2022
CHAPTER

ICMC SUMMER MEETING
ON DIFFERENTIAL EQUATIONS

JANUARY 31 - FEBRUARY 2, 2022 | SÃO CARLOS-SP, BRAZIL
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ONLINE CONFERENCE

SESSIONS:

- Conservation Laws and Transport Equation
- Elliptic Equations
- Fluid Dynamics
- Free Boundaries and related topics
- Harmonic Analysis and Related Topics
- Integral and Functional Differential Equations
- Linear Equations
- Multiscale Dynamics
- Nonlinear Dynamical Systems

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Welcome

It is a pleasure to welcome you to the online conference *ICMC Summer Meeting on Differential Equations - 2022 Chapter*, which is going to be held on January 31 - February 02, 2022. We wish you enjoy the meeting.

Scientific Committee

José M. Arrieta (Universidad Complutense de Madrid/Spain)

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Lucas Oliveira (UFGRS/Brazil) & Tiago Picon (USP/Brazil) - Harmonic Analysis and Related Topics

João Vitor da Silva (UNICAMP/Brazil), Disson dos Prazeres (UFS/Brazil), Gabrielle Nornberg (U. de Chile/Chile) & Mariana Smit Vega Garcia (WWU/USA) - Free Boundaries Problems and Related Topics

Jean Silva (UFMG/Brazil) - Conservation Laws and Transport Equations

Yao Li (UMass Amherst/USA) & Zhongwei Shen (UAlberta/Canada) - Multiscale Dynamics

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2022 CHAPTER

Plenary Talks

A nonlocal semilinear problem in heat conduction with long time memory

Tomás Caraballo
Universidad de Sevilla, Spain

In this talk, the asymptotic behavior of a semilinear heat equation with long time memory and non-local diffusion is analyzed in the usual set-up for dynamical systems generated by differential equations with delay terms. This approach is different from the previous published literature on the long time behavior of heat equations with memory which is carried out by the Dafermos transformation. As a consequence, the obtained results provide complete information about the attracting sets for the original problem, instead of the transformed one. In particular, the proved results also generalize and complete previous literature in the local case (see [1, 2]). This is joint work with Jiaohui Xu and José Valero.

References:

[1] J. Xu, T. Caraballo, J. Valero. *Asymptotic behavior of a semilinear problem in heat conduction with long time memory and non-local diffusion*, preprint 2021.

[2] J. Xu, T. Caraballo, J. Valero. *Asymptotic behavior of nonlocal partial differential equations with long time memory*. Discrete and Continuous Dynamical Systems, Series S (2022) (to appear).

Fully nontrivial solutions to elliptic systems with mixed couplings

Mónica Clapp
Universidad Nacional Autónoma de México, Mexico

We consider elliptic systems of the form

$$-\Delta u_i + \lambda_i u_i = \sum_{j=1}^{\ell} \beta_{ij} |u_j|^p |u_i|^{p-2} u_i, \quad i = 1, \dots, \ell,$$

in a domain Ω of $\mathbb{R}^N$, where (β_{ij}) is a symmetric matrix that admits a block decomposition such that the diagonal entries β_{ii} are positive, the interaction forces within each block are attractive and the interaction forces between different blocks are repulsive.

We will present some results on the existence and qualitative properties of fully nontrivial solutions (i.e., solutions where every u_i is nontrivial). Some of them were obtained in collaboration with Angela Pistoia (La Sapienza Università di Roma) and others with Mayra Soares (UNAM).

It's time for the linear non-homogeneous PDEs

Márcia Federson
Universidade de São Paulo, Brazil

This is a joint work with professors Fernanda Andrade da Silva (USP, Brazil), John Burns (VTECH, United States) and Eduard Toon (UFJF, Brazil). We are glad to share the main results which led us to prove that linear non-homogeneous PDEs can also be regarded as generalized ODEs, as many other types of equations also do. It is well-known that generalized ODEs encompass ordinary and functional differential equations, impulsive and measure differential equations, dynamic equations on time scales, integral equations, and stochastic differential equations. This time, we will present our forays into PDEs.

References:

[1] F. Andrade da Silva; J. A. Burns; M. Federson; E. Toon. An abstract Cauchy problem in the framework of the Perron integral with application to Dirichlet boundary control system governed by parabolic PDEs. Preprint.

A Kupka-Smale Theorem for a Class of Delay-Differential Equations

John Mallet-Paret
Brown University, USA

We consider generic properties of scalar delay-differential equations of the form $\dot{x}(t) = f(x(t), x(t-1))$. In particular, we prove that for generic nonlinearities f all equilibria and all periodic solutions are hyperbolic. We note that the corresponding result for equations of the form $\dot{x}(t) = f(x(t-1))$ remains open. We discuss the significance of the result as it relates to one-parameter families of equations $\dot{x}(t) = f(x(t), x(t-1), \mu)$ and global continuation of periodic orbits.

Solving Systems of Ordinary Differential Equations via Combinatorial Homological Algebra

Konstantin Mischaikow
Rutgers University, USA

The long goal (we are far from achieving it) is to provide a fully automated approach to identifying the global dynamics of a system of differential equations over a large range of parameters. The purpose of this talk is to describe initial steps toward realizing this goal. Even these initial steps require a wide variety of techniques and arguments, thus we will limit ourselves to major points:

(1) What do we mean by solve? We will argue that a non-traditional notion of solution is necessary and suggest one based on order theory and algebraic topology.

(2) What is the proposed strategy? We will introduce a specific family of differential equations (ramp systems), briefly describe the combinatorial representations of dynamics (rook fields), and touch on the analysis that needs to be done.

(3) What can be done now? We will provide a few simple examples of the computations that can be done currently.

This is ongoing work with W. Duncan, D. Gameiro, M. Gameiro, T. Gedeon, H. Kokubu, H. Oka, B. Rivas, and E. Vieira.

2D Navier-Stokes equations on a bounded domain with holes and Navier friction boundary conditions

Helena J. Nussenzveig Lopes
Universidade Federal do Rio de Janeiro, Brazil

We will discuss the large time behavior of solutions of 2D Navier-Stokes in bounded domains which are not necessarily simply connected, when we impose Navier friction boundary conditions. We establish exponential time decay, for both velocity and vorticity, under various assumptions on the friction coefficient relative to curvature of the boundary, for different types of domains. We also discuss the special role, played by the disk and the annulus, in this analysis. This is joint work with Christophe Lacave, Milton Lopes Filho and Jim Kelliher.

On the existence of solutions to systems of Nonlinear Schrödinger equations

Angela Pistoia
La Sapienza Università di Roma, Italy

I will present some recent results obtained in collaboration with Giusi Vaira about the existence of solutions to systems of Nonlinear Schrödinger equations in both competitive and cooperative regimes.

On the geometry of fully nonlinear diffusive processes

Eduardo Teixeira
University of Central Florida, USA

Fully nonlinear elliptic operators have attracted considerable attention of (pure and applied) mathematicians for the last forty years or so. While a comprehensive existence and regularity theory is well established, many foundational issues are still open and the field of research quite active.

In this talk I will provide a global overview of the theory and will discuss some new universal regularity results for problems driven by fully nonlinear elliptic operators.

Response solutions in degenerate, quasi-periodically forced nonlinear oscillators

Yingfei Yi
University of Alberta, Canada & Jilin University, China

For a quasi-periodically forced differential equation, response solutions are quasi-periodic ones whose frequency vector coincides with that of the forcing function and they are known to play a fundamental role in the harmonic and synchronizing behaviors of quasi-periodically forced oscillators. These solutions are well-understood in quasi-periodically perturbed nonlinear oscillators either in the presence of large damping or in the non-degenerate cases with small or free damping. This talk will present some recent results on the existence of responsive solutions in degenerate, quasi-periodically forced nonlinear oscillators with small or free damping.

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Special Sessions

Session on Conservation Laws and Transport Equations

Organizer: Jean Silva (UFMG/Brazil)

Predator-prey dynamics with hunger structure

Paulo Amorim
Universidade Federal do Rio de Janeiro, Brazil

We present, analyse and simulate a model for predator-prey interaction with hunger structure. The model consists of a nonlocal transport equation for the predator, coupled to an ODE for the prey. We deduce a system of 3 ODEs for some integral quantities of the transport equation, which generalises some classical Lotka-Volterra systems. By taking an asymptotic regime of fast hunger variation, we find that this system provides new interpretations and derivations of several variations of the classical Lotka–Volterra system, including the Holling-type functional responses. We next establish a well-posedness result for the nonlocal transport equation by means of a fixed-point method. Finally, we show that in the basin of attraction of the nontrivial equilibrium, the asymptotic behaviour of the original coupled PDE-ODE system is completely described by solutions of the ODE system.

Homogenization of Schrödinger equations. Extended Effective Mass Theorems for non-crystalline matter

Vernny Chavez Ccajma
Universidade Federal do Rio de Janeiro, Brazil

In this talk, we study the homogenization of the Schrödinger equation beyond the periodic setting. Rigorous derivation of the effective mass theorems in solid state physics for non crystalline materials are obtained. We prove that the solution is approximately the product of a fast oscillating eigenfunction and a slowly varying solution of an homogenized Schrödinger equation. This is a joint work with Professor Wladimir Neves at UFRJ, and Professor Jean Silva at UFMG.

References:

[1] Allaire G., Homogenization and two-scale convergence, *SIAM J. Math. Anal.* ***23****(6), 1482-1518, 1992.*

[2] Allaire G., Piatnistki A., Homogenization of the Schrödinger Equation and Effective Mass Theorems, *Commun. Math. Phys.* ***258****(1), 1-22, 2005.*

[3] Bensoussan A., Lions J.-L., Papanicolaou G., Asymptotic analysis for periodic structures, *Amsterdam: North-Holland Pub. Co., 1978.*

[4] Blanc X., Le Bris C., Lions P.-L., Une variante de la théorie de l'homogénéisation stochastique des opérateurs elliptiques, *C. R. Math. Acad. Sci. Paris* ***343****(11-12), 717-724, 2006.*

[5] Blanc X., Le Bris C., Lions P.-L., Stochastic homogenization and random lattices, *J. Math. Pures Appl.* ***88****(1), 34-63, 2007.*

[6] Bourgeat A., Mikelić A., Wright S., Stochastic two-scale convergence in the mean and applications, J. Reine Angew. Math. **456**, 19-51, 1994.

[7] Jikov V. V., Kozlov S. M., Oleinik O. A., Homogenization of differential operators and integral functionals, *Springer-Verlag, Berlin, 1994.*

Homogenization of parabolic systems

Juan Gonzalez
Universidade Federal da Bahia, Brazil

In this talk we overview some techniques to study homogenization on parabolic systems. In special we review the two-scale asymptotic expansion and Bloch waves, inspired by Grégoire Allaire's works on the subject. We will also discuss some new possible extensions of the theory. This is a joint work with Jean Silva and Wladimir Neves.

Solvability of the Fractional Hyperbolic Keller-Segel System

Gerardo Huaroto
Universidade Federal de Alagoas, Brazil

We study a new nonlocal approach to the mathematical modelling of the Chemotaxis problem, which describes the random motion of a certain population due a substance concentration. Considering the initial-boundary value problem for the fractional hyperbolic Keller-Segel model, we prove the solvability of the problem. The solvability result relies mostly on the kinetic method. This is joint with and Wadimir Neves.

Homogenization of Stochastic Conservation Laws with Multiplicative Noise

Daniel R. Marroquin
Universidade Federal do Rio de Janeiro, Brazil

We consider the generalized almost periodic homogenization problem for two different types of stochastic conservation laws with oscillatory coefficients and multiplicative noise. In both cases the stochastic perturbations are such that the equation admits special stochastic solutions which play the role of the steady-state solutions in the deterministic case. Specially in the second type, these stochastic solutions are crucial elements in the homogenization analysis. Our homogenization method is based on the notion of stochastic two-scale Young measure, whose existence we establish. This is a joint work with Hermano Frid and Kenneth Karlsen.

Velocity averaging lemmas for second-order equations

João Fernando Nariyoshi
Universidade Estadual de Campinas, Brazil

We study the regularization properties of the so-called velocity averages $\varrho(\mathbf{x}) = \int_{\mathbb{R}_v} f(\mathbf{x}, v)\psi(v)\, dv$, where $\psi(v)$ is a given real function, and $f(\mathbf{x}, v)$ solves a second-order equation of the form $\mathbf{a}(v) \cdot (\nabla_\mathbf{x} f)(\mathbf{x}, v) - \nabla_\mathbf{x} \cdot (\mathbf{b}(v)(\nabla_\mathbf{x} f)(\mathbf{x}, v)) = (-\Delta_\mathbf{x} + 1)^{1/2}(-\Delta_v + 1)^{r/2} g(\mathbf{x}, v)$ with $r \geq 0$. Assuming very weak and natural conditions on $\psi(v)$, $\mathbf{a}(v)$, $\mathbf{b}(v)$, $f(\mathbf{x}, v)$ and $g(\mathbf{x}, v)$, we establish the compactness of such velocity averages $\varrho(\mathbf{x})$. Thus, we are able to completely justify and extend a general theorem previously stated in the seminal work of P.-L. Lions, B. Perthame and E. Tadmor [*J. Amer. Math. Soc.* **7** (1994) 169–191].

Homogenization of a generalized second-order operators

Fábio Júlio da Silva Valentim
Universidade Federal do Espírito Santo, Brazil

We considere a generalization of Laplace operator and study the homogenization's problem, under minor assumptions regarding weak convergence and ellipticity conditions. We provide two examples: The first one consists on the case with minor regularity, the second one consists on the case with random environment associated the an ergodic group. The evolution equation associated with the operator considered provides, for example, a model diffusions of particles in an enviromment with presence of permeable membranes. Joint work with Alexandre B. Simas.

A phase field porous media fracture model

Henrique Versieux
Universidade Federal de Minas Gerais, Brazil

A novel regularized fracture model for crack propagation in porous media is proposed. Our model is obtained through formal asymptotic expansions. We start with a regularized quasi-static fracture model posed in a periodically perforated domain obtained by periodic extension of a re-scaled unit cell with a hole. This setup allows us to write two separated minimality conditions for the primary (displacement) and secondary (or phase field) variables plus a balance of energy relation. Then we apply the usual asymptotic expansion matching to deduce limit relations when the re-scaling parameter of the unit cells vanishes. By introducing cell problems solutions and a homogenized tensor we can recast the obtained relations into a novel model for crack propagation in porous media. The proposed model can be interpreted as a regularized quasi-static fracture model for porous media. This model yields two separated (homogenized) minimality conditions for the primary and secondary variables and a balance of a homogenized energy relation. This is joint work with Juan Galvis.

Session on Elliptic Equations

Organizers: Giovany J. M. Figueiredo (UnB/Brazil) & Marcos T. O. Pimenta (UNESP/Brazil)

On existence of multiple normalized solutions to a class of elliptic problems in whole $\mathbb{R}^N$ via Lusternik-Schnirelman category

Claudianor O. Alves
Universidade Federal de Campina Grande, Brazil

In this paper we study the existence of multiple normalized solutions to the following class of elliptic problems

$$\begin{cases} -\Delta u + V(\epsilon x)u = \lambda u + f(u), & \text{in } \mathbb{R}^N, \\ \int_{\mathbb{R}^N} |u|^2 dx = a^2, \end{cases}$$

where $a, \epsilon > 0$, $\lambda \in \mathbb{R}$ is an unknown parameter that appears as a Lagrange multiplier, $V : \mathbb{R}^N \to [0, \infty)$ is a continuous function, and f is continuous function with L^2-subcritical growth. It is proved that the numbers of normalized solutions are related to the topology of the set where the potential V attains its minimum value. In the proof our main result we apply minimization techniques and Ljusternik–Schnirelmann category. This is joint work with Nguyen Van Thin.

Infinitely many radial solutions for a p-Laplacian problem with negative weight at the origin

Alfonso Castro
Harvey Mudd College, USA

We prove the existence of infinitely many sign-changing radial solutions for a Dirichlet problem in a ball defined by the p-Laplacian operator perturbed by a nonlinearity of the form W(|x|)g(u), where the weight function W changes sign exactly once, W(0)<0, W(1) > 0, and function g is p-superlinear at infinity. Standard phase plane analysis arguments do not apply here because the solutions to the corresponding initial value problem may blow up in the region where the weight function is negative. Our result extend those in [2] where W is assumed to be positive at 0 and negative at 1. This is joint work with J. Cossio, S. Herron, and C. Velez.

Critical points of the Robin function in domains with small hole

Massimo Grossi
Sapienza Università di Roma, Italy

The Robin function of a domain $D \subset \mathbb{R}^N$ is defined as $R_D(x) = H_D(x, x)$ where $H_D(x, y)$ is the regular part of the *Green function* in D .

We compute the number of critical points of the Robin function R_{Ω_ϵ} in domains with small holes, namely, $\Omega_\epsilon = \Omega \setminus B(P, \epsilon)$ where Ω is a smooth bounded domain in R^N, $N \geq 3$ and $B(P, \epsilon)$ is a ball centered at $P \in \Omega$ and (small) radius ϵ . We will show that the location of the point P plays a crucial role. Indeed, if P is NOT a critical point of the Robin function $R(x)$ of Ω, then removing a small hole, we get the existence of *exactly* one more *nondegenerate* critical points for R_{Ω_ϵ}

This allow us to compute the *exact* number of the critical points of R_{Ω_ϵ} in several situations.

On the other hand the scenario is completely different if P is a critical point of $R(x)$.

These results have a straightforward application to the computation of the number of solutions of well knows semilinear problems. problems.

This is a joint paper with F. Gladiali, P. Luo and S. Yan.

New results on Choquard equation

Liliane Maia
Universidade de Brasília, Brazil

We will present some recent results on existence of positive solutions for a class of Choquard equations with potential decaying at a positive limit at infinity. A comparison between the study assuming symmetries and the non symmetric case is going to be highlighted. We investigate superlinear, linear and sublinear nonlinearities, and we take into account an arbitrary number of bumps in the symmetric case. Our results in particular include the physical case. This is joint work with Benedetta Pellacci and Delia Schiera.

Reverse Faber-Krahn inequality for a truncated Laplacian operator

Enea Parini
Aix-Marseille Université, France

In this talk we will prove a reverse Faber-Krahn inequality for the principal eigenvalue $\mu_1(\Omega)$ of the fully nonlinear eigenvalue problem

$$\begin{cases} -\lambda_N(D^2u) &= \mu u \quad \text{in } \Omega, \\ u &= 0 \quad \text{on } \partial\Omega. \end{cases}$$

Here $\lambda_N(D^2u)$ stands for the largest eigenvalue of the Hessian matrix of u. More precisely, we prove that, for an open, bounded, convex domain $\Omega \subset \mathbb{R}^N$, the inequality

$$\mu_1(\Omega) \leq \frac{\pi^2}{[\mathrm{diam}(\Omega)]^2} = \mu_1(B_{\mathrm{diam}(\Omega)/2}),$$

where $\mathrm{diam}(\Omega)$ is the diameter of Ω, holds true. The inequality actually implies a stronger result, namely, the maximality of the ball under a diameter constraint. Furthermore, we discuss the minimization of $\mu_1(\Omega)$ under different kinds of constraints. This is a joint work with Julio D. Rossi and Ariel Salort.

Elliptic equations driven by the Stuart differential operator: new results and perspectives

Vicentiu D. Radulescu
University of Craiova, Romania
AGH University of Science and Technology, Krakow, Poland
Institute of Mathematics of the Romanian Academy, Bucharest, Romania

In this talk, I shall report on some recent results obtained in collaboration with Louis Jeanjean and Giovany Figueiredo. I shall be concerned with the qualitative analysis of solutions for two classes of nonlinear elliptic equations driven by a new quasilinear operator introduced by C.A. Stuart. The first part of my talk gives a thorough description that covers the sublinear and linear cases. Next, I shall discuss the subcritical and critical cases for problems with lack of compactness. Several open problems and perspectives are raised in the final part of this lecture.

References:

[1] L. Jeanjean, V.D. Radulescu, Nonhomogeneous quasilinear elliptic problems: linear and sublinear cases, J. d'Analyse Math., in press.

[2] G. Figueiredo, V.D. Radulescu, Nonhomogeneous indefinite problems with lack of compactness: subcritical and critical cases, paper in preparation.

Critical points with prescribed energy for a class of functionals depending on a parameter

Humberto Ramos Quoirin
Universidad Nacional de Córdoba, Argentina

We investigate the existence of critical points at a prescribed level for the functional $\Phi_\lambda = I_1 - \lambda I_2$, where I_1, I_2 are C^1 even functionals on a Banach space, and $\lambda \in \mathbb{R}$. For some classes of Φ_λ and some values of $c \in \mathbb{R}$ we obtain a sequence $(\lambda_{n,c}, u_{n,c})$ such that $\Phi'_{\lambda_{n,c}}(\pm u_{n,c}) = 0$ and $\Phi_{\lambda_{n,c}}(\pm u_{n,c}) = c$. In addition, we analyse the behavior of $\lambda_{n,c}$ and $u_{n,c}$ with respect to c, which leads to the existence of a family of *energy curves*. These results are then applied to several classes of elliptic problems. This is joint work with Gaetano Siciliano, Jefferson Silva, and Kaye Silva.

Gelfand-type problems involving the 1-Laplacian operator

Sergio Segura de León
Universitat de València, Spain

In this talk the Gelfand problem is addapted to the 1-Laplacian setting. Concretely, we deal with the following problem

$$\begin{cases} -\Delta_1 u = \lambda e^u & \text{in } \Omega; \\ u = 0 & \text{on } \partial\Omega; \end{cases}$$

We prove the existence of a threshold λ^* such that Gelfand problem has no solution when $\lambda > \lambda^*$ and there exists a solution when $\lambda \leq \lambda^*$. The 1 dimensional and the radial cases are analyzed in more detail, showing the existence of multiple (even singular) radial solutions. We also study the behavior of solutions to problems involving the p-Laplacian as p tends to 1, which allows us to identify proper solutions through an extra condition. This is joint work with Alexis Molino.

Nonlinear problems: compactness and partial symmetries

Raffaella Servadei
Università degli Studi di Urbino Carlo Bo, Italy

Several important problems arising in many research fields, such as physics and differential geometry, lead to consider elliptic equations defined on unbounded domains of the Euclidean space and a great deal of work has been devoted to their study. From the mathematical point of view, the main interest relies on the fact that often the tools of nonlinear functional analysis, based on compactness arguments, cannot be used, at least in a straightforward way, and some new techniques have to be developed.

In a joint paper with Giuseppe Devillanova (Politecnico di Bari) and Giovanni Molica Bisci (Urbino) we introduce a group theoretical scheme, developed in the framework of problems which are invariant with respect to the action of orthogonal subgroups, to show the existence of multiple solutions distinguished by their different symmetry properties.

The aim of the talk is to present this construction, called flower-shape geometry, and to show its applications to the study of various nonlinear problems set in unbounded domains.

Session on Fluid Dynamics

Organizers: Anne Bronzi (UNICAMP/Brazil) & Gabriela Planas (UNICAMP/Brazil)

A solidification model with convection in non-solid regions and rigid motion in the solid regions: Existence of solution

Bianca Morelli Rodolfo Calsavara
Universidade Estadual de Campinas, Brazil

In this work, we introduce a PDE problem modeling a solidification/melting process in bounded $3D$ domains, coupling a phase-field equation and a free-boundary Navier-Stokes-Boussinesq system, where the latent heat effect is considered via a modification of the Caginalp model. Moreover, the convection in the non-solid regions is treated via a phase-dependent viscosity of the material that degenerates in the solid phase, letting only rigid motions in this phase. Then, we prove existence of global in time weak solutions for a regularized model, by means of the convergence of non-degenerate problems furnished truncating the viscosity. In fact, this result also holds into $2D$ domains for the original (non-regularized) problem. This is joint work with Francisco Guillén González.

On the self-similar blowup for the dissipative SQG equation

Ricardo Martins Guimarães
Universidade Estadual de Campinas, Brazil

we study the locally self-similar solutions of the 2D SQG equation with fractional dissipation in the supercritical range. We prove that under some control on the L^p growth of the self-similar profile the self-similar blow-up is excluded in a supercritical range. This is joint work with Anne Bronzi and Cecília Mondaini.

Spontaneously stochastic Arnold's cat

Alexei A. Mailybaev
Instituto Nacional de Matemática Pura e Aplicada - IMPA, Brazil

We propose a simple model for the phenomenon of Eulerian spontaneous stochasticity in turbulence. This model is solved rigorously, proving that infinitesimal small-scale noise in otherwise a deterministic multi-scale system yields a large-scale stochastic process with Markovian properties. Besides its theoretical value, our model opens new ways for the experimental verification of spontaneous stochasticity in optics and electronics, and suggests new applications beyond fluid dynamics. This is joint work with Artem Raibekas.

Long-term accuracy of numerical approximations of SPDEs

Cecilia F. Mondaini
Drexel University, USA

We consider a general framework for obtaining uniform-in-time rates of convergence for numerical approximations of SPDEs in suitable Wasserstein distances. The framework is based on two general results under an appropriate set of assumptions: a Wasserstein contraction result for a given

Markov semigroup; and a uniform-in-time weak convergence result for a parametrized family of Markov semigroups. We provide an application to a suitable space-time discretization of the 2D stochastic Navier-Stokes equations in vorticity formulation. Specifically, we obtain that the Markov semigroup induced by this discretization satisfies a Wasserstein contraction result which is independent of any discretization parameters. This allows us to obtain a corresponding weak convergence result towards the Markov semigroup induced by the 2D SNSE. The proof required technical improvements from the related literature regarding finite-time error estimates. Finally, our approach does not rely on standard gradient estimates for the underlying Markov semigroup, and thus provides a flexible formulation for further applications. This is a joint work with Nathan Glatt-Holtz (Tulane U).

Upper and lower Hm estimates for solutions to a class of diffusive equations

Cilon F. Perusato
Universidade Federal de Pernambuco, Brazil

We prove results concerning upper and lower decay estimates for homogeneous Sobolev norms of solutions to a rather general family of diffusive equations. Following the ideas of Kreiss, Hagstrom, Lorenz and Zingano, we use eventual regularity of solutions to directly work with smooth solutions in physical space, bootstrapping decay estimates from the L^2 norm to higher order derivatives. Besides obtaining upper and lower bounds through this method, we also obtain reverse results: from higher order derivatives decay estimates, we deduce bounds for the L^2 norm. We use these general results to prove new decay estimates for some equations and to recover some well known results. This is joint work with Robert Guterres, César Niche, and Paulo Zingano.

Similarity for turbulent flows at the extreme Reynolds regime

Fabio Ramos
Universidade Federal do Rio de Janeiro, Brazil

In this talk we will present some recent similarity scaling laws for wall bounded flows at the Extreme Reynolds number regime. This is joint work with Gabriel Sanfins, Hamidreza Anbarlooei, and Daniel Cruz.

Negative control results for the Stokes equation with memory

Diego Araujo de Souza
Universidad de Sevilla, Spain

Stokes equations have been studied since many years and its understanding is very relevant from the mathematical and physical viewpoint. In this talk, we will consider the Stokes equations in the presence of an integro-differential term (integral in time and differential in space), called *memory term*. We will study the boundary null controllability problem (to steer the flow to the rest at an arbitrarily small time) for the Stokes equations with memory in two and three dimensional cases. Precisely, we will construct explicitly initial conditions such that the null controllability does not hold even if the controls act on the whole boundary. Moreover, we also prove that this negative result holds for distributed controls. Finally, we will present some issues which remain open.

Joint work with Enrique Fernández-Cara (University of Sevilla) and José Lucas Ferreira Machado (IFCE).

Session on Free Boundaries Problems and Related Topics

Organizer: João Vitor da Silva (UNICAMP/Brazil), Disson dos Prazeres (UFS/Brazil), Gabrielle Nornberg (U. de Chile/Chile) & Mariana Smit Vega Garcia (WWU/USA)

Regularity properties in obstacle-type problems for higher-order fractional powers of the Laplacian.

Donatella Danielli
Arizona State University, USA

In this talk we will discuss a sampler of obstacle-type problems associated with the fractional Laplacian $(-\Delta)^s$, $1 < s < 2$. Our goals are to establish regularity properties of the solution and to describe the structure of the free boundary. To this end, we combine classical techniques from potential theory and the calculus of variations with more modern methods, such as the localization of the operator and monotonicity formulas. This is joint work with A. Haj Ali (Arizona State University) and A. Petrosyan (Purdue University).

Nonhomogeneous PDE

Cristiana De Filippis
University of Parma, Italy

Nonhomogeneous partial differential equations play a key role in the modelling of anisotropic diffusion processes characterized by multiple degeneracy phenomena such as material depending conductivity or electromagnetic processes in ferromagnetic media. Recently, double phase problems like:

$$- \operatorname{div} \left(|Du|^{p-2}Du + a(x)|Du|^{q-2}Du \right) = f(x), \tag{1}$$

attracted the interest of a huge community of researchers. Equation (1) is mainly connected to the analysis of composite materials, characterized by the coexistence of different media that are mixed according to the behavior of the modulating coefficient $a(\cdot)$. In this talk I will present sharp Lipschitz regularity results for solutions to variational obstacle problems including those of double phase type, [4]. I will also introduce the fully nonlinear counterpart of (1):

$$\left[|Du|^p + a(x)|Du|^q \right] F(D^2u) = f(x), \tag{2}$$

cf. [3] and describe the tangential approach leading to optimal regularity for viscosity solutions to (2). Finally, I will show a new model for anisotropic free transmission problems [1]:

$$\left[|Du|^{p^+\chi_{\{u>0\}}+p_-\chi_{\{u<0\}}} + a(x)\chi_{\{u>0\}}|Du|^q + b(x)\chi_{\{u<0\}}|Du|^s \right] F(D^2u) = f(x) \tag{3}$$

inspired by the variational multi phase energy [2,5].

This talk is (partly) based on joint work with Giuseppe Mingione (University of Parma) and Jehan Oh (Kyungpook National University).

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Global minimizers to the one-phase free boundary problem

Daniela De Silva
Barnard College, Columbia University, USA

Given a global 1-homogeneous minimizer U_0 to the Alt–Caffarelli energy functional, with $sing(F(U_0)) = \{0\}$, we provide a foliation of the half-space $\mathbb{R}^n \times [0, +\infty)$ with dilations of graphs of global minimizers $\underline{U} \leq U_0 \leq \bar{U}$ with analytic free boundaries at distance 1 from the origin. This is joint work with D. Jerison and H. Shahgholian.

Free boundary regularity for a one-phase problem with non-standard growth

Claudia Lederman
Universidad de Buenos Aires and IMAS-UBA-CONICET, Argentina

We consider viscosity solutions to a one-phase free boundary problem for a nonlinear elliptic PDE with non-zero right hand side. We obtain regularity results for solutions and their free boundaries.

The operator under consideration is a model case in the class of partial differential equations with non-standard growth. This type of operators have been used in the modelling of non-Newtonian fluids, such as electrorheological or thermorheological fluids, also in non-linear elasticity and image reconstruction.

We also obtain some new results for the governing operator that are of independent interest.

This is joint work with Fausto Ferrari (University of Bologna, Italy)

Obstacle-type problems in nonlocal settings

Diego Marcon
Universidade Federal do Rio Grande do Sul, Brazil

We present two models in relation to the classical obstacle problem. First, we consider a free boundary optimization for the fractional Laplacian operator with volume and lower bound constraints, which was inspired by local heat conduction models. We provide not only geometric properties of solutions, but also of the corresponding free boundaries. Next, we describe a parabolic obstacle problem that naturally arises in the pricing of American options. The parabolic operator that shows up is a combination of nonlocal diffusion terms with a drift term. We prove optimal regularity of solutions in space and almost optimal regularity in time.

Free boundary regularity for one-phase doubly degenerate fully non-linear elliptic equations

Giane Casari Rampasso
Universidade Estadual de Campinas, Brazil

The purpose of this work is to discuss the free boundary regularity for a class of one-phase problem governed by doubly degenerate fully non-linear elliptic operators with non-zero right hand side. Our findings include Lipschitz continuity of solutions and a non-degeneracy property. Moreover, we examine the Caffarelli's classification scheme: flat and Lipschitz free boundaries are locally of class $\mathcal{C}^{1,\beta}$ for some $0 < \beta < 1$ universal.

This is a joint-work with J.V. da Silva (IMECC-Unicamp), G.C. Ricarte (UFC) and H.A. Vivas (UNMdP-Argentina).

Optimal design problems for a degenerate operator in Orlicz-Sobolev spaces

Jefferson Abrantes dos Santos
Universidade Federal de Campina Grande, Brazil

An optimization problem with volume constraint involving the Φ-Laplacian in Orlicz-Sobolev spaces is considered for the case where Φ does not satisfy the natural condition introduced by Lieberman. A minimizer u_Φ having non-degeneracy at the free boundary is proved to exist and some important consequences are established like the Lipschitz regularity of u_Φ along the free boundary, that the set $\{u_\Phi > 0\}$ has uniform positive density, that the free boundary is porous with porosity $\delta > 0$ and has finite $(N - \delta)$-Hausdorff measure. Under a geometric compatibility condition set up by Rossi and Teixeira, it is established the behavior of an ℓ-quasilinear optimal design problem with volume constraint for ℓ small. As $\ell \to 0^+$, we obtain a limiting free boundary problem driven by the infinity-Laplacian operator and find the optimal shape for the limiting problem. The proof is based on a penalization technique and a truncated minimization problem in terms of the Taylor polynomial of Φ. This is joint work with Sergio H. Monari Soares (USP).

Yamabe systems, optimal partitions and nodal solutions to the Yamabe equation

Hugo Tavares
Universidade de Lisboa, Portugal

In this talk we will discuss optimal partition problems for the Yamabe equation on a closed Riemannian manifold (M, g), giving conditions for the existence of regular optimal partitions with an arbitrary number $\ell \geq 2$ of components, To this aim, we study a weakly coupled competitive elliptic system of ℓ equations, related to the Yamabe equation. We show that this system has a least energy solution with nontrivial components if the dimension of M is greater than or equal to 10, (M, g) is not locally conformally flat and satisfies an additional geometric assumption whenever the dimension is equal to 10. Moreover, we show that the limiting profiles of the components of the solution separate spatially as the competition parameter goes to $-\infty$, giving rise to an optimal partition. We show that this partition exhausts the whole manifold, and prove the regularity of both the interfaces and the limiting profiles, together with a free boundary condition. For $\ell = 2$ the optimal partition obtained yields a least energy sign-changing solution to the Yamabe equation with precisely two nodal domains. This is based in a joint work with Monica Clapp (UNAM) and Angela Pistoia (Università di Roma "La Sapienza"), arXiv:2106.00579

Surfaces of Minimum Curvature Variation

Hernan Vivas
Universidad Nacional de Mar del Plata, Argentina

Morivated by problems that arise in computer-aided design, we will introduce the notion of surface of minimum curvature variation and discuss some of its basic properties. This is joint work with Luis Caffarelli and Pablo Stinga.

Session on Harmonic Analysis and Related Topics

Organizer: Lucas Oliveira (UFGRS/Brazil) & Tiago Picon (USP/Brazil)

From weak-type weighted inequality to pointwise estimate

Jorge Abel Antezana
Universidad Nacional de La Plata & Instituto Argentino de Matemática, Argentina

It is well known that the decreasing rearrangement of any Calderón-Zygmund operator is estimated by the sum of Hardy operator and its adjoint. In this talk, we prove similar pointwise estimates for the decreasing rearrangement of Tf, where T covers a wide range of interesting operators in Harmonic Analysis, such as the Bochner-Riesz operators, Rough operators, Sparse operators, Fourier multipliers, operators satisfying a Feffermen-Stein inequality, among others. Relationships of these estimations with extrapolation theory will be discussed throughout the talk. In particular, some extensions of Zygmund extrapolation will be considered. This is joint work with Elona Agora, Sergi Baena-Miret, and María Jesús Carro.

Mean oscillation bounds on symmetrization

Almut Burchard
University of Toronto, Canada

The symmetric decreasing rearrangement ("symmetrization") of a function f in n variables is the unique radially decreasing function f^* equimeasurable with f. Classical inequalities say that symmetrization reduces the overall oscillation of functions: it shrinks L^p-distances, decreases gradient norms, and increases certain negative Sobolev norms. But how does symmetrization act on spaces of bounded mean oscillation (BMO) and vanishing mean oscillation (VMO)? I will describe recent results with Galia Dafni and Ryan Gibara on boundedness and continuity of symmetrization in these spaces.

Function spaces of generalized smoothness

Thaís Jordão
Universidade de São Paulo, Brazil

We present the function spaces of generalized smoothness (generalized Besov/Lipschitz spaces) defined in terms of majorant functions and the fractional modulus of smoothness. The well definition and embeddings type theorems between them will be discussed. The formulation of these spaces makes use of a general majorant class of functions, extending the class considered in previously in the literature in terms of Bari's condition. These generalized Besov spaces were characterized, in 2020, in terms of decay of Fourier transforms where necessary and sufficient conditions of Titchmarsh type were obtained.

Atomic and molecular decomposition of local Hardy spaces and applications

Chun Ho Lau
Concordia University, Canada

In this talk, we will discuss a new atomic and molecular decomposition of Goldberg's local Hardy spaces h^p, using approximate cancellation conditions. We will also use these decompositions to show a version of Hardy's inequality, and prove boundedness of inhomogeneous operators on h^p. This talk is based on joint work with Galia Dafni, Tiago Picon (University of São Paulo), and Claudio Vasconcelos (Federal University of São Carlos).

Limits of Fractional Sobolev spaces and Gagliardo Nirenberg inequalities via interpolation and extrapolation

Mario Milman
Instituto Argentino de Matematica, Argentina

Using interpolation/extrapolation methods we extend the celebrated Brezis-Bourgain-Mironescu-Maz'ya-Shaposhnikova limit theorems to Fractional Sobolev spaces. An important role is played by a new extension of the classical Gagliardo seminorms: the Butzer seminorms. We also show the corresponding Gagliardo-Nirenberg inequalities. This is joint work with Oscar Dominguez (Lyon1 and Complutense de Madrid).

Stability for Geometric and Functional Inequalities

João P.G. Ramos
ETH Zürich, Switzerland

The celebrated isoperimetric inequality states that, for a measurable set S with fixed perimeter per(S), its area is maximal if and only if S is a ball. This result has many applications throughout analysis, but an interesting feature is that it can be obtained as a corollary of a more general inequality, the Brunn–Minkowski theorem: if A, B are two measurable sets, define $A + B = \{a + b, a \in A, b \in B\}$. Then

$$|A + B|^{1/n} \geq |A|^{1/n} + |B|^{1/n}.$$

Here, equality holds if and only if A and B are homothetic and convex. A question pertaining to both these results, that aims to exploit deeper features of the geometry behind them, is that of stability: if S is close to being optimal for the isoperimetric inequality, can we say that it is close to being a ball? Analogously, if A,B are close to being optimal for Brunn–Minkowski, can we say they are close to being compact and convex? These questions, as stand, have been answered only in very recent efforts by several mathematicians. In this talk, we shall outline these results, with focus on the following new result, obtained jointly with A. Figalli and K. Boroczky. If f, g are two non-negative measurable functions on $\mathbb{R}^n$, and h is measurable an nonnegative such that

$$h(x + y) \geq f(2x)^{1/2} g(2y)^{1/2}, \forall x, y \in \mathbb{R}^n,$$

then the Prekopa–Leindler inequality asserts that

$$\int h \geq \left(\int f\right)^{1/2} \left(\int g\right)^{1/2},$$

where equality holds if and only if h is log-concave, and f,g are 'homothetic' to h, in a suitable sense. We prove that, if $\left(\int h\right)^2 \leq (1+\varepsilon)\int f \int g$, then f, g, h are ε^{γ_n}-close in L^1 to being optimal. We will discuss the general idea for the proof and, time-allowing, discuss on a conjectured sharper version and more recent developments and partial results.

Heat kernel estimates and related results in manifolds with sub-gaussian estimates

Emmanuel Russ
Université Grenoble Alpes, France

Let (M, g) be a Riemannian manifold, Δ the Laplace-Beltrami operator and p_t the corresponding heat kernel. We consider the case where p_t satisfies pointwise sub-gaussian upper estimates, and establish, under suitable assumptions, pointwise bounds for the gradient of the heat kernel. Some consequences for the boundedness of the Riesz transform (or a suitable modification) are also derived. This is joint work with Baptiste Devyver and Meng Yang.

Interpolation formulas, uncertainty principles and sphere packing

Mateus Sousa
Basque Center for Applied Mathematics - BCAM, Spain

In this talk we will discuss some problems related to the theory of Fourier interpolation. The goal is to talk about the general problem of how to obtain new interpolation formulas from a previously known one by some perturbation argument, and also mentions some recent developments in joint work with João Pedro Ramos (ETH Zürich).

Divergence-measure fields: Gauss-Green formulas and normal traces.

Monica Torres
Purdue University, USA

The Gauss-Green formula is a fundamental tool in analysis. In this talk we present new Gauss-Green formulas for divergence-measure fields (i.e.; vector fields in L^p whose divergence is a Radon measure) and which hold on sets with low regularity, thus allowing the integration by parts on very rough domains. This is joint work with Gui-Qiang Chen, Giovanni Comi, and Qinfeng Li.

Continuity properties of strongly singular Calderón-Zygmund operators on Hardy spaces

Claudio Machado Vasconcelos
Universidade Federal de São Carlos, Brazil

In this talk, we discuss some recent progress on boundedness properties of strongly singular Calderón-Zygmund-type operators in Hardy spaces and its weighted version. In particular, we provide weaker conditions on their kernel so that good continuity properties remain true. Also, we discuss some progress made, on Goldberg's local Hardy spaces, to extend the continuity of the inhomogeneous version of such operators for $0 < p \leq 1$ with an appropriate cancellation condition. Joint work with Tiago Picon (University of São Paulo) and with Galia Dafni and Chun Ho Lau (Concordia University).

Session on Integral and Functional Differential Equations

Organizer: Pierluigi Benevierio (USP/Brazil) & Everaldo M. Bonotto (USP/Brazil)

Global bifurcation for nonlinear dynamic equations on time scales

Pierluigi Benevieri
Universidade de São Paulo, Brazil

The theory of dynamic equations on time scales is very recent in the literature, it was introduced by Stefan Hilger in 1988 in his PhD thesis and, through the years, it has been attracting the attention of many mathematicians. On the other hand, the investigation about global bifurcation for dynamic equations on time scales is still very scarce. In the talk, we present a global bifurcation result, recently obtained in [1], for nonlinear dynamic equations on time scales with Dirichlet boundary conditions, and depending on a real parameter λ, of the form

$$\begin{cases} x^{\Delta}(t) + \lambda\phi\Big(t, x(t), x^{\Delta(t)}\Big) + \lambda\psi\Big(t, x(t)\Big) = 0 \\ x(0) = x(T), \end{cases} \tag{4}$$

where

- $x^{\Delta}(t)$ is the so-called Δ–derivative of x;
- the variable of x belongs to a periodic time scale $\mathbb{T}$ of a positive period $T \in \mathbb{T}$;
- $\phi : \mathbb{T} \times \mathbb{R}^n \times \mathbb{R}^n \to \mathbb{T}^n$ and $\psi : \mathbb{T} \times \mathbb{R}^n \to \mathbb{R}^n$ are T-periodic with respect to the first variable and continuous in the domain.

(Other suitable conditions are assumed, here omitted for reasons of conciseness.) The approach is topological and based on a notion of topological degree for compact perturbations on nonlinear Fredholm maps in Banach spaces.

In the last part of the talk, we briefly present a research in progress with J. Mesquita and O. Guzman concerning the global bifurcation of periodic solutions for a class of functional Volterra integral-type equations.

This is joint work with Jaqueline G. Mesquita and Aldo Pereira.

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[1] Benevieri Pierluigi, Mesquita Jaqueline, Pereira Aldo, *Global bifurcation results for nonlinear dynamic equations on time scales*, J. Differential Equations. 269 (12) (2020), 11252–11278.

Parallelizable impulsive systems

Everaldo de Mello Bonotto
Universidade de São Paulo, Brazil

In this talk, we present a notion of parallelizability in the context of impulsive semidynamical systems. We investigate the relationship between parallelizable systems and the existence of sections and the relationship between parallelizable systems and dispersive systems.

On asymptotic and exponential stability of equations with a distributed delay

Elena Braverman
University of Calgary, Canada

We explore asymptotic and exponential stability of scalar equations and systems with a distributed delay. There are cases when stability is delay-independent, once the delay is not infinite. The dependency of stability properties on the delay distribution is also discussed. This is joint work with Leonid Berezansky.

Stability and global attractivity for a Nicholson's equation with mixed monotonicities

Teresa Faria
University of Lisbon, Portugal

We consider a Nicholson's equation with multiple pairs of time-varying delays, where each nonlinear term incorporates two delays and is given by a mixed monotone function. Sufficient conditions for the permanence and the global attractivity of its positive equilibrium are established. Our criteria depend on the size of some delays and enhance results in recent literature. This is joint work with Henrique C. Prates.

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Periodic solutions of Φ-Laplacian differential systems: continuation theorems and bound sets

Guglielmo Feltrin
University of Udine, Italy

We present some recent results about the existence of periodic solutions of vector differential systems involving Φ-Laplacian differential operators. We first review the corresponding theorems concerning the linear differential operator, then new continuation theorems are exploited to obtain existence results with "bound set" conditions. Moreover, as an application, we extend to the Φ-Laplacian vector case classical theorems by Hartman and Knobloch and by Reissig. The talk is based on a recent collaboration with prof. Fabio Zanolin (University of Udine, Italy).

Random Neural Networks with Delays

Xiaoying Han
Auburn University, USA

Lattice models of continuous-time recurrent neural networks with various types of delays will be introduced. A special character of the networks is random connection weights among neurons and non-Lipschitz activation functions. Existence of solutions, random attractors, as well as structures of the attractors, will be discussed. This is joint work with Meiyu Sui, Yejuan Wang, and Peter E. Kloeden.

On relation between single and multivalued semiflows and their attractors: three examples

Piotr Kalita
Jagiellonian University, Poland

For some problems of mathematical physics, while it is unknown how to prove the uniqueness of weak solutions, there holds the weak-strong uniqueness property. If the problem is, in appropriate sense, dissipative and one can bootstrap the regularity of the initial data such that the translations of weak solutions are strong solutions, then there exists a link between the single valued theory of global attractors for strong solutions and multivalued theory of global attractors for weak solutions. Namely, we prove that there exists the global attractor for weak solutions in the in the sense of multivalued semiflows [1, 2] and the one for strong solutions in the classical sense. Moreover, both attractors coincide. We present three problems of mathematical physics belonging to such class.

(1) Two dimensional Rayleigh-Bénard problem of thermal convection in thermomicropolar fluid. Here, every weak solution instantaneously becomes the global strong one and global attractors for both classes coincide. The problem is described in [3, 5].

(2) Forced surface quasi-geostrofic equation with critical damping. Here, similar as in (1), weak solutions instantaneously become strong ones and also global attractors for both classes coincide. The problem is described in [4, 5].

(3) Three dimensional Rayleigh-Bénard problem for micropolar fluids at large Prandtl number. Here, there exists the time T depending uniformly on the size of initial datum such that translation by this time of every weak solution is a global strong one, so passing from multivalued theory to the single valued one is not instantaneous. Still there exists the global attractor for, not necessaritly unique, weak solutions such that, on this attractor, the semiflow is governed by strong solutions and is single valued. The problem is described in [6].

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Neutral FDEs with state-dependent delays: an overview and new results

Jaqueline Godoy Mesquita
Universidade de Brasília, Brazil

In this talk, we will present an overview about neutral FDEs with state-dependent delays, as well as some recent advances in the study of these equations. Finally, we will discuss about open and developing problems in this direction. This is joint work with Bernhard Lani-Wayda.

Hidden Positivity and a New Approach to Rigorous Computation of Hausdorff Dimension: Higher Order Methods

Roger D. Nussbaum
Rutgers University, USA

We shall begin with an old motivating example: the question of rigorous computation of the Hausdorff dimension of some subsets of the real numbers which can be represented by special classes of continued fractions. We shall then generalize and describe a new approach to high order rigorous approximation of the Hausdorff dimension of the invariant set of an iterated function system or IFS which acts on a subset of the reals. We extend our earlier methods by allowing higher order numerical methods, but the extension requires new ideas. We again rely on the fact that associated to our IFS is a parametrized family $L(s)$, $s \geq 0$, of bounded positive linear operators. In our setting $L(s)$ is not compact but has essential spectral radius strictly less than its spectral radius $R(L(s))$ and for every positive integer k has a unique strictly positive k-times continuously differentiable eigenfunction $v(s)$ with eigenvalue $R(L(s))$. In our setting it is always true that there exists a unique $s^* \geq 0$ such that $R(L(s^*)) = 1$. The Hausdorff dimension h of the invariant set of the IFS always satisfies $h \leq s^*$, and under appropriate assumptions, $h = s^*$. For a positive integer m let $L(s;m)$ denote the mth iterate of $L(s)$ and note that the eigenvalue problem of estimating $R((L(s))$ is equivalent to the problem of estimating $R(L(s;m))$. This eigenvalue problem is then approximated using a collocation method, extended Chebyshev points and continuous piecewise polynomials of degree r to obtain a large square matrix $M(s;m)$ whose spectral radius $R(M(s;m))$ closely approximates $R(L(s;m))$. Using the theory of positive linear operators and explicit (s-dependent) bounds on the derivatives of the eigenfunction $v(s)$, we obtain explicit upper and lower bounds for s^*; and these upper and lower bounds converge rapidly to s^* as a certain mesh size decreases. This is joint work with Richard S. Falk (Rutgers University).

Existence and global bifurcation of periodic solutions for retarded functional differential equations on manifolds

Maria Patrizia Pera
Università di Firenze, Italy

In this talk, I will present some results on the existence and global bifurcation of T-periodic solutions to first and second order retarded functional differential equations with infinite delay on boundaryless smooth manifolds. I will consider both cases of a topologically nontrivial compact manifold (e.g., an even dimensional sphere) and of a possibly noncompact constraint, assuming in the latter case that the topological degree of a suitable tangent vector field is nonzero. The approach is topological and based on the fixed point index theory for locally compact maps on metric ANRs.

I will also show how to deduce from our results a Rabinowitz-type global bifurcation result as well as a Mawhin-type continuation principle.

Periodic perturbations of second order functional differential equations

Marco Spadini
Università di Firenze, Italy

Motivated by similar results existing for first order retarded equations, in this talk we investigate the set of (harmonic) periodic solutions of periodic perturbations to a particular class of retarded functional equations with quickly fading memory.

Namely, we consider scalar second order functional differential equations of the following form:

$$\ddot{x}(t) = g\left(x(t), \dot{x}(t), \int_{-\infty}^{t} \gamma_a^b(t-s)\varphi(x(s), \dot{x}(s))\,\mathrm{d}s\right), \tag{5}$$

where $g\colon \mathbb{R}^3 \to \mathbb{R}$ is a continuous map, $\varphi\colon \mathbb{R}^2 \to \mathbb{R}$ is Lipschitz continuous, and the integral kernel γ_a^b, for $a > 0$ and $b \in \mathbb{N} \setminus \{0\}$ is the gamma probability distribution

$$\gamma_a^b(s) = \frac{a^b s^{b-1} \mathrm{e}^{-as}}{(b-1)!} \text{ for } s \geq 0, \qquad \gamma_a^b(s) = 0 \text{ for } s < 0,$$

with mean b/a and variance b/a^2. We then prove a so-to-speak branching result for T-periodic solutions of the following perturbation of (5):

$$\ddot{x}(t) = g\left(x(t), \dot{x}(t), \int_{-\infty}^{t} \gamma_a^b(t-s)\varphi(x(s), \dot{x}(s))\,\mathrm{d}s\right) + \lambda f\Big(t, x(t), \dot{x}(t)\Big), \tag{6}$$

assuming that f is $T > 0$ periodic in t. Applications to existence and multiplicity of T-periodic solutions are shown.

The techniques employed are based on topological degree and fixed point index theory but a peculiarity of our end results is that it can be formulated and understood without any reference to these theories.

This is joint work with Alessandro Calamai and Maria Patrizia Pera.

Session on Linear Equations

Organizers: Igor A. Ferra (UFABC/Brazil) & Luis Fernando Ragognette (UFSCAR/Brazil)

The Cauchy Problem for 3-evolution operators in Gevrey type spaces

Alexandre Arias Junior
Universidade Federal do Paraná, Brazil

Consider the Cauchy Problem for evolution operators of the form

$$P(t,x,D_t,D_x) = D_t + a_p(t)D_x^p + \sum_{i=0}^{p-1} a_i(t,x)D_x^i, \quad t \in [0,T],\, x \in \mathbb{R},$$

where $T > 0$, $D = -i\partial$, $a_p(t) \in C([0,T];\mathbb{R})$, $a_p(t) \neq 0$ for every t and $a_i(t,x) \in C([0,T];C^\infty(\mathbb{R};\mathbb{C}))$, $i = 0,1,\ldots,p-1$. The operator P is known in the literature as $p-$evolution operator.

In the situation that each coefficient $a_i(t,x)$, $i = 0,1,\ldots,p-1$, is purely real, it is well known that that the Cauchy Problem is well posed in Sobolev spaces $H^m(\mathbb{R})$, $m \in \mathbb{R}$. When there are complex valued coefficients, some decay conditions at infinity are required in order to achieve well-posedness in $H^m(\mathbb{R})$ or $H^\infty(\mathbb{R}) = \cap_m H^m(\mathbb{R})$.

Concerning well-posedness results in Gevrey type spaces, as far as the authors know, there are only results for $p = 1$ (strictly hyperbolic operators) and $p = 2$ (Schrödinger type operators). In this lecture we focus in the case $p = 3$ and we prove sufficient conditions on the coefficients $a_i(t,x)$, $i = 0,1,2$, in order to obtain well-posedness of the Cauchy Problem associated with P, with initial data in Gevrey type spaces.

This is joint work with Alessia Ascanelli and Marco Cappiello.

Analytic and Gevrey Regularity for Sums of Squares

Antonio Bove
University of Bologna, Italy

We present three results concerning the regularity of solutions to sums of squares with real analytic data.

In the first we disprove Treves conjecture (sufficient part) in dimension $n \geq 4$.

In the second we give an optimality result for a generalization of the Métivier operator (in dimension 2.)

In the third we give the Gevrey regularity for general sums of squares in 2 variables.

Very weak solutions of hypoelliptic equations

Marianna Chatzakou
Ghent University, Belgium

I will present the works on the study of the well-posedeness of a set of hypoelliptic differential equations in the graded Lie group setting as appeared in [1], [2] and [3]. In these works we employ the notion of very weak solution and prove that, the notion of the very weak solution can be applied to our settings and converges, under some assumptions, to the classical solutions of them.

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[2] M. Chatzakou, N. Tokmagambetov and M. Ruzhansky, Fractional Schrödinger equations with singular potentials of higher order. II: Hypoelliptic case, *Rep. Math. Phys.*, to appear, arXiv:2105.12862 (2021).

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Global Gevrey solvability for a class of involutive systems

Cleber de Medeira

Federal University of Paraná, Brazil

This work deals with the global Gevrey solvability of the following system of complex vector fields

$$Lj = \partial/\partial t_j + (a_j + ib_j)(t_j)\partial/\partial x, \quad j = 1, \ldots, n,$$

defined on the $(n+1)$-dimensional torus, where a_j and b_j are real-valued functions belonging to the Gevrey class $G^s(\mathbb{T}^1)$, $s > 1$. We present a complete characterization to the global s-solvability of this system in terms of diophantine properties of the coefficients and the Nirenberg-Treves condition (P). This is joint work with Adalberto P. Bergamasco and Sérgio L. Zani.

Strichartz estimates for some variable coefficient Schrödinger operators

Serena Federico

Ghent University, Belgium

In this talk we will analyze the validity of Strichartz estimates for some classes of variable coefficient Schrödinger operators. We will first consider the problem in the Euclidean setting for a class of time-degenerate operators. Afterwards, we shall change the setting to the two-dimensional torus and study the problem for two classes of operators, specifically for some time-degenerate and for some space-variable nondegenerate Schrödinger operators. Local well-posedness results following from such estimates will also be given.

Elliptic sequences

Gerardo A. Mendoza

Temple University, USA

I'll discuss some aspects of sequences of first order differential operators $P_q : C^\infty(M; E^q) \to C^\infty(M; E^{q+1})$ which are elliptic in the sense that the symbol sequence is exact at any nonzero covector of T^*M, but the the composition $P_{q+1} \circ P_q$ is not zero, so not a complex. Some features are similar to those of elliptic complexes, but some are not. For instance, if M is compact, the sequence is finite, and the vector bundles E^q are Hermitian, then the index of the rolled up sequence is equal to the alternating sum of the dimensions of the null spaces of the Laplacians (this is not a deep result). Because of the exactness of the symbol sequence the operators $P_{q+1} \circ P_q$ are at most first order. I'll focus on the case where the order is in fact 0.

Remarks on sums of squares of complex vector fields

Alberto Parmeggiani
Università di Bologna, Italy

In this talk, I will review some hypoellipticity properties of operators of the kind sums of squares of complex vector fields and give a generalization of Kohn's subellipticity result.

Weighted Hardy Spaces and Ultradistributions

Patrícia Yukari Sato Rampazo
Universidade Federal Fluminense, Brazil

In this talk, we will introduce generalized Hardy spaces defined in cones and show that boundary values of functions in these Hardy spaces are well defined as global ultradistributions; and such ultradistributions can be identified as sums of boundary values of generalized Hardy space functions defined in different cones. The ultradistributions arise as elements of dual spaces of classes of globally L^q-integrable ultradifferentiable functions defined in terms of weight functions.

This is joint work with Gustavo Hoepfner and Andrew Raich.

On the range of unsolvable systems of complex vector fields

Antonio Victor da Silva Junior
Texas A&M University at Qatar, Qatar

In this talk we discuss some properties of the range of the differential complex associated to a locally integrable system of vector fields. We provide necessary conditions for solvability of certain systems of partial differential equations under local non-exactness assumptions in the differential complex.

Session on Multiscale Dynamics

Organizers: Yao Li (UMass Amherst/USA) & Zhongwei Shen (UAlberta/Canada)

Lyapunov exponents of high-dimensional, weakly dissipated SDE with applications to stochastic Galerkin-Navier-Stokes and Lorenz 96

Alex Blumenthal
Georgia Institute of Technology, USA

While chaos (sensitivity w.r.t. initial conditions, rapid decay of correlations) is expected to describe the behavior of a wide variety of real-world systems, it remains a major open challenge to prove the existence of these regimes in systems of practical interest. Remarkably, in the presence of stochastic driving, this problem becomes tractable, and one can prove results on chaos far beyond the scope of what is possible for deterministic systems. This talk will discuss recent results, joint with J Bedrossian (UMD) and S Punshon-Smith (IAS / Tulane), on establishing sensitivity w.r.t. initial conditions for weakly dissipated stochastic differential equations, with applications to the Lorenz 96 model and Galerkin truncations of stochastic Navier-Stokes.

Lyapunov exponents in random dynamical systems and how to find and use them

Maximilian Engel
Free University of Berlin, Germany

This talk aims to give an overview on various notions of Lyapunov exponents (LEs) in random dynamical systems, depending on the timescale one wants to study: from finite-time LEs to classical asymptotic LEs and corresponding spectra up to LEs for processes conditioned on staying in bounded domains. We demonstrate how these notions become relevant in the context of stochastic bifurcations, in finite and infinite dimensions. This is joint work with A. Blumenthal, M. Breden, T.S. Doan, C. Kuehn, J. Lamb, A. Neamtu, and M. Rasmussen.

Coexistence, extinction, and optimal harvesting in discrete-time stochastic population models

Alexandru Hening
Texas A&M, USA

We analyze the long-term behavior of interacting populations which can be controlled through harvesting. The dynamics is assumed to be discrete in time and stochastic due to the effect of environmental fluctuations. We present sharp extinction and coexistence criteria when there are one or two interacting species. We then use these tools in order to see when harvesting leads to extinction or persistence of species, as well as what the optimal harvesting strategies, which maximize the expected long-term yield, look like. For single species systems, we show under certain conditions that the optimal harvesting strategy is of bang-bang type: there is a threshold under which there is no harvesting, while everything above this threshold gets harvested.

Tipping near forced dynamic bifurcations: smooth vs. non-smooth

Rachel Kuske
Georgia Tech, USA

We contrast the behavior of dynamic bifurcations near smooth and non-smooth fold bifurcations, with periodic or noisy forcing. Dynamic bifurcation refers to the state transition or "tipping" that takes place when a parameter slowly varies through a value corresponding to a bifurcation in the static parameter case. Note that these models correspond to non-autonomous systems with multiple time scales. Historically dynamic bifurcations have been studied for 1D unforced systems and white noise forcing, but have received relatively little attention for larger systems with oscillatory forcing and time-varying coefficients, delayed feedback, and non-smooth bifurcations. We give results for high and low frequency forcing, and contrast the behavior for smooth and non-smooth dynamics near bifurcations. We develop new approaches in the setting of a Stommel ocean (AMOC) circulation model, and compare with other canonical models. We then apply to a variety of applications in environmental and biological dynamics. We also highlight some critical features for non-smooth dynamic bifurcations in the stochastic setting. This is joint work with Chris Budd, Cody Griffith, and Ziming Yin.

Population persistence under different noises

Weiwei Qi
University of Alberta, Canada

We study a family of randomly perturbed dynamical systems that mainly arise from chemical reactions and population dynamics. They often display multi-scale dynamics. In order to characterize the multi-scale dynamics in very detail, we established the sub-exponential large deviation principle of quasi-stationary distributions and the sub-exponential asymptotic of the principal eigenvalue of the Fokker-Planck operator. This also allows us to characterize the lifespan of transient dynamics. It turns out that the lifespan is asymptotically the reciprocal of the principal eigenvalue. This is joint work with Zhongwei Shen and Yingfei Yi.

Statistical Physics and Thermodynamic Behavior of Scientific Data

Hong Qian
University of Washington, USA

If we consider entropy as a potential function, then its derivatives w.r.t. independent variables are entropic forces: temperature, pressure, and chemical potentials are all entropic forces. When two systems reach a thermodynamic equilibrium, their entropic forces are balanced, e.g., equal temperature, pressure, and chemical potential. This equal conjugate variables is actually a consequence of "equal treatment of data": When we add X1 to X2, we made an assumption to give them an "equal treatment". This yields their conjugate variables being equal. Therefore, the concept of thermodynamic equilibrium is in fact a fundamental theorem of data science. The assumptions one makes in statistical data processing will appear as mathematical results in the form of information entropic force balance.

Machine learning with large learning rate: dynamics revealed implicit biases

Molei Tao
Georgia Tech, USA

This talk will present some of our efforts in showing how dynamics help understand deep learning practice. Some implicit biases of training with large learning rates will be quantified. For example, they can lead to quantitative escapes from local minima, via chaotic dynamics, which is an alternative mechanism to commonly known noisy escapes due to stochastic gradients. I will also report how larger learning rates bias toward flatter minimizers, which are often believed to be associated with better test accuracies.

Can one hear the shape of high-dimensional landscape?

Shirou Wang
University of Alberta, Canada

This talk introduces a numerical coupling approach, which is relatively dimension-free, in understanding the landscape of potential functions including those in high dimensions. Running a large number of sample pairs of trajectories of the stochastic gradient flow and making each pair coupled efficiently, the coupling times are collected and the corresponding distributions are computed. Theoretically, for potential functions with single or multiple local minima, the coupling time distributions admit qualitatively distinct exponential tails in terms of noise magnitudes. This provides a promising way to numerically probe the shape of a potential function. The barrier height of a potential function can also be computed via linear extrapolation. A wide range of numerical examples will be demonstrated, from the classical quadratic well potentials, Rosenbrock functions, to the more complicated ones including interacting particle systems in double potentials, and loss landscapes of neural networks with different sizes. This is joint work with Yao Li and Molei Tao.

Nonlinear model reduction for slow-fast stochastic systems near unknown invariant manifolds

Felix X.-F. Ye
SUNY Albany, USA

We introduce a nonlinear stochastic model reduction technique for high-dimensional stochastic dynamical systems that have a low-dimensional invariant effective manifold with slow dynamics, and high-dimensional, large fast modes. Given only access to a black box simulator from which short bursts of simulation can be obtained, we design an algorithm that outputs an estimate of the invariant manifold, a process of the effective stochastic dynamics on it, which has averaged out the fast modes, and a simulator thereof. This simulator is efficient in that it exploits of the low dimension of the invariant manifold, and takes time steps of size dependent on the regularity of the effective process, and therefore typically much larger than that of the original simulator, which had to resolve the fast modes. The algorithm and the estimation can be performed on-the-fly, leading to efficient exploration of the effective state space, without losing consistency with the underlying dynamics. This construction enables fast and efficient simulation of paths of the effective dynamics, together with estimation of crucial features and observables of such dynamics, including the stationary distribution, identification of metastable states, and residence times and transition rates between them. I will talk about the possible extension in the talk. This is joint work with Sichen Yang and Mauro Maggioni.

Session on Nonlinear Dynamical Systems

Organizers: Phillipo Lappicy (UFRJ/Brazil) & Marcone C. Pereira (USP/Brazil)

Selective Feedback Stabilization of Ginzburg-Landau Spiral Waves in Circular and Spherical Geometries

Jia-Yuan Dai
National Chung Hsing University, Taiwan

The complex Ginzburg-Landau equation serves as a paradigm of pattern formation. Within circular and spherical geometries, the existence and stability property of Ginzburg-Landau spiral waves have been proved. However, many spiral waves are unstable and thereby rarely visible in experiments and numerical simulation. In this talk we selectively stabilize certain significant classes of unstable spiral waves. Our tool for stabilization is the control triple method, which generalizes the celebrated Pyragas control to the setting of PDEs. This is a joint work with I. Schneider and B. de Wolff.

Asymptotic behaviour for a localized reaction-diffusion equation

Raúl Ferreira
Universidad Complutense de Madrid, Spain

We study the behaviour of unbounded solutions to the semilinear heat equation with a reaction localized in a ball

$$u_t = \Delta u + \chi_{B_L} u^p,$$

for $0 < L < \infty$. We study when global solutions are bounded or unbounded. In particular we show that the precise value of the length L plays a crucial role in the critical case $p = 1$ for $N \geq 3$. We also obtain the asymptotic behaviour of unbounded solutions and prove that the grow-up rate is different to the one obtained when $L = \infty$. This is joint work with A. de Pablo.

Limit models for thin heterogeneous structures with high contrast

Antonio Gaudiello
Università degli Studi della Campania "Luigi Vanvitelli", Italy

We investigate two diffusion problems, with strongly contrasting diffusivity, in a thin heterogeneous cylinder with a small cross-section of radius h_n. In this cylinder we distinguish an inner cylindrical core with cross-section of radius $r_n << h_n$ and its complementary annulus, and we treat two complementary cases. In the first case we consider a low conductivity of order δ_n^2 in the core and a conductivity of order 1 in the annulus; the opposite situation in the second case. We study the asymptotic behavior of these problems as h_n, r_n, $\frac{r_n}{h_n}$, and δ_n vanish. This is a joint work with A. Sili (Institut de Mathématiques de Marseille (I2M), UMR 7373, Aix-Marseille Université, CNRS, Centrale Marseille).

Homogenization in random domains

Arianna Giunti
Imperial College London, UK

We consider the homogenization of a Stokes/ Navier-Stokes system in a domain having many small random holes. This model mainly arises from problems of solid-fluid interaction (e.g. the flow of a viscous and incompressible fluid through a porous medium). We investigate the rigorous derivation of the homogenization limit both in the Brinkmann regime and in the one of Darcy's law. In particular, we focus on holes that are distributed according to probability measures that allow for overlapping and clustering phenomena. This is joint work with J. J. L. Velazquez and R. Hoefer.

Existence of Rotating Waves in Oscillatory Media with Nonlocal Coupling

Gabriela Jaramillo
University of Houston, USA

Biological and physical systems that can be classified as oscillatory media give rise to interesting phenomena like target patterns and spiral waves. The existence of these structures has been proven in the case of systems with local diffusive interactions. In this talk the more general case of oscillatory media with nonlocal coupling is considered. We model these systems using evolution equations where the nonlocal interactions are expressed via a diffusive convolution kernel, and explore the existence of rotating wave solutions. Our approach consists on first deriving a normal form for this system and then using a multiple-scale analysis and Lyapunov-Schmidt reduction to rigorously prove the existence of these patterns.

Parabolic semilinear PDE with crowded dependence and attractors

Pedro Marin Rubio
Universidad de Sevilla, Spain

We present some results concerning existence of solutions and attractors for dynamical systems coming from PDEs with nonlocal diffusion.

This is a joint-work with T. Caraballo and M. Herrera-Cobos.

Homogenization of the non-isothermal, non-Newtonian fluid flow in a thin domain with oscillating boundary

Jean Carlos Nakasato
University of Zagreb, Croatia

In this paper, we study the flow of a non-Newtonian fluid through a thin three-dimensional domain with an oscillating boundary. Starting from a nonlinear coupled system describing a non-isothermal regime of the flow, we rigorously derive three different effective models, depending on the period of the boundary roughness. We employ a homogenization technique based on the adaption of the unfolding method and deduce the roughness-induced effects on the fluid flow. This is joint work with Igor Pazanin.

Asymptotic analysis of the nonsteady micropolar fluid flow through a pipe

Igor Pažanin
University of Zagreb, Croatia

In this talk, we consider a time-dependent flow of an incompressible micropolar fluid through a thin pipe. The effective behavior of the flow is found by means of asymptotic analysis with respect to the pipe's thickness. The complete asymptotic expansion (up to an arbitrary order) of the solution is constructed and the detailed boundary-layer analysis is provided. The convergence of the expansion is proved rigorously justifying the formally derived asymptotic model. This is joint work with Michal Benes and Marko Radulovic.

Nonlocal diffusion equations in perforated domains

Silvia Sastre Gómez
Universidad de Sevilla, Spain

In this work, we analyze the behavior of the solutions to nonlocal evolution equations with a nonlocal nonlinear reaction term in a perturbed perforated domain. This perforated domain is thought of as a fixed set from where we remove a subset called the holes. We choose appropriated families of bounded functions in order to deal with both Neumann and Dirichlet conditions in the holes setting and Dirichlet condition outside the domain. Under the assumption that the characteristic functions of the perturbed domain have a weak limit, we study the limit of the solutions providing a nonlocal homogenized equation. This is joint work with and Marcone C. Pereira.

ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS

2022 CHAPTER

Programme

	MONDAY 31	TUESDAY 1	WEDNESDAY 2
08:50-09:00 (UTC -3)	**Opening**		

Plenary Lectures

	MONDAY 31	TUESDAY 1	WEDNESDAY 2
Chair	Alexandre Nolasco de Carvalho	Ederson Moreira dos Santos	Márcia Federson
09:00-09:50 (UTC -3)	**John Mallet-Paret** Brown University	**Márcia Federson** Universidade de São Paulo	**Yingfei Yi** Univ. of Alberta and Jilin Univ.
10:00-10:50 (UTC -3)	**Angela Pistoia** Sapienza Università di Roma	**Mónica Clapp** Univ. Nac. Autónoma de México	**Helena J. Nussenzveig Lopes** Univ. Federal do Rio de Janeiro
11:00-11:50 (UTC -3)	**Tomás Caraballo** Universidad de Sevilla	**Eduardo Teixeira** University of Central Florida	**Konstantin Mischaikow** Rutgers University

Special Session on Nonlinear Dynamical Systems

	MONDAY 31	TUESDAY 1	WEDNESDAY 2
Chair	Phillipo Lappicy Lemos Gomes	Juliana Fernandes	Marcone C. Pereira
14:00-14:50 (UTC -3)	**Raúl Ferreira** Univ. Complutense de Madrid	**Antonio Gaudiello** U. della Campania Luigi Vanvitelli	**Arianna Giunti** Imperial College London
15:00-15:40 (UTC -3)	**Jia-Yuan Dai** National Chung Hsing University	**Igor Pazanin** University of Zagreb	**Jean Nakasato** University of Zagreb
15:50-16:30 (UTC -3)	**Gabriela Jaramillo** University of Houston	**Silvia Sastre Gomez** Universidad de Sevilla	**Pedro Marín-Rubio** Universidad de Sevilla

Special Session on Conservation Laws and Transport Equations

	MONDAY 31	TUESDAY 1	WEDNESDAY 2
Chair	Jean Silva	Wladimir Neves	Gerardo Cardenas Huaroto
14:00-14:50 (UTC -3)	**Paulo Amorim** Univ. Federal do Rio de Janeiro	**Henrique Versieux** Univ. Federal de Minas Gerais	**Daniel Rodriguez Marroquin** Univ. Federal do Rio de Janeiro
15:00-15:40 (UTC -3)	**Gerardo Cardenas Huaroto** Universidade Federal de Alagoas	**João Fernando Nariyoshi** Univ. Estadual de Campinas	**Fabio Julio Valentim** Univ. Federal do Espírito Santos
15:50-16:30 (UTC -3)	**Juan Gonzalez Marin** Universidade Federal da Bahia	**Vernny Chavez Ccajma** Univ. Federal do Rio de Janeiro	

Special Session on Elliptic Equations

	MONDAY 31	TUESDAY 1	WEDNESDAY 2
Chair	Claudianor Alves	Marcos Pimenta	Eugenio Massa
14:00-14:50 (UTC -3)	**Vicentiu Radulescu** University of Craiova	**Alfonso Castro** Harvey Mudd College	**Claudianor Alves** Univ. Federal de Campina Grande
15:00-15:40 (UTC -3)	**Sergio Segura de León** Universitat de València	**Enea Parini** Aix-Marseille Université	**Massimo Grossi** Sapienza Università di Roma
15:50-16:30 (UTC -3)	**Raffaella Servadei** University of Urbino Carlo Bo	**Humberto Ramos Quoirin** Universidad Nacional de Cordoba	**Liliane Maia** Universidade de Brasília

Special Session on Fluid Dynamics

	MONDAY 31	TUESDAY 1	WEDNESDAY 2
Chair		Gabriela Planas	Anne Bronzi
14:00-14:50 (UTC -3)		**Alexei Mailybaev** IMPA, Brazil	**Cecilia Mondaini** Drexel University
15:00-15:40 (UTC -3)		**Fábio Ramos** Univ. Federal do Rio de Janeiro	**Diego Araujo de Souza** Universidad de Sevilla
15:50-16:30 (UTC -3)		**Cilon Perusato** Univ. Federal de Pernambuco	**Bianca M. Rodolfo Calsavara** Univ. Estadual de Campinas
16:40-17:20 (UTC -3)		**Ricardo M. Mendes Guimarães** Univ. Estadual de Campinas	

Special Session on Free Boundaries Problems and Related Topics

	MONDAY 31	TUESDAY 1	WEDNESDAY 2
Chair	João Vitor da Silva	Mariana Smit Vega Garcia	Gabrielle Nornberg
14:00-14:50 (UTC -3)	**Donatella Danielli**	**Claudia Lederman**	**Daniela De Silva**

	Arizona State University	Universidad de Buenos Aires	Columbia University
15:00-15:40 (UTC -3)	**Cristiana De Filippis** University of Parma	**Diego Marcon** Univ. Fed.do Rio Grande do Sul	**Hugo Tavares** Instituto Superior Técnico
15:50-16:30 (UTC -3)	**Giane Rampasso** Univ. Estadual de Campinas	**Jefferson Abrantes Santos** Univ. Federal de Campina Grande	**Hérnan Vivas** Univ. Nacional de Mar del Plata

	Special Session on Harmonic Analysis and Related Topics		
Chair	Tiago Picon	Claudio Vasconcelos Filho	Lucas Oliveira
14:00-14:50 (UTC -3)	**Mario Milman** IAM, Argentina	**Emmanuel Russ** Université Grenoble Alpes	**Jorge Antezana** Universidad Nacional de La Plata
15:00-15:40 (UTC -3)	**Almut Burchard** University of Toronto	**Monica Torres** Purdue University	**João Pedro Ramos** ETH Zurich
15:50-16:30 (UTC -3)	**Thaís Jordão** Universidade de São Paulo	**Mateus Costa de Sousa** BCAM, Spain	**Chun Ho Lau** Concordia University
16:40-17:20 (UTC -3)	**Claudio Vasconcelos Filho** Univ. Federal de São Carlos		

	Special Session on Integral and Functional Differential Equations		
Chair	Pierluigi Benevieri	Marco Spadini	Jaqueline Godoy Mesquita
14:00-14:50 (UTC -3)	**Roger Nussbaum** Rutgers University	**Elena Braverman** University of Calgary	**Teresa Faria** Universidade de Lisboa
15:00-15:40 (UTC -3)	**Piotr Kalita** Jagiellonian University	**Maria Patrizia Pera** University of Florence	**Marco Spadini** Università di Firenze
15:50-16:30 (UTC -3)	**Guglielmo Feltrin** Università degli Studi di Udine	**Jaqueline Godoy Mesquita** Universidade de Brasília	**Pierluigi Benevieri** Universidade de São Paulo
16:40-17:20 (UTC -3)	**Everaldo M. Bonotto** Universidade de São Paulo	**Xiaoying Han** Auburn University	

	Special Session on Linear Equations		
Chair	Renan Medrado	Bruno de Lessa Victor	Max Reinhold Jahnke
14:00-14:50 (UTC -3)	**Antonio Bove** Università di Bologna	**Alberto Parmeggiani** Università di Bologna	**Gerardo Mendoza** Temple University
15:00-15:40 (UTC -3)	**Cleber de Medeira** Universidade Federal do Paraná	**Serena Federico** Ghent University	**Patrícia Yukari Sato Rampazo** Universidade Federal Fluminense
15:50-16:30 (UTC -3)	**Alexandre Arias Junior** Universidade Federal do Paraná	**Marianna Chatzakou** Ghent University	**Antonio Victor da Silva Junior** Texas A&M University, Qatar

	Special Session on Multiscale Dynamics		
Chair	Zhongwei Shen	Molei Tao	Yao Li
14:00-14:50 (UTC -3)	**Rachel Kuske** Georgia Tech.	**Hong Qian** University of Washington	**Molei Tao** Georgia Tech.
15:00-15:40 (UTC -3)	**Alex Blumenthal** Georgia Tech.	**Maximilian Engel** Free University of Berlin	**Shirou Wang** Jilin University
15:50-16:30 (UTC -3)	**Alex Hening** Texas A&M University	**Weiwei Qi** University of Alberta	**Felix Ye** SUNY Albany

ICMC SUMMER MEETING ON
DIFFERENTIAL EQUATIONS
2022 CHAPTER

List of Speakers

List of speakers (ordered by last name)

ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS

2022 CHAPTER

Sponsors

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