scalar parabolic partial differential equations with nonlinear boundary conditions. In this case, we will examine how the compactification technique aids in understanding bifurcations from infinity, the associated equilibria, and their connection to the Steklov eigenfunctions. This is joint work with P. Lappicy and J. M. Arrieta.

Reaction-Diffusion Equations with Large Diffusion and Convection Heating at the Boundary

Leonardo Pires

Universidade Estadual de Ponta Grossa

We considers a model of a reaction-diffusion equation with large diffusion and convection heating at the boundary, which consists of a family of coupled PDE-ODE systems with nonhomogeneous boundary conditions. We analyze the singular limiting problem by examining the convergence of linear and nonlinear problems. We apply the Invariant Manifold Theorem to reduce the problem to finite dimensions and prove the C^1 convergence of the solutions. Conditions to ensure the structural stability of the system are also derived.

The asymptotic dynamics of non-dissipative problems: continuity of unbounded attractors

Maykel Boldrin Belluzi

Universidade de São Paulo - USP

In this talk we will present some recent advances on the topic of unbounded attractors for non-dissipative problems. Those unbounded attractors lack the compactness property that characterizes global attractors for dissipative problems, but despite this absence of compactness, they are still an efficient tool to describe the asymptotic dynamics of evolution equations. They were first introduced in the paper [3], but only recently they were presented in an abstract framework, in the context of semigroups and process (see [2]). We shall briefly present those general conditions to ensure existence of unbounded attractor. As an application, we will consider a family of perturbed reaction-diffusion equations, proving that each problem has an unbounded attractor. To conclude the topic, we present a result proved in [1] that ensures continuity of this family of unbounded attractors associated to the reaction-diffusion equations.

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Long-time dynamics for a nonlinear Bresse system with localized damping

Paulo N. Seminario-Huertas

Universidad Politécnica de Madrid

This talk focuses on Bresse systems, which model circular beams through a set of three coupled wave equations. The main goal is to prove the existence of global attractors for the dynamics of semilinear problems with localized damping. To handle localized damping, we need a unique continuation property (UCP). Therefore, we also establish a suitable UCP for Bresse systems. Our approach involves setting up the problem within a Riemannian framework, treating the system as a single equation with different Riemannian metrics. We then use Carleman-type estimates to obtain our results.

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Hybrid Bifurcations and Stable Periodic Coexistence for Competing Predators

Phillipo Lappicy, Alejandro López-Nieto, Nicola Vassena, Hannes Stuke, Jia-Yuan Dai
Universidad Complutense de Madrid

We describe a new mechanism that triggers periodic orbits in smooth dynamical systems. To this end, we introduce the concept of hybrid bifurcations: Such bifurcations occur when a line of equilibria with an exchange point of normal stability vanishes with some parameter. This constitutes of the mixture of a classical bifurcation and a bifurcation without parameters. Our main result is the existence and stability criteria of periodic orbits that bifurcate from breaking a line of equilibria. As an application, we obtain stable periodic coexistent solutions in an ecosystem for two competing predators with Holling's type II functional response.

A characterization of the structure of uniform attractors

Rodiak N. Figueroa López, José A. Langa Rosado, Hongyong Cui, Marcelo J. D. Nascimento
UFSCar

The forward dynamics of nonautonomous dynamical systems in terms of forward attractors. We first, by weakening the uniformity of attraction we introduced semiuniform forward attractors and minimal (nonuniform) forward attractors. With these semiuniform attractors, a characterization of the structure of uniform attractors was given: a uniform attractor is composed of two semiuniform attractors and bounded complete trajectories connecting them. A criterion for certain semiuniform attractors to have finite fractal dimension was given and the finite dimensionality of uniform attractors was discussed. A sufficient condition and a necessary condition for a time-dependent set to be forward attracting were given with illustrative counterexamples.

Joint work with Professors Phd. José A. Langa Rosado (US/Spain), Phd. Hongyong Cui (Huazhong University of Science and Technology/China) and Phd. Marcelo J. D. Nascimento (UFSCar/Brazil).

We would like to thank to the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001 and to the National Council for Scientific and Technological Development - Brazil (CNPq), process #200887/2022-0 and #102286/2024-8, by supported this project.

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Pullback trajectory attractors

Rodrigo Antonio Samprogna, Jacson Simsen
Universidade Federal de Alfenas

We use the concept of generalized processes to establish an abstract theory to ensure the existence of pullback trajectory attractors for evolution processes associated with nonautonomous evolution problems without guarantee of uniqueness of global solutions. We also present a result that shows

that the pullback attractor can be obtained from the pullback trajectory attractor. Finally, we illustrate the application of the theory to a differential inclusion.

Dynamics of stochastic differential equations with memory driven by colored noise

Tomás Caraballo

Universidad de Sevilla

In this talk, we will show two approaches to analyze the dynamics of a stochastic PDE with long time memory, which does not generate a random dynamical system and, consequently, the general theory of random attractors is not applicable. On the one hand, we first approximate the stochastic PDEs by a random one via replacing the white noise by a colored one. The resulting random equation does generate a random dynamical system which possesses a random attractor depending on the covariance parameter of the colored noise. On the other hand, we define a mean random dynamical system via the solution operator and prove the existence and uniqueness of weak pullback mean random attractors when the problem is driven by a more general white noise.

Dispersive Equations

Organizer: Marcia A. G. Scialom (UNICAMP/Brazil) & Mahendra Panthee (UNICAMP/Brazil)

Airy and Schrödinger-type equations on looping-edge graphs

Alexander Munoz Garcia, Jaime Angulo Pava
Universidade de Sao Paulo

The aim of this work is to study the Airy and Schrödinger operators on looping-edge graphs, a graph consisting of a circle and a finite number N of infinite half-lines attached to a common vertex. Characterizations of extensions generating unitary and contractile dynamics are provided for the Airy operator in terms of self-orthogonal subspaces and linear operators acting on indefinite inner product spaces (Krein spaces) associated to the boundary values at the vertex. Employing the same abstract techniques used in the former case, we characterize the self-adjoint extensions of the Schrödinger operator on $\mathcal{T}$-shaped graphs, *i.e.*, to graphs that consists of an internal edge that can be identified with $[-L, 0]$ and a finite amount of half-lines $[0, \infty)$ attached to a common vertex identified with $\nu = 0$. The theory established in this manuscript can be considered as a first step towards a better understanding of the dynamics for the remarkable dispersive models NLS and KdV on metric graphs.

Well-Posedness for the Extended Schrödinger-Benjamin-Ono System

Argenis J. Mendez, Felipe Linares, Didier Pilod
Universidade Estadual de Campinas

In this study, we investigate the local well-posedness of the initial value problem for the *Schrödinger-Benjamin-Ono type system*:

$$\begin{cases} i\partial_t u + \partial_x^2 u = uv + \beta u|u|^2, \\ \partial_t v - \mathcal{H}\partial_x^2 v + \rho v \partial_x v = \partial_x(|u|^2), \\ u(x,0) = u_0(x), \quad v(x,0) = v_0(x), \end{cases}$$

where $\beta, \rho \in \mathbb{R}$. The analysis is conducted for initial data $(u_0, v_0) \in H^{s+\frac{1}{2}}(\mathbb{R}) \times H^s(\mathbb{R})$ with $s > \frac{5}{4}$.

Our approach leverages energy methods combined with compactness arguments. A notable difficulty stems from the asymmetry of the nonlinear terms, which requires adapting the standard energy functional to control problematic terms arising in the estimates effectively.

To further advance the results and lower the regularity threshold below the Sobolev limit $s = \frac{3}{2}$, we employ a refined Strichartz estimate. This estimate, initially proposed by Koch and Tzvetkov in the context of the Benjamin-Ono equation and subsequently refined by Kenig and Koenig, plays a critical role in addressing challenges associated with reduced regularity.

A Glimpse into Cauchy Problems Describing Pseudospherical Surfaces

Igor Leite Freire
Universidade Federal de São Carlos

It is well known that solutions of certain integrable equations can define abstract surfaces with negative and constant Gaussian curvature, commonly referred to as pseudospherical surfaces. Many of these equations are dispersive equations and have been extensively studied, particularly regarding the existence and uniqueness of solutions. In this talk, we will explore the connections between Cauchy problems involving the Camassa-Holm equation and pseudospherical surfaces.

Threshold Behavior in Schrödinger-type Problems

Luccas Campos
UFMG

In the context of nonlinear, focusing dispersive and wave equations, the associated ground state often gives a quantitative threshold, under which the long-time behavior is well-understood. Such thresholds arise from sharp Gagliardo-Nirenberg-Sobolev inequalities, and initial data below these quantities are subject to the so-called *energy trapping*, which guarantees coercivity for quantities related to the associated potential and kinetic energies. Combined with the concentration-compactness approach, the energy trapping can be used to prove a dichotomy for the asymptotic behavior of H^1 solutions. In this talk, we discuss recent results for Schrödinger-type problems with initial data *exactly* at the mass-energy threshold in the L^2-supercritical setting.

The long wavelength limit of Periodic solutions of water wave models

Mahendra Panthee, J. L. Bona, H. Chen, Y. Hong, M. Scialom
Universidade Estadual de Campinas

This is concerned with providing rigorous justification of a long-standing practice in numerical simulation of partial differential equations. Theory often sets initial-value problems on all of $\mathbb{R}$ or $\mathbb{R}^d$. If the initial data is localized in space, it has been usual practice to approximate the problem by an associated periodic problem or a homogeneous Dirichlet problem set on a finite interval. While these strategies are commonplace, rigorous justification of the practice is sparse. It is our purpose here to indicate justification of this practice in the concrete context of a surface water wave model. While the theory worked out here is specific to the particular partial differential equation, it will be apparent to the reader that more general results may be derived using the same approach.

A Gardner-type equation: Bore propagation

Marcia Scialom, J. L. Bona, H. Chen, M. Panthee
Universidade Estadual de Campinas

Discussed here is a regularized version of the classical Gardner equation

$$u_t + u_x + uu_x + Au^2u_x - u_{xxt} = 0,$$

that arises in hydrodynamics and plasma physics. This initial-value problem posed on all of $\mathbb{R}$ will be considered with bore-like initial data. That is, the initial wave configuration will consist of a

moderately smooth function that asymptotes to zero as the spatial variable $x \to +\infty$, but converges to $r > 0$ as $x \to -\infty$. Such initial profiles can arise in internal wave propagation, for example. In their idealized versions set on all of $\mathbb{R}$, they possess an infinite amount of potential energy. This makes the analysis of the initial-value problem a slightly more subtle than the common situation where the initial profile is assumed to be localized, so being modelled by Sobolev-class initial data.

Boundary controllability for the Benjamin equation posed on a bounded domain

Miguel Soto

Universidade Estadual de Campinas

In this talk deals with the boundary controllability properties of the Benjamin equation posed on a bounded domain. We show that the equation is exactly controllable by controls that depend only on time and acts on the boundary conditions of the system. Firstly, we prove that the exact controllability property is established for the linearized system through a method based in Fourier expansion of solutions of the adjoint system and Hilbert Uniquenesss Method (H.U.M).

Blow-up for the 3D Intercritical Inhomogeneous NLS with Inverse-Square Potential

Mykael Cardoso, Luccas Campos, Luiz Gustavo Farah

Universidade Federal do Piauí

In this talk, we consider the inhomogeneous nonlinear Schrödinger equation with inverse square potential (INLSa)

$$i\partial_t u + \Delta u - a|x|^{-2}u + |x|^{-b}|u|^{2\sigma}u = 0, \quad \text{in } \mathbb{R}^3,$$

where $a > -\frac{1}{4}$, $0 < b < 2$, and $\frac{2-b}{3} < \sigma < 2 - b$. This model naturally arises in nonlinear optics for the propagation of laser beams. The equation generalizes the classical nonlinear Schrödinger equation, which is recovered when $a = b = 0$. First, we discuss the local well-posedness theory for the (INLSa) equation in the homogeneous Sobolev space $\dot{H}^{s_c}_a \cap \dot{H}^1_a$, where $s_c = \frac{3}{2} - \frac{2-b}{2\sigma}$. Let $T^* > 0$ denote the maximal time of existence for the solution. The solution is called a global solution if $T^* = \infty$, and it is called a blow-up solution if $T^* < \infty$. We then show that if u is a blow-up solution to the initial value problem (IVP) for (INLSa) in $\dot{H}^{s_c}_a \cap \dot{H}^1_a$, there exists a constant $c > 0$ such that

$$\|\mathcal{L}_a^{\frac{1}{2}} u(t)\|_{L^2_x} \geq \frac{c}{(T^* - t)^{\frac{1-s_c}{2}}}, \quad \text{for all } t \in [0, T^*).$$

Next, we present results on the existence of blow-up solutions for the intercritical (INLSa) equation in $\dot{H}^{s_c}_a \cap \dot{H}^1_a$, as well as the blow-up rates for the critical norm $\|\cdot\|_{L_x^{\frac{2\sigma}{2-b}}}$ of these solutions.

On the controllability of a higher-order water wave model

Oscar Sierra Fonseca, George J. Bautista

Fundação Getúlio Vargas

This work investigates the controllability properties of a class of higher-order unidirectional equations. We analyze a linearized version of these equations on a finite domain with boundary controls. Despite the inherent difficulties in achieving exact controllability due to spectral limitations, we demonstrate

that approximate controllability can still be achieved. Our analysis utilizes spectral methods to examine the system's response to boundary controls. These findings extend previous results on both lower- and higher-order Boussinesq systems and contribute to a broader understanding of controllability in higher-order wave equations. Specifically, our study focuses on the response of the system to boundary control inputs, shedding light on the underlying dynamics. The results have significant implications for the control of wave phenomena in various physical contexts, including oceanography, optics, and acoustic wave propagation. By exploring the controllability properties of these equations, this research advances our understanding of complex wave dynamics and informs the development of effective control strategies.

Global analytic solutions of a pseudospherical Novikov equation

Priscila Leal da Silva

UFSCar

In this talk we consider a Novikov equation, recently shown to describe pseudospherical surfaces, to extend some recent regularity results of its solutions. By making use of the global well-posedness in Sobolev spaces, for analytic initial data in Gevrey spaces we prove some new estimates for the solution in order to use the Kato-Masuda Theorem and obtain a lower bound for the radius of spatial analyticity. As a consequence of embeddings between spaces, we conclude that the unique solution is, in fact, globally analytic in both variables.

Evolution of the radius of analyticity for a system of mKdV-type equations with damping

Renata O Figueira, Mahendra Panthee

University of Campinas

In this work, we present constant lower bounds for the radius of analyticity of solutions to the Cauchy problem for a coupled system of mKdV-type equations with damping. The initial data is taken from the class of analytic functions $G^{\sigma,0}(\mathbb{R})$ equipped with hyperbolic cosine weight. We prove the local well-posedness in $G^{\sigma,0}(\mathbb{R})$ and show that the local solution can be extended globally in time. Moreover, we demonstrate that the radius of analyticity $\sigma(t)$ remains bounded below by a positive constant as time tends to infinity. This is a joint work with Mahendra Panthee.

Linear Equations

Organizer: Bruno de Lessa Victor (UFSC/Brasil) & Nicholas Braun Rodrigues (UFSCar/Brazil)

A rigidity result for Kolmogorov-type operators

Alessia Kogoj, Ermanno Lanconelli
Università di Urbino Carlo Bo

Let D be a bounded open subset of $\mathbb{R}^N$ and let z_0 be a point of D. Assume that the Newtonian potential of D is proportional outside D to the potential of a mass concentrated at z_0. Then D is a Euclidean ball centred at z_0. This theorem, proved by Aharonov, Schiffer and Zalcman in 1981, was extended to the caloric setting by Suzuki and Watson in 2001. In this note, we extend the Suzuki–Watson Theorem to a class of hypoellliptic operators of Kolmogorov-type.

On the Gevrey well-posedness for the Cauchy problem for $p-$evolution equations

Alexandre Arias Junior
Universidade de São Paulo - FFCLRP

We deal with a class of $p-$evolution equations with real characteristics, where $p \geq 2$ is an integer number. This class of pdes contains, for instance, the Schrödinger and the linear part of the KdV equations. More into the point, we consider the initial value problem for the equation

$$Pu = 0,\ P = D_t + D_x^p + \sum_{j=1}^{p} a_{p-j}(t,x) D_x^{p-j},\ t \in [0,T], x \in \mathbb{R},\ D_x = -i\partial_x, \tag{4}$$

with $a_{p-j} \in C([0,T]; \mathcal{B}^\infty(\mathbb{R}^n))$ where $\mathcal{B}^\infty(\mathbb{R}^n)$ stands for the space of all complex-valued functions bounded on $\mathbb{R}$ together with all their derivatives.

It is well known that in the case of real-valued lower order coefficients a_{p-j} the Cauchy problem associated to (4) is well-posed in the functional settings: L^2, H^m, H^∞ and suitable Gevrey type spaces. The problem is more involved when one allows complex-valued coefficients. Necessary and sufficient conditions to well-posedness in Sobolev spaces have been investigated in the literature. In the realm of Gevrey spaces, the results are restricted to $p = 2$ and $p = 3$.

In this talk we shall discuss a necesary condition on the decay of the coefficients a_{p-j} for the well-posedness in suitable Gevrey spaces for the Cauchy problem associated with (4).

Finite regularity global hypoellipticity and global solvability on the n-torus

André Pedroso Kovacs
Universidade Federal do Paraná

The concepts of global hypoellipticity and global solvability for (pseudo) differential operators have been intensely studied in the last few years, especially on compact manifolds such as the torus. These concepts usually describe a type of regularity for (pseudo)differential operators and involve C^∞ or even more regular functions, such as analytic functions.

In this talk, we present a new (to the author's knowledge) definition of finite regularity global hypoellipticity, which we call r-global hypoellipticity, or r-GH, $r \in \mathbb{R}$ and of finite regularity global solvability which we call r-global solvability, or r-GS, $r \in \mathbb{R}$, both of which involve the Sobolev spaces $H^m(\mathbb{T}^n)$, $m \in \mathbb{R}$, where $\mathbb{T}^n$ is the n-torus.

We then present necessary and sufficient conditions for Fourier multipliers on $\mathbb{T}^n$ to be r-GH or r-GS. Finally, we present a few corollaries and examples.

Local Hypoellipticity for pairs of spaces

Bruno de Lessa Victor, Luis Fernando Ragognette
Universidade Federal de Santa Catarina

Hypoellipticity is one of the main notions in the study of regularity of differential operators. The goal of this work is to give a systematic treatment for several different notions of hypoellipticity, trying to find conditions to guarantee equivalence between them. Joint work with Luis Fernando Ragognette.

Globally solvable complexes of pseudo-differential operators on the torus

Fernando de Ávila Silva, Cleber de Medeira
Universidade Federal do Paraná

In this talk, we consider a complex of pseudo-differential operators associated with an overdetermined system of operators defined on the torus. We characterize the global solvability of this complex when the system has constant coefficients. Furthermore, for a class with time-dependent coefficients, we establish connections between the global solvability of the complex and the global solvability of its normal form, namely, a suitable system with constant coefficients.

Global Analytic Solvability of Involutive Systems on Compact Manifolds

Gabriel Araújo, Paulo Leandro Dattori da Silva, Bruno de Lessa Victor
Universidade de São Paulo

Let M be a compact, connected, orientable and real-analytic manifold; consider closed, real-valued, real-analytic 1-forms $\omega_1, \ldots, \omega_m$ on M and the differential complex over $M \times \mathbb{T}^m$ naturally associated to the involutive system determined by them. In the real-analytic context, we completely characterize global solvability of the operators in its first (functional setting) and last (distributional setting) levels. Analogous results are obtained simultaneously in the Gevrey framework.

Critical exponent for semilinear plate equation with mass term

Halit Sevki Aslan, Alexandre A. Junior, Marcelo R. Ebert,
Antonio Lagioia
Universidade de São Paulo

In this talk, we are going to study the following Cauchy problem for the plate equation with mass term:

$$\begin{cases} u_{tt} + \Delta^2 u + u = 0, & (t,x) \in (0,\infty) \times \mathbb{R}^n, \\ u(0,x) = u_0(x), \quad u_t(0,x) = u_1(x), & x \in \mathbb{R}^n. \end{cases} \tag{5}$$

Our goal is to derive $L^p - L^q$ estimates for the solutions to problem (11) in the full range $1 \leq p \leq q \leq \infty$. After that, we study the associated semilinear model with power non-linearity $|u|^\alpha$ with $\alpha > 1$, where we apply the derived $L^p - L^q$ estimates in the analysis of local (in time) existence of solution and for the global (in time) small data solutions.

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Asymptotic behavior of two thermoelastic plates of Moore-Gibson-Thompson type

Hugo D. Fernandez Sare, Ramon Quintanilla

Universidade Federal de Juiz de Fora - UFJF

We investigate two examples of thermoelastic plates free of the paradox of instantaneous propagation of thermal or mechanical waves. Depending of the constitutive law (Moore Gibson Thompson type), we establish exponential or polynomial reates of decay for the solutions.

Global properties of real involutive systems on compact Lie groups

Igor Ambo Ferra, Gabriel Araújo, Luis Fernando Ragognette, Max Jahnke

Universidade Federal de São Carlos

In this work we shall discuss some global properties about the existence and regularity of global solutions associated to real involutive systems on compact Lie groups as well as properties about the cohomology groups associated to the complex induced by the involutive structure. Joint work with Gabriel Araújo, Luis Fernando Ragognette and Max Jahnke.

Suspension bridge with internal damping

Leandro Correia Araújo, Carlos Raposo, Joilson Ribeiro, Arthur Cunha

Universidade Estadual do Sudoeste da Bahia

This manuscript deals with a suspension bridge model with internal damping. We use semigroup theory. The existence of solution is proved by applying the Lumer-Phillips theorem. Exponential stability is obtained due to the analyticity of the semigroup associated with the energy space.

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Microlocal regularity for CR sections on Levi nondegenerate CR manifolds

Nicholas Braun Rodrigues

Universidade de São Paulo

A longstanding problem in CR geometry is to understand the microlocal regularity of CR functions. For embedded CR manifolds, several authors have pursued the problem of holomorphic extendability (or microlocal hypo-analyticity) of CR functions, including François Treves, Salah Baouendi, Linda Rothschild, Alex Tumanov, just to name a few. One of the main tools employed in this quest is the F.B.I. transform introduced by Salah Baouendi, Chang and François Treves. One great advantage of hypo-analytic (microlocal) regularity (or homorphic extendability) is that it is enough to study the trace of CR functions to maximally real submanifolds, because of the Baouendi-Treves approximation formula. We point out that the same arguing fails for $\mathcal{C}^\infty$-smooth (microlocal) regularity, and this might be the source of the difficulty for obtaining microlocal regularity results for CR functions on the abstract setting. Note that in the abstract case, there is no notion of holomorphic extendability, so we do not benefit from the theory of holomorphic functions anymore, this shorten the distance between the CR case and the one of general involutive structures.

On the same lines of understanding the mircolocal regularity of CR functions, there is an interesting question concerning the microlocal regularity or CR sections of CR bundles over abstract CR manifolds. The novelty here is that instead of homogeneous, purely first order partial differential equation we have a first order term that involves all the components of the section, *i.e.* the equation that a CR section u satisfies (locally) is of the kind

$$Lu + Au = 0,$$

where L is a CR vector field, A is a $r \times r$ matrix with $\mathcal{C}^\infty$-smooth coefficients, and r is the complex dimension of the CR bundle.

L^1 Stein-Weiss type inequalities with Borel measures and applications to elliptic PDEs

Victor Biliatto, Tiago Picon

Universidade de São Paulo

In this talk we present global and local versions for Stein-Weiss type inequalities with Borel measures for kernels with decay similar to the Riesz potential, extending a previous result with power weight measures due to De Nápoli and Picon. We also show how these inequalities are used to obtain sufficient conditions for the solvability in $L^\infty(\mathbb{R}^N)$ of the equation $A^*(x,D)f = \mu$, associated to an elliptic and canceling differential operator $A(x,D)$ of order $m < N$.

This is a joint work with Tiago Picon (FFCLRP-USP).

On a function-theoretic approach to the $A^\infty(K)$ algebra in the plane

Vinícius Novelli

University of São Paulo

We study, in the one-dimensional case, the Fréchet algebra $A^\infty(K)$ (introduced recently by Cordaro, Della Sala and Lamel, to treat questions about the Borel map). We prove some function-theoretic properties about this algebra (like a localization property, in analogy with the uniform case $P(K)$) and study the question of determining when this algebra coincide with the full algebra of formal power series with coefficients in $C(K)$. To do this, we introduce as the main tool a generalization of the Cauchy transform.

Global properties for a class of periodic-evolution operators on compact manifolds.

Wagner Augusto Almeida de Moraes, Fernando de Ávila Silva

Universidade Federal do Paraná

In this talk, I will present necessary and sufficient conditions for the global hypoellipticity and solvability for a class of periodic-evolution operators defined on compact manifolds. The method involves establishing conditions on the matrix symbol of the system. This allows for its transformation into a suitable triangular form, represented as a sum of a diagonal matrix and a nilpotent upper triangular matrix. Consequently, the study of global hypoellipticity focuses on analyzing the eigenvalues and their averages. This is a joint work with Fernando de Ávila Silva (UFPR-Brazil).

Elliptic Equations

Organizer: Ederson Moreira dos Santos (USP/Brazil) & Gustavo Ferron Madeira (UFSCar/Brazil)

Elliptic problems with interface

Cristian Morales Rodrigo, Braulio B.V. Maia, Monica Molina-Becerra, Antonio Suarez
Universidad de Sevilla

In this talk we study the principal eigenvalues of a linear elliptic interface problem and we apply those results in some models related to population dynamics.

Standing waves for nonlinear Hartree type equations: existence and qualitative properties

Eduardo de Souza Böer, Ederson Moreira dos Santos
Universidade de São Paulo - ICMC

This work is devoted to discuss the existence and qualitative properties of the following Hartree type equations

$$\begin{cases} -\Delta u + u = \dfrac{2p}{p+q}(I_\alpha * |v|^q)|u|^{p-2}u \quad \text{in } \mathbb{R}^N, \\ -\Delta v + v = \dfrac{2q}{p+q}(I_\alpha * |u|^p)|v|^{q-2}v \quad \text{in } \mathbb{R}^N, \end{cases} \tag{6}$$

also called Choquard type system. Using variational techniques we prove the existence of a positive ground state solution, the definite sign and radiality of ground states, the integrability/regularity of any solution and the asymptotic decay of ground states.

Multiple nodal solutions for a critical nonlinear Choquard equation

Eudes Mendes Barboza, Claudia Santana, Olimpio Miyagaki
Universidade Federal Rural de Pernambuco

In this talk, our goal is to investigate the existence of multiple nodal solutions to the following class of problems

$$\begin{cases} -\Delta u + V(x)u = (I_\alpha * |u|^{2^*_\alpha})|u|^{2^*_\alpha - 2}u + \lambda g(u) \quad \text{in} \quad \mathbb{R}^N; \\ u \in H^1(\mathbb{R}^N), \end{cases}$$

where I_α represents the Riez potential, V is a continuous potential, $N \geq 3$, $0 < \alpha < N$, $\lambda > 0$, $2^*_\alpha = \dfrac{N+\alpha}{N-2}$ is the critical exponent in the sense of the Hardy-Littlewood-Sobolev inequality and g is a local or nonlocal superlinear perturbation with subcritical growth in the sense of Sobolev or Hardy-Littlewood-Sobolev, respectively. For this matter, we show that for any positive $k \in \mathbb{N}$ the previous problem with a nonlinearity involving critical growth has at least a radially symmetrical ground state solution changing sign exactly k-times.

Monotone heteroclinic solutions to semilinear PDEs in cylinders and applications

Fabio De Regibus
Universidad de Granada

In this talk we present an existence result for strictly monotone heteroclinic type solutions of semilinear elliptic equations in cylinders. The motivation of this construction is twofold: first, it gives an example of a steady solution for the 2D Euler equations without stagnation points which is not a shear flow. Second, it implies the existence of an entire bounded solution of a semilinear equation without critical points which is not one-dimensional in $\mathbb{R}^2$.
Work in collaboration with David Ruiz (Universidad de Granada).

Some elliptic equation with indefinite nonlinearities

Francisco Odair de Paiva
Universidade Federal de São Carlos

We investigate some nonlinear elliptic equations of the form

$$-\Delta u = f(u) - h(x)|u|^{p-1}u$$

. in a bounded domain, where h a nonnegative bounded function, and $p > 1$. The nonlinearity f may exhibit either asymptotically linear or superlinar growth.

On the planar Taylor-Couette system and related exterior problems

Gianmarco Sperone, Filippo Gazzola, Jiří Neustupa
Pontificia Universidad Católica de Chile

We consider the planar Taylor-Couette system for the steady motion of a viscous incompressible fluid in the region between two concentric disks, the inner one being at rest and the outer one rotating with constant angular speed. We study the uniqueness and multiplicity of solutions to the forced system in different classes. For any angular velocity we prove that the classical Taylor-Couette flow is the unique smooth solution displaying rotational symmetry. Instead, we show that infinitely many solutions arise, even for arbitrarily small angular velocities, in a larger, class of incomplete solutions that we introduce. By prescribing the transversal flux, unique solvability of the Taylor-Couette system is recovered among rotationally invariant incomplete solutions. Finally, we study the behavior of these solutions as the radius of the outer disk goes to infinity, connecting our results with the celebrated Stokes paradox. This is a joint work with Filippo Gazzola (Politecnico di Milano) and Jiří Neustupa (Institute of Mathematics of the Czech Academy of Sciences).

Minimizers of constrained functionals involving a point interaction

Gustavo de Paula Ramos
Universidade de São Paulo

The presence of punctual impurities is often described by a formal operator of the form $-\Delta + \frac{1}{\alpha}\delta_0$, where $\alpha \in \mathbb{R} \setminus \{0\}$ and δ_0 denotes the Dirac delta. In this work, we consider the model for this kind of interaction furnished by the *Hamiltonian of point interaction*

$$H_\alpha : \mathrm{Dom}(H_\alpha) \to L^2(\mathbb{R}^3),$$

which is a differential operator defined with the goal of mimicking the action of $-\Delta+\frac{1}{\alpha}\delta_0$ on $C_c^\infty(\mathbb{R}^3)$, where $\mathrm{Dom}(H_\alpha)$ is a subspace of $L^2(\mathbb{R}^3)$. For more details about H_α, see [2].

Even though this model remounts to the work of Berezin & Faddeev in the 1960s, the study of nonlinear problems involving point interactions in dimensions 2 and 3 is a very recent topic of research. For instance, consider the nonlinear Schrödinger equation with a point interaction (δ-NLSE). Its well-posedness was established in [5], while the existence of ground states was obtained in [3,4].

The goal of our work in question is to propose conditions under which *nonlinear Schrödinger-type equations involving a point interaction* in $\mathbb{R}^3$ of the form

$$\mathrm{i}\partial_t\psi = H_\alpha\psi + \tau(\psi)$$

have ground states, where $\tau\colon \mathrm{Dom}(H_\alpha) \to L^2(\mathbb{R}^3)$ is a given nonlinearity (which is possibly nonlocal and could involve derivatives up to second order) and $0 < \alpha < \infty$. Stationary solutions to the aforementioned equation are naturally associated with critical points of an energy functional $I_\alpha\colon \mathcal{W} \to \mathbb{R}$ of the form

$$I_\alpha(u) := \frac{1}{2}E_\alpha(u) + T(u),$$

where $\mathcal{W}$ denotes the energy space associated with H_α, E_α denotes the expectation value of H_α (often called its *associated quadratic form*) and T is the nonlinear functional associated with the nonlinearity τ. As such, we are lead to consider the following abstract minimization problem under a mass constraint:

$$I_\alpha(u) = \inf_{\|v\|_{L^2}^2=\rho^2} I_\alpha(v); \quad \|u\|_{L^2}^2 = \rho^2.$$

Concretely, we propose a set of conditions on ρ, I_α and T under which we can ensure the existence of solutions to the aforementioned minimization problem. As applications, we prove the existence of ground states to the following nonlinear problems with a point interaction when ρ is sufficiently small: (i) a Kirchhoff-type equation; (ii) the Schrödinger–Poisson system and (iii) the Schrödinger–Bopp–Podolsky system.

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Asymptotics for eigenfunctions of $-\Delta$ in domains with small holes

Massimo Grossi, Laura Abatangelo
Sapienza Università di Roma

Let us consider the following eigenvalue problem in $\mathbb{R}^N$, $N \geq 2$,,

$$\begin{cases} -\Delta u_\epsilon = \lambda_\epsilon u_\epsilon & \text{in } \Omega_\epsilon = \Omega \setminus B(P,\epsilon), \\ u_\epsilon = 0 & \text{on } \partial\big(\Omega \setminus B(P,\epsilon)\big). \end{cases} \tag{7}$$

where $B(P,\epsilon)$ is the ball centered at $P \in \Omega$ and small radius ϵ. It is well known that the previous problem "converges as $\epsilon \to 0$" in a suitable sense to

$$\begin{cases} -\Delta u = \lambda u & \text{in } \Omega, \\ u = 0 & \text{on } \partial\Omega. \end{cases} \tag{8}$$

In this talk we want to give additional information on the convergence of the pair $(\lambda_\epsilon, u_\epsilon)$ to (λ, u) as $\epsilon \to 0$. In particular we try to give an answer to the following questions,

- If $u(P) \neq 0$ we have that u_ϵ does not converge uniformly to u near $\partial\Omega_\epsilon$. Is it possible to describe more precisely the behavior of u_ϵ near $\partial\Omega_\epsilon$?
- If λ is a multiple eigenvalue is it true that the eigenvalues λ_ϵ are simple (Uhlenbeck's property) for ϵ small?
- What about the nodal region of u_ϵ near $\partial B(P,\epsilon)$?

This is a joint paper with Laura Abatangelo (Politecnico di Milano, Italy).

Some properties of perturbed Duffing equations arising in models for the dynamics of suspension bridges

Maurizio Garrione, Filippo Gazzola, Emanuele Pastorino
Politecnico di Milano

We discuss a class of perturbed Duffing equations motivated by the investigation of unimodal and bimodal solutions of PDE systems describing the dynamics of suspension bridge-type structures. We deal with the boundedness of the solutions and with their long-time behavior, possibly in the presence of damping/forcing terms. To this end, we employ different techniques such as energy methods, estimates in the phase plane and topological arguments.

Elliptic equations in $\mathbb{R}^N$ involving Sobolev supercritical and upper Hardy-Littlewood-Sobolev critical exponents

Olimpio Hiroshi Miyagaki, Gustavo Ferron Madeira, Patrizia Pucci
Universidade Federal de São Carlos

This paper deals with the existence of nontrivial nonnegative solutions of model parametric elliptic equations in $\mathbb{R}^N$ involving a possibly supercritical term in Sobolev sense, and a nonlocal term with the

upper Hardy-Littlewood-Sobolev critical exponent. Under some conditions, we describe the precise parametric range of existence and nonexistence of a nonnegative solution. Furthermore, in a slightly smaller range, a second nontrivial nonnegative solution is constructed. Additionally, infinitely many solutions, with energy asymptotic behavior, are also obtained if the growth near the origin is concave. These results, which are inspired by the pioneering work of Alama and Tarantello (1996) in the local case of Dirichlet problems in bounded domains, are obtained by combining variational methods, Leray-Schauder degree theory, and the Krasnoselskii genus via biorthogonal functionals in separable and reflexive Banach spaces.

Curvature and geometric obstructions for phase transitions

Pedro Henrique Gaspar, Jingwen Chen

Pontificia Universidad Católica de Chile

The Allen-Cahn equation is a semilinear partial differential equation that serves as a mathematical model for the evolution of phase separation and pattern formation phenomena, and whose solutions display striking geometric features.

In this talk, we present new examples of domains that exhibit geometric obstructions to the existence of equilibrium solutions of this PDE in connection to the degenerate minimal hypersurfaces. We also discuss how these examples relate to a theorem by Frankel about minimal surfaces in spaces of nonnegative curvature and to an associated rigidity property.

This is joint work with Jingwen Chen (University of Pennsylvania)

The Fučík and Dirichlet spectra of the one-dimensional anisotropic p-Laplacian

Raul Fernandes Horta, Marcos Montenegro

UFMG

Let $a, b, L > 0$ and $p > 1$. We define the one-dimensional anisotropic p-Laplacian as

$$-\Delta_p^{a,b} u := \left(a^p[(u')^+]^{p-1} - b^p[(u')^-]^{p-1}\right)',$$

where $u^{\pm} = \max\{\pm u, 0\}$. To be more precise, we consider $-\Delta_p^{a,b} u$ for functions $u \in W_0^{1,p}(0, L)$ as a linear functional acting as follows

$$\langle -\Delta_p^{a,b} u, \varphi \rangle = \int_0^L (a^p[(u')^+]^{p-1} - b^p[(u')^-]^{p-1})\varphi'(t)\, dt$$

for every $\varphi \in W_0^{1,p}(0, L)$. When $a = b = 1$, this operator is the classical one-dimensional p-Laplacian and is denoted as $-\Delta_p$.

We consider the following boundary value problems

$$\begin{cases} -\Delta_p^{a,b} u = \lambda |u|^{p-2} u & \text{in} \quad (0, L), \\ u(0) = 0 = u(L) \end{cases} \tag{9}$$

and

$$\begin{cases} -\Delta_p^{a,b} u = \alpha |u|^{p-2} u^+ - \beta |u|^{p-2} u^- & \text{in} \quad (0, L), \\ u(0) = 0 = u(L), \end{cases} \tag{10}$$

where $\lambda, \alpha, \beta \in \mathbb{R}$ and $u^{\pm} = \max\{\pm u, 0\}$. Associated with (9) and (10) we have the Dirichlet and Fučík spectra, respectively:

$$\Lambda_p^{a,b}(0,L) := \{\lambda \in \mathbb{R} : \text{ (9) admits a nontrivial weak solution } u \in W_0^{1,p}(0,L)\},$$
$$\Sigma_p^{a,b}(0,L) := \{(\alpha,\beta) \in \mathbb{R}^2 : \text{ (10) admits a nontrivial weak solution } u \in W_0^{1,p}(0,L)\}.$$

For the classical p-Laplacian (i.e. $a = b = 1$) we denote $\Lambda_p^{1,1}(0,L) = \Lambda_p(0,L)$ and $\Sigma_p^{1,1}(0,L) = \Sigma_p(0,L)$

We study these problems, computing the eigenvalues of each and studying the behavior of the eigenfunctions of each spectrum. For instance, we prove generalized simplicity in the first Dirichlet eigenvalue. Also, we can relate both eigenvalues and eigenfunctions of the anisotropic problem to the classical one, e.g.

$$\Lambda_p^{a,b}(0,L) = \left(\frac{a+b}{2}\right)^p \Lambda_p(0,L) \qquad \Sigma_p^{a,b}(0,L) = \left(\frac{a+b}{2}\right)^p \Sigma_p(0,L).$$

Large conformal metrics with prescribed Gauss and geodesic curvatures.

Rayssa Caju, Tiarlos Cruz, Almir Silva Santos

Universidad de Chile

In this talk, our goal is to discuss the existence of at least two distinct conformal metrics with prescribed Gaussian curvature and geodesic curvature respectively, $K_g = f + \lambda$ and $k_g = h + \mu$, where f and h are nonpositive functions and λ and μ are positive constants. Utilizing Struwe's monotonicity trick, we investigate the blowup behavior of the solutions and establish a non-existence result for the limiting PDE, eliminating one of the potential blow-up profiles.

Symmetrization results for general nonlocal linear ellipitic and parabolic problems

Vincenzo Ferone,

Università di Napoli Federico II

We discuss a Talenti-type symmetrization result in the form of mass concentration (i.e. integral comparison) for very general linear nonlocal elliptic problems, equipped with homogeneous Dirichlet boundary conditions. In this framework, the relevant concentration comparison for the classical fractional Laplacian can be reviewed as a special case of our main result, thus generalizing previous results obtained in collaboration with B. Volzone. Also a Cauchy-Dirichlet nonlocal linear parabolic problem is considered. The results are contained in a joint paper with G. Piscitelli and B. Volzone.

Harmonic Analysis and Related Topics

Organizer: Guilherme da Silva (USP/Brazil), Tiago Picon (USP/Brazil)
& Charles Ferreira dos Santos (USP/Brazil)

Div-curl type decomposition for local BMO

Catarina Barbosa Machado, Tiago Henrique Picon
UFSCar

Coifman, Lions, Meyer & Semmes proved a decomposition of BMO($\mathbb{R}^n$) in terms of div-curl quantities, in the sense: for $g \in BMO(\mathbb{R}^n)$,

$$\|g\|_{BMO} \approx \sup_{V,W} \int_{\mathbb{R}^n} gV \cdot W, \tag{11}$$

where the supremum is taken over all vector fields $V, W \in L^2(\mathbb{R}^n, \mathbb{R}^n)$ such that $\|V\|_{L^2}, \|W\|_{L^2} \leq 1$, $div\, V = 0$ and $curl\, W = 0$, in the sense of distributions.

The goal of this work is to prove an analogue decomposition theorem for functions in $bmo(\mathbb{R}^n)$, the dual of the local Hardy space $h^1(\mathbb{R}^n)$, in terms of the $div_{\mathcal{L}^*} - curl_{\mathcal{L}}$ quantities. Now, given any $1 < p < \infty$ and $\mathcal{L}$ a system of complex vector fields with constant coefficients, each $g \in bmo(\mathbb{R}^n)$ can be obtained through the supremum of all vector fields $V \in L^p, W \in L^{p'}$ such that $\|V\|_{L^p}, \|W\|_{L^{p'}} \leq 1$, $div_{\mathcal{L}^*} = 0$ and $curl_{\mathcal{L}} W \in L^{p'}$, in the sense of distributions.

A classification of Fourier summation formulas

Guilherme Vedana
IMPA

A Fourier summation formula (FSF) is a pair (μ, a), where μ is a tempered measure on $\mathbb{R}$ and $a : \mathbb{R} \to \mathbb{C}$ is a function with countable support, and such that $\int_{\mathbb{R}} \widehat{\varphi}(t)dt = \sum_{n\geq 0} a(\lambda_n)\varphi(\lambda_n)$. Here $\{\lambda_n; n \geq 0\} = \{x \in \mathbb{R}; a(x) \neq 0\}$ is any enumeration of the support of a.

In this talk we present a classification of the FSFs (μ, a) for which the measure μ has polynomial growth, i.e., $\int_{\mathbb{R}}(1 + t^2)^{-k}dt < \infty$, for some integer k. We prove that any such pair can be uniquely associated to a holomorphic and almost periodic function $F(z)$ in $\mathbb{C}^+$ and conversely, i.e., to any such function it is possible to generate a FSF (μ, a).

Hilbert space embeddings of independece tests with radial functions

Jean Guella
UEMS

The aim of this talk is to present several classes of continuous radial basis functions that can be employed to determine whether a interaction of a probability is zero or not and are a broader generalization of the Hilbert Schmidt independence Criteriun and distance covariance, which are popular methods for independence tests in machine learning and statistics.

Boundedness of inhomogeneous Calderón-Zygmund operators on local Hardy spaces over spaces of homogeneous type

Joel Coacalle, Tiago Picon, Claudio Vasconcelos
Universidade de São Paulo

In this talk, we present sufficient conditions for the boundedness of inhomogeneous Calderón-Zygmund type operators on local Hardy spaces associated to spaces of homogeneous type in the sense of Coifman & Weiss for $0 < p \leq 1$. A new approach to atoms and molecules for local Hardy spaces in this setting is introduced with special cancellation conditions.

Approximations on the unit circle

Luana L. Silva Ribeiro, A. Sri Ranga
Universidade Federal de Itajubá - campus Itabira

The aim of this talk is consider approximations of functions defined on the unit circle by Laurent polynomials. The approximants are given in terms of special Christoffel-Darboux kernels of orthogonal polynomials on the unit circle. We present a Bessel-type inequality and some conditions for norm and pointwise convergence. Joint work with A. Sri Ranga.

Extending homeomorphisms of the real line to the upper half plane

Lucas Oliveira, José Afonso Barrionuevo, Felipe Gonçalves, José Victor Medeiros
Universidade Federal do Rio Grande do Sul

Consider the following question: is it possible to extend a quasisymmetric homeomorphism of the real line to a quasiconformal homeomorphism of upper-half plane such that the extension of a composition it is the composition of the extensions?

Answer to this question is already known in this precise situation, but there are cases where these problems still need an answer (positive or negative). In this talk I would like to present the result of recent collaborations that provides some advance in the specific case of BiLipschitz homeomorphisms.

Spectrum of elliptic differential operators with constant coefficients in dimension n on real scales of localized Sobolev spaces

Luís M. Salge, Tiago H. Picon
Universidade do Estado do Rio de Janeiro

In this work, we extended the study of spectrum started in [4] for elliptic homogeneous differential operatators with constant coefficients to the n dimensional case in the real scale of localized Sobolev Spaces. This is quite different from what we find in the literature, where all the relevant results are concerned with spectrum on Banach spaces.

Our aim is to understand the behavior of the spectrum using the closure of the operator. In particular we show that there is no complex number in the resolvent set of such operators, which suggest a new way to define spectrum if we want to reproduce the classical theorems of the Spectral Theory in Fréchet spaces.

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Adams' trace principle in Morrey spaces

Marcelo F. Almeida, Lima, L.S.M.

Universidade Federal de Sergipe

In this presentation, we discuss the renowned trace principle introduced by Adams and explore the challenges involved in extending this principle to Morrey spaces. We also highlight some applications of this principle. If time permits, additionally, through a careful analysis of the non-doubling Calderón-Zygmund decomposition, we establish an appropriate "good$-\lambda$" for all non-doubling measure. This inequality was crucial for demonstrating the equivalence between the fractional maximal function and the Riesz potential in the sense of trace.

Minimal invariant subspaces for Toeplitz operators

Marcos dos Santos Ferreira, João Marcos Ribeiro do Carmo

Universidade Estadual de Santa Cruz

The *Invariant Subspace Problem* (ISP) for Hilbert spaces asks if every bounded linear operator has a non-trivial closed invariant subspace. Due to the existence of universal operators (in the sense of Rota) the ISP can be solved by proving that every minimal invariant subspace of a universal operator is one dimensional. In this talk, we present sufficient conditions for the ISP to be true via Toeplitz operators on the Hardy space over the bidisk.

The Pólya-Tchebotarev problem with semiclassical external fields

Victor Alves, Guilherme L. F. Silva

Universidade de São Paulo

Given a collection of points $C = \{c_1, \ldots, c_n\} \subset \boldsymbol{C}$ and a function $\phi : \boldsymbol{C} \to \overline{\boldsymbol{R}}$, the *Weighted Pólya-Tchebotarev continuum problem* consists in finding a connected compact K_0 that maximizes the *weighted logarithmic energy functional*

$$\mathrm{I}^{\phi}(K) = \min_{\substack{\mu(K)=1 \\ \phi \in \mathcal{L}^1(\mu|_K)}} \left[\iint_{K^2} \log|x-y| \, \mathrm{d}\mu(x) \, \mathrm{d}\mu(y) + 2 \int_K \phi(x) \, \mathrm{d}\mu(x) \right],$$

over all possible K that contains C.

Stahl [1, 2] showed that the problem of determining K_0 is equivalent to finding the assymptotic regime of the sequence of zero counting measures of the denominators of a Padé Approximation problem, that is intimately connected with the theory of Orthogonal Polynomials. Following his ideas, Gonchar and Rakhmanov [3] related the solution for $\phi = \Re\Phi$ with the convergence of the zeroes of orthogonal polynomials with varying orthogonality weights.

We present a solution for a generalized weighted Pólya-Tchebotarev problem under a semiclassical external field, i.e., $\phi = \Re\Phi$ where Φ' is a rational function.

The characterization of solutions is given by a systematic study of critical measures, measures that are saddle points of the energy functional. We extend the theory developed by [4, 5] to encompass semiclassical external fields.

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Dynamical Systems via Ordinary Differential Equations

Organizer: Alex Carlucci Rezende (UFSCar/Brazil) & Tiago Carvalho (USP/Brazil)

Analysis of the period function in a class of planar piecewise Hamiltonian systems

Alex Carlucci Rezende, Mirianne Andresa Silva Santos, Joan Torregrosa
UFSCar

This study examines the monotonicity and critical periods of the period function associated with a family of planar piecewise continuous potential systems. We provide a detailed bifurcation diagram for the period function, delineating parameter regions where it increases or decreases monotonically and where it possesses at most one simple critical period. The core analysis leverages the decomposition of the period function into two components corresponding to the uncoupled planar Hamiltonian systems joined along the separation line.

Puiseux inverse integrating factors and Puiseux first integrals at monodromic singularities

Ana Livia Rodero, Isaac A. García, Jaume Giné
Universidade de São Paulo - ICMC

The main goal of this talk is to show that neither the existence of a Puiseux first integral H nor the existence of a Puiseux inverse integrating factor V are able to characterize degenerate centers in planar vector fields with a monodromic singularity. We also show that the existence of a Puiseux first integral H is a sufficient center condition. These results are part of [1], a work in collaboration with Prof. Isaac A. García and Prof. Jaume Giné, from Universitat de Lleida (UdL/Spain).

This study was financed, in part, by the São Paulo Research Foundation (FAPESP), Brasil, process numbers 2021/12630-5 and 2023/05686-0; by the Agencia Estatal de Investigación grant number PID2020-113758GB-I00; and by the Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR) grant number 2021SGR 01618.

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Multi-dimensional piecewise contractions are asymptotically periodic

Benito Pires
Universidade de São Paulo

Piecewise contractions (PCs) are piecewise smooth maps that decrease distance between pairs of points in the same domain of continuity. The dynamics of a variety of systems is described by PCs. During the last decade, a lot of effort has been devoted to proving that in parametrized families of one-dimensional PCs, the limit set of a typical PC consists of finitely many periodic orbits while there exist atypical PCS with Cantor limit sets. In this talk, we will discuss how to extend the one-dimensional results to the multi-dimensional case. We will also introduce the notion of multiplicity entropy in the framework of piecewise smooth maps. Joint work with José Pedro Gaivão (Universidade de Lisboa).

On the limit cycles of piecewise hybrid Hamiltonian linear systems separated by a line or a circle

Camila Ap. B. Rodrigues de Lima, Jaume Llibre
Universidade Federal de Santa Catarina (UFSC)

In this work we study a class of hybrid differential systems formed by two linear Hamiltonian systems separated by the y-axis or the circle $\mathbb{S}^1$. We investigate an upper bound for the maximum number of limit cycles that these differential systems can exhibit.

Persistent Limit Cycles from Periodic Annuli in Piecewise Hamiltonian Linear Differential Systems with Three-Zone

Claudio Pessoa, Denis Braga, Alexander Fonseca, Luis Fernando Mello, Ronisio Ribeiro
IBILCE/UNESP

The main issue studied in this work is the number of limit cycles that simultaneously bifurcate of three periodic annuli in piecewise Hamiltonian linear differential systems with three zones. More precisely, we use the expressions of the Melnikov functions associated with the differential system to estimate the number of limit cycles that simultaneously bifurcate of the periodic annuli under suitable linear perturbations. We present a concrete example of a piecewise quasi-Hamiltonian linear differential system in which the lower bound for the number of limit cycles that bifurcate of the periodic annuli is reached.

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Detecting and counting isolated invariant tori

Douglas Duarte Novaes
Universidade Estadual de Campinas

Invariant compact manifolds, such as equilibria, periodic orbits, and invariant tori, provide important information about the dynamics of differential systems. This knowledge is significantly increased when we can describe the behavior of nearby trajectories. In this talk, we present conditions that ensure the existence of invariant tori in perturbed differential systems, along with results on their regularity,

stability, and dynamics. These conditions are based on higher-order averaged equations and extend classical theorems by Krylov, Bogoliubov, Mitropolsky, and Hale. We also explore a three-dimensional version of Hilbert's 16th Problem, focusing on the number of isolated invariant tori in 3D polynomial vector fields. For a given degree m, we define $N(m)$ as the upper bound for the number of isolated invariant tori of 3D polynomial vector fields of degree m and provide a result that relates the number of normally hyperbolic invariant tori in 3D polynomial systems to the number of hyperbolic limit cycles in planar systems. This leads to a lower bound for $N(m)$, showing that it grows as fast as $m^3/128$.

Codimension one piecewise smooth vector fields in 3D

Durval Jose Tonon, Marco Antonio Teixeira , Rodrigo Euzebio
Universidade Federal de Goias

This presentation addresses openness, density and structural stability conditions of one-parameter families of 3D piecewise smooth vector fields (PSVF) defined around typical singularities. Our treatment is local and the switching set, M, is a $2D$ surface embedded in $\mathbb{R}^3$. In short, we analyze the robustness and normal forms of certain codimension one singularities that occur in PSVF. The main machinery used in this paper involves the theory of contact between a vector field and M, Bifurcation Theory and the Topology of Manifolds. Our main result states robust mathematical statements resembling the classical Kupka-Smale Theorem in the sense that we establish the openness and density of a large class of PSVF presenting generic and quasi-generic singularities.

As an application, we present results involving PSVF that are a combination of linear and quadratic vector fields. Due to the lack of uniqueness of certain solutions associated with PSVF, we employ Filippov's theory as the basis of our approach throughout the paper.

Early detection of unstable car-and-driver motion

Fabio Della Rossa, Samuele Giacintucci, Gianpiero Mastinu
Politecnico di Milano

A comprehensive mathematical description and classification of unstable motions of road vehicle and driver is currently lacking, despite more than one billion vehicles run on roads all around the globe. The loss of vehicle stability stands out as one of the primary causes of road accidents, with over one million road fatalities being recorded yearly in the world according to World Health Organization. In this talk, we tackle this problem with the aim of distinguishing stable versus unstable trajectories as early as possible, after a disturbance has acted. First, a simple car-and-driver model is introduced to simulate the response of the system to severe perturbations, e.g. wind gusts or evasive maneuvers. We then show that the motion of the system is influenced by the existence of an unstable limit cycle, generated from a Hopf bifurcation that occurs at relatively high vehicle forward velocity. Resorting to bifurcation theory, we demonstrate that the unstable limit cycle is saddle-type with an $N-1$-dimensional stable manifold, being N the dimension of the system. Such stable manifold divides the phase space into two regions, delimiting the stability region of the vehicle. Initial states outside this region cause an uncontrolled motion. By exploiting the properties of the manifolds and by resorting to Floquet theory, we finally derive a *Degree of Stability (DoS) criterion* valid for motions close to the saddle limit cycle. The criterion serves as a strategy to promptly detect unstable car-and-driver motion in real time during a maneuver, also offering a quantitative indication of the severity of the instability. Two examples show that the DoS criterion can distinguish between a controlled and an uncontrolled maneuver when the corresponding trajectories are still almost equivalent.

A new formula for limit cycle detection in some families of planar multi-parametric differential systems

Jackson Itikawa, Regilene Oliveira, Joan Torregrosa
Universidade Federal de São João del-Rei

We introduce a closed-form expression for the first-order Taylor expansion of the first Melnikov function to investigate the emergence of limit cycles in multi-parametric differential vector fields with center-type singularities. In some cases, this approach may allow for the determination of a greater number of limit cycles through first-order computations, effectively circumventing challenges associated with higher-order analyses.

Study of Limit Cycle on non-Smooth Welander's Ocean Convenction Model

Luiz Fernando da Silva Gouveia, Yagor Romano Carvalho, Richard McGehee
Unicamp

Our focus in this work is to study the non-smooth Welander's model that describes ocean convection. Using the Poincaré Map, we demonstrate analytically the bifurcation of an unic stable limit cycle surrounding an escaping segment. This work is joint with Yagor Romano Carvalho (ICMC - USP) and Richard McGehee (University of Minnesota).

Luiz F.S. Gouveia was supported by São Paulo Paulo Research Foundation (FAPESP) grants number 490 2022/03801-3, 2020/04717-0. Yagor Romano Carvalho was supported by São Paulo Paulo Research Foundation (FAPESP) grants number 2022/03800-7, 2021/14695-7.

Emergence and Control of Synchronization in Network with Directed Many-Body Interactions

Pietro De Lellis, Fabio Della Rossa, Francesco Lo Iudice, Davide Liuzza
University of Naples Federico II

The spontaneous or induced emergence of collective behaviors in networks of coupled dynamical units has been extensively studied under the assumption of pairwise, directed interactions, and has been explained as the effect of diffusive coupling protocols. In the presence of many-body interactions over hypergraphs, what are the diffusive-like mechanisms that lead to the emergence of a synchronized behavior? In this talk, we introduce a diffusion protocol over hypergraphs that is Inspired by actuation and measurement constraints typical of physical and engineered systems. Using a fundamental association between directed hypergraphs and a special class of signed graphs, we can explain the onset of synchronization in the presence of higher-order interactions. Namely, we derive both local and global condition for convergence to synchronization that can aid control design.

Topological equivalence at infinity of second order planar vector fields and its upper principal part

Regilene Oliveira
ICMC-USP, São Carlos

Let X be a planar polynomial vector field with a fixed Newton polytope Γ. Recently, in Dalbelo-Oliveira-Perez(2024), it was proved that the monomials associated to the upper boundary of Γ satisfying some non-degeneracy conditions determine, under topological equivalence, the phase portrait of X in a neighbourhood of the boundary of the Poincaré–Lyapunov disc.

In the present talk we show that there exist vector fields of chief interest which do not satisfy such non-degeneracy conditions but still their phase portraits are determined by the monomials associated to the upper boundary of Γ in the Newton polytope of X. This is the case of the second order vector fields of the form

$$x' = y, \quad y' = -\sum_{j=0}^{m} g_j x^j - \sum_{i=0}^{n} f_i y^i - y \sum_{l=0}^{k} h_l x^l \tag{12}$$

with m, n, k integers, g_j, f_i, h_l real numbers for $j = 0, \ldots, m$, $i = 0, \ldots, n$, $l = 0, \ldots, k$ and $g_m \neq 0$.

Such a result can be seen as a version of Brunella&Miari (1990) for the dynamics at infinity. Moreover, using such results we are able to completely classify the dynamics near the infinity of systems (12).

This is a joint work with Claudia Valls (IST-Lisboa, Portugal).

ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS 2025 CHAPTER

Poster Section

Poster

Organizer: Everaldo de Mello Bonotto

Shadowing Properties on Hilbert Spaces

Carlos Roberto Takaessu Jr, Alexandre Nolasco de Carvalho, José María Arrieta
Universidade de São Paulo - ICMC

It is known that Morse-Smale dynamical systems defined on a compact manifold (without border) have the Lipschitz Shadowing property. We will show that some of this properties (Shadowing, Holder-Shadowing, Lipschitz Shadowing) also holds for Morse-Smale semigroups defined on infinite dimensional Hilbert spaces, that is, the Lispchitz Shadowing property holds on the global attractor $\mathcal{A}$ and the Hölder Shadowing property holds on a neighborhood of $\mathcal{A}$. This results can be applied to estimate the Hausdorff semidistance of global attractors.

Acknowledgements: We would like to thanks CAPES (DO-11169228) and FAPESP (2020/14353-6 and 2022/02172-2) by financial support.

Non-autonomous semilinear parabolic equations with nonlinear Neumann boundary conditions and time-varying domains

Daniel Morales, Gleiciane da Silva Aragão
Universidade de São Paulo - IME USP

Let $\Omega \subset \mathbb{R}^n$, $n \geq 2$, be a nonempty bounded open set with C^2 boundary $\partial\Omega$. We consider the function $r : \mathbb{R} \times \overline{\Omega} \to \mathbb{R}^n$ such that $r \in C^1(\mathbb{R} \times \overline{\Omega}, \mathbb{R}^n)$ and $r(t, \cdot) : \overline{\Omega} \to \overline{\Omega}_t$ is a C^2-diffeomorphism, for all $t \in \mathbb{R}$, with $\Omega_t = r(t, \Omega)$. We define

$$Q_\tau = \bigcup_{t\in(\tau,+\infty)} \{t\} \times \Omega_t \quad \text{and} \quad \Sigma_\tau = \bigcup_{t\in(\tau,+\infty)} \{t\} \times \partial\Omega_t, \quad \text{for all } \tau \in \mathbb{R}.$$

We are interested in studying the following non-autonomous semilinear parabolic problem with nonlinear Neumann boundary conditions

$$\begin{cases} \dfrac{\partial u}{\partial t}(t,x) - \Delta u(t,x) + \beta u(t,x) = f(t,u), & (t,x) \in Q_\tau \\ \dfrac{\partial u}{\partial n_t}(t,x) = g(t,u), & (t,x) \in \Sigma_\tau \\ u(\tau,x) = u_\tau(x), & x \in \Omega_\tau \end{cases} \tag{13}$$

where $\beta > 0$, $n_t(x)$ is the unit outward normal vector at $x \in \partial\Omega_t$, $u_\tau : \Omega_\tau \to \mathbb{R}$ and $f, g : \mathbb{R}^2 \to \mathbb{R}$ are nonlinear functions satisfying certain conditions.

Initially, we apply a coordinate transformation technique of [2] to rewrite the original problem (13) as an auxiliary non-autonomous problem on the fixed domain Ω. So we show the existence and uniqueness of solutions to this problem and then we prove the existence of pullback attractors. Therefore, this work extends the results obtained in [1] to the case of nonlinear Neumann boundary

conditions.

[1] G. S. Aragão, F. D. M. Bezerra and L. G. Mendonça, Pullback dynamics for a semilinear parabolic equation with homogeneous Neumann boundary conditions and time-varying domains, Submitted for publication (2024).

[2] P. Kloeden, J. Real and C. Sun, Pullback attractors for a semilinear heat equation on time-varying domains, Journal of Differential Equations **246** (12) (2009), 4702–4730.

Global solutions by logistic law on two-dimensional Keller-Segel-Navier-Stokes of potential type

Daniel Moraes Barbosa, Gabriela Planas, Francisco Guillén-Gonzalez
UNICAMP

The present work deals with a Keller-Segel-Navier-Stokes system with potential consumption and production, under homogeneous boundary conditions of Neumann type for both the cell density, n, an attracting chemical signal c and an repulsive chemical signal v and of Dirichlet type for the velocity field u, over a bounded two-dimensional domain. In this work we investigate the effect of a generalized logistic law of degradation type and global solutions for the system

$$\begin{cases} n_t + u \cdot \nabla n - \Delta n = -\chi \nabla \cdot (n \nabla c) + \xi \nabla \cdot (n \nabla v) + kn - \mu n^{\beta} \\ c_t + u \cdot \nabla c - \Delta c = -n^s c, \\ v_t + u \cdot \nabla v - \Delta v = n^r - v, \\ u_t + u \cdot \nabla u - \Delta u = -\nabla P - n \nabla \Phi, \\ \nabla \cdot u = 0, \\ \partial_v n = \partial_v c = \partial_v v = u = 0, \quad n(0) = n_0, \quad c(0) = c_0, \quad v(0) = v_0, \quad u(0) = u_0. \end{cases} \tag{14}$$

Restraints on the degradation rate and support capacity for global solutions of the system are dependent on the rate of production and consumption, and this relationship is explored. Overall we extend the already existing existence results for the case $s = r = 1$.

Joint work with Gabriela Planas (Universidade Estadual de Campinas) and Francisco Guillén-Gonzalez (Universidad de Sevilla)

[1] Corrêa Vianna Filho, A. & Guillén-González, F. Uniform in time solutions for a chemotaxis with potential consumption model. Nonlinear Analysis: Real World Applications. **70** pp. 103795 (2023,4).

[2] Winkler, M. Does repulsion-type directional preference in chemotactic migration continue to regularize Keller–Segel systems when coupled to the Navier–Stokes equations? Nonlinear Differential Equations And Applications NoDEA. **26** (2019,10).

[3] Ren, G. & Liu, B. A new result for global solvability to a two-dimensional attraction-repulsion Navier-Stokes system with consumption of chemoattractant. Journal Of Differential Equations. **336** pp. 126-166 (2022,11).

Positive solutions for a Kirchhoff-type problem with critical growth

Eduardo Dias Lima, Edcarlos Domingos da Silva , José Carlos de Oliveira Júnior
Universidade Federal de São Carlos

In the present work we establish the existence and multiplicity of positive solutions for a critical elliptic problem in $\mathbb{R}^N$. More specifically, we consider the following elliptic problem:

$$\begin{cases} -m\left(\|\nabla u\|_2^2\right)\Delta u + V(x)u = \lambda f(x)|u|^{q-2}u - \theta|u|^{2^*-2}u \text{ in } \mathbb{R}^N, \\ u \in H^1(\mathbb{R}^N), \end{cases} \tag{15}$$

where $\lambda, \theta > 0$, $N \geq 3$, $2 < q < 2(\sigma+1) < 2^* := \frac{2N}{N-2}$ and $m(t) = \alpha_1 + \alpha_2 t^\sigma$ for all $t \in \mathbb{R}^+$ with $\alpha_1, \alpha_2 > 0$ and $0 < \sigma < \frac{2}{N-2}$. The function $f : \mathbb{R}^N \to \mathbb{R}$ satisfies $f \in L^{\frac{2^*}{2^*-q}}(\mathbb{R}^N) \cap L^\infty_{\text{loc}}(\mathbb{R}^N)$ with $f(x) > 0$ almost everywhere in $\mathbb{R}^N$. The main feature here is to treat a Kirchhoff-type elliptic problem where the nonlinearity is critical and defines a sign-changing function. Our approach relies on the minimization method applied to the Nehari method together with the nonlinear Rayleigh quotient method. Here, we use the fibering map associated with the energy functional which exhibits degenerate points under suitable values on the two parameters within the nonlinearity. This difficulty does not allow us to apply the Lagrange Multipliers Theorem in general. Our main contribution relies on restoring the strong convergence and compactness results. Furthermore, we establish nonexistence results under specific assumptions on the nonlinear term by using a Pohozaev identity.

An energy formula for fully nonlinear degenerate parabolic equations in one spatial dimension

Ester Beatriz, Phillipo Lappicy
Universidade de São Paulo - ICMC

Energy (or Lyapunov) functions are used to prove stability of equilibria, or to indicate a gradient-like structure of a dynamical system. Matano constructed a Lyapunov function for quasilinear non-degenerate parabolic equations. We modify Matano's method to construct an energy formula for fully nonlinear degenerate parabolic equations. We provide several examples of formulae, and in particular, a new energy candidate for the porous medium equation.

Crystalline Measures

Henrique Sotel Pio
Universidade Federal do Rio Grande do Sul

A study on crystalline measures and on quasicrystals. How this relates to the Poisson summation formula. Some results involving the Fourier transform of distributions and examples. Finally, a result on the existence of odd crystalline measuresμ on $\mathbb{R}$ where every finite subset is linearly independent over $\mathbb{Q}$, and every subset in the spectrum is linearly independent over $\mathbb{Q}$ of an article by Yves F. Meyer.

Differential process on time-dependent normed spaces

Heraclio López Lázaro, Alexandre Nolasco de Carvalho, Tomas Caraballo, Arthur Cavalcante Cunha
Universidade de São Paulo

We introduce the concept of uniformly differentiable evolution processes for dynamical systems on families of time-dependent phase spaces. Under certain sufficient conditions (based on the smoothing property) on the evolution process, this will help us to estimate the fractal dimension of pullback attractors associated with non-cylindrical problems in partial differential equations. As a partial application of these results, we will analyze non-cylindrical problems for two-dimensional Navier-Stokes equations.

Schrödinger-Bopp-Podolsky system: existence and asymptotic behavior of the solutions

Heydy Melchora Santos Damian, Gaetano Siciliano
Universidade de São Paulo

We consider the following Schrödinger-Bopp-Podolsky system with critical and sublinear terms

$$\begin{cases} -\Delta u + u + Q(x)\phi u = |u|^4 u + \lambda K(x)|u|^{p-1}u \quad \text{in} \quad \mathbb{R}^3 \\ -\Delta \phi + a^2\Delta^2\phi = 4\pi Q(x)u^2, \quad \text{in} \quad \mathbb{R}^3 \end{cases}$$

Here $u, \phi : \mathbb{R}^3 \to \mathbb{R}$ are the unknowns, Q and K are given functions satisfying assumptions, $a, \lambda > 0$ are parameters and $p \in (0, 1)$. We show existence of infinitely many negative energy solutions, including the ground state, when the parameter λ is small. Then we give general results concerning the structure of the set solutions. We show also behavior of the solutions as the parameters a, λ tend to zero. In particular the ground states solutions tends to ground state solution of the Schrödinger-Poisson system as a tends to zero.

Asymptotic behaviour for discontinuous dynamical systems

Iguer Luis Domini dos Santos
Universidade Estadual Paulista

We study the asymptotic behavior of discontinuous dynamical systems determined by discontinuous differential equations. So, in analogy with results for continuous ordinary differential equations, we use nonsmooth Lyapunov functions to study the decay rate and stability of solutions of discontinuous differential equations.

Global existence and blow-up of solution for a heat equation with nonlocal interaction

Jian Zhang
University of Brasilia

We consider a nonlocal parabolic equation

$$u_t - \Delta u = \left(\int_\Omega \frac{|u(y,t)|^{2^*_\mu}}{|x-y|^\mu} dy \right) |u|^{2^*_\mu - 2} u, \text{ in } \Omega \times (0, \infty),$$

where Ω is a bounded domain in $\mathbb{R}^N$, $N \geq 3$, $0 < \mu < N$ and $2^*_\mu = (2N - \mu)/(N - 2)$ denotes the critical exponent in the sense of the Hardy-Littlewood-Sobolev inequality. We investigate the global asymptotic behavior of the solutions. More precisely, we discuss the existence of the global solution and blow-up in finite time. In particular, the blow-up in infinite time is shown, i.e. $\lim_{t\to\infty} \|u(t)\|_\infty = +\infty$. In addition, we prove that the global solutions have a L^∞-uniform bound under suitable conditions.

Renormalized solutions for quasilinear elliptic equations with Robin boundary conditions, lower-order terms, and L^1 data

Juan Pablo Alcon Apaza, Manassés de Souza
Universidade Federal de São Carlos

In this paper, we establish the existence of a solution for a class of quasilinear equations characterized by the prototype:

$$\begin{cases} -\operatorname{div}\left(\vartheta_\alpha |\nabla u|^{p-2}\nabla u\right) + \vartheta_\gamma b|\nabla u|^{p-1} + \vartheta_\gamma c|u|^{r-1}u = f\vartheta_\alpha & \text{in } \Omega, \\ \vartheta_\alpha |\nabla u|^{p-2}\nabla u \cdot \nu + \vartheta_\beta |u|^{p-2}u = g\vartheta_\beta & \text{on } \partial\Omega. \end{cases}$$

Here, Ω is an open subset of $\mathbb{R}^N$ with a Lipschitz boundary, where $N \geq 2$ and $1 < p < N$. We define $\vartheta_a(x) = (1 + |x|)^a$ for $a \in (-N, (p-1)N)$, and the constants α, β, γ, r satisfy suitable conditions. Additionally, f and g are measurable functions, while b and c belong to a Lorentz space. Our approach also allows us to establish stability results for renormalized solutions.

Behavior of the number of Crossing Limit Cycles in Planar Piecewise Polynomial Vector Fields

Luana Ascoli
Unicamp

For planar polynomial vector fields, Christopher & Lloyd showed, using a polynomial perturbations sequence of a particular Hamiltonian center and a coordinate transformation which quadruple the number of limit cycles at each iteration, that the Hilbert Number $H(n)$ (the maximum number of limit cycles of a planar polynomial vector field of degree n) grows at least as fast as $n^2 \log(n)$.

In the context of piecewise polynomial planar vector fields, $H_c(n)$ denotes the maximum number of crossing limit cycles for piecewise polynomial planar vector fields of degree n. Only very recently was demonstrated the finiteness of $H_c(1)$ by Carmona et al., and the best known general lower bound for $H_c(n)$ is $2n - 1$ as established by Buzzi, Lima & Torregrossa. Building on the approach of Christopher & Lloyd, we aim to extend the analysis to study the asymptotic growth of $H_c(n)$.

Global stability of the Lengyel-Epstein systems

Lucas Queiroz Arakaki, Luís Fernando Mello, Ronísio Moisés Ribeiro
Unicamp

We study the global (asymptotic) stability of the Lengyel-Epstein differential systems, sometimes called Belousov-Zhabotinsky differential systems. Such systems are topologically equivalent to a two-parameter family of cubic systems in the plane. We show that for each pair of admissible parameters the unique equilibrium point of the corresponding system is not globally (asymptotically) stable. On the other hand, we provide explicit conditions for this unique equilibrium point to be asymptotically

stable and we study its basin of attraction. We also study the generic and degenerate Hopf bifurcations and highlight a subset of the set of admissible parameters for which the phase portraits of the systems have two limit cycles.

Dolph-Hammerstein results for fully-nonlinear operators

Maria Luísa Pasinato, Boyan Sirakov

PUC-Rio

We present criteria for the unique solvability of the Dirichlet problem for Nemitskii perturbations of a class of fully nonlinear operators. To circumvent the unavailability of the usual spectral description of the assumptions on the perturbation function, we resort to the principal half-eigenvalues described by Quaas and Sirakov (2008). We establish that, for convex positively 1-homogenous operators $F(D^2u, Du, u, x)$, the perturbed Dirichlet problem $F(D^2u, Du, u, x) + f(u) = g, \quad u|_{\partial\Omega} = 0$ is uniquely solvable as long as the derivative of the lipschitz perturbation f does not interact with either half-eigenvalue and is not much bigger than either of them.

Global Hypoellipticity for Perturbations of Complex Vector Fields on the Three-Torus

Maria Verônica Bartmeyer

Universidade Estadual de Maringá

The aim of this work is to analyze the size of the set of globally hypoelliptic perturbations of complex vector fields on the three-torus. This study presents conditions on the coefficients so that the set is a meager subset of the real line, and other conditions under which the set is a dense G-delta of the complex plane.

[1] A.P. Bergamasco, Perturbtions of Globally Hypoelliptic Operators, Journal of Differential Equations. 144, 513-526 (1994).

[2] S.J. Greenfield, N.R. Wallach, Global hypoellipticity and Liouville numbers, Proceedings of the American Mathematical Society. 31, 112-114 (1972).

Gradient-type nonhomogeneous fractional plate equations with critical exponent

Masterson Falcão de Morais Costa, Bruno de Andrade, Claudio Cuevas

Universidade Federal de Pernambuco

In this presentation, we are concerned with existence, uniqueness, regularity, and dependence upon the initial data for ϵ-regular mild solutions to the problem in time of an equation of fractional plate equations with critical exponent in the H_0^1-setting. We also analyze the continuation of this solution up to a maximal time of existence and a blow-up alternative.

Functional calculus associated with problems with dynamic boundary conditions

Muriel Andreane Dalcy, Prof. Dr. Rafael Fernando Barostichi, Prof. Dr. Pedro Tavares Paes Lopes
Universidade Federal de São Carlos

This work aims to study the holomorphic functional calculus associated with the problem

$$\begin{aligned}
&\frac{\partial u}{\partial t} = \operatorname{div}(a_\Omega \cdot \operatorname{grad}(u)) + b_\Omega \cdot \operatorname{grad}(u) + c_\Omega u + f(u), && t > 0, x \in \Omega,\\
&\frac{\partial u}{\partial t} = \operatorname{div}_\Gamma(a_\Gamma \cdot \operatorname{grad}_\Gamma(u)) + b_\Gamma \cdot \operatorname{grad}_\Gamma(u) - a_\Omega \cdot \operatorname{grad}(u) \cdot \nu + c_\Gamma u + g(u), && t > 0, x \in \partial\Omega,\\
&u = u_0, && t = 0, x \in \overline{\Omega},
\end{aligned}$$

where $\Omega \subset \mathbb{R}^n$ is a bounded and connected open set with C^∞ boundary $\Gamma = \partial\Omega$. Our main goal is to show that the sectorial operator associated with the above problem has a bounded H_∞ functional calculus and, for this purpose, we will utilize tools from the Boutet de Monvel calculus, as well as concepts from Functional Analysis.

A note on Hilbert 16th Problem

Paulo Santana, Armengol Gasull
UNESP - São José do Rio Preto

Let $\mathcal{H}(n)$ be the maximum number of limit cycles that a planar polynomial vector field of degree n can have. This presentation we prove that $\mathcal{H}(n)$ is realizable by structurally stable vector fields with only hyperbolic limit cycles and that it is a strictly increasing function whenever it is finite. Coauthored with Armengol Gasull.

Crossing limit cycles of discontinuous piecewise differential systems formed by linear and cubic isochronous centers separated by a circle

Pedro Iván Suárez Navarro
Instituto Nacional de Matemática Pura e Aplicada

In this work, we study the extension of the 16th Hilbert problem for discontinuous planar piecewise differential systems formed by a linear and an isochronous cubic center separated by a circle. We provide a sharp upper bound for the maximum number of crossing limit cycles that these classes of discontinuous piecewise differential systems can exhibit.

Existence of blow-up for the generalized quasi-geostrophic equations in the hyperbolic saddle scenario

Ricardo M. Guimarães, Lucas C. Ferreira
UNICAMP

We analyze finite-time blowup scenarios of locally self-similar type for the inviscid generalized surface quasi-geostrophic equation (gSQG) in $\mathbb{R}^2$, given by

$$\begin{cases} \theta_t + u \cdot \nabla\theta = 0, & x \in \mathbb{R}^2,\ t > 0,\\ u = -\nabla^\perp(-\Delta)^{-1+\frac{\beta}{2}}\theta, & x \in \mathbb{R}^2,\ t > 0, \end{cases} \tag{16}$$

where $\beta \in (0,2)$ is a fixed parameter, $\theta = \theta(x,t)$ is an unknown scalar function, the operator $(-\Delta)^{-s/2}$, $0 < s < 2$, is the Riesz potential, and $u = u(x,t)$ denotes a velocity field given by

$$u(x,t) = C_\beta P.V. \int_{\mathbb{R}^2} K_\beta(x-y)\theta(y,t)dy, \quad x \in \mathbb{R}^2, \tag{17}$$

where

$$K_\beta(x) = \frac{x^\perp}{|x|^{2+\beta}}, \quad x \in \mathbb{R}^2 \backslash \{0\},$$

and C_β is a constant.

For $\beta = 0$, equation (16) reduces to the vorticity formulation of the 2D incompressible Euler equations, a model for the evolution of inviscid and incompressible fluid flows in $\mathbb{R}^2$. Whereas for $\beta = 1$, (16) coincides with the surface quasi-geostrophic equation (SQG), which models the evolution of surface temperature or buoyancy in certain large-scale atmospheric or oceanic flows. Besides its physical relevance, the SQG equation has also received considerable attention due to its strong analytical and physical similarities to the 3D incompressible Euler equations.

We investigate potential finite-time blow-up scenarios for the inviscid generalized surface quasi-geostrophic (gSQG) equation in $\mathbb{R}^2$ within a more singular framework. Under these conditions, the initial value problem (IVP) for the gSQG equation does not admit a global solution in the class $C^2(\mathbb{R}^2) \cap L^p(\mathbb{R}^2)$ for all $p \in [2, \infty)$.

Existence and Uniqueness of Weak Solutions for the Poisson Equation

Rony Geymar Pastor Hurtado

PUC-Rio

This work addresses the existence and uniqueness of weak solutions to the Poisson equation in a bounded domain, framing the problem within functional analysis. We construct a continuous and coercive bilinear form, supported by Poincaré's inequality, and a continuous linear functional. By applying Lax-Milgram's theorem, we ensure existence and uniqueness. Additionally, the Trace Theorem is used to guarantee that the solutions vanish on the boundary.

Exponential stability of the Suspension bridge in von Kármán theory with internal damping

Roseane da Silva Martins, Carlos Alberto Raposo, Joilson Ribeiro, Mirelson Freitas

Universidade Federal da Bahia

This work introduces a suspension bridge where the deck is modeled by von Kármán theory with internal dampings. We prove the existence, uniqueness and exponential stability of the solution. Well-posedness is proved using the semigroup theory and exponential stability is obtained using the energy method. We will show that the existence of weak solutions can be obtained through a regularization process and then going to the limit, by energy method we prove the exponential stability. Furthermore, for initial data taken from the generator domain, semigroup theory also implies that the corresponding solutions are continuous.

Mathematical Modeling of Cell Growth under Fed-Batch Cultivation Mode Using Constant Feed Profile

Samuel Conceição Oliveira
Universidade Estadual Paulista-UNESP

In fed-batch cell cultivation, intermittent or continuous feeding is used to provide nutrients to microorganisms and also to control substrate availability. This is important, for example, when high substrate concentrations are inhibitory or deviate the cell metabolism to undesirable metabolic pathways. Fed-batch cultivation is widely used in the production of baker's yeast to overcome catabolic repression and control oxygen demand. This cultivation mode is also commonly used in the production of penicillin to avoid negative effects of substrate excess on the synthesis of the antibiotic. Depending on the specific cell growth rate desired for the microorganism, different substrate feeding profiles can be employed, including constant, linear, and exponential profiles. In this work, the logistic growth of a microorganism in a fed-batch reactor with constant feed was modeled by a differential equation, whose solution was analytically obtained to describe the temporal profile of cell concentration throughout the cultivation. Such solution is complicated and given in terms of the exponential integral function, making its numerical calculation difficult.

Reaction diffusion equations with hysteresis

Sergey Tikhomirov, Pavel Gurevich
PUC-Rio

Hysteresis naturally appears as a mechanism of self-organization and is often used in control theory. Important features of hysteresis operator are discontinuity and memory. We consider reaction-diffusion equations with hysteresis. Such equations describe processes in which diffusive and non-diffusive instances interact according to a hysteresis law. Due to the discontinuity of hysteresis, questions of well-posedness of such equations are highly non trivial.

For so-called transverse initial data it is possible to establish existence and uniqueness of the solution. Important part of the proof is the free boundary problem and fixed point theorem.

For non transverse initial data we consider a spatial discretization of the problem and present a new mechanism of pattern formation, which we call rattling. The profile of the solution forms two hills propagating with non-constant velocity. The profile of hysteresis forms a highly oscillating quasiperiodic pattern, which explains mechanism of illposedness of the original problem and suggests a possible regularization. Rattling is very robust and persists in arbitrary dimension and in systems acting on different time scales. We expect that it could be explained via Young measures – this is subject of future research.

Crossing limit cycles of the planar discontinuous piecewise linear Hamiltonian system

Sonia Isabel Renteria Alva
Universidade de São Paulo

In this work, we consider discontinuous piecewise linear differential systems separated by the line Σ. The line of separation Σ may take one of the following forms: a straight line $x = 0$, a nonregular line defined by the boundary of a sector with an angle α in $(0, \pi)$ and its vertex at the origin, or a singular and irreducible cubic algebraic curve. We investigate the maximum number of limit cycles that such discontinuous piecewise differential systems can exhibit.

About the article "Smooth deformations of piecewise expanding unimodal maps" by Daniel Smania and Viviane Baladi

Victor Henrique Huff
Universidade Federal do Rio Grande do Sul - UFRGS

We show results that studies and classifies the C^1 smooth families (that are called smooth deformations) in the space of C^k piecewise expanding unimodal maps who are in the same topological class (the dynamic sense). These families are defined as the families tangent to a continuous distribution of subspaces with codimensional one, that arises from a usefull class of linear functionals in that space, more specifically, by their kernels.

Method to determine time-dependent attractors with finite fractal dimension for non-cylindrical problems with and without delay

Vinicius Tavares Azevedo, Heraclio L. López-Lázaro, Carlos R. Takaessu Jr, Shuang Yang
Universidade Federal de são Carlos

The main objective of this work is to develop a method to estimate the fractal dimension of pullback attractors associated with nonlinear parabolic equations with and without delay terms defined on families of Banach spaces parameterized in time. The latter is motivated by non-cylindrical problems associated with partial differential equations with hereditary conditions. Therefore, this method is applied to the semilinear heat transfer equation with delay on a family of time-dependent domains, then on some results of the regularity of the history of the solutions, we can apply the method to guarantee the existence of a pullback attractor with finite fractal dimension.

On the Lane–Emden conjecture with convolution part

Xiang Li
UnB

We study the Hartree type Lane-Emden conjecture, which states the non-existence of the positive classical solutions for the following Hartree type system

$$\begin{cases} -\Delta u = \left(\int_{\boldsymbol{R}^N} \frac{v^p(y)}{|x-y|^\mu} dy \right) v^{p-1}, & x \in \boldsymbol{R}^N, \\ -\Delta v = \left(\int_{\boldsymbol{R}^N} \frac{u^q(y)}{|x-y|^\mu} dy \right) u^{q-1}, & x \in \boldsymbol{R}^N, \end{cases}$$

where $N \geq 3$, $0 < \mu < N$ and $p, q > 1$ satisfy

$$\frac{1}{p} + \frac{1}{q} > \frac{2(N-2)}{2N-\mu}.$$

We use elliptic methods to provide partially positive answers as an extension of the classical Lane-Emden conjecture. We also identify the regions where non-existence occurs in relation to this nonlocal problem.

Piecewise smooth system with a nonregular switching curve via a nonlinear double-regularization

Yagor Romano Carvalho, Claudio Aguinaldo Buzzi
Icmc/Usp

Considering a class of piecewise smooth vector fields with a nonregular switching manifold, we are interested in an analysis of the preservation of the bifurcations according to a regularization process. Thanks FAPESP by the support, process 2021/14695-7.

Traveling waves in gravitational fingering instability

Yulia Petrova, Sergey Tikhomirov, Yalchin Efendiev
IME-USP

The poster is devoted to viscous / gravitational fingering phenomenon - the unstable displacement of miscible liquids in porous media with the speed determined by Darcy's law. Laboratory and numerical experiments show the linear growth of the mixing zone, and we are interested in determining the exact speed of propagation of fingers. One of the possible mechanisms of slowing down the fingers' growth is due to convection in the transversal direction, that we try to explain by introducing a semi-discrete "toy" model of incompressible porous medium equation (IPM). In the simplest setting we show the structure of gravitational fingers - the mixing zone consists of space-time regions of constant intermediate concentration and the profile of propagation is characterized by two consecutive travelling waves which we call a terrace. The main tool in the proof is a reduction to pressure-free transverse flow equilibrium (TFE) model using geometrical singular perturbation theory and the persistence of stable and unstable manifolds under small perturbations. Based on joint work with S. Tikhomirov and Ya. Efendiev (SIMA, 2025).

ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS 2025 CHAPTER

Programme

ICMC Summer Meeting on Differential Equations - 2025 Chapter

Schedule Overview

SUNDAY 02 from 16:00 to 18:00, Registration at the ICMC Auditorium (Building 6)

	MONDAY 03	TUESDAY 04	WEDNESDAY 05
08:00-08:40	Registration		
08:40-09:00	Opening		
Auditorium	**PLENARY LECTURES**		
Chair	Ederson Moreira dos Santos	Anibal Rodriguez-Bernal	Maria Eugenia Perez Martinez
09:00-10:00	**Wolfgang Arendt**	**Irena Lasiecka**	**Angela Pistoia**
10:00-10:30		Coffee Break and Poster Session	
10:30-11:30	**Hugo Tavares**	**Michael Ruzhansky**	**Valéria Neves D. Cavalcanti**
11:30-13:30		**Lunch**	
Auditorium	**PLENARY LECTURES**		
Chair	Valéria Neves D. Cavalcanti	Angela Pistoia	Tomás Caraballo
13:30-14:30	**Maria Eugenia Perez Martinez**	**Diego Moreira**	**Anibal Rodriguez-Bernal**
14:30-15:00		Coffee Break	
15:00-17:30	**Sessions 1-10**	**Sessions 1-10**	**Sessions 1-10**
	SOCIAL EVENTS		
11:30		**Photo**	
20:00		**Conference Dinner**	

Session 1 – Conservation Laws and Transport Equations
Session 2 – Domain Perturbation for PDEs and Applications
Session 3 – Free Boundaries Problems and Related Topics
Session 4 – Integral and Functional Differential Equations
Session 5 – Nonlinear Dynamical Systems
Session 6 – Dispersive Equations
Session 7 – Linear Equations
Session 8 – Elliptic Equations
Session 9 – Harmonic Analysis and Related Topics
Session 10 – Dynamical Systems via Ordinary Differential Equations

THEMATIC SESSIONS

Room 5-004	**Session 1 – Conservation Laws and Transport Equations**		
Chair	Claudia Espitia	Nikolai Chemetov	Daniel Marroquin
15:00-15:30	**Nikolai Chemetov**	**Wladimir Neves**	**Jean Silva**
15:30-16:00	**Henrique Souza**	**Jomar Ramos**	**Luis Salvino**
16:00-16:30	**Daniel Marroquin**	**Alexandre Batista**	**Claudia Espitia**
16:30-17:00	**João Nariyoshi**		**Fábio Valentim**
Room 5-102	**Session 2 – Domain Perturbation for PDEs and Applications**		
Chair	Marcone Pereira	Alessandra Verri	
15:00-15:30	**Diana Carolina Suarez Bello**	**Jean Carlos Nakasato**	
15:30-16:00	**José Nazareno Vieira Gomes**	**Elaine Andressa Tavares de Lima**	
16:00-16:30	**Marcone Correa Pereira**	**Patricia Neves de Araujo**	
16:30-17:00	**Pedro Tavares Paes Lopes**	**Pablo Miranda**	
Room 5-003	**Session 3 – Free Boundaries Problems and Related Topics**		
Chair	Disson dos Prazeres	João Vitor da Silva	Ginaldo de Santana Sá
15:00-15:30	**João Vitor da Silva**	**Yuwei Hu**	**Disson dos Prazeres**
15:30-16:00	**Claudemir Alcantara Santos Jr**	**Romário Tomilhero Frias**	**Junior da Silva Bessa**
16:00-16:30	**Ginaldo de Santana Sá**	**Pedro Fellype Pontes**	
16:30-17:00	**Mayra Soares**	**Julio Correa**	
Room 5-101	**Session 4 – Integral and Functional Differential Equations**		
Chair	Martin Bohner	Jaqueline Mesquita	Claudio A. Gallegos
15:00-15:30	**Jaqueline Mesquita**	**Dana Franková**	**Robert Skiba**
15:30-16:00	**Hugo Leiva**	**Claudio A. Gallegos**	**Fernanda Andrade da Silva**
16:00-16:30	**Ma To Fu**	**Martin Bohner**	**Adriano Leandro Costa Peixoto**
16:30-17:00	**Matthias Wolfrum**	**Matthias Wolfrum**	**Matthias Wolfrum**
Auditorium	**Session 5 – Nonlinear Dynamical Systems**		
Chair	Juliana Fernandes	Phillipo Lappicy	Maykel Boldrin Belluzi
15:00-15:30	**Tomás Caraballo**	**Iacopo P. Longo**	**Christian Pöetzsche**
15:30-16:00	**Estefani Moreira**	**Juliana Fernandes**	**Phillipo Lappicy**
16:00-16:30	**Leonardo Pires**	**Paulo Nicanor**	**Alexandre Oliveira-Sousa**
16:30-17:00	**Maykel Boldrin Belluzi**	**Arthur Cunha**	**Rodrigo Samprogna**
17:00-17:30	**Javier López-de-la-Cruz**	**Joaquín Domínguez de Tena**	**Rodiack Figueroa López**
Room 5-104	**Session 6 – Dispersive Equations**		
Chair	Marcia Scialom	Luccas Cassimiro Campos	Mahendra Panthee
15:00-15:30	**Alexander Munoz**	**Igor Leite Freire**	**Miguel Dario Soto Vieira**
15:30-16:00	**Renata de Oliveira Figueira**	**Mykael Cardoso**	**Luccas Cassimiro Campos**
16:00-16:30	**Priscila Leal da Silva**	**Oscar Sierra Fonseca**	**Argenis José Mendez García**
16:30-17:00	**Mahendra Panthee**	**Marcia Scialom**	

Room 5-103	Session 7 – Linear Equations		
Chair	Bruno de Lessa Victor	Gabriel Araújo	Wagner Augusto de Moraes
15:00-15:30	**Gabriel Araújo**	**Nicholas Braun Rodrigues**	**Alexandre Arias Junior**
15:30-16:00	**Vinicius Novelli da Silva**	**Bruno de Lessa Victor**	**André Kowacs**
16:00-16:30	**Halit Sevki Aslan**	**Victor Sandrin Biliatto**	**Alessia Kogoj**
16:30-17:00	**Hugo D Fernandez Sare**	**Leandro Correia Araújo**	**Fernando de Ávila Silva**
17:00-17:30	**/agner Augusto Almeida de Mora**	**Igor Ambo Ferra**	

Room 5-002	Session 8 – Elliptic Equations		
Chair	Ederson Moreira dos Santos	Sergio Henrique Monari Soares	Gustavo Ferron Madeira
15:00-15:30	**Massimo Grossi**	**Vincenzo Ferone**	**Olimpio Hiroshi Miyagaki**
15:30-16:00	**Gianmarco Sperone**	**Maurizio Garrione**	**Cristian Morales Rodrigo**
16:00-16:30	**Rayssa Helena Aires de Lima Caju**	**Pedro Gaspar**	**Eudes Mendes Barboza**
16:30-17:00	**Eduardo Böer**	**Fabio de Regibus**	**Francisco Odair de Paiva**
17:00-17:30	**Raul Fernandes Horta**	**Gustavo Ramos**	

Room 5-001	Session 9 – Harmonic Analysis and Related Topics		
Chair	Tiago Picon	Charles dos Santos	Victor Souza
15:00-15:30	**Lucas Oliveira**	**Luana Ribeiro**	**Jean Carlo Guella**
15:30-16:00	**Catarina Barbosa**	**Joel Coacalle**	**Guilherme Vedana**
16:00-16:30	**Victor Julio Alves**	**Marcelo Fernandes Almeida**	**Luis Marcio Salge**
16:30-17:00	**Marcos dos Santos Ferreira**		

Room 4-001	Session 10 – Dynamical Systems via Ordinary Differential Equations		
Chair	Alex Carlucci Rezende	Claudio Buzzi	Tiago Carvalho
15:00-15:30	**Fabio Della Rossa**	**Pietro de Lellis**	**Regilene Oliveira**
15:30-16:00	**Camila Rodrigues de Lima**	**Douglas Duarte Novaes**	**Benito Frazão Pires**
16:00-16:30	**Durval José Tonon**	**Luis Fernando da Silva Gouveia**	**Claudio Gomes Pessoa**
16:30-17:00	**Jackson Itikawa**	**Ana Livia Rodero**	**Alex Carlucci Rezende**

Ground floor of the Library	Poster Session		
10:00-10:30			
	Carlos Roberto Takaessu Junior	**Daniel Alberto Morales Ramirez**	**Henrique Sotel Pio**
	Daniel Moraes Barbosa	**Eduardo Dias Lima**	**Juan Pablo Alcon Apaza**
	Heraclio López Lázaro	**Heydy Melchora Santos Damian**	**Lucas Queiroz Arakaki**
	Luana Ascoli	**Iguer Luis Domini dos Santos**	**Maria Veronica Bartmeyer**
	Masterson Falcão de Morais Costa	**Maria Luísa Pasinato**	**Pedro Iván Suarez Navarro**
	Muriel Andreane Dalcy	**Paulo Santana**	**Rony Pastor Hurtado**
	Roseane da Silva Martins	**Ricardo Martins Guimarães**	**Sonia Isabel Renteria Alva**
	Vinicius Tavares Azevedo	**Samuel Conceição Oliveira**	**Victor Henrique Huff**
	Xiang Li	**Sergey Tikhomirov**	**Yagor Romano Carvalho**
		Jian Zhang	**Yulia Petrova**
		Ester Beatriz de Souza dos Santos	

	SOCIAL EVENTS
11:30	**Photo**
20:00	**Conference Dinner**

ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS 2025 CHAPTER

List of Speakers

List of speakers **(ordered by first name)**

ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS 2025 CHAPTER

Sponsors

The ICMC Summer Meeting on Differential Equations - 2025 Chapter are promoted by Instituto de Ciências Matemáticas e de Computação (ICMC), Instituto Nacional de Ciência e Tecnologia de Matemática (INCTMat), Pró-Reitoria de Pós-Graduação da USP, Pró-Reitoria de Cultura e Extensão da USP, and Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro.

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