2020
chapter

ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS

3-5 FEBRUARY 2020 | SÃO CARLOS, SP BRAZIL
summer.icmc.usp.br

Celebrating the **60th** birthday of

TOMÁS CARABALLO

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John Mallet-Paret (Brown University/USA)
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Shui-Nee Chow (Georgia Institute of Technology/USA)
Xiaoying Han (Auburn University/USA)
Yingfei Yi (University of Alberta/Canada and JLU/China)

LIST OF SESSIONS

Elliptic Equations
Fluid Equations
Linear Equations
Evolution Equations and Applications
Integral and Functional Differential Equations
Boundary Perturbations of Domains for PDEs and Applications
Nonlinear Dynamical Systems
Dispersive Equations
Conservation Laws and Transport Equations
Poster Session

USP ICMC USP SÃO CARLOS CAPES CNPq FAPESP

Welcome

It is a pleasure to welcome you to the *ICMC Summer Meeting on Differential Equations - 2020 Chapter* and to São Carlos. We wish you a pleasant stay and that you enjoy the meeting.

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Xiaoying Han (Auburn University/USA)

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Session Organizers

Claudianor O. Alves (UFCG/Brazil) & Marcone C. Pereira (USP/Brazil) - Elliptic Equations/Boundary Perturbations of Domains for PDEs and Applications

Gabriela Planas (UNICAMP/Brazil) & Jean Silva (UFMG/Brazil) - Conservation Laws and Transport Equations/Fluid Dynamics

Rafael Gonzales (UEL/Brazil) & Gabriel Araújo (USP/Brazil) - Linear Partial Differential Equations

Pierluigi Benevieri (USP/Brazil) - Integral and Functional Differential Equations

Juliana Fernandes (UFRJ/Brazil) - Nonlinear Dynamical Systems/Evolution Equations and Applications

Márcia A. G. Scialom & Mahendra Panthee (UNICAMP/Brazil) - Dispersive Equations

Address

ICMC Summer Meeting on Differential Equations - 2020 Chapter
Instituto de Ciências Matemáticas e de Computação
Universidade de São Paulo
Avenida Trabalhador São-carlense, 400
CEP: 13566-590 - São Carlos - SP
FAX: +55 (16) 3371-2238
E-mail: summer@icmc.usp.br

ICMC SUMMER MEETING on DIFFERENTIAL EQUATIONS

CHAPTER 2020

Maps

Nome/Name: _____

Hosted in São Sarlos at the hotel: _____

Address: _____

Phone number: _____

Contact: _____

Tipo sanguíneo / Blood type: _____

Tomando medicação/Taking medication: _____

Alérgico a medicamentos / Alergic to medication: _____

Doença crônica / Chronic disease: _____

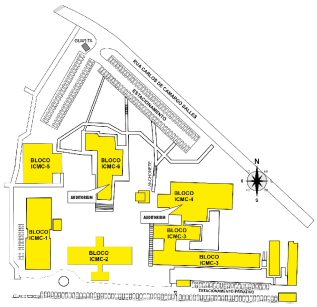
USEFUL NUMBERS

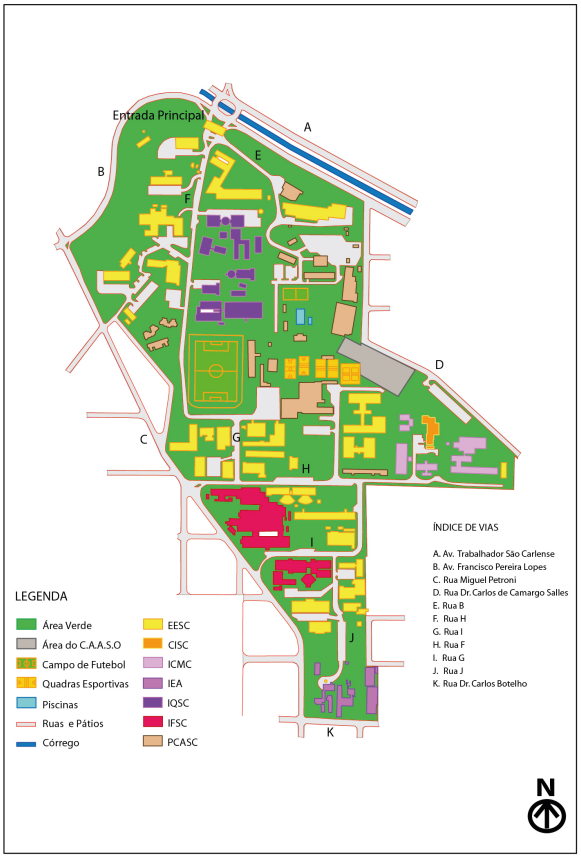
3373-9700	ICMC-USP
3373-9112	Campus Security Staff
190	Police Dept.
192	Medical Emergency
193	Fire Dept. and Rescue
0800-560159	National Courier Service
3371-2171	Local Post Office
3415-6005	Taxi-Cab Co.

www.visitesaocarlos.com.br/taxis.htm
(other Taxi-Cab Companies)

ENTRANCES AND EXITS OF THE CAMPUS

1. ICMC entrance
2. Main entrance
3. Observatory´s entrance
4. Physic´s institute entrance
5. Physic´s institute entrance





HOTÉIS - HOTELS

H1. Indaiá Hotel
R. Jacinto Favoreto, 351

H2. Atlantic Inn Residence
R. Salomão Dibbo, 321

H3. Indaiá Hotel Residence
R. Jacinto Favoretto, 782

H4. Parisi Hotel
Av. São Carlos, 3.163

H5. Hotel Anacã
Av. São Carlos, 2.690

H6. Hotel Ypê
Av. Dr. Carlos Botelho, 2.060

H7. Central Park Apart Hotel
Av. Francisco Pereira Lopes, 2.600

H8. Hotel Acaccio
Av. São Carlos, 1.981

H9. Atlantic Inn Royale
R. Conde do Pinhal, 1.630

H10. Hotel Caiçara
R. Conde do Pinhal, 2.217

H11. Hotel Othon Suítes
R. Cons João Alfredo, 77

H12. Ibis Hotel
R. Passeio dos Ipês, 140

H13. Sleep Inn
R. Cons João Alfredo, 455

BRAZILIAN SOUVENIRS

1. Papelaria CAASO (USP)
2. Praça XV de novembro (Sunday after 15h)
3. Duda Maria
   rua José Bonifácio, 1177 - 3307.2402

RECOMMENDED BAR, RESTAURANTS AND PIZZERIAS

R1. Restaurante Kallas
Av. São Carlos, 2784 - 3364.6362 - LUNCH/DINNER

R2. Quase 2 Restaurante e Hamburgueria
Av. São Carlos, 2796 - 3372.7240 - LUNCH and FAST FOOD at night

R3. Roda Chopp Restaurante
Av. São Carlos, 2603 - 3372.2343 - LUNCH ONLY

R4. Restaurante La Salute
R. Cons. João Alfredo, 47 - 3116.4939 - VEGETARIAN FOOD - LUNCH ONLY

R5. Casa do Café Restaurante
R. Riachuelo, 1201 - 3371.3033 - LUNCH/DINNER

R6. Cantina Ciao Bello
R. Riachuelo, 1.191 - 3371.4174 - LUNCH ONLY

R7. Restaurante Curinga
Av. Trabalhador Sãocarlense, 650 - 3413.3777 - LUNCH ONLY

R8. Barone Restaurante
Av. Dr. Carlos Botelho, 1.671 - 3412.8586 - LUNCH/DINNER

R9. Restaurante Mosaico
R. Aquidaban, 1.342 - 3371.4474 - LUNCH/DINNER

R10. Yo Konno
R. Aquidaban, 1368 - 3413.1666

R11. YouOki Culinária Asiática
R. Aquidaban, 1390 - 3415.2848 - ASIAN FOOD - LUNCH/DINNER

R12. Restaurante Paraíso
R. Dna. Maria Jacinta, 340 - 3376.6424 - LUNCH ONLY

R13. Habbib´s
Av. Trabalhador Sãocarlense, 620 - 3371.2223 - LUNCH/DINNER

R14. Bom Pedaço Pizza & Bar
Av. Trabalhador Sãocarlense, 584 - 3371.3696 - DINNER ONLY

R15. La Villa Restaurante e Lanchonete
R. Quinze de Novembro, 1330 - 3376.2843 - LUNCH/DINNER
Tip: Special brazilian food (Feijoada) and music at Saturdays

R16. Amici Pizza & Cibo
R. Quinze de Novembro, 1289 - 3371.6463 - DINNER ONLY

R17. West Brothers Chopp & Culinária
Av. Trabalhador Sãocarlense, 671 - 3415.5717 - DINNER ONLY

R18. Yasan Restaurante/Bar
Av. Dr. Carlos Botelho, 1768 - 3307.1165 - LUNCH/DINNER

R19. King Fish Restaurante
Av. Trabalhador Sãocarlense, 25 - 3412.7400 - DINNER ONLY

R20. Restaurante Picanha na Tábua
Av. Francisco Pereira Lopes, 2520 - 3361.1453 - LUNCH/DINNER

R21. McDonald´s
Av. São Carlos, 3134 - 3374.7402 - 24 hours

R22. Seo Gera
R. Episcopal, 2442 - 3372.1051 - DINNER ONLY

R23. Trembão Burger & Grill
Av. São Carlos, 3055 - 3307.6189 - DINNER ONLY

R24. Restaurante Mamãe Natureza
R. Cap. Adão Pereira Cabral, 457 - 3374.2653 - VEGETARIAN FOOD - LUNCH ONLY

R25. China in Box
Av. São Carlos, 3030 - 3376.1221 - LUNCH/DINNER

R26. Restaurante Panela
R. Dr. Orlando Damiano, 2157 - 3371.4157 - LUNCH/DINNER

R27. Casa do Filé Restaurante
R. Nove de Julho, 1688 - 3307.2412 - DINNER ONLY

R28. Restaurante Frei Damião
R. Nove de Julho, 1606 - 3416.8133 - LUNCH ONLY

R29. Restaurante Frei Damião
R. Quinza de Novembro, 1447 - 3416-3276 - LUNCH ONLY

R30. Don Raffaele Pizze & Ristorante
R. Marechal Deodoro, 1758 - 3371.1478 - ONLY DINNER

R31. Subway
Av. São Carlos, 2911 - 3416.4000 - 24 hours

R32. Kalil Cozinha Árabe
R. Dr. Carlos Botelho, 1737 - 3372.1696
ARABIC AND VEGETARIAN FOOD - LUNCH/DINNER

R33. Café Sete - Café Gastrobar
R. Sete de Setembro, 1447 - 3415.1026 - DINNER ONLY

R34. Churrascaria Tabajara
Av. São Carlos, 3677 - 3361.4282 - STEAKHOUSE - LUNCH/DINNER

R35. Churrascaria Trevo
Av. Prof. Luis Augusto de Oliveira, 385
(extension of the Av. São Carlos) - 3361.3052 - STEAKHOUSE - LUNCH/DINNER

R36. Restaurante e Buffet Cantos e Contos
Rua Major José Inácio, 2211 - 3372.6661

R37. Restaurante Sushi Ya-San
Rua Tiradentes, 128 - 3307.1165 - JAPANESE FOOD - LUNCH/DINNER

R38. A Fábrica Cervejaria Artesanal
Rua 28 de Setembro, 2066 - 3372.6288 - DINNER ONLY

R39. Restaurante Niray
Rua Major José Inácio, 2273 - 3415-6505 - JAPENESE FOOD - LUNCH/DINNER

R10. Restaurante e Choperia Rola Papo
Rua Major José Inácio, 2270 - 3412-6757 - DINNER ONLY

R41. Água Doce Cachaçaria
Rua 9 de julho, 1625 - 3376.2077 - LUNCH/DINNER

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ICMC USP SÃO CARLOS


Rodovia Washington Luiz
UFSCAR
Churrascaria Trevo (R36)
Churrascaria Tabajara (R35)
USP (campus 2)
Café Tropical
Shopping Center
Ibis Hotel (H12)
Av. Comendador
Alfredo Maffei
USP - São Carlos
Campus 1
Al. dos Crisântemos
R. Alvarenga Peixoto
R. W. Cury
Av. Trabalhador Sãocarlense
Al. das Hortências
Al. das Crisandálias
Av. das Azaléias
Av. Prof. Luis A. Oliveira
R. Antonio Blanco
R. Dna. Alexandrina
R. São Joaquim
R. Salomão Dibbo
R. 9 de Julho
R. Achile Bassi
R. Cezar Ricomi
R. Jacinto Favoretto
Rodoviária
(Bus Station)
R. Episcopal
R. Adolfo Cattani
R. Alfredo Lopes
R. Orlando Damiano
R. Tiradentes
R. 28 de Setembro
R. Miguel Petrone
Rua Dr. Carlos de Camargo Salles
Bank of Brazil AG 6845-4
11h00m to 16h00m
MON to FRI
PAPELARIA
CAASO
BIBLIOTECA
PRAÇA
ALOGAMENTO
ICMC-USP
(ZOOM UP AT THE BACK OF THIS PAGE)
R. Conselheiro João Alfredo
R. Dna. Maria Jacinta
R. Dr. Serafim Vieira de Almeida
Santa Casa
(Hospital)
R. Princesa Isabel
R. Maestro João Seppe
R. Paulino Botelho de Abreu Sampaio
R. Paulino Botelho A. Sampaio
R. Cap. Adão Pereira de Souza Cabral
Av. Dr. Carlos Botelho
Av. São Carlos
Praça
XV de
Novembro
R. 15 de Novembro
R. São Sebastião
R. Visconde de Inhaúma
R. Aquidaban
R. José Bonifácio
Escola
Dr. Álvaro
Guião
R. Padre Teixeira
R. Riachuelo
R. Marechal Deodoro
R. 7 de Setembro
Praça
dos
Pombos
R. Major José Inácio
R. Conde do Pinhal
Catedral
Praça
da
Catedral
Av. Comendador Alfredo Maffei
Centro
Portaria "A"
Portaria "B"
Portaria "C"
Portaria "D"
Campus Entrances
Money Exchange
Hotel
ATM
Drugstore
Supermarket-Grocery
Post Office
Bus Station
Bakery-Coffee-Snack bar
Restaurant
Other restaurant or Pizzeria
Açaí (Brazilian Ice Cream)
Bar Restaurant

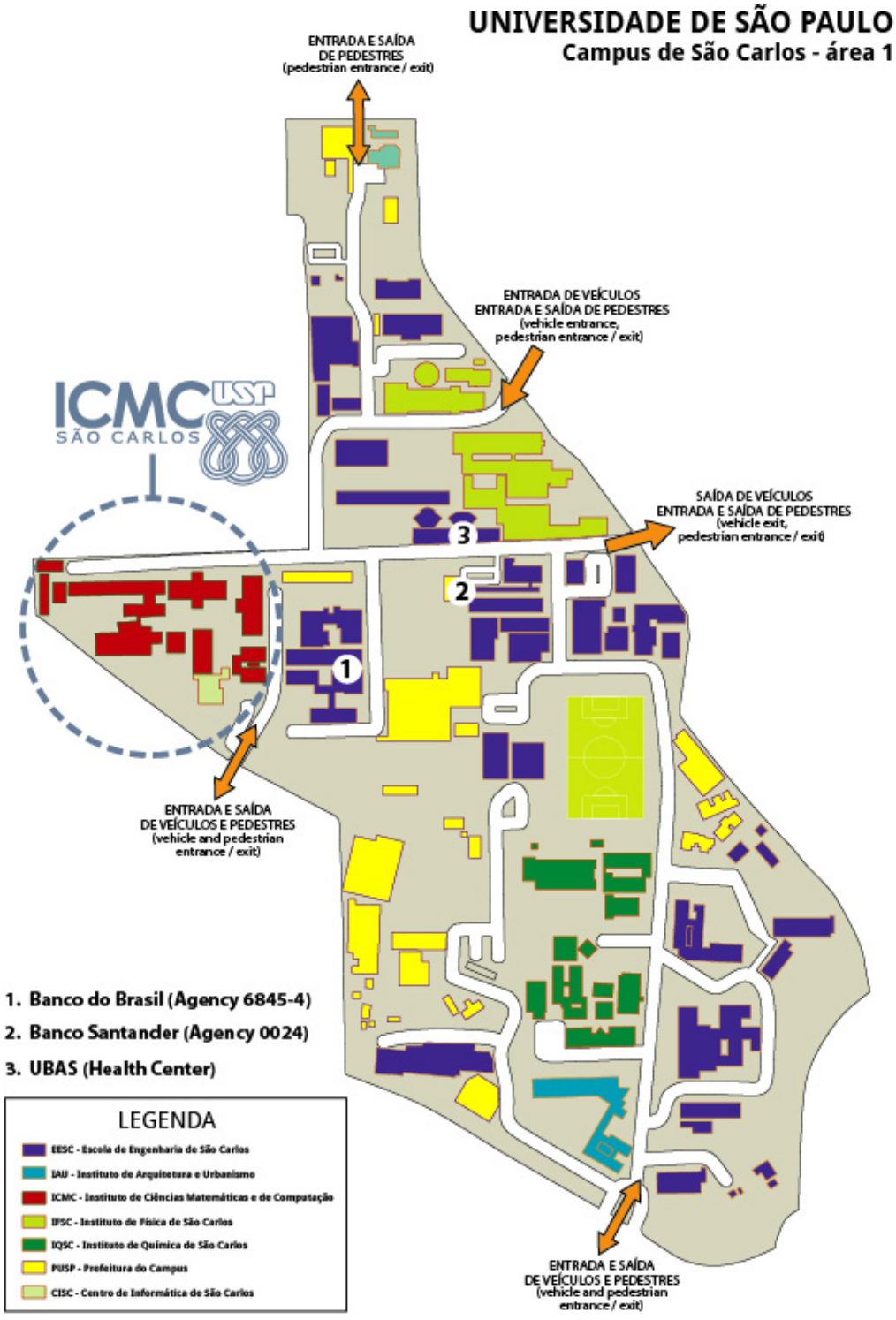

Figure 1: Campus map

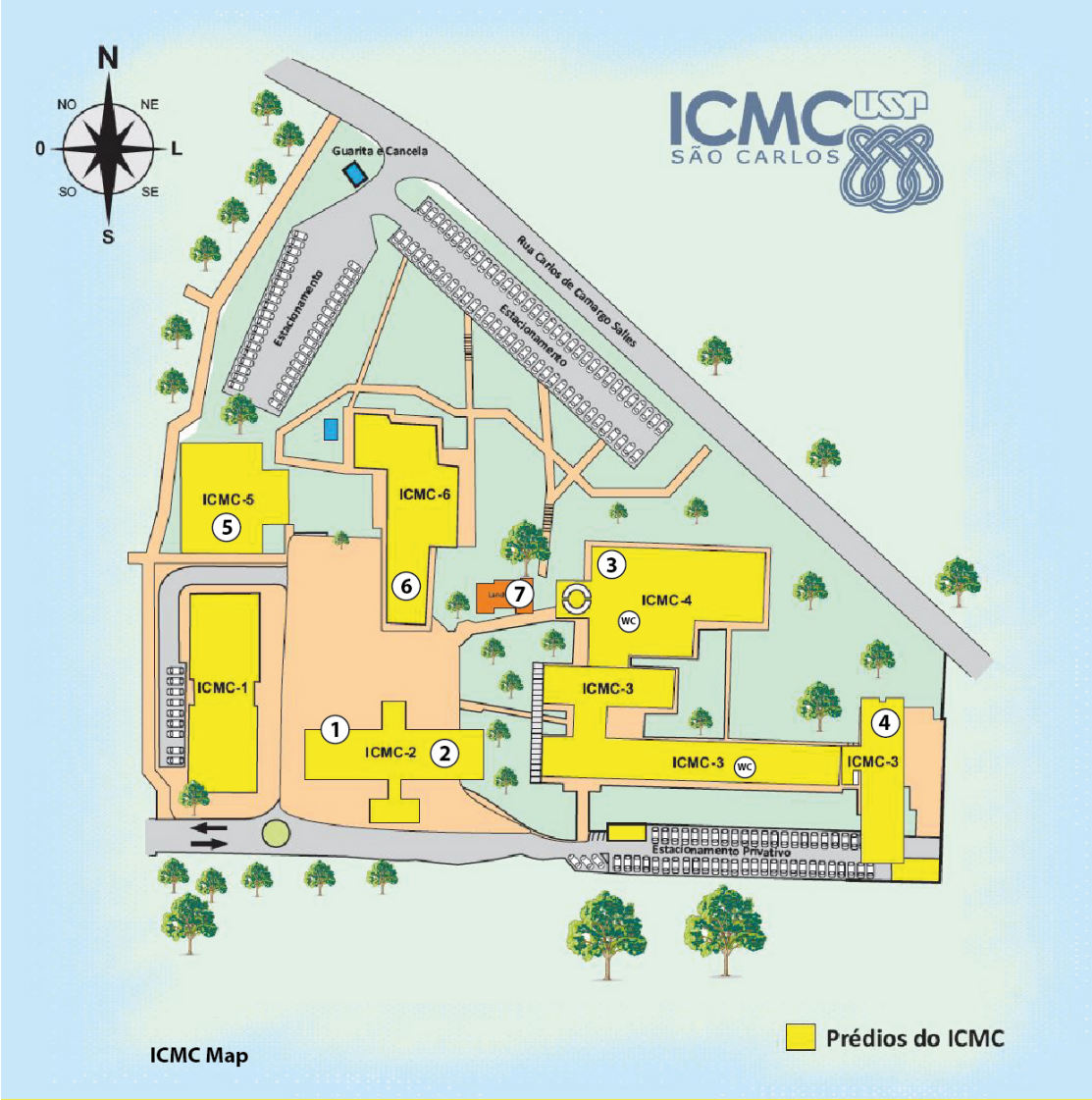

Figure 2: ICMC map

Contents

ICMC SUMMER MEETING on
DIFFERENTIAL EQUATIONS
CHAPTER 2020

General Information

Conference site

The meeting will take place at Buildings 5 and 6, and also in the Coffee Area, of ICMC. All these buildings are indicated in the map on page 8.

Plenary talks will take place at the Auditorium (Building 6).

Special session on Conservation Laws and Transport Equations/Fluid Dynamics in Room 5103 (Building 5).

Special session on Dispersive Equations in Room 5102 (Building 5).

Special session on Elliptic Equations/Boundary Perturbations of Domains for PDEs and Applications in Room 5001 (Building 5).

Special session on Integral and Functional Differential Equations in Room 5003 (Building 5).

Special session on Linear Equations in Room 5002 (Building 5).

Special session on Nonlinear Dynamical Systems/Evolution Equations and Applications at the Auditorium (Building 6).

Poster session in Coffee Area (ground floor of the Library).

Registration

The registrations will be made in the following schedule:

Sunday, February 2^{th}: From 15:00hs to 18:00hs in the entrance of the ICMC Auditorium (Building 6).

Monday, February 3^{th}: From 8:00hs to 8:50hs in the entrance of the ICMC Auditorium (Building 6).

We will provide you a badge at registration. Please wear your badge at the event.

The Events Office (3, map at page 8) will be at your disposal for any questions and information, also the Events Office will set up a help desk with all the necessary information at the entrance of the Auditorium.

Registration fees

Student Fee: R$ 60,00 (reais).

Regular Fee: R$ 120,00 (reais).

Regular and student registration fees include access to sessions and lectures, conference materials and refreshments at coffee breaks.

Financial support

The financial support from the local organizing committee will be available on Tuesday, February 4^{th}, at the help desk at the entrance of the Auditorium (Building 6, map of page 8). In order to receive your support, it is mandatory to completely fill out the on-line registration form available at `http://summer.icmc.usp.br/user_summer/index.php` .

Meals and refreshments

There are several restaurants near the campus. You can find them by looking at the city map located on pages 5 and 6. There are also choices of pizzerias. At night, there are many bars around the city.

There is also a canteen on the campus (7, map at page 8) where you can have either snacks or lunch.

Social events

Monday, February 3^{th}*:* Photo of the meeting at 12:10hs at ICMC.

Tuesday, February 4^{th}*:* Conference Banquet at 20:00hs at Café Sete at 1447, Sete de Setembro Street (R34, map at pages 5 and 6).

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 8:00 to 19:00 (Mon-Fri) and from 9:00 to 16:00 (Sat).

• JIS Câmbio at 1976, Episcopal Street. The working hours are from 9:30 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

There will be available computers and a printer for use at the lobby of the Auditorium.

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: *summer*

   Password: smode202@
5. You may freely browse the internet after logging in. You may occasionally need to re-authenticate using the above procedure.

ICMC SUMMER MEETING on DIFFERENTIAL EQUATIONS

CHAPTER 2020

Plenary Talks

Plenary Speaker

Numerical Dynamics of Integrodifference Equations

Christian Poetzsche
Alpen-Adria University Klagenfurt

Integrodifference equations model the temporal evolution and spatial dispersal of populations having non-overlapping generations. As infinite-dimensional discrete dynamical systems, for numerical simulations they need to be discretized in space. We investigate how the saddle point property near hyperbolic solutions or global attractivity behave under discretization, show convergence results and that the convergence rate of the numerical scheme is preserved in this process.

A survey on the thermistor problem

Francisco Ortegón Gallego, Hicham Moussa, Mohamed Rhoudaf, Hicham Moussa
University of Cádiz

The direct current passing through a semiconductor device is governed by the so-called thermistor problem, namely

$$\begin{cases} \dfrac{\partial u}{\partial t} - \nabla \cdot A(u) = \rho(u)|\nabla \varphi|^2 \ \text{ in } Q_T = \Omega \times (0,T), \\ \nabla \cdot (\rho(u)\nabla \varphi) = 0 \ \text{ in } Q_T, \\ \varphi = \varphi_0 \text{ on } \partial\Omega \times (0,T), \\ u(x,0) = u_0(x) \ \text{ in } \Omega, \\ u = 0 \ \text{ on } \partial\Omega \times (0,T), \end{cases}$$

where $\Omega \subset \mathbb{R}^d$, $d \geq 2$, is the space region occupied by the semiconductor, u is the temperature, φ is the electric potential, $Au = a(u)\nabla u$, $a, \rho \in C(\mathbb{R}) \cap L^\infty(\mathbb{R})$, $a(s) > 0$ for all $a \in \mathbb{R}$ and the functions φ_0 and u_0 are given.

The mathematical analysis of this problem has been studied extensively in the last three decades. We will describe some classic and new results and extend this problem when A is a monotone type operator given by $A(u) = a(x,t,u,\nabla u)$ and in the nonuniformly elliptic case. Depending on the growth assumptions on a, we will consider the search of the so-called capacity-solutions ([1, 4]) in the classical Sobolev spaces $W^{1,p}(\Omega \times (0,T))$ (polynomial growth) or more generally in some Orlicz-Sobolev or Musielak-Orlicz-Sobolev spaces ([2, 3]).

Acknowledgements

This research was partially supported by Ministerio de Ciencia, Innovación y Universidades under grant TEC2017-86347-C2-1-R with the participation of FEDER.

References:

[1] M. T. González Montesinos and F. Ortegón Gallego, *Existence of a capacity solution to a coupled nonlinear parabolic-elliptic system*. Commun. Pure Appl. Anal. (2007) **6:1**, pp. 23-42.
[2] H. Moussa, F. Ortegón Gallego and M. Rhoudaf (2018), *Capacity solution to a coupled system of parabolic-elliptic equations in Orlicz-Sobolev spaces*. Nonlinear Differ. Equ. Appl. (2018) 25:14.

[3] F. Ortegón Gallego, M. Rhoudaf and H. Sabiki, *Nonlinear parabolic-elliptic system in Musielak-Orlicz-Sobolev spaces*. Electronic Journal of Differential Equations, Vol. 2018 (2018), No. 121, pp. 1-36.
[4] X. Xu, *A strongly degenerate system involving an equation of parabolic type and an equation of elliptic type*. Comm. Partial Differential Equations, (1993) **18**, pp. 199-213.

Nodal solutions to quasilinear elliptic problems involving the 1-laplacian operator via variational and approximation methods

Giovany M. Figueiredo, Giovany M. Figueiredo, Pedro Ubilla
Universidade de Brasília

In this work we use two different methods to get nodal solutions to quasilinear elliptic problems involving the $1-$Laplacian operator. In the first one, we develop an approach based on a minimization of the energy functional associated to a problem involving the $1-$Laplacian operator in $\mathbb{R}^N$, on a subset of the Nehari set which contains just sign-changing functions. In the second part we obtain a nodal solution to a quasilinear elliptic problem involving the $1-$Laplacian operator in a bounded domain, through a thorough analysis of the sequence of solutions of the $p-$Laplacian problem associated to it, as $p \to 1^+$. In both cases, several technical difficulties appears in comparison with the related results involving signed solutions.

Complicated motion from monotone delay

Hans-Otto Walther
University of Giessen

The lecture reports about present work on the impact of *state-dependent* delay on the behaviour of solutions to otherwise simple delay differential equations. It is shown that also *monotonic* delayed arguments generate a kind of complicated motion where along a solution a sequence of short segments is dense in an infinite-dimensional subset of a function space. This answers a question posed at the previous Chapter of the Summer Meeting. The proof involves a tubular neighbourhood of a flowline, which simplifies earlier constructions considerably.

Analyticity versus Genericity in Delay-Differential Equations

John Mallet-Paret
Brown University

In studying parameterized systems of evolution equations, one wishes to understand the global structure of various types of solutions (such as equilibria, and periodic solutions). Two possible approaches present themselves: (1) prove that the solutions of interest have an analytic dependence on the parameters, and thus have the structure of an analytic variety; or (2) prove that generically the solutions of interest have the structure of a manifold or union of manifolds.

In the case of delay-differential equations it turns out that the second approach is superior. We shall describe the reasons for this, but also note the limitations of this approach. We shall also point out some related open questions.

Monotone autonomous and nonautonomous multivalued dynamical systems

José Valero, Tomás Caraballo, José Antonio Langa
Miguel Hernández de Elche

Monotone dynamical systems are important from the point of view of the structure of global attractors. They allow establishing the existence of maximal and minimal elements that contain the global attractor between them, which are generally speaking stationary points. The main characteristic of monotone systems is the fact that the solutions are ordered, which means that if the initial conditions are ordered, then such order is preserved along the whole trajectories forward in time. In the multivalued situation, when the uniqueness of solutions of the Cauchy problem fails, this concept is a bit more complicated, as there are several ways of comparing solutions. What we need is a strong comparison principle saying that if one initial condition is bigger than the other, then there exist maximal and minimal elements of the multivalued semiflow (or process) preserving the order for each time greater than the initial one. We study first the structure of the global attractor for general monotone autonomous multivalued dynamical systems, applying then the results to a differential inclusion of reaction-diffusion type governed by a Heaviside function. Second, we consider this same differential inclusion but including time-depending terms and prove the existence of two special extremal bounded complete trajectories, which play the role of nonautonomous equilibria, containing the pullback attractor between them.

Tomás Caraballo's contributions to the qualitative analysis of stochastic and non-autonomous PDEs

José A. Langa
Universidad de Seville

In this talk we will describe Prof. Tomás Caraballo main contributions to the study of the qualitative properties of stochastic and non-autonomous PDEs. The analysis of the asymptotic behaviour of PDEs has been the focus of the relevant research of Tomas in the last 35 years. He has been able to develop his studies in many directions: delay differential equations, multivalued analysis, stochastic stabilization and destabilization, non-autonomous dynamics and random dynamical systems. Multiple applications modeled by PDEs have been also developed in his long succesfull career, where it is remarkable the group of Phd students he has trained during all these years and the vaste set of excellent collaborators he possesses all around the world.

Nonautonomous degenerate logistic equations

José M. Arrieta, Marcos Molina, Lucas Araujo Santos
Universidad Complutense de Madrid

We study the behavior of positive solutions of a logistic equation of the type $u_t - \Delta u = \lambda u - n(x,t)u^\rho$ in a bounded smooth domain with some homogeneous boundary conditions. We assume $\rho > 1$ and $n(x,t) \geq 0$. We want to understand how the relation between the value of the parameter λ and the geometry of the set $K_0(t) = \{x \in \Omega : n(x,t) = 0\}$ affects the global behavior of the solutions of the equation. If $n(x,t)$ is independent of t, then we know from previous works that there is a critical value $\lambda_0(K_0) > 0$ such that if $\lambda < \lambda_0(K_0)$ the solutions are globally bounded, while if $\lambda > \lambda_0(K_0)$ the solutions are unbounded as $t \to +\infty$. In the nonautonomous case, we will also find regimes in which the solutions are globally bounded and others in which the solutions are unbounded

as $t \to +\infty$. This is a joint work with Marcos Molina (Univ Complutense de Madrid) and Lucas Araujo Santos (Univ Federal de Paraiba).

Existence, nonexistence and multiplicity of positive solutions for an equation with degenerate nonlocal diffusion

Leszek Gasinski, Joao R. Santos Junior
Pedagogical University of Krakow

An elliptic boundary value problem with degenerate nonlocal term is considered. The existence, nonexistence and multiplicity of positive solutions for the problem are studied. The results are obtained in two different cases: under monotonicity assumptions on the nonlinearity term as well as without monotonicity conditions. Some order in the set of obtained solutions is provided.

Forwards attraction properties in scalar non-autonomous parabolic PDEs

Rafael Obaya, Jose Langa, Ana Sanz
Valladolid. Spain

As it is well-known, the forwards and pullback dynamics are in general unrelated. In this talk we present an in-depth study of whether the pullback attractor is also a forwards attractor for the processes involved with the skew-product semiflow induced by a family of scalar non-autonomous reaction-diffusion equations which are linear in a neighbourhood of zero and have null upper Lyapunov exponent. Besides, the notion of Li-Yorke chaotic pullback attractor for a process is introduced, and we prove that this chaotic behaviour might occur for almost all the processes. Some of these resultas are also extended for nonautonomous purely dissipative reaction-diffusion equations including Fisher and Chafee-Infante models.

On some properties of the solutions to a class of second-order functional differential equations

Rosana Rodríguez-López
Universidade de Santiago de Compostela

The theory of functional differential equations is an excellent framework for the description of the evolution of processes affected by memory effects (see, for instance, [4]).

Here, we give some properties of the solutions to a certain type of second-order differential equations with delay given by a piecewise constant function. The starting point is the study of a boundary value problem for linear equations made in [6], which is an extension of some results appearing in [3, 5] for a related first order problem. Thus, the analysis of the solutions to an impulsive periodic boundary value problem, with an impulse given in the derivative at a certain fixed instant, provides the kernel to obtain the explicit expression of the solution to the non-impulsive problem by integration.

Using the expression of the solutions to the linear problem (see [6], and also [7] for some generalizations to variable coefficients), we can deduce several interesting properties for the solutions to linear and nonlinear problems. First, we provide sufficient conditions for the existence of solutions with a constant sign for the linear equation in the lines of the joint work with Sebastián Buedo-Fernández, Daniel Cao Labora, and Stepan A. Tersian [1], and then we explore some of the implications of these

results (see, among others, the joint work with Sebastián Buedo-Fernández, and Daniel Cao Labora [2]).

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Fractional impulsive stochastic differential equations with unbounded delay

Tomás Caraballo, Jiaohui Xu
Universidad de Sevilla

This talk is first devoted to the local and global existence of mild solutions for a class of fractional impulsive stochastic differential equations with infinite delay driven by both $\mathbb{K}$-valued Q-cylindrical Brownian motion and fractional Brownian motion with Hurst parameter $H \in (1/2, 1)$. A general framework which provides an effective way to prove the continuous dependence of mild solutions on initial value is established under some appropriate assumptions. Furthermore, it is also proved the exponential decay to zero of solutions to fractional stochastic impulsive differential equations with infinite delay. Finally, some comments and remarks will be mentioned concerning the existence of attracting sets.

Fractional Benney type System

Wladimir Neves, Dionicio Orlando
UFRJ

Benney introduced a general strategy for deriving systems of nonlinear partial differential equations associated with long and short-wave solutions. Motivated by Benney's general theory, we propose new models for short wave-long wave interactions, when short waves are described by fractional Schrödinger equation and long waves by fractional porous media equation. We have established existence of weak solutions to the following Cauchy problem

$$\begin{cases} i\partial_t u - (-\Delta)^s u = \alpha\ v\ u + |u|^2 u, \quad x \in \mathbb{R}, \quad t > 0, \\ \partial_t v + (-\Delta)^{s/2} g(v) = \beta\ (-\Delta)^{s/2} |u|^2, \quad x \in \mathbb{R}, \quad t > 0, \end{cases}$$

where $0 < s < 1$, $\alpha, \beta \in \mathbb{R}$. Here, $u(t,x) \in \boldsymbol{C}$, $v(t,x) \in \mathbb{R}$ are the unknowns and $g : \mathbb{R} \to \mathbb{R}$ is a nonlinear real function.

Lattice models for artificial neural networks

Xiaoying Han, Peter Kloeden, Xiaoli Wang, Basiru Usman
Auburn University

In this talk I will introduce a few lattice dynamical systems arising from mathematical models of artificial neural networks. For each system, the asymptotic dynamics will be investigated in terms of existence of attractors, structure of attractors as well as their upper semi-continuity. Physical interpretations will be given on the theoretical results. The talk is based on a sequence of joint work with Prof. Dr. Peter Kloeden, two PhD students Xiaoli Wang and Basiru Usman.

Quasi-stationary distributions in stochastic systems

Yingfei Yi University of Alberta & Jilin University

We consider in this talk small noise perturbations to an ordinary differential equation having a uniform absorbing state and exhibiting transient dynamics in the sense that interesting dynamics governed by transient states display over finite time intervals and the eventual dynamics is simply controlled by the absorbing state. To capture the transient states, we study the noise-vanishing concentration of the so-called quasi-stationary distributions (QSDs) that describe the dynamics before reaching the absorbing state. By establishing measure estimates, we show the concentration of QSDs to the deterministic global attractor. Applications to diffusion approximations of chemical reactions and birth-and-death processes of logistic type are also discussed.

ICMC SUMMER MEETING on DIFFERENTIAL EQUATIONS

CHAPTER 2020

Special Sessions

Conservation Laws and Transport Equations/Fluid Dynamics

Organizers: Jean Silva & Gabriela Planas

Optimal mixing lower bounds L^2 initial dada via optimal transport tools

Brayan Mauricio Rodriguez Garzon, Helena Nussenzveig Lopes, Milton C. Lopes Filho
Universidade Federal do Rio de Janeiro

We prove an exponential lower bound for the $\|\rho(x,t)\|_{\dot{H}^{-1}}$ norm where $\rho(x,t)$ is the solution of the transport equation with a vector field $u \in W^{1,p}(\mathbb{T}^2)$ for $2 \leq p \leq \infty$ and initial data in $L^2(\mathbb{T}^2)$, we use the Monge-Kantorovich-Rubinstein distance, where this approach was first implemented in [1] into the context of mixing measurement for binary tracers. We obtain constants depending only of $\|\rho_{in}\|_{L^2}$ where ρ_{in} is the initial data.

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Generalized Fractional Benney type System

Dionicio Orlando Moreno Vega, Wladimir Augusto das Neves
Universidad Nacional del Callao

In this work we introduce a fractional version of Benney's equations, which is a non-linear model with non-local effects described by the system

$$\begin{cases} i\partial_t u - (-\Delta)^s u = \alpha\ v\ u + |u|^2 u, \quad x \in \mathbb{R}, \quad t > 0, \\ \partial_t v + (-\Delta)^{s/2} g(v) = \beta\ (-\Delta)^{s/2}(|u|^2), \quad x \in \mathbb{R}, \quad t > 0, \\ u(0,x) = u_0(x), \ \ v(0,x) = v_0(x), \end{cases}$$

where $0 < s < 1$. Here $u(t,x) \in \mathbb{C}$, $v(t,x) \in \mathbb{R}$ are, respectively, the short wave and long wave unknowns, which are solutions of the fractional Schrodinger equation and the fractional porous medium equations. We demonstrate the strong convergence of the solutions of the approximate system of shor twave and long wave interactions using new estimates of energy obtained for the coupled system.

The main result is:

Theorem 1. *Given* $(u_0, v_0) \in H^s(\mathbb{R}) \times H^{s/2}(\mathbb{R})$, $(\frac{1}{2} < s < 1)$, *with* v_0 *real-valued,* $g \in C^1(\mathbb{R})$, $0 < m \leq g'(x) \leq M < \infty$, $g(0) = 0$, *there exist functions*

$$(u, v) \in L^\infty(0, T; H^s(\mathbb{R})) \times L^\infty(0, T; H^{s/2}(\mathbb{R}))$$

such that

$$i\int_0^T\int_{\mathbb{R}}\Big(u(t,x)\ \partial_t\overline{\varphi}(t,x)+(-\Delta)^{s/2}u(t,x)\ (-\Delta)^{s/2}\overline{\varphi}(t,x)\Big)\ dxdt+i\int_{\mathbb{R}}u_0(x)\ \overline{\varphi}(0,x)\ dx$$
$$+\alpha\int_0^T\int_{\mathbb{R}}v(t,x)\ u(t,x)\ \overline{\varphi}(t,x)\ dxdt+\int_0^T\int_{\mathbb{R}}|u(t,x)|^2\ u(t,x)\ \overline{\varphi}(t,x)\ dxdt=0, \tag{1}$$

$$\int_0^T\int_{\mathbb{R}}v(t,x)\ \partial_t\psi(t,x)-g(v(t,x))\ (-\Delta)^{s/2}\psi(t,x)\ dxdt+\int_{\mathbb{R}}v_0(x)\ \psi(0,x)\ dx$$
$$+\beta\int_0^T\int_{\mathbb{R}}(-\Delta)^{s/2}(|u|^2)(t,x)\ \psi(t,x)\ dtdx=0 \tag{2}$$

for each test functions $\varphi,\psi\in C_c^\infty\Big((-\infty,T)\times\mathbb{R}\Big)$, *with* φ *being complex-valued and* ψ *real-valued.*

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Radiative Transfer with long-range interactions in the half-space

Edison Fausto Cuba Huamani, Ricardo Alonso
Pontifícia Universidade Católica do Rio de Janeiro - PUC-Rio

We study the well-posedness and regularity theory for the Radiative Transfer equation in the peaked regime posed in the half-space. An average lemma for the transport equation in the half-space is stablished and used to generate interior regularity for solutions of the model. The averaging also shows a fractional regularization gain up to the boundary for the spatial derivatives. We also prove the existence and uniqueness of the solution of this equation. This work is based in a part of my PhD thesis. Its preprint is available on https://arxiv.org/abs/1910.01207.

On Stokes and Navier-Stokes equations in a punctured periodic domain

Gabriela Planas
Universidade Estadual de Campinas

We consider three problems on a two-dimensional 'punctured periodic domain': we take $\Omega_r = (-L,L)^2 \setminus rK$, where $r > 0$ and K is the closure of an open connected set that is star-shaped with respect to 0 and has a C^1 boundary. We impose periodic boundary conditions on the boundary of $\Omega = (-L,L)^2$, and Dirichlet boundary conditions on $\partial(rK)$. In this setting, we consider the Poisson equation, the Stokes equations, and the time-dependent Navier–Stokes equations, all with a fixed forcing function f, and examine the behaviour of solutions as $r \to 0$. In all three cases, we show the convergence of the solutions to those of the limiting problem, i.e. the problem posed on all of Ω with periodic boundary conditions.

IBVP For Anisotropic Fractional Type Degenerate Parabolic Equation

Gerardo Huaroto
UFAL

The main purpose of this work is to study the existence of solutions for an initial-boundary value problem (IBVP) driven by a fractional type degenerate parabolic equation posed in bounded domains.

$$\begin{cases} \partial_t u = \operatorname{div}(u\, A(x)\, \nabla \mathcal{L}^{-s} u) & \text{in } \Omega_T, \\ u|_{t=0} = u_0 & \text{in } \Omega, \\ u = 0 & \text{on } (0,T) \times \partial\Omega, \end{cases} \tag{3}$$

where $\mathcal{L}u = -\operatorname{div}(A(x)\nabla u)$ be a uniformly elliptic operator in divergence form and $\mathcal{L}^{-s}$ is the inverse s-fractional elliptic operator, moreover $\Omega_T := (0,T) \times \Omega$, for any real number $T > 0$, and $\Omega \subset \mathbb{R}^n$ $(n \geq 1)$ is a bounded open set having smooth boundary. Here, $u(t,x)$ is an unknown real function, which can be physical, an absolute temperature, or a density, also a concentration, thus non-negative. Moreover, the initial data u_0 is a measurable, bounded non-negative function in Ω, and we consider homogeneous Dirichlet boundary condition. The nonlocal diffusion effect relies on $\mathcal{L}^{-s}$ operator and the solvability is proved for any $s \in (0,1)$.

Existence and uniqueness of weak solution for the non-autonomous Ladyzhenskaya model and their asymptotic pullback behavior in H and Vp

Heraclio López, Gabriela Del Valle Planas, Pedro Marín Rubio
Universidade Estadual de Campinas - UNICAMP

We establish a result of existence of pullback attractors in H and V_p for the Ladyzhenskaya model of incompressible viscous fluid in a domain $\Omega \subset \mathbb{R}^n$, $n \in \{2,3\}$. The motion of incompressible, viscous fluids in Ω, characterized by the velocity field $u = (u_1, ..., u_n)$ and the pressure π, is governed by the system of $n+1$ equations

$$\begin{cases} \frac{\partial u}{\partial t} - div_x S(Du) + div_x(u \otimes u) + \nabla_x \pi = f(t) \ \ in\ (\tau, +\infty) \times \Omega, \\ div_x u = 0 \ \ in\ (\tau, +\infty) \times \Omega, \\ u(\tau, x) = u_\tau(x), \ \ x \in \Omega, \\ u = 0 \ \ on\ (\tau, +\infty) \times \partial\Omega, \end{cases}$$

where the operator S is a potential.

This is a joint work with Pedro Marin-Rubio (Universidad de Sevilla, Spain) and Gabriela Planas (Universidade de Campinas, Brazil).

References:

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Ergodic Functions that are not Almost Periodic Plus L^1-Mean Zero.

Jean Carlos da Silva
Universidade Federal de Minas Gerais

Ergodic Functions are bounded uniformly continuous (BUC) functions that are typical realizations of continuous stationary ergodic process. It has been a long standing question whether such functions are always the sum of an almost periodic with an L^1-mean zero BUC function. The paper answers this question presenting a framework that can provide infinitely many ergodic functions that are not almost periodic plus L^1- mean zero.

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

Vernny Chavez Ccajma, Wladimir Neves, Jean Silva
Universidade Federal do Rio de Janeiro

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.

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Dispersive Equations

Organizer: Mahendra Panthee & Marcia A. G. Scialom

Orbital stability of the black soliton for the quintic Gross-Pitaevskii equation

Adán J. Corcho, Miguel A. Alejo
Universidade Federal do Rio de Janeiro

In this talk I will present recent results, obtained in collaboration with prof. M. Alejo (UFSC, Brazil), on the study of the orbital stability properties of the simplest nonlinear pattern in low dimensional Bose gases, the black soliton solution. This is a solution of a one dimensional nonintegrable defocusing Schrödinger model, represented by the quintic Gross-Pitaevskii equation (5GP). Once the black soliton is characterized as a critical point of the associated Ginzburg-Landau energy of the 5GP, I will show some coercivity properties of that energy around the black (and dark) soliton. I will also explain how to impose suitable orthogonality conditions and how to control the growth of some modulation parameters to finally prove that perturbations generated by the symmetries of the 5GP stay close to the black soliton in the energy space.

On the well-posedness, ill-posedness and norm-inflation for a higher order water wave model on a periodic domain

Mahendra Panthee, Xavier Carvajal, Ricardo Pastran
Universidade Estadual de Campinas

In this work we are interested in the well-posedness issues for the initial value problem associated with a higher order water wave model posed on a periodic domain $\mathbb{T}$. We derive some multilinear estimates and use them in the contraction mapping argument to prove the local well-posedness for initial data in the periodic Sobolev space $H^s(\mathbb{T})$, $s \geq 1$. With some restriction on the parameters appeared in the model, we use the conserved quantity to obtain the global well-posedness for given data with Sobolev regularity $s \geq 2$. Also, we use splitting argument to improve the global well-posedness result in $H^s(\mathbb{T})$ for $1 \leq s < 2$. Well-posedness result obtained in this work is sharp in the sense that the flow-map that takes initial data to the solution cannot to be continuous for given data in $H^s(\mathbb{T})$, $s < 1$. Finally, we prove a norm-inflation result by showing that the solution corresponding to a smooth initial data may have arbitrarily large $H^s(\mathbb{T})$ norm, with $s < 1$, for arbitrarily short time.

Coupled third-order nonlinear Schrödinger System

Marcia Scialom, Luciana Mendonca
Universidade Estadual de Campinas

We investigate some well-posedness issues for the initial value problem (IVP) associated to the system

$$\begin{cases} 2i\partial_t u + q\partial_x^2 u + i\gamma\partial_x^3 u = F_1(u,w) \\ 2i\partial_t w + q\partial_x^2 w + i\gamma\partial_x^3 w = F_2(u,w), \end{cases}$$

where F_1 and F_2 are polynomials of degree 3 involving u, w and their derivatives. This system describes the dynamics of two nonlinear short-optical pulses envelopes $u(x,t)$ and $w(x,t)$ in fibers . We prove

periodic local well-posedness for the IVP with data in Sobolev spaces $H^s(\mathbb{T})\times H^s(\mathbb{T})$, $s \geq 1/2$ and global well-posedness result in Sobolev spaces $H^1(\mathbb{T})\times H^1(\mathbb{T})$.

Well posedness in weighted Sobolev spaces for a higher dimensional version of the Benjamin-Ono equation

Oscar Riano
IMPA

This work concerns the Cauchy problem associated to a higher dimensional version of the Benjamin-Ono equation

$$\partial_t u - \mathcal{R}_1 \Delta u + u\partial_{x_1} u = 0, \qquad x \in \mathbb{R}^d,\, t \in \mathbb{R}^d,$$

where $\mathcal{R}_1 = -(-\Delta)^{-1/2}\partial_{x_1}$ denotes the Riesz transform with respect to x_1 and Δ stands for the standard Laplacian operator in the spatial variables. Our purpose is to establish local well-posedness in weighted Sobolev spaces and some global unique continuation principles. In consequence, optimal spatial decay rate for this model is determined. A key ingredient is the deduction of a new commutator estimate involving Riesz transforms.

Sharp ill-posedness and well-posedness results for dissipative KdV equations on the real line

Raphael Santos, Carvajal, Xavier, Gamboa, Pedro
Universidade Federal do Rio de Janeiro - Campus Macaé

This work is concerned about the Cauchy problem for the following generalized KdV- Burgers equation

$$\begin{cases} \partial_t u + \partial_x^3 u + L_p u + u\partial_x u = 0, \\ u(0,\, x) = u_0(x), \end{cases}$$

where L_p is a dissipative multiplier operator. Using Besov-Bourgain Spaces, we establish a bilinear estimate and we prove sharp global well-posedness in the Sobolev spaces $H^{-p/2}(\mathbb{R})$ and sharp ill-posedness in $H^s(\mathbb{R})$ when $s < -p/2$ with $p \geq 2$.

On fractional growth-dissipative Benjamin-Ono equations

Ricardo Pastrán, Oscar G. Riaño C.
Universidad Nacional de Colombia

We consider the initial value problem (IVP) for the following fractional growth-dissipative Benjamin-Ono (fgdBO) equations

$$\begin{cases} u_t + \mathcal{H}u_{xx} - (D_x^\alpha - D_x^\beta)u + uu_x = 0, & x \in \mathbb{R}, \quad t > 0, \\ u(x,0) = u_0(x), \end{cases} \tag{4}$$

where $u = u(x,t)$ is a real valued function, the third and the fourth terms in (4) will be considered as the growth and dissipation respectively, satisfying $0 < \alpha < \beta$, the operator D_x^s is defined via the Fourier transform by $\widehat{D_x^s\varphi}(\xi) = |\xi|^s\widehat{\varphi}(\xi)$ and $\mathcal{H}$ denotes the Hilbert transform given by $\widehat{\mathcal{H}\varphi}(\xi) = -i\,\mathrm{sgn}(\xi)\widehat{\varphi}(\xi)$ for all $\varphi \in \mathcal{S}(\mathbb{R})$.

Our aim is to present well-posedness results in Sobolev spaces, persistence properties of the solution flow in the weighted Sobolev spaces $Z_{s,r} = H^s(\mathbb{R}) \cap L^2(|x|^{2r}\,dx)$ for s, $r \in \mathbb{R}$ and decay properties.

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Odd Periodic Waves and Stability Results for the Defocusing Mass-Critical Korteweg-de Vries Equation

Sabrina Amaral, Fábio Natali
Universidade Estadual de Maringá

In this work, we present results of existence and stability of odd periodic traveling wave solutions for the defocusing mass-critical Korteweg-de Vries equation. The existence of periodic wavetrains is obtained by solving a constrained minimization problem. Concerning the stability, we use the Floquet theory to determine the behaviour of the first three eigenvalues of the linearized operator around the wave, as well as the positiveness of the associated hessian matrix.

On the local well-posedness for a coupled system of mKdV type equations

Xavier Carvajal, Raphael Antunes dos Santos
Universidade Federal Do Rio De Janeiro

We consider the initial value problem associated to a system consisting modified Korteweg-de Vries type equations

$$\begin{cases} \partial_t v + \partial_x^3 v + \partial_x(vw^2) = 0, & v(x,0) = \phi(x), \\ \partial_t w + \alpha\partial_x^3 w + \partial_x(v^2 w) = 0, & w(x,0) = \psi(x), \end{cases}$$

and prove the local well-posedness results for given data in low regularity Sobolev spaces $H^s(\mathbb{R}) \times H^k(\mathbb{R})$, $s,k > -\frac{1}{2}$, $|s-k| \geq 1/2$ for $\alpha \neq 0,1$. Our result covers the whole scaling sub-critical range of Sobolev regularity contrary to the case $\alpha = 1$, where the sharp local well-posedness holds only for $s = k \geq \frac{1}{4}$. We also prove that the local well-posedness result is sharp in two different ways.

Elliptic Equations/Boundary Perturbations of Domains for PDEs and Applications

Organizer: Claudianor O. Alves and Marcone Corrêa Pereira

On an Ambrosetti-Prodi Problem in $\mathbb{R}^N$

Alânnio Barbosa Nóbrega, Claudianor Oliveira Alves, Romildo Nascimento de Lima
Universidade Federal de Campina Grande

In this presentation we will show results of existence and non-existence to following Ambrosetti-Prodi problem type

$$\begin{cases} -\Delta u = P(x)\Big(g(u) + f(x)\Big), \text{ in } \mathbb{R}^N \\ u \in D^{1,2}(\mathbb{R}^N),\ \lim_{|x|\to+\infty} u(x) = 0, \end{cases} \tag{P}$$

where $N \geq 3$, $P \in C(\mathbb{R}^N, \mathbb{R}^+)$, $f \in C(\mathbb{R}^N) \cap L^\infty(\mathbb{R}^N)$ and $g \in C^1(\mathbb{R})$. The main tools used is the sub-supersolution method and Leray-Schauder topological degree theory.

Absolute continuity and band gaps of the spectrum of the Dirichlet Laplacian in periodic waveguides

Alessandra A. Verri, Carlos R. Mamani
UFSCar

Consider the Dirichlet Laplacian operator $-\Delta^D$ in a periodic waveguide Ω. Under the condition that Ω is sufficiently thin, we show that its spectrum $\sigma(-\Delta^D)$ is absolutely continuous (in each finite region). In addition, we ensure the existence of at least one gap in $\sigma(-\Delta^D)$ and locate it.

On the logistic equation with a refugee: local and nonlocal problems

Cristian Morales-Rodrigo, Willian Cintra, Tarcyana S. Figueiredo-Sousa, Antonio Suárez
Universidad de Sevilla

In this talk, I will focus on a specie that growths linearly in region of the domain and satisfies the logistic equation on the complementary of that region. The movement of the specie will be governed either by a local nonlinear operator or a non-local operator.

Critical Metrics of the $\mathcal{S}^k$ Operator

Flávio Almeida Lemos, Ezequiel Rodrigues Barbosa
Universidade Federal de Ouro Preto

We will focus on complete critical metrics of $\mathcal{S}^k(g) = \int_M R^k dV_g$. As for as we know, complete critical metrics of $\mathcal{S}^k$ were not studied yet. Our main result characterizes critical metrics with positive scalar curvature.

Let (M^n, g), $n \geq 3$, be a complete critical metric of $\mathcal{S}^k$ with positive scalar curvature and $k \geq 2 \in \mathbb{N}$. Then (M^n, g) has constant scalar curvature. On the other hand, if $n < 2k$, then (M^n, g) is scalar flat.

A free boundary problem for the $p(x)$-laplacian involving area

Giane Casari Rampasso, Noemi Wolanski
Universidade Estadual de Campinas

In this work, we examine a minimization problem involving the functional associated to the $p(x)$-laplacian plus the area of level surfaces, where $p(x)$ satisfies certain conditions as Lipschitz continuity and boundedness. In this setting, we prove that such minimizer exists and it is a classical solution for a free boundary problem. In particular, the free boundary $\partial\{u > 0\}$ is an almost minimal surface, and therefore $\mathcal{C}^{1,1/2}$-smooth. To conclude, we deduce the free boundary condition which involves the mean curvature of the domain.

This is a work joint with Noemi Wolanski (Universidad de Buenos Aires).

The p-Laplacian equation in a rough thin domain with terms concentrating on the boundary

Jean Carlos Nakasato, Ariadne Nogueira
Universidade de São Paulo

In this work we use reiterated homogenization and unfolding operator approach to study the asymptotic behavior of the solutions of the p-Laplacian equation with Neumann boundary conditions set in a rough thin domain with concentrated terms on the boundary. We study weak, resonant and high roughness, respectively. In the three cases, we deduce the effective equation capturing the dependence on the geometry of the thin channel and the neighborhood where the concentrations take place.

An obstacle problem governed by p-fractional Laplacian and its limit as $p \to \infty$

João Vitor da Silva, Ariel Salort
Universidade de Brasília - UnB

In this work we study an inhomogeneous obstacle type problem involving the fractional $p-$Laplacian operator (cf. Korvenpää *et al* [3]). Firstly, we establish existence and uniform estimates for any family of solutions $\{u_p\}_{p\geq 2}$ which depend on the data of the problem and universal parameters. Finally, we analyze the asymptotic behavior of such a family as $p \to \infty$. At this point, we prove that $\lim_{p\to\infty} u_p(x) = u_\infty(x)$ there exists (up to a subsequence), verifies a limiting obstacle type problem in the viscosity sense, and it is an $s-$Hölder continuous function (cf. da Silva & Rossi [1]).

References:

[1] J.V. da Silva and J.D. Rossi - *The limit as $p \to \infty$ in free boundary problems with fractional p-Laplacians*. Trans. Amer. Math. Soc. 371 (2019), no. 4, 2739-2769.

[2] J.V. da Silva and A.M. Salort - *A limiting obstacle type problem for the inhomogeneous $p-$fractional Laplacian*. Calc. Var. Partial Differential Equations 58 (2019), no. 4, 58:127.

[3] J. Korvenpää, T. Kuusi and G. Palatucci - *The obstacle problem for nonlinear integro-differential operators*. Calc. Var. Partial Differential Equations 55 (2016), no. 3, Art. 63, 29 pp.

Non-local Degenerate Diffusion Coefficients Break Down the Components of Positive Solutions

João R. Santos Júnior, Manuel Delgado, Cristian Morales-Rodrigo, Antonio Suarez
UFPA

This work deals with nonlinear elliptic problems where the diffusion coefficient is a degenerate non-local term. We show that this degeneration implies the growth of the complexity of the structure of the set of positive solutions of the equation. Specifically, when the reaction term is of logistic type, the continuum of positive solutions breaks into two disjoint pieces. Our approach uses mainly fixed point arguments.

Improved regularity for the porous medium equation along zero level-sets

Makson S. Santos, Edgard Pimentel
PUC-Rio

In this presentation, we are going to talk about the regularity theory for an inhomogeneous porous medium equation of the form

$$u_t - \Delta(u^m) = f \quad \text{in} \quad Q_1,$$

and produce a new sharp regularity result for the solutions to such equation. We produce regularity estimates as the solutions approach their zero level-set. More precisely, we show that weak solutions to our equation are locally asymptotically Lipschitz along their zero level-set. Our techniques are based on geometric and approximation methods. This is joint work with Edgard Pimentel.

Remarks on the spectrum of a nonlocal Dirichlet problem

Marcone C. Pereira, Rafael D. Benguria
Universidade de São Paulo

In this talk we analyse the spectrum of nonlocal Dirichlet problems with non-singular kernels in bounded open sets. The novelty are two folds, the continuity of eigenvalues with respect to domain perturbation via Lebesgue measure and differentiability of simple eigenvalues for smooth kernel and open sets.

Sub-supersolution method for a quasilinear elliptic problem involving the $1-$laplacian operator and a gradient term

Marcos T. O. Pimenta, Giovany M. Figueiredo
FCT - UNESP - Universidade Estadual Paulista

In this work we study a quasilinear elliptic problem involving the $1-$laplacian operator and a gradient term. The problem requires the definition of a suitable sense of solution, which allows us to show the existence of a solution in $BV(\Omega)$, having no jump part. Despite the lack of regularity of the solutions, we develop a sub-supersolution approach, together with a thorough analysis of the distributional derivative of the functions in $BV(\Omega)$.

Fully nonlinear mean-field games

Pêdra D. S. Andrade, Edgard Pimentel
PUC-Rio

In this talk, we examine fully nonlinear mean-field games systems. We start with a variational approach and derive our problem as the Euler-Lagrange equation associated with a minimization problem. First, we combine the regularity theory for fully nonlinear problems with the information on the double-divergence equation to produce gains of integrability/regularity for the solutions of the MFG system. Second, we prove the existence of minimizers for the variational problem and the existence of solutions to the mean-field games system. We also investigate a unidimensional example and unveil new information on the explicit solutions. This is joint work with Edgard Pimentel.

Existence and concentration of positive solutions for a system of coupled saturable Schrödinger equations

Raquel Lehrer, Sérgio Henrique Monari Soares
Universidade Estadual do Oeste do Paraná

It is considered a saturable system of coupled Schrödinger equations with asymptotically linear nonlinearities. The bound states (solutions with finite energy) are proved to exist and have a concentration behavior under hypotheses involving the coupling and saturation parameters. The proof is based on variational methods. More precisely, we consider the following system in $\mathbb{R}^N$ ($N \geq 3$):

$$(P_\varepsilon)\begin{cases} -\varepsilon^2\Delta u + a(x)u &= \dfrac{u^2+v^2}{1+s(u^2+v^2)}u + \lambda v, \\ -\varepsilon^2\Delta v + b(x)v &= \dfrac{u^2+v^2}{1+s(u^2+v^2)}v + \lambda u, \end{cases}$$

with $u(x), v(x) \to 0$ as $|x| \to \infty$ and $u(x), v(x) > 0$ for all $x \in \mathbb{R}^N$, with appropriate conditions on the funcitons $a, b : \mathbb{R}^N \to \mathbb{R}$.

On a Hamiltonian System with Critical Exponential Growth

Yony Raúl Santaria Leuyacc, Sérgio Monari Soares
Universidad Nacional Mayor de San Marcos

In this work we discuss the existence of nontrivial solutions to the following Hamiltonian elliptic system

$$\begin{cases} -\Delta v + V(x)v &= Q_1(x)f(u), \qquad x \in \mathbb{R}^2, \\ -\Delta u + V(x)u &= Q_2(x)g(v), \qquad x \in \mathbb{R}^2, \end{cases}$$

where V, Q_1, Q_2 are continuous functions and the nonlinearities f and g possess critical exponential growth established by Trudinger-Moser inequalities for Lorentz-Sobolev spaces. The proof involves linking theorem and a finite-dimensional approximation.

References:

[1] Leuyacc, Y.R.S., Soares, S.H.M. *On a Hamiltonian System with Critical Exponential Growth*. Milan J. Math. 87, 105-140 (2019).

Integral and Functional Differential Equations

Organizer: Pierluigi Benevieri

Abstract resolvent families on time scales

Aldo Pereira, Rogelio Grau, Jaqueline Mesquita
Universidade de Brasília

We introduce in this talk a general formulation of resolvent family on time scales, which unifies the continuous and discrete cases, and the cases in between the above. This definition allows us to describe formulas for solutions of first-order, second-order and fractional-order dynamic equations on time scales. We study the relationship between the abstract resolvent family and its infinitesimal generator, along with the main properties of resolvent families, and the existence of solutions of abstract dynamic equations on time scales. As applications, we present some functional equations for time scales with the group property. Further, we introduce explicit formulas for resolvent families for the cases of discrete and quantum time scales.

Absence of small solutions and existence of Morse decomposition for a cyclic system of differential equations

Ábel Garab
Alpen-Adria University Klagenfurt

We consider unidirectional cyclic systems of delay differential equations of the form

$$\dot{x}^i(t) = g^i(x^i(t), x^{i+1}(t-\tau^i), t), \qquad 0 \le i \le N,$$

with continuously differentiable right-hand side, which fulfills either a positive of negative feedback in the delayed terms. In the theory of functional differential equations, the question of existence of superexponential solutions have a crucial role, since only in the absence of such solutions can one describe asymptotically the solutions from the stable manifold by the associated linear equation.

In this work we show that any component of a superexponential solution must change sign infinitely many times on any interval of length τ, where $\tau = \sum_{i=0}^{N} \tau^i$. As a corollary we obtain that if a bounded global pullback attractor exists, then it does not contain any superexponential solutions. This allows us in the autonomous case to construct a Morse decomposition of the global attractor of such equations, which is based on an integer valued Lyapunov functional introduced by Mallet-Paret and Sell [2]. This extends the results obtained by Mallet-Paret [1] and Polner [3] in the scalar case for cyclic systems.

References:

[1] J. Mallet-Paret, Morse decompositions for delay-differential equations, *J. Differential Equations*, **72** (1988), 270–315.
[2] J. Mallet-Paret and G. R. Sell, Systems of differential delay equations: Floquet multipliers and discrete Lyapunov functions, *J. Differential Equations*, **125** (1996), 385–440.
[3] M. Polner, Morse decomposition for delay-differential equations with positive feedback, *Nonlinear Anal.*, **48** (2002), 377–397.

PROFESSOR LUCIANO BARBANTI: A Bright Trajectory in Analysis and in Life

Berenice Camargo Damasceno, Marcia Federson, Milan Tvrdy,
Luciano Barbanti (in memorian)
Universidade Estadual Paulista - UNESP

Professor Luciano Barbanti was passionate about Mathematical Analysis. His contributions in this area are not restricted to his research, which includes the study of nonlinear Volterra-Stieltjes Integral Equations with the Dushnik and Kurzweil integrals, Control Theory, non-ideal Systems and Chaos. His contributions are also in the training of many researchers, formally or not, through his generosity in sharing his knowledge and his respectful treatment dedicated to his students. Professor Barbanti took that same generosity and respect to the classroom. The focus of this talk is mainly to remember and pay a simple tribute to Professor Barbanti. It would be pretentious to be able to put all his contributions in this work. Some highlights of his papers and his brilliant trajectory will be mentioned here.

Existence results for state-dependent abstract functional differential equations with infinite delay and applications

Henrique Costa dos Reis, Hernán R. Henríquez, Jaqueline Godoy Mesquita
Universidade de Brasília

This work is devoted to investigate the existence of mild solutions of abstract state-dependent retarded functional differential equations with infinite delay. We obtain the result concerning the existence of mild solutions for the state-dependent equations as a fixed point of the solution operator of an associated abstract time-dependent retarded functional differential equation. We are concerned with equations that present a phenomena of lacunary memory.

A method for the integration of stochastic advection equations

Hugo de la Cruz, C. Olivera
Fundação Getúlio Vargas

The integration of stochastic advection equation is considered. We propose a method for the effective simulation of trajectories of the solution of this equation in the case of regular and irregular coefficients. Results on the convergence of the suggested scheme and details on their efficient implementation are presented. The performance of the introduced method is illustrated through computer simulations.

A study of the Lyapunov stability of discontinuous systems

Iguer Luis Domini dos Santos
Universidade Estadual Paulista

In this work, we study the stability analysis of equilibrium of ordinary differential equations with discontinuous right-hand sides, also called discontinuous differential equations, using the notion of Carathéodory solution for differential equations. Thus, we study the stability in the sense of Lyapunov of equilibrium of discontinuous systems through nonsmooth Lyapunov functions. Then two Lyapunov existence theorems are obtained. The results established refer to systems determined by non-autonomous differential equations.

Linearized instability for neutral functional differential equations with state-dependent delays

Jaqueline Godoy Mesquita, Bernhard Lani-Wayda, Hans-Otto Walther
Universidade de Brasília

In this work, we investigate a principle of linearized instability for neutral functional differential equations with state-dependent delays. This is a joint work with Professor Bernhard Lani-Wayda and Professor Hans-Otto Walther.

Faedo-Galerkin approximation of mild solutions of nonlocal fractional functional differential equations

J. Vanterler da C. Sousa, Michael Feckan, E. Capelas de Oliveira
Universidade Estadual de Campinas

In this work, we investigate the existence, uniqueness and convergence of approximation of mild solutions for a class of abstract fractional functional differential equation with nonlocal condition in Hilbert separable space $\mathcal{H}$, given by

$$\begin{cases} {}^{H}\mathcal{D}_{0^+}^{\mu,\nu}u(t) + \mathcal{A}u(t) &= f(t,u(t),u(b(t))),\ t\in(0,T_0] \\ \mathbf{I}_{0^+}^{1-\gamma}u(0) + \sum\limits_{k=1}^{p} C_k\mathbf{I}_{0^+}^{1-\gamma}u(t_k) &= u_0 \end{cases} \tag{5}$$

where ${}^{H}\mathcal{D}_{0^+}^{\mu,\nu}(\cdot)$ is the Hilfer fractional derivative of order $0<\mu\leq 1$ and type $0\leq\nu\leq 1$, $\mathbf{I}_{0^+}^{1-\gamma}(\cdot)$ is the Riemann-Liouville fractional integral of order $1-\gamma$ ($\gamma=\mu+\nu(1-\mu)$, $0\leq\gamma\leq 1$), $0<t_1<\cdots<t_p\leq T_0$, $I=[0,T_0]$, $-\mathcal{A}$ be the infinitesimal generator of a $(\mathbb{S}(t))_{t\geq 0}$ semigroup of bounded linear operators on a separable Hilbert space $\mathcal{H}$ and the nonlinear application $f:[0,T_0]\times\mathcal{H}\times\mathcal{H}\to\mathcal{H}$, $b\in C_{1-\gamma}(I,I)$, where $C_{1-\gamma}(I,I)$ the weighted space of all continuous functions from I into I, $c_k\neq 0$ for all $k=1,2,3,\ldots,p$, $p\in\mathbb{N}$ and $u_0\in\mathcal{H}$.

C^1-smooth dependence on initial conditions and delay: spaces of initial histories of Sobolev type, and differentiability of translation in L^p

Junya Nishiguchi
Tohoku University

The objective of this paper is to clarify the relationship between the C^1-smooth dependence of solutions to delay differential equations (DDEs) on initial histories (i.e., initial conditions) and delay parameters. For this purpose, we consider a class of DDEs which include a constant discrete delay. The problem of C^1-smooth dependence is fundamental from the viewpoint of the theory of differential equations. However, the above mentioned relationship is not obvious because the corresponding functional differential equations have the less regularity with respect to the delay parameter. In this paper, we prove that the C^1-smooth dependence on initial histories and delay holds by adopting spaces of initial histories of Sobolev type, where the differentiability of translation in L^p plays an important role.

A red blood cell multi-component mathematical model for slow transient virtual experiments

Luca Meacci, Gustavo C. Buscaglia, Roberto F. Ausas, Fernando Mut
ICMC - USP

This lecture consists in the presentation of a mathematical model to simulate the behavior of red blood cells in slow transient processes such as, for example, micropipette aspiration and optical tweezers stretching.

The basic model, inspired by the best models currently available, considers the cytoskeleton as a discrete non-linear elastic structure. The novelty of the proposal is to couple this skeleton not with discrete models (molecular dynamics, particle methods) of the lipid membrane and internal and external fluids as usual, but with continuum models. The interaction of the solid cytoskeleton with the membrane, which is a two-dimensional fluid, will be done through adhesion forces adapting efficient solid-solid adhesion algorithms. The continuous treatment of the fluid parts is well justified by scale arguments and leads to much more stable and precise numerical problems when, as is the case, the size of the molecules (0.3nm) is much smaller than the overall size (8000nm).

Existence of mild solutions for integro-differential equations in Banach spaces via kuratowski measure of noncompactness (30mn)

Mamadou Abdoul Diop
Gaston Berger

The talk focuses on the existence of mild solutions in Banach space for a first order semi-linear integro-differential equation. The results are achieved with fixed-point theorem and Kuratowski measure of noncompactness. We conclude this study with an example to illustrate our findings.

Periodic solutions of linear generalized ODEs via Fredholm operators

C. Mesquita, M. Federson, K. Schiabel
Universidade Federal de São Carlos

We established a result on the existence of periodic solutions of linear generalized ordinary differential equations. In order to do that, we defined operators L and N from the space of regulated functions to itself and L is a Fredholm operator of index 0. We proved that there exists a correspondence between the periodic solutions of $L(x) = N(x)$ and the periodic solutions of linear generalized ordinary differential equation. Then it was possible to prove our main result on the existence of a solution of $L(x) = N(x)$. The theories of coincidence degree and of linear operators were also employed to obtain the main result. Finally, we applied the result to linear measure differential equations.

Periodic solutions of generalized ODEs in Banach spaces

Marielle Aparecida Silva, Márcia Federson, Marta Gadotti
Universidade de São Paulo

In this work, we define periodicity of solutions of generalized ordinary differential equations that assume values in $\mathbb{R}^n$ and in a Banach space any. We present conditions necessary and sufficient for a solution to be periodic. We deal with the integral forms of the differential equations using the

Kurzweil integral. Thus the functions involved can have many discontinuities and be of unbounded variation and yet we obtain good results which encompass those in the literature.

Massera's theorems for various types of equations with discontinuous solutions

Mateus Fleury, Jaqueline G. Mesquita, Antonín Slavík
Universidade de Brasília

In 1950, Massera published an article on the existence of periodic solutions for ordinary differential equations. Since then, this result has been studied and extended to other classes of equations, such as differential equations on time scales.

In this presentation, we present new Massera-type theorems for generalized ordinary differential equations. We also use the correspondence of this equations with various types of equations to also establish new Massera-type theorems for measure differential equations, impulsive equations and also dynamic equations on time scales.

For scalar nonlinear equations, we find sufficient conditions that imply that bounded solution converge asymptotically to a periodic solution. For linear systems, we show that if there is a bounded solution, the existence of a periodic solution is also guaranteed.

Stochastic Differential Equations via Generalized ODEs and applications

M. Federson, E. M. Bonotto, R. Collegari, F. Federson
Universidade de São Paulo

In this talk, we will show that stochastic differential equations can be regarded as generalized ODEs. In order to do this, we will show that a certain class of functions which are Itô integrable are also integrable in the sense of Kurzweil-Henstock with left tagged divisions in its definition. Finally, we will address some of our progresses on Fock spaces and elementary particles.

Dynamics of a delayed chemostat with periodic nutrient supply

Pablo Amster, Gonzalo Robledo, Daniel Sepúlveda
Buenos Aires

A model of a one-species chemostat with a periodic input is described by a system of delay differential equations, where the delay represents the interval time between the consumption of nutrient and its metabolization by the microbial species. A necessary and sufficient condition ensuring the existence of a periodic solution is obtained by means of a Poincaré operator method combined with Leray-Schauder degree techniques. In addition, uniqueness shall be proved when the delay is sufficiently small.

Nonlinear eigenvalue problems in Hilbert spaces

Pierluigi Benevieri, A. Calamai, M. Furi, M.P. Pera
Universidade de São Paulo - USP

We consider the nonlinear eigenvalue problem $Lx + \varepsilon N(x) = \lambda Cx$, $\|x\| = 1$, where ε, λ are real parameters, $L, C\colon G \to H$ are bounded linear operators between separable real Hilbert spaces, and $N\colon S \to H$ is a continuous map defined on the unit sphere of G. We prove a global persistence result

regarding the set Σ of the *solutions* $(x, \varepsilon, \lambda) \in S \times \mathbb{R} \times \mathbb{R}$ of this problem. Namely, if the operators N and C are compact, under suitable assumptions on a solution $p_* = (x_*, 0, \lambda_*)$ of the unperturbed problem, we prove that the connected component of Σ containing p_* is either unbounded or meets a triple $p^* = (x^*, 0, \lambda^*)$ with $p^* \neq p_*$. When C is the identity and $G = H$ is finite dimensional, the assumptions on $(x_*, 0, \mathrm{I}_*)$ mean that x_* is an eigenvector of L whose corresponding eigenvalue λ_* is simple. Therefore, we extend a previous result obtained by the authors in the finite dimensional setting. Our work is inspired by a paper of R. Chiappinelli concerning the local persistence property of the unit eigenvectors of perturbed self-adjoint operators in a real Hilbert space.

Time-scale analysis for vector-borne diseases with spatial dynamics

Sergio Oliva, Marcone Pereira, Larissa Sartori
Universidade de São Paulo

Vector-borne diseases are becoming increasingly widespread in a growing number of countries and it has the potential to get out of control,either associated to changes in vectors habitats, human circulation or climate changes. We use the available dengue incidence and some cell phone data to study, from the dynamical point of view, the spatial-temporal interaction of models that try to adjust to such events. The first challenges are to address the dynamics of the vectors (very fast and local) and the dynamics of humans (very heterogeneous and non-local). The objective is to use the well known Ross-Macdonald models, incorporating spatial movements, identifying different times scales and estimate in a suitable way the parameters.

Linear Equations

Organizer: Rafael Gonzales and Gabriel Araújo

Global solvability in the sense of Denjoy-Carleman on tori

Alexandre Kirilov
Universidade Federal do Paraná

In this talk, we will analyze the problem of global solvability in Denjoy-Carleman classes for some classes of (pseudo)differential operators defined on the n-dimensional torus. As an application, we will recover known results in Gevrey classes and present new results in classes of quasi-analytic functions, which were not previously considered in the literature.

Strong uniqueness in the Cauchy problem for finite degeneracy type vectors fields

Camilo Campana, Jorge Guillermo Hounie
Universidade Federal de São Carlos

Consider the planar vector field

$$L = \partial/\partial t + a(x,t)\partial/\partial x$$

defined in a domain Ω containing the origin of $\mathbb{R}^2$, where $a(x,t)$ is a complex function of class C^1 and the problem

$$\begin{cases} Lu = Au + B\overline{u} \quad \text{for } t > 0, \\ u(x,0) = u_0(x), \end{cases} \tag{6}$$

where A, $B \in L^p(\Omega)$. One says that there is uniqueness in the local forward Cauchy problem for (6) if $u_0 \equiv 0$ implies that $u(x,t)$ vanishes identically on a neighborhood of the set $\{t = 0\}$. We will discuss the uniqueness in the Cauchy Problem for a class of local integrable complex vector fields with finite degeneracy type defined in the plane.

Local solvability for a class of linear operators in Triebel-Lizorkin spaces

Evandro Raimundo da Silva
USP - Instituto de Ciências Matemáticas e de Computação

We show local solvability in Triebel-Lizorkin spaces for a class of first order linear operators L defined on an open set of $\mathbb{R}^{n+1}$, $n \in \mathbb{N}$, satisfying the condition (P) of Nirenberg-Treves and whose coefficients are Hölder continuous

Global Gevrey solvability for a class of systems of differential operators of order 1 on the torus

Igor Ambo Ferra
Universidade Federal do ABC

In this work we study the global Gevrey solvability of the following classes of differential operators acting in $\mathbb{T}^n_t \times \mathbb{T}_x$:

$$P_j = \partial_{t_j} + a_j(t)\partial_x + b_j(t), j = 1, \dots, n, \tag{7}$$

where $a(t) = \sum_{j=1}^n a_j(t)dt_j$ and $b(t) = \sum_{j=1}^n b_j(t)dt_j$ are closed 1-forms on $\mathbb{T}^n_t$ and a is real. Assuming that the principal part of the system is globally Gevrey solvable, that is the system

$$L_j = \partial_{t_j} + a_j(t)\partial_x, j = 1, \dots, n,$$

is globally Gevrey solvable we characterize the global solvability of the system (7) in terms of Diophantine conditions and the order of vanishing of some perturbations of the functions b_j.

L^2 Regularity Theory of the Complex Green Operator on CR Manifolds of Hypersurface Type

Joel Coacalle, Andrew Raich
Universidade Federal de São Carlos - UFSCar

In this presentation we establish sufficient conditions for closed range estimates on $(0,q)$-forms, for some fixed q, $1 \leq q \leq n-1$, for $\bar{\partial}_b$ in both L^2 and L^2-Sobolev spaces in embedded, not necessarily pseudoconvex, CR manifolds of hypersurface type. The condition, named weak $Y(q)$, is both more general than previously established sufficient conditions and easier to check. Applications of these estimates include estimates for the Szegö projection as well as an argument that the harmonic forms have the same regularity as the complex Green operator. It will also be presented the microlocal argument used, by constructing a norm well-suited for a microlocal decomposition of form. We do not require that the CR manifold is the boundary of a domain. Finally, it will be provided an example that demonstrates that weak $Y(q)$ is an easier condition to verify than earlier, less general conditions, and we will also explain our recent and future advances in this topic.

When gaussians extremize the Strichartz inequalities?

Lucas da Silva Oliveira, Emanuel Carneiro, Mateus Sousa
Universidade Federal do Rio Grande do Sul

In this talk we will give a brief introduction to the topic of sharp Strichartz inequalities, and after that, we will discuss what is know about existence of gaussians extremizers for this inequalities; we will focus on a result obtained recently in collaboration with Emanuel Carneiro and Mateus Sousa, where we prove that gaussians never extremize such inequalities in the case of hyperbolic paraboloids.

Hypoellipticity of sum of squares in compact manifolds

Luis Fernando Ragognette, Gabriel Araújo, Igor Ambo Ferra
DM-UFSCar

Our goal here is to discuss global hypoellipticity of a class of operators in the form sum of squares of vector fields in the product of two compact Riemannian manifolds $M_1 \times M_2$. In a recent work

of Barostichi, Petronilho and Ferra the global smooth and Gevrey hypoellipticities in the torus are classified using a notion of simultaneous approximability which in some sense is a more sophisticated version of the Diophantine conditions that first appeared in the work of Greenfield and Wallach.

We are able to find a necessary condition for global hypoellipticity and we proved that it is equivalent to the one given by Barostichi, Petronilho and Ferra when $M_1 = \mathbb{T}^n$ and $M_2 = \mathbb{T}^m$, i.e., $M_1 \times M_2$ is a torus. We also proved that our condition is sufficient when M_1 is any compact Riemannian manifold and $M_2 = \mathbb{T}^m$.

The Method of Stationary Phase for wave type models

Marcelo Rempel Ebert
Universidade de São Paulo

In this talk we derive L^pL^q estimates for solution to the Cauchy problem for the following linear σ-evolution equation with non effective damping

$$\begin{cases} u_{tt} + (-\Delta)^{\sigma} u + a(-\Delta)^{\theta} u_t = 0, \quad x \in \mathbb{R}^n,\, t \in \mathbb{R}_+, \\ u(0,x) = 0, \\ u_t(0,x) = u_1(x), \end{cases} \tag{8}$$

with $\sigma < 2\theta \leq 2\sigma$ and $a > 0$. The condition $\sigma < 2\theta$ implies that the considered multiplier has oscillations at small frequencies. Hence, similar for the wave equation

$$u_{tt} - \triangle u = 0$$

and the plate equation

$$\partial_t^2 u + \triangle^2 u = 0,$$

we have to derive estimates for oscillatory integrals by using Littman type lemma. However, if $a \neq 0$, we no longer can use the homogeneity as done for the case $a = 0$

On the class of Anharmonic Oscillators

Marianna Chatzakou, Michael Ruzhansky, Julio Delgado
Imperial College London

In this work, we study a class of anharmonic oscillators within the framework of the Weyl-Hörmander calculus. The anharmonic oscillators arise from several applications in mathematical physics as natural extensions of the harmonic oscillator. A prototype is an operator on $\mathbb{R}^n$ of the form $(-\Delta)^l + |x|^{2k}$ for k, l integers ≥ 1. The simplest case corresponds to Hamiltonians of the form $|\xi|^2 + |x|^{2k}$. Here by associating a Hörmander metric g to a given anharmonic oscillator we investigate several properties of the anharmonic oscillators. We obtain spectral properties in terms of Schatten-von Neumann classes for their negative powers. We also study some examples of anharmonic oscillators arising from the analysis on Lie groups

The FBI transform on hypo-analytic structures and Gevrey regularity

Nicholas Braun Rodrigues
Universidade de São Paulo

The FBI transform is widely used to study the regularity of solutions of PDE's. In 1983 Baouendi, Chang and Treves proposed an FBI adapted to a hypo-analytic structure, and with it, they characterized the so-called hypo-analytic functions, for instance, CR-functions. An important application of this characterization is that hypo-analytic singularities propagate along elliptic submanifolds, which was proved in 1983 by F. Treves and N.Hanges. The aim of this talk is to show that the FBI presented in Baouendi-Chang-Treves' paper also characterizes the Gevrey (or hypo-Gevrey) functions.

Continuity of pseudo-differential operators with Banach space valued symbols

Pedro T P Lopes, Tiago H. Picon
Universidade de São Paulo

It is known that several results and concepts of harmonic analysis (Fourier multipliers, maximal functions and so on) can be extended to functions with values in Banach spaces. In particular, versions of the Miklhin Theorem can be proved. Theorems in this direction can be applied to evolution equations, where they allow to obtain regularity results.

It is also possible to study pseudo-differential operators with Banach space valued symbols, targeting the same kind of applications. Here we present some results that can be found in the literature and we show some directions that can be taken, in particular some of our own results and challenges. (Partially supported by FAPESP. Processo número 2019/15200-1).

Global solvability for perturbations of real vector fields on the torus

Rafael Borro Gonzalez
UEL

We show that a perturbation of zero order may change the global solvability (closed range) of certain real vector fields on the torus. The results produce a contrast to the local and semiglobal aspect of solvability.

A characterization of ultradifferentiable functions via a class of FBI transforms

Renan Dantas Medrado, Gustavo Hoepfner
Universidade Federal de Alagoas

We present a class of FBI transforms (including the class of FBI transforms presented by M. Christ in 1997) using weight functions. We use this class of transforms to characterize Braun, Meise and Taylor (BMT) locally regularity of ultradistibutions. We also characterize the BMT vectors in terms of the FBI transform and prove a BMT version of the Kotake-Narasimhan Theorem.

The Cauchy problem for the “good" Boussinesq equation with Gevrey initial data

Renata Figueira, Alex Himonas, Rafael Barostichi
Federal University of São Carlos

We shall consider the Cauchy problem for the “good" Boussinesq equation with initial data belonging in a class of Gevrey functions on both the line and the circle, which includes a class of analytic function that can be extended holomorphically in a symmetric strip of the complex plane around the x-axis. This talk is devoted to present a result about well-posedness in these classes of functions, which guarantees the Gevrey regularity of the solutions in space variable. Also, we shall discuss the time regularity of the solution obtained.

On the Global Analytic Hypoellipticity of a Class of Left-invariant Operators on Lie Groups

Ricardo Paleari, Alexandre Kirilov, Wagner de Moraes
Universidade Federal do Paraná

We divide this work into two parts. First, we analyze a class of perturbations of constant coefficients operators on a product of two compact Lie groups $G = G_1 \times G_2$. The operators are of the form

$$L_\lambda = X_1 + \alpha X_2 + \lambda$$

where X_i is a left-invariant vector field on G_i for $i = 1, 2$ and $\alpha, \lambda \in \mathbb{C}$. Using the Fourier transform in this context, we can translate the condition about L being GAH in terms of a Diophantine-like condition. In the second part, we study some operators on the particular Lie group $G = \mathbb{T}^1 \times \mathbb{S}^3$. In this case, we try to mimic a (P)-condition on operators in the form

$$L_\lambda = \partial_t + c(t)\partial_0 + \lambda$$

where $c(t) = a(t) + ib(t) \in C^\omega(\mathbb{T}^1 \times \mathbb{S}^3)$, in order to characterize when L_λ is GAH.

On the local solvability of some degenerate linear partial differential operators

Serena Federico
Ghent University

In this talk I will show the local solvability property of some classes of linear degenerate second order partial differential operators with smooth and non-smooth coefficients. In particular, I will give sufficient conditions for the local solvability to hold, conditions involving both the principal and the subprincipal symbol of the operators under consideration.

Convolution Equations on Compact Lie Groups

Wagner Augusto Almeida de Moraes
Universidade Federal do Paraná

We discuss the convolution of functions and distributions defined on compact Lie groups. We show that some properties are slightly different from the standard convolution in $\mathbb{R}^d$ because of the general non-commutativity of the groups and we present necessary and sufficient conditions to obtain global properties of convolution equations.

Nonlinear Dynamical Systems/Evolution Equations and Applications

Organizer: Juliana Fernandes

Existence for Reaction-Diffusion Equations with almost-monotonic reaction terms

Alejandro Vidal-López, Aníbal Rodríguez-Bernal
Xi'an Jiaotong-Liverpool University

In this talk we present global existence and uniqueness results for reaction-diffusion equations in Lebesgue spaces with almost-monotonic nonlinearities, not fitting in the standard theory of local existence.

A local/nonlocal diffusion model

Bruna Cassol dos Santos, Sergio Muniz Oliva, Julio Daniel Rossi
University of São Paulo

In this work, we study some qualitative properties for an evolution problem that combines local and nonlocal diffusion operators acting in two different subdomains of $\Omega = (-1,1)$. The local part is composed of a heat equation with Neumann/Robin type boundary condition and the Robin type boundary condition at $x = 0$ encodes the coupling with the nonlocal part of the problem. The energy functional associated with this evolution problem can be viewed as the gradient flow associated with this energy. We prove existence and uniqueness results, as well as, that the model preserves the total mass. We also study the asymptotic behavior of the solutions. In addition, rescaling the nonlocal kernel in a suitable way, we can recover the usual heat equation.

An average principle for stochastic differential equations

Fabiano Borges da Silva, Diego Sebastian Ledesma
UNESP

In this work we use the decomposition of stochastic flows to obtain components that represent the fast and slow motion of a solution flow of a given stochastic differential equation (SDE), which has a perturbation in a certain direction transversal to a foliation. And through a special metric, that works well with stochastic calculation tools, we obtain some estimates for the approximation between slow motion and the solution of a differential equation obtained using an average principle.

On the dynamics of a parabolic PDE driven by the p-Laplacian with indefinite logistic source

Gustavo F. Madeira, Tito L. M.Luna
UFSCar

We are concerned with existence, uniqueness and asymptotic behaviour of positive solutions of a parabolic PDE driven by the p-Laplacian with indefinite and unbounded potentials besides a logistic source having weight which is also indefinite and unbounded. The boundary condition appearing is of flux type, precisely, Neumann or Robin. The asymptotic stability properties of the stationary solutions are described using principal eigenvalues of some elliptic eigenvalue problems.

Linearization and Stability in Infinite Dimensional Dynamical Systems

Hildebrando Munhoz Rodrigues, Hildebrando Munhoz Rodrigues, J. Solà-Morales
Universidade de São Paulo

- Some historic results. Some Elementary Motivations.
- On the relationship between norms of bounded linear operators and their spectral radius.
- A Hartman-Grobman Theorem with parameters. Continuity of the Conjugation with respect to parameters.
- The Continuity of the Fixed Point with respect to parameters.
- The Differentiability of the Fixed Point with respect to parameters.
- A Hartman-Grobman Theorem with parameters. Differentiability of the Conjugation with respect to parameters.
- A surprising example. Stabilization of Unstable system.

Robustness with respect to spatially variable exponents for evolution problems with large diffusion

Jacson Simsen
UNIFEI - Universidade Federal de Itajubá

This talk is based on the papers [1-6] where the authors had considered evolution problems with large diffusion and studied the stability of the solutions and the robustness of the attractors when the spatially variable exponents vary.

Acknowledgements: Thanks to CAPES, FAPEMIG and CNPq for the Supports during the development of the referenced works.

References:

[1] Simsen, Jacson; Simsen, Mariza Stefanello; Valero, José, Convergence of nonautonomous multivalued problems with large diffusion to ordinary differential inclusions, To appear at CPAA 2020.
[2] Simsen, Jacson, Weak upper semicontinuity of pullback attractors for nonautonomous reaction-diffusion equations, Electronic Journal of Qualitative Theory of Differential Equations 68 (2019) 1–14.
[3] Fernandes, Antonio Carlos; Gonçalves, Marcela Carvalho; Simsen, Jacson, Non-autonomous reaction-diffusion equations with variable exponents and large diffusion. Discrete Contin. Dyn. Syst. Ser. B 24 (2019), no. 4, 1485–1510.
[4] Simsen, Jacson; Simsen, Mariza Stefanello; Zimmermann, Aleksandra, Study of ODE limit problems for reaction-diffusion equations. Opuscula Math. 38 (2018), no. 1, 117–131.
[5] Simsen, Jacson, Partial differential inclusions with spatially variable exponents and large diffusion, Mathematics in Engineering, Science and Aerospace (MESA) 7 (2016), no. 3, 479–489.

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Studying the long time dynamics of fermentation models: production of dry and sweet wine

Javier López-de-la-Cruz
University of Sevilla

In this talk we will consider two classical mathematical models of wine fermentation. The first model will describe the wine-making process that is used to produce dry wine. The second model will be obtained by introducing a term in the equation of the dynamics of the yeast. Thanks to this change it will be possible to inhibit the fermentation of the sugar and as a consequence a sweet wine will be obtained. We will first prove the existence, uniqueness, positiveness and boundedness of solutions for both models. Then we will pass to analyse the long-time dynamics. For the second model we will also provide estimates for the concentration of ethanol, nitrogen and sugar at the end of the process. Moreover, several numerical simulations will be provided to support the theoretical results.

Fredholm-Schroedinger PDE problem for variational electrodynamics

Jayme De Luca
Universidade Federal de São Carlos

We start from the Balmer series of 1890 and a historical review of the Rydberg-Ritz principle of spectroscopy, which calculates spectroscopic lines by differences of eigenvalues of the Schroedinger equation. A later improvement to describe the multiplicity and splitting of spectral lines was the spin-orbit coupling between two identical copies of the Schroedinger equation. After the review, we present our derivation of a PDE from variational electrodynamics and the calculation of the Bohr radius from the boundary layer of some periodic orbits with discontinuous velocities chosen according to our Chemical Principle criterion. Our PDE has a natural spin-orbit forcing term in the Sobolev space W(2,2), which we call the Fredholm-Schroedinger PDE problem.

Attractors as informational structures

José A. Langa
Universidad de Seville

In this talk we will revisited the concept of the global attractor as a global transformation of the phase space generating an informational landscape. When we are able to describe its internal structure, the global attractor shows as a very robust object under autonomous and nonautonmous perturabations. We will show some results on the topological and geometrical structural stability of attractors for infinite dimensional dynamical systems. Moreover, we will try to explain how the nature of the attractor can be intepreted to be as informational, and the implications this fact may possess related to the Neuroscience and the global brain dynamics.

A Poincaré compactification of finite time blow-up for parabolic equations

Juliana Fernandes, Phillipp Lappicy, Juliana Honda
Universidade Federal do Rio de Janeiro

We compactify the semiflow for parabolic equations when blow-up occurs. We introduce a new notion of Poincare compactification that allows for a "heigth" function to be spatially dependent (non-homogeneous compactification), and hence different points in the domain are compactified with different rates: the blow-up point is normalized to be one, whereas points nearby are below this value. The new compactification provides a global picture of the dynamics outside bounded sets of phase-space. In particular, we compactify the unstable manifold of the trivial equilibria, and show the structure of its boundary that consists of compactifications of the blow-up profiles.

Global attractor for semilinear heat equation

Juliana Honda Lopes, Juliana Fernandes S. Pimentel, Phillipo Lappicy
Universidade Federal do Rio de Janeiro

Perturbation of compact attractors for semilinear heat equation is an ongoing topic of research with a well-developed theory. On the other hand, not much is known about unbounded attractors. Therefore a better understanding of the dynamical structure of such objects is of paramount relevance.

In [1] the asymptotic behavior of the following problem was studied

$$\begin{cases} u_t = u_{xx} + bu + f(u) - \epsilon u^3, \quad x \in [0, \pi] \\ u_x(t,0) = u_x(t,\pi) = 0, \end{cases} \tag{9}$$

where $b > 0$ and $f \in C^2$ is a bounded and globally Lipschitz function. The dynamic system generated by (9), for all $\epsilon > 0$ is dissipative. When $\epsilon = 0$, the associated dynamic system is slowly non-dissipative. So, the limit equation has solutions that blowing-up in infinite time, while the solutions for equation with $\epsilon > 0$ are bounded for $t \geq 0$. The authors of [1] proved the continuity of the family of attractors in compact set and that the limit of the compact attractor of (9) is not the unbounded attractor of the limiting equation.

Currently, we are studying the dynamic of the problem (9) when $\epsilon < 0$. In this case, we have a fast nondissipative dynamical system that produces finite-time blow-up solutions. When the parameter ϵ goes to zero, we verified that the maximal time of existence for solutions goes to infinity, what makes sense since the limiting equation is globally well-posed. We are studying the continuity of the solutions and global attractors as $\epsilon \to 0$ using a non-homogeneous Poincaré Projection, as well as understanding whether or not the "limit of the attractor is the attractor of the limit."

This work is a collaboration with Phillipo Lappicy e Juliana Fernandes S. Pimentel.

References:

[1] S. Bruschi, A. N. Carvalho, J. Pimentel, *Limiting grow-up behavior for a one-parameter family of dissipative PDEs*, Indiana University Mathematics Journal, (to appear).

Infinite delay in a non-classical and non-automomous diffusion equation

Felipe Rivero, Tomás Caraballo, Antonio Miguel Márquez-Durán, Felipe Rivero
Universidad Politécnica de Madrid

We are goingo to talk about the study the following non-classical and non-autonomous diffusion equation with infinite delay

$$\begin{cases} \dfrac{\partial u}{\partial t} - \gamma(t)\Delta\dfrac{\partial u}{\partial t} - \Delta u = g(u) + f(t, u_t) \text{ in } (\tau, +\infty) \times \Omega, \\ u = 0 \text{ on } (\tau, +\infty) \times \partial\Omega \\ u(t, x) = \phi(t - \tau, x), t \in (-\infty, \tau], x \in \Omega \end{cases}$$

showing the well-posedness and the asymptotic dynamic of the problem where u_t denotes a segment of the solution. This abstract formulation allows to consider different kinds of delay terms.

References:

[1] T. Caraballo, A.M. Márquez-Durán, F. Rivero, Well–posedness and asymptotic behaviour for a non-classical and non-autonomous diffusion equation with delay, *International J. Bifurcation and Chaos* 25 (2015), no. 14, 1540021.
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Boundary stabilization and global solutions of MGT equation arising in nonlinear acoustics with a second sound

Marcelo Bongarti, Irena Lasiecka
University of Memphis

The Moore-Gibson-Thompson (MGT) equation is a benchmark model describing propagation of nonlinear waves in a heterogeneous medium. This is a third order (in time) dynamics which accounts for a finite speed of propagation of acoustic waves. In fact, by replacing Fourier's law by Maxwell-Cattaneo's law one introduces a thermal relaxation parameter whose presence resolves the so called infinite speed of propagation paradox. The model under consideration leads to a quasilinear system of predominantly hyperbolic type. While uniform stability of nonlinear waves has been recently shown under the assumption that diffusive effects of an acoustic medium are sufficiently large, it is of interest to consider the so called *critical case* with small diffusion such that the linearization of the system leads to conservative dynamics only. In such case one obtains *local in time* solutions to the corresponding quasilinear model. The goal of the talk is to present recent results on boundary stabilization of the linearized MGT equation and global solvability of the corresponding quasilinear system also in the *critical case*.

Rigorous numerical integration for PDEs with the use of Finite Element Method

Piotr Kalita, Piotr Zgliczyński
Jagiellonian University, Krakow, Poland

Rigorous numerical integration can be used as a tool to study the attractor structure for problems governed by evolutionary dissipative PDEs. I will demonstrate that the approach based on the Finite Element Method can be used in computer assisted proofs based on the rigorous numerical integration to get the analytical results on identification of the trajectories belonging to the attractor. As an example I will show the computer assisted construction of periodic in time trajectory for the Burgers equation with periodic forcing and Dirichlet conditions. The results have been obtained jointly with Piotr Zgliczynski.

A reaction-diffusion model with nonlocal viscosity and Lyapunov structure

Rubén Caballero Toro, Pedro Marín Runio, José Valero Cuadra
Miguel Hernández de Elche

During the last decades many mathematicians have been studying non local problems. One of the justification of such model lies in the fact that they appear in a variety of biological fields.

For instance, let consider the problem of finding a function $u(x,t)$ such that

$$\begin{cases} u_t - a(\int_\Omega u(x,t)dx)\Delta u = f, \text{ in } \Omega \times (0,T), \\ u = 0 \quad \text{on } \partial\Omega \times (0,T), \\ u(0) = u_0 \quad \text{in } \Omega. \end{cases} \tag{10}$$

Here Ω is a bounded open subset in $\mathbb{R}^n$, $n \geq 1$ with smooth boundary. T is some arbitrary time and a is some function from $\mathbb{R}$ into $(0, +\infty)$. In such equation u could describe the density of a population subject to spreading. The diffusion coefficient a is then supposed to depend on the entire population in the domain rather than on the local density.

A wide literature with significant results about (10) have been developed during the last few decades. However, it has not been so far when the dependence of a has been changed. By this way, in our paper the following problem is considered

$$\begin{cases} u_t - a(\|u\|^2_{H^1_0})\Delta u = f(u) + h(t), \text{ in } \Omega \times (0,T), \\ u = 0 \quad \text{on } \partial\Omega \times (0,T), \\ u(0) = u_0 \quad \text{in } \Omega, \end{cases} \tag{11}$$

where $h(t) \in L^2(0,T;L^2(\Omega))$. Also, we suppose that there exists constants $0 < m < M$ and $\kappa \geq 0$, α_1, $\alpha_2 > 0$ and $p \geq 2$ such that

$$a \in C([0,\infty),[m,M]) \text{ and } f \in C(\mathbb{R}) \text{ with } -\kappa - \alpha_2|s|^p \leq f(s)s \leq \kappa - \alpha_1|s|^p.$$

Following this framework, new challenging difficulties raises on problem (11). We have proved existence and uniqueness of solution under certain conditions on the function f and considering the initial condition in two spaces $L^2(\Omega)$ and $H^1_0(\Omega) \cap L^p(\Omega)$. Furthermore, the existence of a compact global attractor is ensured in each case to obtain a caracterization of it.

Stabilization by boundary noise: a Chafee-Infante equation with dynamical boundary conditions

Stefanie Sonner, Klemens Fellner , Bao Quoc Tang , Do Duc Thuan
Radboud University Nijmegen

The stabilization of parabolic PDEs by Itô noise has been widely studied over the past decades. However, the stabilization by a noise acting only on the boundary of a domain has not been addressed so far. As a first model case we analyze whether a multiplicative Itô noise on the boundary can have a stabilizing effect on the Chafee-Infante equation with dynamical boundary conditions. In particular, we show that there exists a finite range of noise intensities that imply the exponential stability of the trivial steady state. Our results differ from previous works on stabilization, where the noise acts inside the domain, and stabilization typically occurs for an infinite range of noise intensities.

Well posedness and asymptotic behavior of parabolic problem with non local term and flux type boundary condition

Tito Luciano Mamani Luna
Universidade de São Paulo

The purpose of this lecture is dedicated to the study of dynamical properties of the parabolic problem with term $u_t = a\left(\int |\nabla u|^2\right)\Delta u - \alpha(x)u + f(x)$ and flux boundary condition where a is a continuous function lower bounded by a positive constant. We prove well posedness, regularity and establish the asymptotic behavior, for large times. First we prove existence and continuous dependence on data using Faedo-Galerkin method and a suitable change of variables. Some sufficient conditions are given to ensure uniqueness of solution. Concerning asymptotic behavior, we show that the omega limit set of each (semi) orbit contains, at least, one stationary solution. We then study stability of local minima of the associated energy functional showing first a result on asymptotic stability of a global minimum for the energy. We also prove a sufficient condition for the existence of isolated local minimum of the energy functional, which is proved to be an asymptotically stable stationary solution in a suitable neighborhood.

ICMC SUMMER MEETING on DIFFERENTIAL EQUATIONS

CHAPTER 2020

Poster Section

Poster Session

Normalized solutions for a Schrödinger-Bopp-Podolsky systme

Danilo Gregorin Afonso
Universidade de São Paulo

Schrödinger-Poisson systems first appeared as the coupling of the Schrödinger's equation with a newtonian gravitational potential. Benci and Fortunato [1] studied a system of similar nature arising from the coupling of Schrödinger's equation with Maxwell's equations and, under Dirichlet boundary conditions, developed a now standard method to deal with this kind of problem. Later, Pisani and Siciliano [2] treated a Neumann problem for a similar system, where the procedure of Benci and Fortunato fails. In the present work we treat a modification of the problem studied in [2] which consists in the addition of a biharmonic term in the second equation (and imposition of appropriate boundary conditions):

$$-\Delta u + q\varphi u = \omega u$$
$$-\Delta \varphi + \Delta^2 \varphi = q u^2$$

in a smooth, bounded domain Ω subject to

$$u = 0, \qquad \frac{\partial \varphi}{\partial n} = h_1, \qquad \frac{\partial \Delta \varphi}{\partial n} = h_2$$

on $\partial\Omega$, where h_1, h_2 are continuous, $q \in C(\overline{\Omega})$, $\omega \in \mathbb{R}$ and $\int_\Omega u^2 \, dx = 1$. Motivation for the introduction of the biharmonic operator comes from the Bopp-Podolsky electrodynamics, where the equation for the electric potential is of this form. We introduce an auxiliary problem in order to deal with homogeneous boundary datum, outline the procedure developed by Benci and Fortunato and point out why it fails, present a technique to overcome this obstacle and prove the existence of infinitely many solutions $(u_n, \omega_n, \varphi_n)_n \subset H_0^1(\Omega) \times \mathbb{R} \times H^2(\Omega)$ with $||\nabla u_n||_2 \to +\infty$.

References:

[1] Vieri Benci and Donato Fortunato. *An eigenvalue problem for the Schrödinger-Maxwell equations*. Topological Methods in Nonlinear Analysis, 1998.
[2] Lorenzo Pisani and Gaetano Siciliano. *Constrained Schrödinger-Poisson System with Non-Constant Interaction*. Communications in Contemporary Mathematics, Vol 15, 2013.

The Dirichlet Neumann Laplacian in thin strips

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

Let $-\Delta_{DN}^{\Omega_\varepsilon}$ be the Dirichlet Neumann Laplacian in a thin strip Ω_ε of width $\varepsilon > 0$. The goal is to find an asymptotic behaviour for the eigenvalues of $-\Delta_{DN}^{\Omega_\varepsilon}$ under the condition that Ω_ε is thin enough, as it was done in [1].

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A non-autonomous bifurcation problem for a non-local parabolic equation

Estefani M. Moreira, Alexandre N. Carvalho, Yanan Li, Tito L. M. Luna
Universidade de São Paulo

In this paper we study the asymptotic behavior of solutions for a non-local non-autonomous scalar quasilinear parabolic problem in one space dimension. Our aim is to give a fairly complete description of the the forwards asymptotic behavior of solutions for models with Kirchoff type diffusion. In the autonomous we use the gradient structure of the model, some symmetry properties of solutions and develop comparison results to obtain a sequence of bifurcations of equilibria analogous to that seen in the model with local diffusivity. We give conditions so that the autonomous problem admits at most one positive equilibrium and analyse the existence of sign changing equilibria. Also using symmetry and our comparison results we construct what is called non-autonomous equilibria to describe part of the asymptotics of the associated non-autonomous non-local parabolic problem.

Pullback attractors for impulsive evolution processes

José Manuel Uzal
Universidade de Santiago de Compostela

The theory of impulsive dynamical systems describes systems on which a continuous evolution process is interrupted by sudden changes in their state. In this poster the theory of impulsive evolution processes is developed and the existence of pullback attractors is studied. Furthermore, we also present some results on the semicontinuity and a few examples to illustrate the theory. This is based on a joint work with Matheus C. Bortolan (UFSC).

Attainability of weighted Trudinger-Moser type supremums and related Henón problems

José Vitor Pena, Bernhard Ruf
UNICAMP

We present some results regarding critical nonlinearities of exponential type with appropriate weights: first regarding the attainability of supremums of a Henon-type functional on the unit ball:

$$\sup_{u\in H^1_{0,\mathrm{rad}}(B),\|\nabla u\|_2=1}\int_B e^{2\pi(2+\beta)u^2}h(x)\,dx. \tag{12}$$

and of a Hardy-type functional on a simply connected domain containing the origin:

$$\sup_{v\in H^1_0(\Omega),\|v\|\leq 1}\int_\Omega \frac{e^{\alpha v^2}-1}{h(x)}<\infty. \tag{13}$$

and then an existence result for the critical case of an elliptical problem with exponential nonlinearity on the ball. We arrive on decayment conditions for the limit of the weight at the origin (thus, we do care about the behavior of the weight only on a neighbourhood of the origin, ignoring it on the rest of the domain). This is achieved using Concentration-Compactness-type techniques.

Multiplicity results for elliptic problems involving nonlocal integrodifferential operators without Ambrosetti-Rabinowitz condition

Lauren M. M. Bonaldo, Elard Juarez Hurtado, Olimpio H. Miyagaki
UFSCar- Univiersidade Federal de São Carlos

In this work, we study the existence and multiplicity of weak solutions for a general class of elliptic equations $(\mathcal{P})$ in a smooth bounded domain, driven by a nonlocal integrodifferential operator $\mathcal{L}_{\mathcal{A}}$ with Dirichlet boundary conditions involving variable exponents without Ambrosetti and Rabinowitz type growth conditions. Using different versions of the Mountain Pass Theorem, as well as, the Fountain Theorem and Dual Fountain Theorem with Cerami condition, we obtain the existence of weak solutions for the problem $(\mathcal{P})$ and we show that the problem treated has at least one nontrivial solution for any parameter $\lambda > 0$ small enough as well as that the solution blows up, in the fractional Sobolev norm, as $\lambda \to 0$. Moreover, for the case sublinear, by imposing some additional hypotheses on the nonlinearity $f(x, \cdot)$, by using a new version of the symmetric Mountain Pass Theorem due to Kajikiya, we obtain the existence of infinitely many weak solutions which tend to be zero, in the fractional Sobolev norm, for any parameter $\lambda > 0$. As far as we know, the results of this paper are new in the literature.

Toy model for the SIS epidemic process using quantum many body techniques

Naomy Duarte Gomes , Gilberto Medeiros Nakamura
University of São Paulo

Mathematical models of disease transmission in populations began with the work of McKendrick and Kermack in 1927 and since then numerous models have been formulated to analyze, among others, the dynamics of the disease spreading process, epidemiological parameters such as the rates of cure and transmission and the possible effects of the underlying network and the environment. The latter are variables that introduce the stochastic nature of epidemics, and their consideration makes the modeling closer to reality. The analysis of epidemic processes and estimates of epidemiological parameters are of great importance to society since they can be used to study effective intervention policies to stop or reduce the spreading of the disease. However, epidemic models are, in most cases, deterministic. To be closer to reality, it is essential to include effects that account for the stochastic fluctuations. In this work, for the SIS epidemic model, we consider a stochastic model that takes into account the adjacent network, and we investigate the role of fluctuations for small populations, defining a closed system of equations for which we have the evolution of both the density of infected and the fluctuation itself. In the limit where the considered population is high, fluctuations are irrelevant and can be taken as constant. With this consideration, we introduce coherent states through the Holstein-Primakoff transformation and use the properties of these states to construct equations that allow for the estimation of epidemiological parameters.

Time-reversal and equivariant symmetries in planar slow-fast systems

Pedro Toniol Cardin
Universidade Estadual Paulista

It is well known that symmetry is a fundamental topic in many areas of physics and mathematics, in particular into the context of nonlinear dynamical systems. In fact, the symmetries of a given

system of nonlinear ordinary differential equations can be used to analyze and understand many general mechanisms of pattern formation. In this work we focus on problems involving time-reversal or equivariant symmetries into the context of singularly perturbed slow-fast dynamical systems. We want to know how such symmetries are affected by singular perturbations. Our results concern the persistence of such symmetries and symmetric invariant sets when the singular perturbation parameter is positive and small enough.

Inelastic Boltzmann equation driven by a particle thermal bath

Rafael Antonio Sanabria Villalobos
PUC Rio de Janeiro

Dilute granular flows are commonly modelled by Boltzmann equation for inelastic hard-spheres interacting through binary collisions [3]. Due to dissipative collisions, energy continuously decreases in time which implies that, in absence of energy supply, the corresponding dissipative Boltzmann equation admits only trivial equilibria. This is no longer the case if the spheres are forced to interact with a forcing term, in which case the energy supply may lead to a non-trivial steady state. For such a driven system we consider hard spheres particles described by their distribution density $f = f(t,x,v) \geq 0$, $x \in \mathbb{T}^2$, $t > 0$ satisfying

$$\partial_t f + v \cdot \nabla_x f = \mathcal{Q}_\alpha(f,f) + \mathcal{L}(f). \tag{14}$$

where $\mathcal{Q}_\alpha(f,f)$ is the inelastic quadratic Boltzmann collision operator, and $\mathcal{L}(f)$ models the forcing term. The parameter $\alpha \in (0,1)$ is the so called "restitution coeficient" that characterized the inelasticity of the binary collisions.

We consider a situation in which the system of inelastic hard spheres is immersed into a thermal bath of particles, so that the forcing term $\mathcal{L}$ is given by a linear scattering operator describing inelastic collisions with the background medium. More precisely, the forcing term $\mathcal{L}$ is given by a linear Boltzmann collision operator of the form

$$\mathcal{L}(f) := \mathcal{Q}_e(f, \mathcal{M}_0), \tag{15}$$

where $\mathcal{Q}_e(\cdot,\cdot)$ is the Boltzmann collision operator associated to the fixed restitution coefficient $e \in (0,1)$, and $\mathcal{M}_0$ stands for the distribution function of the host fluid which we assume to be a given Maxwellian with unit mass, bulk velocity u_0 and temperature $\theta > 0$:

$$\mathcal{M}_0(v) = \left(\frac{1}{2\pi\theta_0}\right)^{\frac{3}{2}} \exp\left(-\frac{(v-u_0)^2}{2\theta_0}\right), \quad v \in \mathbb{R}^3. \tag{16}$$

The existence of smooth stationary solutions F_α for the inelastic Boltzmann equation under the thermalization given by the forcing term $\mathcal{L}$ has been proved in [1]. Uniqueness of the steady state is proven in [2] for a smaller range of parameters α. When the restitution coefficient is close to 1 we proved in [4] the existence of global solutions considering the close-to-equilibrium regime. We also studied the long-time behaviour of these solutions and proved a convergence to equilibrium with an exponential rate.

Theorem 1. *Consider the functional space $\mathcal{E}_0 = W^{s,1}_x W^{2,1}_v(\langle v\rangle\, e^{b\langle v\rangle^\beta})$ where $b > 0$, $\beta \in (0,1)$ and $s > 6$. For α and e close to 1, and for an initial datum $f \in \mathcal{E}_0$ close enough to the equilibrium F_α, there exists a unique global solution $f \in L^\infty_t(\mathcal{E}_0)$ to (14) which furthermore satisfies for all $t \geq 0$,*

$$\|f_t - F_\alpha\|_{\mathcal{E}_0} \leq Ce^{-at}\|f_{in} - F_\alpha\|_{\mathcal{E}_0},$$

for some constructive constants C and a.

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[4] Sanabria, Rafael, Inelastic Boltzmann equation driven by a particle thermal bath, Final preparation, 2019.

The Dirichlet Laplacian Operator in a Narrow Strip

Rafael Toledo Amorim, Alessandra Aparecida Verri
Universidade Federal de São Carlos

Let $h(s) > 0$ be a continuous function defined on $I = [-a, b]$, where $a, b > 0$. We assume that $x = 0$ is the only point of global maximum of h on I, h is C^1 on $I\backslash\{0\}$ and in a neighborhood of $x = 0$ it admits an expansion

$$h(x) = \begin{cases} M - c_+ x^m + O(x^{m+1}), & x > 0, \\ M - c_- |x|^m + O(|x|^{m+1}), & x < 0, \end{cases} \tag{17}$$

where $M, c_\pm > 0$ and $m \geq 1$. Considering the Dirichlet Laplacian operator in the strip $\Lambda := \left\{(s,t) \in \mathbb{R}^2 : s \in I, 0 < t < h(s)\right\}$, an interesting problem is to find the effective operator as the width of the strip approaches zero and also to find an asymptotic behavior for the eigenvalues of the spectral problem provided that Λ is thin enough, as it was done in [1].

This work is currently carried out under the mentoring of Prof. Alessandra Aparecida Verri, PhD, with the financial support of CNPq.

References:

[1] L. Friedlander and M. Solomyak, *On the spectrum of the Dirichlet Laplacian in a narrow strip*, Israel J. Math., 337−354 (2007).
[2] L. Friedlander and M. Solomyak, *On the spectrum of the Dirichlet Laplacian in a narrow infinite strip*, Amer. Math. Soc. Transl, 225, 103−116 (2008).

Propagation of regularity for the dispersive generalized Benjamin-Ono-Zakharov-Kuznetsov equation

Ricardo C. Freire, Argenis J. Mendez, Oscar G. Riaño
IMPA

We study some special regularity properties of solutions to the IVP associated to the dispersive generalized Benjamin-Ono-Zakharov-Kuznetsov equation

$$\partial_t u - D_x^{\alpha+1}\partial_x u + u_{xyy} + uu_x = 0, \quad (x, y, t) \in \mathbb{R}^3,\ 0 < \alpha < 1.$$

Mainly, we establish that for initial datum $u_0 \in H^s(\mathbb{R}^2)$, $s > (17-2\alpha)/12$ whose restriction belongs to $H^m((x_0,\infty)\times\mathbb{R})$ for some $m \in \mathbb{R}$, $m > s$, and $x_0 \in \mathbb{R}$, we prove that the restriction of the corresponding solution $u(t)$ belongs to $H^m(\beta,\infty)$, for any $\beta \geq x_0$ and any $t \in (0,T)$. It is also deduced from our analysis that the solutions corresponding to this equation gain extra regularity on certain regions of the plane. In addition, we obtain that this kind of regularity travels with infinite speed.

The oscillon equation via fractional powers

Rodiak Nicolai Figueroa López
Universidade Federal de São Carlos

In this work we are concerned with the asymptotic behavior of nonautonomous fractional approximations of oscillon equation

$$u_{tt} - \mu(t)\Delta u + \omega(t)u_t = f(u),\ x \in \Omega,\ t \in \mathbb{R},$$

subject to Dirichlet boundary condition on $\partial\Omega$, where Ω is a bounded smooth domain in $\mathbb{R}^N$, $N \geqslant 3$, the function ω is a time-dependent damping, μ is a time-dependent squared speed of propagation, and f is a nonlinear functional. Under structural assumptions on ω and μ we establish the existence of time-dependent attractor for the fractional models in the sense of Carvalho, Langa, Robinson [3] and Di Plinio, Duane, Temam [4].

Joint work with the professors Phd. Marcelo J. D. Nascimento (UFSCar, Brazil) and Phd. Flank D. M. Bezerra (UFPB, Brazil).

Research partially supported by CAPES/Finance Code 001/2019, Brazil.

References:

[1] F. D. M. Bezerra and M. J. D. Nascimento, Non-autonomous approximations governed by the fractional powers of damped wave operators, Electronic Journal of Differential Equations, **2019** (2019), No. 72,1–19.
[2] F. D. M. Bezerra, A. N. Carvalho, J. W. Cholewa and M. J. D. Nascimento, Parabolic approximation of damped wave equations via fractional powers: fast growing nonlinearities and continuity of the dynamics, Journal of Mathematical Analysis and Applications, **450**, (2017), 377–405.
[3] A. N. Carvalho, J. A. Langa and J. C. Robinson, Attractors for Infinite-dimensional Non-autonomous Dynamical Systems. Applied Mathematical Sciences 182, Springer-Verlag, 2012.
[4] F. Di Plinio, G.S. Duane, R. Temam, Time dependent attractor for the oscillon equation, Discrete Contin. Dyn. Syst., **29** (2011), 141–167.

Optimal Temperature Profile Prediction for Batch Antibiotic Production Bioprocesses

Samuel Conceição de Oliveira, Angel Gustavo Tolaba
UNESP

Industrial batch antibiotic production bioprocesses are generally operated under constant temperature, while pH and concentrations of substrate, cell, and product are allowed to change with little or no control as the bioprocess progresses. In recent years has been developed mathematical methods to

determine the optimum control profiles for several bioprocesses. In this work, optimization methods based on Pontryagin?s maximum principle in conjunction with a simplified mathematical model for the microbial growth and product formation were applied to predict optimum temperature profile for a batch penicillin production bioprocess. This particular bioprocess was chosen for study because this type presents challenging optimization problems, as will demonstrated. The results indicated that an improvement in penicillin yield is possible when the optimum temperature profile is followed.

Radial Hardy Spaces

Victor Hugo Falcão Francheto, Francheto, Victor Hugo
Universidade Federal de São Carlos

One presents in this work an atomic decomposition via radial atoms for distributions on subspace $\mathcal{H}^p_{rad}(\mathbb{R}^n)$ for $0 < p \leqslant 1$ of Hardy radial spaces $H^p_{rad}(\mathbb{R}^n) \doteq H^p(\mathbb{R}^n) \cap \mathcal{S}'_{rad}(\mathbb{R}^n)$. Such atomic decomposition tell us that, if $f \in \mathcal{H}^p_{rad}(\mathbb{R}^n) \subseteq H^p_{rad}(\mathbb{R}^n)$, then f has an atomic decomposition and the atoms of its decomposition are radials.

This work extends a theorem proved by R. R. Coifman and G. Weiss [1] in which the authors give a radial atomic decomposition for radial functions in $H^1(\mathbb{R}^n)$ where the atoms of such decomposition are radial functions.

The atomic decomposition that we present here give us similar information but for $0 < p \leqslant 1$. Specifically we define a maximal radial Hardy space and we prove an atomic decomposition for this spaces via radial atoms.

References:

[1] R. R. Coifman e G. Weiss, Extensions of Hardy spaces and their use in analysis, *Bull. Amer. Math. Soc.*, 83(4):569-645, 1977.

ICMC SUMMER MEETING on DIFFERENTIAL EQUATIONS

CHAPTER 2020

Programme

	SUNDAY 2 from 15:00 to 18:00, Registration at the ICMC Auditorium (Building 6)		
Auditorium	**MONDAY 3**	**TUESDAY 4**	**WEDNESDAY 5**
08:00-08:50	**Registration**		
08:50-09:00	**Opening**		
Auditorium	**Plenary Talks**		
Chair	José Arrieta	José Langa	John Mallet-Parret
09:00-09:40	**José Langa**	**John Mallet-Parret**	**Hans-Otto Walther**
09:40-10:20	**Christian Poetzsche**	**Rafael Obaya**	**Leszek Gasinski**
10:20-10:50	**Coffee Break**	**Coffee Break and Posters**	**Coffee Break**
Chair	Yingfei Yi	Hans-Otto Walther	Alexandre Nolasco Carvalho
10:50-11:30	**Xiaoying Han**	**José Valero**	**Rosana Rodríguez-López**
11:30-12:10	**José Arrieta**	**Yingfei Yi**	**Francisco Ortegón**
12:10-12:50	**Wladimir Neves**	**Giovany M. Figueiredo**	**Tomás Caraballo**
	Lunch	**Lunch**	**Lunch**
Auditorium	**Special Session on Nonlinear Dynamical Systems/Evolution Equations and Applications**		
Chair	Piotr Kalita	Stefanie Sonner	Felipe Rivero
14:30-15:00	**Hildebrando M. Rodrigues**	**José Langa**	**Piotr Kalita**
15:00-15:30	**Alejandro Vidal-López**	**Felipe Rivero**	**Javier López-de-la-Cruz**
15:30-16:00	**Stefanie Sonner**	**Juliana Fernandes**	**Rubén Caballero Toro**
16:00-16:30	**Coffee Break**	**Coffee Break and Posters**	**Coffee Break**
16:30-17:00	**Fabiano Borges**	**Juliana Honda**	**Bruna Cassol**
17:00-17:30	**Gustavo F. Madeira**	**Jacson Simsen**	**Tito Luciano Mamani Luna**
17:30-18:00	**Marcelo Bongarti**	**Jayme De Luca**	
Room 5001	**Special Session on Elliptic Equations/Boundary Perturbations of Domains for PDEs Domains and Applications**		
Chair	Marcos Pimenta	Marcone C. Pereira	Raquel Lehrer
14:30-15:00	**João V. da Silva**	**Alessandra Verri**	**Makson Santos**
15:00-15:30	**João R. Santos Júnior**	**Jean Carlos Nakasato**	**Pêdra D. S. Andrade**
15:30-16:00	**Alânnio Barbosa Nóbrega**	**Cristian Morales-Rodrigo**	
16:00-16:30	**Coffee Break**	**Coffee Break and Posters**	**Coffee Break**
Chair	João R. Santos Júnior	Giovany M. Figueiredo	
16:30-17:00	**Marcos Pimenta**	**Flávio Lemos**	
17:00-17:30	**Raquel Lehrer**	**Giane Casari Rampasso**	
17:30-18:00	**Yony Leuyacc**	**Marcone C. Pereira**	
Room 5102	**Special Session on Dispersive Equations**		
Chair	Marcia Scialom	Mahendra Panthee	
14:30-15:00	**Adan Corcho**	**Sabrina Amaral**	
15:00-15:30	**Raphael Santos**	**Xavier Carvajal**	
15:30-16:00	**Oscar Riano**	**Marcia Scialom**	
16:00-16:30	**Coffee Break**	**Coffee Break and Posters**	
16:30-17:00	**Mahendra Panthee**		
17:00-17:30	**Ricardo Pastran**		

Room 5103	**Special Session on Conservation Laws and Transport Equations/Fluid Dynamics**		
Chair	Gerardo J. H. Cardenas	Jean Silva	
14:30-15:00	**Gabriela Planas**	**Vernny Uriel C. Ccajma**	
15:00-15:30	**Heraclio L. L. Lázaro**	**Edison F. C. Huamani**	
15:30-16:00	**Brayan M. Rodríguez Garzón**	**Gerardo J. H. Cardenas**	
16:00-16:30	**Coffee Break**	**Coffee Break and Posters**	
Chair	Gabriela Planas		
16:30-17:00	**Jean Silva**		
17:00-17:30	**Dionicio O. M. Vega**		
Room 5002	**Special Session on Linear Partial Differential Equations**		
Chair	Paulo Leandro Dattori da Silva	Marcelo R. Ebert	Gabriel Araújo
14:30-15:00	**Marcelo R. Ebert**	**Alexandre Kirilov**	**Joel Coacalle**
15:00-15:30	**Marianna Chatzakou**	**Wagner A. A. Moraes**	**Camilo Campana**
15:30-16:00	**Lucas da Silva Oliveira**	**Ricardo Paleari**	**Renata Oliveira**
16:00-16:30	**Coffee Break**	**Coffee Break and Posters**	**Coffee Break**
16:30-17:00	**Nicholas B. Rodrigues**	**Rafael B. Gonzalez**	**Renan Medrado**
17:00-17:30	**Luis F. Ragognette**	**Evandro R. Silva**	**Pedro Lopes**
17:30-18:00	**Serena Federico**	**Igor A. Ferra**	
Room 5003	**Special Session on Integral and Functional Diferential Equations**		
Chair	Marcia Federson	Pierluigi Benevieri	Pablo Amster
14:30-15:00	**Pablo Amster**	**Berenice C. Damasceno**	**Pierluigi Benevieri**
15:00-15:30	**Jaqueline Mesquita**	**Márcia Federson**	**Ábel Garab**
15:30-16:00	**Aldo Pereira**	**Iguer L. D. dos Santos**	**Henrique Costa dos Reis**
16:00-16:30	**Coffee Break**	**Coffee Break and Posters**	**Coffee Break**
16:30-17:00	**Mateus Fleury**	**Marielle Aparecida Silva**	**Junya Nishiguchi**
17:00-17:30	**Carolina Mesquita**	**Sergio Oliva**	**Hugo de la Cruz**
17:30-18:00	**Mamadou Abdoul Diop**	**J. Vanterler da C. Sousa**	**Luca Meacci**
Coffee Area	**Poster Session**		
10:20-10:50		**Danilo Gregorin Afonso**	
10:20-10:50		**Diana Carolina Suarez Bello**	
10:20-10:50		**Estefani Moraes Moreira**	
10:20-10:50		**José Manuel Uzal**	
10:20-10:50		**José Vitor Pena**	
10:20-10:50		**Lauren Maria M. Bonaldo**	
10:20-10:50		**Naomy Duarte Gomes**	
16:00-16:30		**Pedro Toniol Cardin**	
16:00-16:30		**Rafael A. S. Villalobos**	
16:00-16:30		**Rafael Toledo Amorim**	
16:00-16:30		**Ricardo Carlos Freire**	
16:00-16:30		**Rodiak Nicolai F. López**	
16:00-16:30		**Samuel Conceição de Oliveira**	
16:00-16:30		**Victor Hugo F. Francheto**	
	Social Events		
12:10	**Photo**		
20:00		**Conference Banquet**	

ICMC SUMMER MEETING on
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List of Speakers

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

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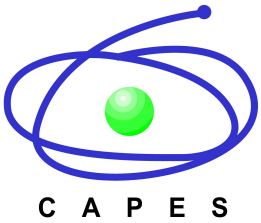

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