ICMC SUMMER MEETING ON DIFFERENTIAL EQUATIONS

2017 CHAPTER

6-8 FEBRUARY 2017 - SÃO CARLOS SP, BRAZIL

Scientific Committee:

Alexandre Nolasco de Carvalho
USP/Brazil

Djairo G. de Figueiredo
UNICAMP/Brazil

Jean L. Mawhin
Université Catholique de Louvain/Belgium

John Mallet-Paret
Brown University/USA

José M. Arrieta
Universidad Complutense de Madrid/Spain

Konstantin Mischaikow
Rutgers University/USA

Michael Y. Li
University of Alberta/Canada

Shui-Nee Chow
GaTech/USA

Tomás Caraballo
Universidad de Sevilla/Spain

Yingfei Yi
University of Alberta/Canada and JLU/China

More information:
summer.icmc.usp.br

List of sessions:

Conservation Laws and Transport Equations
Dispersive Equations
Elliptic Equations
Fluid Dynamics
Linear Equations
Nonlinear Dynamical Systems
Ordinary/Functional Differential Equations
Poster Session

INCTMat
ICMC USP SÃO CARLOS
CAPES
CNPq
FAPESP

Welcome

It is a pleasure to welcome you to the *ICMC Summer Meeting on Differential Equations - 2017 Chapter* and to São Carlos. We wish you a pleasant stay and that you enjoy the meeting.

Executive committee

Alexandre N. de Carvalho (USP/Brazil)

Hildebrando M. Rodrigues (USP/Brazil)

Márcia C. A. B. Federson (USP/Brazil)

Ma To Fu (USP/Brazil)

Sérgio H. Monari Soares (USP/Brazil)

Organizing committee

Ederson M. dos Santos (USP/Brazil)

Everaldo de Melo Bonotto (USP/Brazi)

Marcio F. Gameiro (USP/Brazil)

Paulo L. Dattori da Silva (USP/Brazil)

Scientific committee

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John Mallet-Paret (Brown University/USA)

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Michael Y. Li (University of Alberta/Canada)

Shui-Nee Chow (GaTech/USA)

Tomás Caraballo (Universidad de Sevilla/Spain)

Yingfei Yi (University of Alberta/Canada and JLU/China)

Session Organizers

Wladimir Neves (UFRJ/Brazil): Special Session on Conservation Laws and Transport Equations

Márcia A. G. Scialom & Mahendra Panthee (UNICAMP/Brazil): Special Session on Dispersive Equations

Claudianor O. Alves (UFCG/Brazil): Special Session on Elliptic Equations

Gabriela Planas (UNICAMP/Brazil): Special Session on Fluid Dynamics

Rafael Fernando Barostichi (UFSCAR/Brazil): Special Session on Linear Equations

Juliana F.S. Pimentel (UFABC/Brazil) & Matheus C. Bortolan (UFSC/Brazil): Special Session on Nonlinear Dynamical Systems

Jaqueline Godoy Mesquita (UnB/Brazil) & Bruno de Andrade (UFS/Brazil): Special Session on Ordinary and Functional Differential Equations

Rodolfo Collegari (USP/Brazil): Posters Session

Address

ICMC Summer Meeting on Differential Equations - 2017 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

2017 Chapter

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: _____

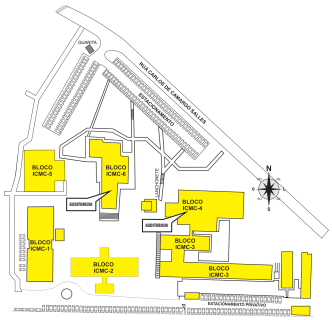
USEFUL NUMBERS

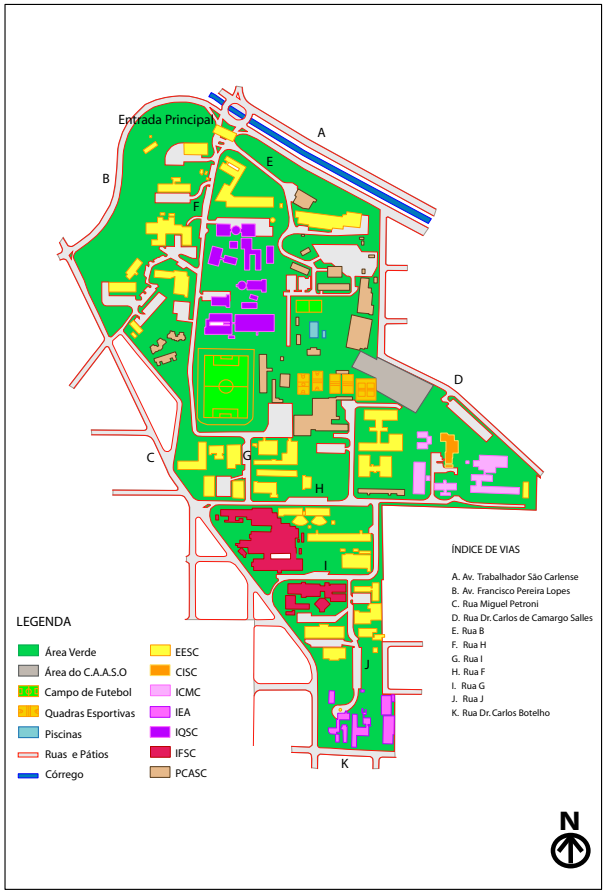
3373-9700	ICMC-USP
3373-9112	Campus Security Staff
190	Police Dept.
192	Medical Emergency
193	Fire Dept. and Rescue
0800-560159	National Courier Service
3371-2171	Local Post Office
3415-6005	Taxi-Cab Co.

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

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 - 24 hours

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. Cabanha Steakhouse & Bar
R. Episcopal, 1661 - 3364.3067 - LUNCH/DINNER

R29. Restaurante Frei Damião
R. Nove de Julho, 1606 - 3416.8133 - LUNCH ONLY

R30. Cachaçaria Água Doce
R. Nove de Julho, 1625 - 3376.2077 - DINNER ONLY

R31. Don Raffaele Pizze & Ristorante
R. Marechal Deodoro, 1758 - 3371.1478 - ONLY DINNER

R32. Subway
Av. São Carlos, 2911 - 3416.4000 - 24 hours

R33. Kalil Cozinha Árabe
R. Dr. Carlos Botelho, 1737 - 3372.1696
ARABIC AND VEGETARIAN FOOD - LUNCH/DINNER

R34. Café Sete - Café Gastrobar
R. Sete de Setembro, 1447 - 3415.1026 - DINNER ONLY

R35. Churrascaria Tabajara
Av. São Carlos, 3677 - 3361.4282 - STEAKHOUSE - LUNCH/DINNER

R36. Churrascaria Trevo
Av. Prof. Luis Augusto de Oliveira, 385
(extension of the Av. São Carlos) - 3361.3052 - STEAKHOUSE - LUNCH/DINNER

R37. Restaurante e Buffet Cantos e Contos
Rua Major José Inácio, 2211 - 3372.6661

R38. Restaurante Sushi Ya-San
Rua Tiradentes, 128 - 3307.1165 - JAPANESE FOOD - LUNCH/DINNER

R39. Restaurante Zettai
Rua Marechal Deodoro, 1846 - 3416.5140 - JAPANESE FOOD - DINNER ONLY

R40. Restaurante Frei Damião
R. Quinza de Novembro, 1447 - 3416-3276 - LUNCH ONLY

R41. Restaurante Niray
Rua Major José Inácio, 2273 - 3415-6505 - JAPENESE FOOD - LUNCH/DINNER

R41. Restaurante e Choperia Rola Papo
Rua Major José Inácio, 2270 - 3412-6757 - DINNER ONLY

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You Tube icmcusp

www.icmc.usp.br

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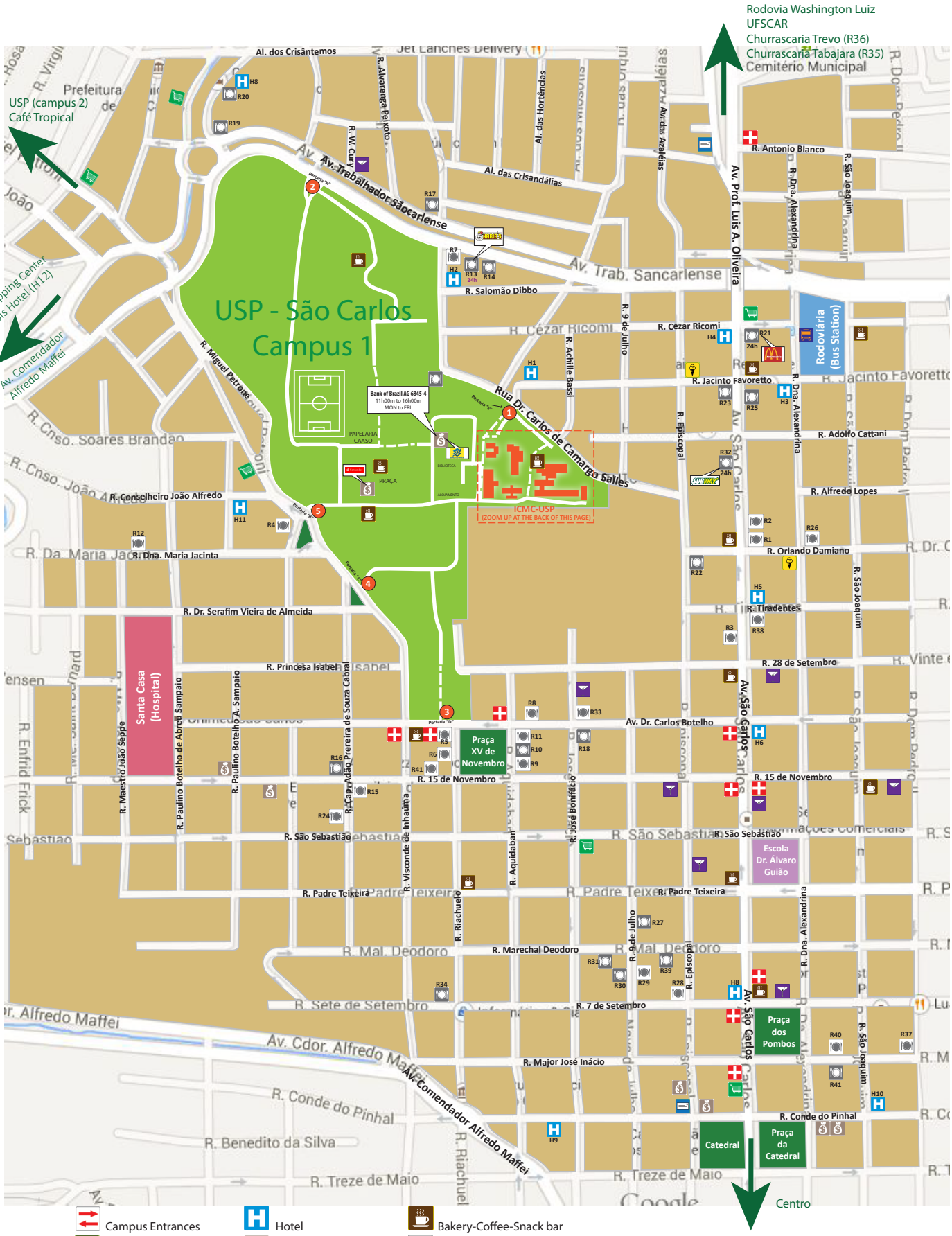
Rodovia Washington Luiz
UFSCAR
Churrascaria Trevo (R36)
Churrascaria Tabajara (R35)
Cemitério Municipal
USP (campus 2)
Café Tropical
Shopping Center
Ibis Hotel (H12)
Av. Comendador Alfredo Maffei
USP - São Carlos Campus 1
Rua Dr. Carlos de Camargo Salles
ICMC-USP
(ZOOM UP AT THE BACK OF THIS PAGE)
Av. Trabalhador Sãocarlense
Av. Trab. Sancarlense
Rodoviária (Bus Station)
Santa Casa (Hospital)
Praça XV de Novembro
Escola Dr. Álvaro Guião
Praça dos Pombos
Catedral
Praça da Catedral
Centro
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

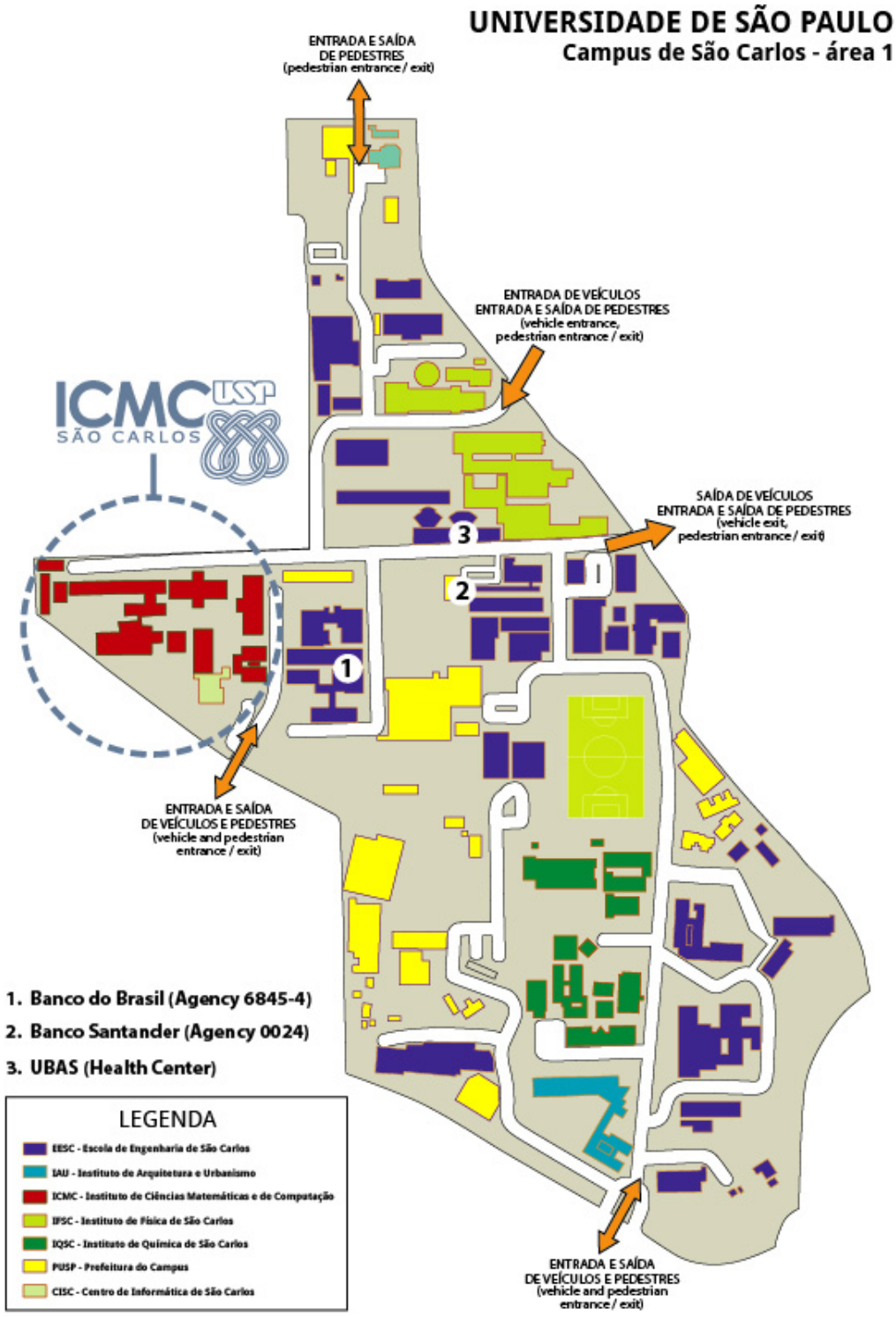

Figure 1: Campus map

Figure 2: ICMC map

Contents

ICMC SUMMER MEETING on DIFFERENTIAL EQUATIONS

2017 Chapter

General Information

Conference site

The meeting will take place at Buildings 5 and 6, and also in the Coffee Area. 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 in room 5-103 (Building 5)

Special session on Dispersive Equations in room 5-004 (Building 5)

Special session on Elliptic Equations in room 5-001 (Building 5)

Special session on Fluid Dynamics in room 5-101 (Building 5)

Special session on Linear Equations in room 5-002 (Building 5)

Special session on Nonlinear Dynamical Systems at the Auditorium (Building 6)

Special session on Ordinary and Functional Differential Equations in room 5-003 (Building 5)

Poster session in Coffee Room (ground floor of the Library)

Registration

The registrations will be made in the following schedule:

Sunday, February 5^{th}: From 18:00hs to 19:00hs in the lobby of Anacã Hotel.

Monday, February 6^{th}: From 8:00hs to 8:30hs in the entrance of the 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.

Financial support

The financial support from the local organizing committee will be available on Tuesday, February 7^{th}, at the Financial Office (4, map of page 8). In order to receive your support, it is mandatory to completely fill out the on-line registration form available at `summer.icmc.usp.br/user_summer/` .

Meals and refreshments

There are several restaurants near the campus. You can find them by looking at the city map located on page 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 6^{th}: Cocktail at 18:00hs in Coffee Room (ground floor of the Library).

Tuesday, February 6^{th}: Photo of the meeting at 12:10hs at ICMC.

Tuesday, February 7^{th}: Conference Banquet at 20:00hs at Café Sete.

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).

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: smode17!
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

2017 Chapter

Plenary Talks

Plenary Speaker

Multiple solutions for a problem with discontinuous nonlinearity

Claudianor O. Alves, Jefferson A. dos Santos, Rodrigo C. M. Nemer
Universidade Federal de Campina Grande

In this work, we use the Lusternik-Schnirelmann category to estimate the number of non-trivial solutions for a problem with discontinuous nonlinearity and subcritical growth. Here we improve a well known result due to Benci-Cerami.

This is a joint work with Jefferson A. dos Santos (UFCG) and Rodrigo C. M. Nemer (UFCG).

Elliptic equations involving the p-Laplacian and a gradient term having natural growth

Djairo G. de Figueiredo, Humberto Ramos Quoirin, Jean-Pierre Gossez, Pedro Ubilla
Universidade Estadual de Campinas

We investigate the problem

$$\begin{cases} -\Delta_p u = g(u)|\nabla u|^p + f(x,u) & \text{in } \Omega, \\ u > 0 & \text{in } \Omega, \\ u = 0 & \text{on } \partial\Omega, \end{cases}$$

in bounded smooth domain $\Omega \subset \mathbb{R}^N$. Using a Kazdan-Kramer change of variable we reduce this problem to a quasilinear one without gradient. Then we come to some new and interesting problems for quasilinear elliptic equations.

Smoothness issues in differential equations with state-dependent delay, and processes for Volterra integro-differential equations

Hans-Otto Walther
Giessen

1) We answer a question which has been around since the first constructions of local invariant manifolds for differental equations with state-dependent delay: In general stable manifolds are not better than continuously differentiable, also in cases where center and unstable manifolds are C^k-smooth, $k \geq 2$.

2) Then we discuss state spaces for equations with state-dependent delay. In general these equations define continuously differentiable solution operators only on the *solution manifold* in $C^1(I, \mathbb{R}^n)$, $I = [-r, 0]$ or $I = (-\infty, 0]$. But there also are classes of such equations which admit nice solution operators on open subsets of the familiar Banach space $C([-r, 0], \mathbb{R}^n)$, and on the Fréchet space $C((-\infty, 0], \mathbb{R}^n)$ in cases of unbounded delay.

3) On the last space we obtain processes for Volterra integro-differential equations, which are nonautonomous with unbounded time-dependent delay.

[1] Krisztin, T., and H.O. Walther, Smoothness issues in differential equations with state-dependent delay. In preparation.

[2] Walther, H. O., Semiflows for differential equations with locally bounded delay on solution manifolds in the space $C^1((-\infty, 0], \mathbb{R}^n)$. Topological Methods Nonlinear Anal., to appear.

[3] WALTHER, H.O., Local invariant manifolds for delay differential equations with state space in $C^1((-\infty,0],\mathbb{R}^n)$. Electronic Journal of the Qualitative Theory of Differential Equations, 2016, No. 85, 1-29.

[4] WALTHER, H.O., Fréchet differentiability in Fréchet spaces, and differential equations with unbounded variable delay. Preprint, 45 pp, 2016.

[5] WALTHER, H.O., Delay differential equations with differentiable solution operators on open domains in $C((-\infty,0],\mathbb{R}^n)$, and processes for Volterra integro-differential equations. Preprint, 25 pp, 2016.

Instantaneous blowup

Jerry Goldstein
Memphis

The original instantaneous blowup result is due to P. Baras and J. Goldstein, TAMS, 1984, for the heat equation with the Hardy potential on Euclidean space. We have new extensions to the Heisenberg group, to the perturbed Kolmogorov equation on the Euclidean and Heisenberg groups, and related results.

Genericity, analyticity, and global bifurcation of periodic solutions of delay equations

John Mallet-Paret
Brown University

We study the global bifurcation of periodic solutions for a class of delay-differential equations of Mackey-Glass type. In particular, the presence of a period-doubling cascade of periodic solutions is established. The proof relies on generic properties (in the sense of Kupka-Smale) for classes of such equations. We also discuss some open questions related to generic properties and analyticity of the solution branches.

Thin domains with a locally periodic highly oscillatory boundary

José M. Arrieta, Manuel Villanueva-Pesquera, Marcone Pereira
Universidad Complutense de Madrid

We consider a two dimensional thin domain where the boundary has a highly oscillatory behavior but the oscillations are not purely periodic. For instance, we may consider the case where the thin domain is of the type $R_\epsilon = \{(x,y) : 0 < x < 1; 0 < y < \epsilon G(x, x/\epsilon)\}$ where the function $G(x,\cdot)$ is periodic of period $L(x)$, for some function $L(\cdot)$. Observe that we are allowing that the period and amplitude of the oscillations varies in space. We will analyze the homogenized limit as the thickness of the domain goes to 0. We are interested in understanding how the varying amplitude and period appear in the homogenized limit problem. This is a joint work with Manuel Villanueva-Pesquera (UCM- Madrid) and Marcone Pereira (USP-Brazil).

Local uniform stability for the semilinear wave equation in inhomogeneous media with Kelvin-VOIGT damping locally distributed

Marcelo Cavalcanti, Maria R. Astudillo Rojas, Ryuichi Fukuoka, Victor H. G. Martinez
State University of Maringá

We consider the semilinear wave equation posed in an inhomogeneous medium Ω with smooth boundary $\partial\Omega$ subject to a local viscoelastic damping distributed around a neighborhood ω of the boundary according to the Geometric Control Condition. We show that the energy of the wave equation goes uniformly and exponentially to zero for all initial data of finite energy taken in bounded sets of finite energy phase-space.

Combinatorial approach to nonlinear dynamics

M. Mrozek
Jagiellonian University

In late 90' R. Forman [1, 2] introduced the concept of a combinatorial vector field on a CW complex and presented a version of Morse theory for acyclic combinatorial vector fields. Recently, an extension of this theory towards topological dynamics, in particular the Conley index theory, has been presented in [3, 4]. In particular, the extension covers such concepts as attractors, repellers, Morse decompositions, Conley-Morse graphs. Moreover, the extension applies to a generalized concept of combinatorial multivector fields. Such fields are better adjusted to the needs of modelling differential equations.

In this talk we will present the foundations of the new theory, the bridges between the classical and combinatorial theory and potential applications to nonlinear differential equations and sampled dynamical systems. In particular, we will show how the combinatorial multivector fields may be used to model the dynamics of a differential equation and how similar methods may be applied to study sampled dynamical systems [5].

[1] R. Forman. Morse Theory for Cell Complexes, Advances in Mathematics, **134**(1998), 90–145.

[2] R. Forman. Combinatorial vector fields and dynamical systems, Math. Z., **228**(1998), 629–681.

[3] T. Kaczynski, M. Mrozek, and Th. Wanner. Towards a Formal Tie Between Combinatorial and Classical Vector Field Dynamics, Journal of Computational Dynamics, **3**(2016), 17–50, DOI:10.3934/jcd.2016002.

[4] M. Mrozek. Conley-Morse-Forman theory for combinatorial multivector fields on Lefschetz complexes, Foundations of Computational Mathematics, 2016, online first, DOI: 10.1007/s10208-016-9330-z.

[5] T. Dey, M. Juda, T. Kapela, M. Mrozek, and M. Przybylski. Research in progress.

Dynamic Opial and Shum inequalities

Martin Bohner
Missouri University of Science and Technology

Recently, various forms and improvements of Opial dynamic inequalities have been given in the literature. In this talk, we survey these recent results and give refinements of Opial inequalities on

time scales that reduce in the continuous case to classical inequalities named after Beesack and Shum. These refinements are new in the important discrete case.

Global dynamics of an infinite dimensional epidemic model with nonlocal state structures

Michael Li, Zhipeng Qiu, Zhongwei Shen
University of Alberta

In this talk, I will describe a state-structured epidemic model for infectious diseases in which the state structure is nonlocal. The state is a measure of infectivity of infected individuals or the intensity of viral replications in infected cells. The model gives rise to a system of nonlinear integro-differential equations with a nonlocal term. I will show the well-posedness and dissipativity of the associated the nonlinear semigroup by overcoming a lack of compactness of the integral form of the equations. By establishing an equivalent principal spectral condition between the linearized operator and the next-generation operator, I will show that the basic reproduction number $\mathcal{R}_0$ is a sharp threshold: if $\mathcal{R}_0 < 1$, the disease-free equilibrium is globally asymptotically stable, and if $\mathcal{R}_0 > 1$, the disease-free equilibrium is unstable and a unique endemic equilibrium is globally asymptotically stable. Our proof of the global stability of the endemic equilibrium utilizes a global Lyapunov function whose construction was motivated by the graph-theoretic method for coupled systems on discrete networks developed by Guo-Li-Shuai.

Asymptotic issues in cylinders

Michel M. Chipot
Zurich

We would like to present some results on the asymptotic behaviour of different problems set in cylindrical domains of the type $\ell\omega_1 \times \omega_2$ when $\ell \to \infty$. For $i = 1, 2$, ω_i are two bounded open subsets in $\boldsymbol{R}^{d_i}$. To fix the ideas on a simple example consider for instance $\omega_1 = \omega_2 = (-1, 1)$ and u_ℓ the solution to

$$-\Delta u_\ell = f \ \text{ in } \ \Omega_\ell = (-\ell, \ell) \times (-1, 1) \ \ , \ \ u_\ell = 0 \ \text{ on } \ \partial\Omega_\ell.$$

It is more or less clear that, when $\ell \to \infty$, u_ℓ will converge toward u_∞ solution to

$$-\Delta u_\infty = f \ \text{ in } \ \Omega_\infty = (-\infty, \infty) \times (-1, 1) \ \ , \ \ u_\infty = 0 \ \text{ on } \ \partial\Omega_\infty.$$

However this problem has infinitely many solutions since for every integer k, $\exp(k\pi x_1)\sin(k\pi x_2)$ is solution of the corresponding homogeneous problem. Our goal is to explain the selection process of the solution for different problems of this type when $\ell \to \infty$.

The evolution p-Laplacian with nonlocal memory

Sergey Shmarev, S.Antontsev, S.Shmarev, J.Simsen, M.S.Simsen
University of Oviedo

We study the homogeneous Dirichlet problem for the evolution p-Laplacian with the nonlocal memory term

$$u_t - \Delta_p u = \int_0^t g(t-s)\Delta_p u(x,s)\,ds + \Theta(x,t,u) + f(x,t) \quad \text{in } Q = \Omega \times (0,T), \tag{1}$$

where $\Omega \subset \mathbb{R}^n$ is a bounded domain, Θ, g and f are given functions. It is proved that for $\frac{2n}{n+2} < p < \infty$, $g, g' \in L^2(0,T)$ and $u_0 \in W_0^{1,p}(\Omega)$, $f \in L^2(Q)$ the problem admits a weak solution, which is global or local in time in dependence on the growth rate of $\Theta(x,t,s)$ as $|s| \to \infty$. Conditions of uniqueness are established. It is proved that for $p > 2$ and $s\Theta(x,t,s) \leq 0$ the disturbances from the data propagate with finite speed and the "waiting time" effect is possible. We present simple explicit solutions that show the failure of the maximum and comparison principles for the solutions of equation (1).

Schrödinger equations on a graph - NELSON'S approach

Shui-Nee Chow, Wuchen Li, Haomin Zhou
Georgia Institute of Technology

Following Nelson's derivation, Schrödinger equation can be viewed as a Hamiltonian system on the space of probabilities with a 2-Wasserstein metric. We consider similar matters on finite graphs. We derive a Schrödinger equation on a graph from the discrete Nelson's problem. The proposed equation is a Hamiltonian system, which conserves total mass and total energy automatically. Several numerical examples are presented.

A comparison between random and stochastic modeling for a SIR model

Tomás Caraballo
Universidad de Sevilla

In this lecture, a random and a stochastic version of a SIR nonautonomous model previously introduced by Kloeden and Kozyakin (2011) is considered. In particular, the existence of a random attractor is proved for the random model and the persistence of the disease is analyzed as well. In the stochastic case, we consider some environmental effect on the model, in fact, we assume that one of the coefficients of the system is affected by some stochastic perturbation, and analyze the asymptotic behavior of the solutions. We aim to emphasize on the comparison between the two different modeling strategies.

Noise stabilization of local attractors

Yingfei Yi
University of Alberta & Jilin University

We consider the limit behaviors of stationary measures of the Fokker-Planck equations associated with a system of ordinary differential equations perturbed by multiplicative white noises. We establish global measure estimates of stationary measures to quantify the concentration of them near a local attractor as the noises vanish. The study is based on the construction of a uniform Lyapunov function near the attractor that satisfies desired properties to carry on measure estimates.

ICMC SUMMER MEETING on DIFFERENTIAL EQUATIONS

2017 Chapter

Special Sessions

Conservation Laws and Transport Equations

Organizer: Wladimir A. Neves

The IBVP for a fractional type degenerated heat equation

Gerardo Huaroto, Wladimir Neves
Universidade Federal do Rio de Janeiro

The main purpose is to study the existence of solutions for an initial-boundary value problem (IBVP) driven by a degenerated fractional heat type equation, that is, we consider

$$\begin{cases} \partial_t u - \operatorname{div}(u\,\nabla \mathcal{K}u) = 0 \quad \text{in } \Omega_T, \\ u|_{t=0} = u_0 \quad \text{in } \Omega, \\ u = 0 \quad \text{on } \Gamma_T, \end{cases} \tag{2}$$

where $\Omega_T := (0,T)\times\Omega$, for $T>0$ be any real number, and $\Omega \subset \boldsymbol{R}^n$ is an open bounded domain having smooth (C^2) boundary Γ, and $\Gamma_T = (0,T)\times\Gamma$. Here, $u(t,x)$ is a seek real function, which can physically be 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 values on Γ_T, while $\mathcal{K} = (-\Delta)^{-s}$, $0<s<1$, is the inverse of the $s-fractional$ Laplacian operator on bounded domain.

The Cauchy problem for a combustion model in porous media

Marcelo M. Santos, J. C. da Mota, R. A. Santos
Universidade Estadual de Campinas

We prove the existence of a global solution to the Cauchy problem for a nonlinear reaction-diffusion-convection system coupled with a system of ordinary differential equations. The system models the propagation of a combustion front in a porous medium with two layers, as derived by J. C. da Mota and S. Schecter in *Combustion fronts in a porous medium with two layers*, Journal of Dynamics and Differential Equations, **18** (3) (2006). For the particular case, when the fuel concentrations in both layers are known functions, the Cauchy problem was solved by J. C. da Mota and M. M. Santos in *An application of the monotone iterative method to a combustion problem in porous media*, Nonlinear Analysis: Real World Application, **12** (2010). For the full system, in which the fuel concentrations are also unknown functions, we construct an iterative scheme that contains a sequence which converges to a solution of the system, locally in time, under the conditions that initial data are Hölder continuous and bounded functions. We also show the existence of a global solution, if the initial date are additionally in the Lebesgue space L^p, for some $p\in(1,\infty)$. Our proof of the local existence relies on a careful analysis on the construction of the fundamental solution for parabolic equations obtained by the parametrix method. In particular, we show the continuous dependence of the fundamental solution for parabolic equations with respect to the coefficients of the equations. To obtain the global existence, we employ the "method of auxiliary functions" as used by O. A. Oleinik and S. N. Kruzhkov in *Quasi-linear second-order parabolic equations with many independent variables*, Russian Mathematical Surveys, **16** (5) (1961).

Boltzmann equation and fluid dynamics

Tiago Domingues, Wladimir Neves
Universidade Federal do Rio de Janeiro

We study the hydrodynamical limits of the continuous Boltzmann equation and the lattice boltzmann method for fluid mechanical simulations. Specifically, the formal asymptotic expansions that link the Boltzmann equation (and the lattice Boltzmann method) to the macroscopic balance equations are reviewed, and we present recent analytical results.

Strong traces for conservations laws with general non-homogeneous flux

Wladimir Neves, Eugeny Panov, Jean Silva
Universidade Federal do Rio de Janeiro

In this talk, we discuss about the important issue of strong traces for scalar conservation laws. Moreover, we present some results about strong traces, where the flux function is assumed non-homogeneous with low regularity in the spatial variable. This is a joint work with Evgeniy Panov, and Jean Silva.

Dispersive Equations

Organizer: Marcia A. G. Scialom and Mahendra Panthee

On the limit of the Schrödinger-Debye system with refractive index of square wave amplitude

Adán J. Corcho, Juan C. Cordero
Universidade Federal do Rio de Janeiro

We consider $(u_\tau, v_\tau) \in H^1 \times H^1$ solutions of the focusing one-dimensional Schrödinger-Debye system with small response time ($0 < \tau \ll 1$) and data (u_{τ_0}, v_{τ_0}) uniformly bounded in $H^1 \times L^2$ and also $u_{\tau_0} \xrightarrow{H^1} u_0$ as τ tends to 0. We prove that (u_τ, v_τ) converge to $(u, -|u|^2)$, when τ tends to zero, in the space $L^\infty_{[0,T]}L^2_x \times L^1_{[0,T]}L^2_x$ where u is the solution of the one-dimensional cubic nonlinear Schrödinger equation with initial data u_0. Our results improve the previous ones obtained by B. Bidégaray in 1998 (see Advances in Differential Equations Vol. 3, Number 3, 1998).

On three-wave interaction Schrödinger systems with quadratic nonlinearities: global well-posedness and standing waves

Ademir Pastor
Universidade Estadual de Campinas

We present results concerning the global well-posedness in the energy space and existence and stability of standing-wave solutions for 1-dimensional threecomponent systems of nonlinear Schrödinger equations with quadratic nonlinearities. For two particular systems we are interested in, the global well-posedness is established in view of the a priori bounds for the local solutions. The standing waves are explicitly obtained and their spectral/orbital stability/instability is studied in the context of Hamiltonian systems. For more general Hamiltonian systems, the existence of standing waves is accomplished with a variational approach based on the Mountain Pass Theorem.

Sufficient conditions for orbital stability of periodic traveling waves

Fábio Natali, Ademir Pastor, Giovana Alves
Universidade Estadual De Maringá

The present talk deals with sufficient conditions for orbital stability of periodic waves of a general class of evolution equations supporting nonlinear dispersive waves. Firstly, our main result do not depend on the parametrization of the periodic wave itself. Secondly, motived by the well known orbital stability criterion for solitary waves, we show that the same criterion holds for periodic waves. In addition, we show that the positiveness of the principal entries of the Hessian matrix related to the "energy surface function" are also sufficient to obtain the stability. Consequently, we can establish the orbital stability of periodic waves for several nonlinear dispersive models. We believe our method can be applied in a wide class of evolution equations; in particular it can be extended to regularized wave equations.

On the Cauchy problem for nonlinear interactions type Schrödinger

Isnaldo Isaac Barbosa
Universidade Federal de Alagoas

We study the Cauchy problem associated to the coupled Schrödinger equations, which appears modeling problems in nonlinear optics, namely:

$$\begin{cases} i\partial_t u(x,t) + p\partial_x^2 u(x,t) - \theta u(x,t) + \bar{u}(x,t)v(x,t) = 0, \quad x \in \boldsymbol{R},\ t \geq 0, \\ i\sigma\partial_t v(x,t) + q\partial_x^2 v(x,t) - \alpha v(x,t) + \frac{1}{2}u^2(x,t) = 0, \quad p,q = \pm 1,\ \sigma > 0, \\ u(x,0) = u_0(x), \quad v(x,0) = v_0(x), \end{cases} \tag{3}$$

where the initial data are considered in the classical Sobolev spaces $(u_0, v_0) \in H^\kappa(\mathbb{R}) \times H^s(\mathbb{R})$.

Well-posedness results for this system, in the periodic case, were obtained by Angulo and Linares in [1]. In this work we develop a local theory for the system, where the regularity (κ, s) of the initial data depends on the different situations of the parameter $\sigma > 0$. Also, we obtain global well-posedness results when $\sigma \neq 2$ and for negative indices $\kappa = s < 0$ included in the local theory developed. Finally, we show some ill-posedness results.

The main references of this work are: [2], [3] and [4].

Remark 0.0.1. *The content of this work is part of the author's Ph.D. Thesis at the Universidade Federal de Alagoas under direction of Professor Adán J. Corcho.*

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Asymptotic behavior of the Zakahrov-Rubenchik system

Juan C. Cordero C.
Universidad Nacional de Colombia-Sede Manizales

We will talk about weak and strong convergence results of the solutions of the Zakahrov-Rubenchik system to solutions of Zakharov system. The weak limit is a classical argument in the theory of compactness, whose main ingredient is the Aubin-Lions Theorem and the Ascoli Theorem. Strong limits are conveniently treated by decomposing the nonlinearities and using the Strichartz estimates associated with the group of the Schrödinger equation and the wave group. This work was recently published in the Journal of Differential Equations Volume 261, Issue 9, 5 November 2016, Pages 5260-5288.

Time-weighted estimates in Lorentz spaces and self-similarity for wave equations with singular potentials

Lucas C. F. Ferreira, Marcelo F. de Almeida
Universidade Estadual de Campinas

We show time-weighted estimates in Lorentz spaces for the linear wave equation with singular potential. As a consequence, assuming radial symmetry on initial data and potentials, we obtain well-posedness of global solutions in critical weak-L^p spaces for semilinear wave equations. In particular, we can consider the Hardy potential $V(x) = c|x|^{-2}$ for small $|c|$. Self-similar solutions are obtained for potentials and initial data with the right homogeneity. Our approach relies on performing estimates in the predual of weak-L^p, i.e., the Lorentz space $L^{(p',1)}$.

On well-posedness of some bi-dimensional dispersive models

Mahendra Panthee, Felipe Linares, Nikolay Tzvetkov
Universidade Estadual de Campinas

We consider an initial value problem (IVP) associated to a third order dispersive model posed in $\mathbb{T}^2$. Using the techniques introduced by Ionescu and Kenig, we prove the local well-posedness result for given data in $H^s(\mathbb{T}^2)$ whenever $s > \frac{3}{2}$.

On the model of fifth order KdV-BBM equation

Marcia Scialom, Jerry Bona, Mahendra Panthee, Xavier Carvajal
Universidade Estadual de Campinas

Formally second-order correct, mathematical descriptions of long-crested water waves propagating mainly in one direction are derived. These equations are analogous to the first-order approximations of KdV- or BBM-type. The advantage of these more complex equations is that their solutions corresponding to physically relevant initial perturbations of the rest state are expected to be accurate on a much longer time scale. The initial-value problem for the class of equations that emerges from our derivation is then considered. A local well-posedness theory is straightforwardly established by way of a contraction mapping argument. A subclass of these equations possess a special Hamiltonian structure that implies the local theory can be continued indefinitely.

On the standing waves of a nonlinear Schrödinger equation (NLS) with point interactions on the star graph

Nataliia Goloshchapova
Universidade de São Paulo

We investigate an orbital stability of the standing waves of the NLS equation with point (δ- and $\delta'-$) interactions and two types of nonlinearities (power and logarithmic) on the star graph. This problem is quite new. To our knowledge the only stability results for NLS-δ equation with power nonlinearity on the star graph were obtained in [R. Adami, C. Cacciapuoti, D. Finco, D. Noja, Stable standing waves for a NLS on star graphs as local minimizers of the constrained energy, arXiv:1509.01810v1] and [R. Adami, C. Cacciapuoti, D. Finco, D. Noja,Variational properties and orbital stability of standing waves for NLS equation on a star graph, J. Diff. Eq. **257**, 3738–3777 (2014)].

We propose a short proof of the orbital stability of a certain family of standing waves for NLS-δ equation with power nonlinearity on the star graph in the case of negative intensity α (of δ-interaction).

It is worth noting that in the mentioned papers it was a big problem to show the stability for any $\alpha < 0$ without restriction $\alpha < \alpha^* < 0$. Our approach allows us to overcame easily the restriction $\alpha < \alpha^*$. Moreover, in the present work we prove some new results on the orbital stability of the standing waves of NLS-δ' equation with power nonlinearity and NLS-δ equation with logarithmic nonlinearity on the star graph.

Our approach relies on the known theory by M. Grillakis, J. Shatah, W. Strauss, the theory of extensions of symmetric operators, and spectral theory of self-adjoint Schrödinger operators.

Global well-posedness results for the 2D-Schrödinger-debye system

Raphael Antunes dos Santos
Universidade Federal do Rio de Janeiro

In this work we study the well-posedness of the Schrödinger-Debye system

$$\begin{cases} i\partial_t u + \frac{1}{2}\Delta u = uv, & t > 0, \quad x \in I\!R^2, \\ \mu\partial_t v + v = \lambda|u|^2, & \mu > 0, \quad \lambda = \pm 1, \\ u(0,x) = u_0(x), \quad v(0,x) = v_0(x). \end{cases}$$

In the context of Sobolev spaces of type $H^{k_1}(I\!R^2) \times H^{k_2}(I\!R^2)$, where k_1, k_2 are integers, we prove some *à priori* estimates and therefore global well-posedness. Using interpolation of nonlinear operators, we prove some global well-posedness results when $(u_0, v_0) \in H^s(I\!R^2) \times H^l(I\!R^2)$, with $s, l \in I\!R$ being convex combinations of those Sobolev indices. We established global well-posedness in $H^s(I\!R^2) \times H^s(I\!R)$ when $s \geq 1$ and in $H^s(I\!R^2) \times H^k(I\!R^2)$, when $s \in [k, k+1]$, with $k \geq 1$ integer.

The IVP for a perturbation of the BO equation in classical and weighted Sobolev spaces

Ricardo Pastrán, Germán Fonseca, Guillermo Rodríguez
Universidad Nacional de Colombia

We prove that the initial value problem associated to a nonlocal perturbation of the Benjamin-Ono equation is locally and globally well-posed in Sobolev spaces $H^s(\mathbb{R})$ for any $s > -3/2$ and we establish that our result is sharp in the sense that the flow map of this equation fails to be C^2 in $H^s(\mathbb{R})$ for $s < -3/2$. Finally, we study 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 $s \geq r > 0$. We also prove some unique continuation properties of the solution flow in these spaces.

Controllability of the nonlinear Schrödinger equation in exterior domains

Roberto Capistrano-Filho, Lionel Rosier, Bingyu Zhang
Universidade Federal de Pernambuco

In this talk we present some results related with the boundary control problem of the semi-linear Schrödinger equation posed on a bounded domain Ω_0 of $\mathbb{R}^n$ with either the Dirichlet boundary conditions and Neumann boundary conditions. We consider the control inputs acting on a part of the boundary of Ω_0. First, we prove that this problem is shown to be equivalent to prove an internal controllability of the Schrödinger equation on a *exterior domain* Ω of $\mathbb{R}^n$. To prove the internal

controllability, the system is linearized around the origin and the corresponding linear system is proved to be locally exactly controllable in the classical Sobolev space $H^s(\Omega)$, for $s \geq -1$, using unique continuation property for the linearized system associated. However, the unique continuation property does not work when the system is linearized around any smooth solution of the cubic Schrödinger equation. Thus, with help of Carleman estimate, we prove that the system is exactly controllable in $H_0^1(\Omega)$ around any smooth solution of the cubic Schrödinger equation. Finally, using Strichartz estimates and contraction mapping principle we extend our result (locally) to the nonlinear system without and with variable coefficients.

Wave models with mass and speed of propagation

Wanderley Nunes do Nascimento, Marcelo Rempel Ebert
Universidade Estadual Paulista

In this talk we will consider the Cauchy problem for a wave equation with time-dependent propagation speed and mass

$$\begin{cases} u_{tt} - a(t)^2\Delta u + m(t)^2 u = 0, \quad (t,x) \in (0,\infty) \times \boldsymbol{R}^n, \\ (u(0,x), u_t(0,x)) = (u_0(x), u_1(x)), \quad x \in \boldsymbol{R}^n. \end{cases} \tag{4}$$

We plan to propose a classification for the potential term $m(t)^2 u$ that should depend on the speed of propagation $a(t)$. We will consider the case $a \notin L^1$ and we expect that the case $a \in L^1$ shall be treated using a different approach, see [1] and [2]. This classification should be a natural generalization of the one proposed in [3] and [4] in the case of constant speed of propagation $a(t) \equiv 1$.

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[2] M. R. Ebert, M. Reissig, Theory of damped wave models with integrable and decaying in time speed of propagation, 22 A4 2015. (Submitted).

[3] C. Böhme, Decay rates and scattering states for wave models with time-dependent potential, Ph.D. Thesis, TU Bergakademie Freiberg, 2011, 143pp.

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L^2-Concentration for a coupled nonlinear Schrödinger system

Xavier Carvajal, Pedro Gamboa
Universidade Federal do Rio De Janeiro

In this work we use ideas of Bourgain to prove the L^2-concentration of blow-up solutions for two-coupled nonlinear Schrödinger equations at critical dimension.

Elliptic Equations

Organizer: Claudianor O. Alves

Nonlocal Neumann problem with critical exponent from the point of view of the trace

Augusto César dos Reis Costa, Francisco Julio Sobreira de Araujo Corrêa
Universidade Federal do Pará

In this work, we are concerned with questions of existence and multiplicity of solutions for a non-local and non-homogeneous Neumann boundary value problems involving the $p(x)$-Laplace operator and critical growth, from the point of view of the trace, via a truncation argument on generalized Lebesgue-Sobolev spaces.

Combining linear and nonlinear diffusion in the logistic equation

Cristian Morales Rodrigo, Willian Cintra, Antonio Suarez
Universidad de Sevilla

In this talk we consider a model where the diffusion of the specie depend on the spatial domain and it can be either linear or nonlinear (either slow or fast). In the case of slow diffusion we will assume also that there exists a refugee where the species can grows following the Malthusian law. We prove existence, uniqueness or multiplicity of positive solution(s) and study the behavior of the solution with respect to the growth rate of the specie. Mainly, we use the bifurcation method, the sub-supersolution method and variational methods.

Geometric regularity theory for degenerate elliptic equations

Edgard A. Pimentel, Ricardo Castillo
Pontifícia Universidade Católica do Rio de Janeiro

In this talk, we examine the regularity of solutions to degenerate fully nonlinear elliptic equations. First, we produce a universal modulus of continuity for the solutions. Further, by assuming that source terms are in certain Lebesgue spaces, we obtain the optimal regularity of solutions in Hölder spaces.

Second eigenvalue of the CR Yamabe Operator

Flávio Almeida Lemos, Ezequiel Barbosa
Universidade Federal de Ouro Preto

Let (M, θ) be a compact, connected, strictly pseudoconvex CR manifold. In this paper, we given some properties of the CR Yamabe Operator L_θ. We show a upper bound for the Second CR Yamabe Invariant, when the First CR Yamabe Invariant is negative, and the existence of the minimizer for the Second CR Yamabe Invariant, given some conditions.

Generalized Nehari manifold and semilinear Schrödinger equation

Francisco Odair de Paiva, Andrzej Szulkin, Wojciech Kryszewski
Universidade Federal de São Carlos

We study the Schrödinger equation $u+V(x)u = f(x,u)$ in $\boldsymbol{R}^N$. We assume that f is superlinear but of subcritical growth and $uf(x,u)/|u|$ is nondecreasing. We also assume that V and f are periodic in $x_1, ..., x_N$. We show that these equations have a ground state and that there exist infinitely many solutions if f is odd in u.

Existence of ground state solutions to Dirac equations with vanishing potentials at infinity

Giovany Figueiredo, Marcos Pimenta
Universidade de Brasília

In this work we study the existence of ground-state solutions of Dirac equations with potentials which are allowed to vanish at infinity. The approach is based on minimization of the energy functional over a generalized Nehari set. Some conditions on the potentials are given in order to overcome the lack of compactness.

Multiple positive solutions for a nonlocal quasilinear problem from population genetics

Gustavo Ferron Madeira
Universidade Federal de São Carlos

In this lecture we consider a nonlocal quasilinear elliptic problem under mixed boundary conditions motivated by a model in population genetics. The reaction term is of strong Allee effect type, which takes place if the growth rate per capita is negative when the population density isso small. Such term has two spatial dependent zeros that we do not require to be continuous functions. Our aim is to construct two positive solutions for the problem when a parameter is large and to prove that no positive solution can exist for small values of such parameter. The results we present generalize some previous works and complete others in the literature.

A Hardy-Littlewood-Sobolev type inequality for variable exponents and applications to quasilinear Choquard equations involving variable exponents

Leandro da Silva Tavares, Claudianor Oliveira Alves
Universidade Federal de Campina Grande

In this work we obtain a Hardy-Littlewood-Sobolev type inequality for variable exponents and we apply such result to obtain a nontrivial solution for the following Choquard equation

$$\begin{cases} -\Delta_{p(x)}u + V(x)|u|^{q(x)-2}u = \left(\displaystyle\int_{\mathbb{R}^N} \frac{F(x,u(x))}{|x-y|^{\lambda(x,y)}}\right) f(y,u(y)) \text{ in } \mathbb{R}^n, \\ \\ u \in W^{1,q(x)}(\mathbb{R}^N), \end{cases}$$

where f, F, q, p and the potential V are functions that satisfy certain conditions.

A positive bound state for an asymptotically linear or superlinear Schrödinger equation in exterior domains

Liliane A. Maia, Alireza Khatib
Universidade de Brasília

We are going to present results from recent work on the existence of a positive solution for semilinear elliptic equation in exterior domains

$$-\Delta u + V(x)u = f(u), \quad \text{in} \quad \Omega \subseteq \mathbb{R}^N \tag{P_V}$$

where $N \geq 2$, $\mathbb{R}^N \setminus \Omega$ is bounded but there is no restriction on its size, nor any symmetry assumption. The nonlinear term f is a non homogeneous, asymptotically linear or superlinear function at infinity. Moreover, the potential V is a positive function, not necessarily symmetric. The existence of a solution is established in situations where this problem does not have a ground state.

Existence of solutions for a class of $p(x)$-Laplacian equations involving a concave-convex nonlinearity with critical growth in $\mathbb{R}^N$

Marcelo C Ferreira, Claudianor O Alves
Universidade Federal de Campina Grande

Under proper hypotheses on the data, by using the variational method we prove the existence of solutions for the following class of quasilinear problems involving variable exponents

$$\begin{cases} -\Delta_{p(x)}u + V(x)u^{p(x)-1} = \lambda h(x)u^{r(x)-1} + \mu u^{q(x)-1} + u^{p^*(x)-1}, \ \mathbb{R}^N \\ u \geq 0 \text{ and } u \neq 0, \ \mathbb{R}^N \\ u \in W^{1,p(x)}\big(\mathbb{R}^N\big), \end{cases} \tag{P}$$

where $\Delta_{p(x)}$ is the $p(x)$-laplacian operator given by

$$\Delta_{p(x)}u = \text{div}(|\nabla u|^{p(x)-2}\nabla u),$$

λ, μ are positive parameters and $p\colon \mathbb{R}^N \to \mathbb{R}, q, r, V : \mathbb{R}^N \to \mathbb{R}$ are continuous functions. This a joint work with C.O. Alves.

Strauss' and Lions' type results in $BV(\mathbb{R}^N)$ with an application to 1-Laplacian problem

Pimenta, M.T.O., Figueiredo, G.M.
Universidade Estadual Paulista

In this work we state and prove versions of some classical results, in the framework of functionals defined in the space of bounded variation functions in $\mathbb{R}^N$. More precisely, we present versions of the Radial Lemma of Strauss, the compactness of the embeddings of the space of radially symmetric functions of $BV(\mathbb{R}^N)$ in some Lebesgue spaces and also a version of the Lions Lemma, proved in his celebrated paper of 1984. As an application, we state and prove a version of the Mountain Pass Theorem without the Palais-Smale condition in order to get existence of a ground-state bounded variation solution of a quasilinear elliptic problem involving the $1-$Laplacian operator in $\mathbb{R}^N$. This seems to be the very first work dealing with stationary problems involving this operator in the whole space.

Remarks on solitary waves for a class of Generalized Kadomtsev-Petviashvili (GKP) equation in $\mathbb{R}^2$

Olimpio Hiroshi Miyagaki, Claudianor O. Alves
Universidade Federal de Juiz de Fora

In this talk we discuss some results concerning the existence, regularity and concentration phenomenon of nontrivial solitary waves for a Generalized Kadomtsev-Petviashvili (GKP) equation in $\mathbb{R}^2$. Variational methods are used to get an existence result, as well as, to study the concentration phenomenon. While the regularity is more delicate because we are leading with functions in an anisotropic Sobolev space. The main tool is to use Hörmander-Mikhlin multipliers theorem due to Lizorkin.

Fluid Dynamics

Organizer: Gabriela Planas

Decay of solutions to dissipative and dissipative modified quasi-geostrophic equations

César J. Niche
Universidade Federal do Rio de Janeiro

The dissipative quasigeostrophic equation (DQGE)

$$\partial_t\theta + u\cdot\nabla\theta + \nu\,(-\Delta)^{\alpha}\theta = 0, \qquad \nu > 0,$$

where $u = \nabla^{\perp}(-\Delta)^{-1/2}\theta$, is for $\alpha = 1/2$, a dimensionally correct 2D model for the 3D Navier-Stokes equations. In the last 20 years, many important techniques and tools have been developed to obtain results for DQGE, when $0 < \alpha \leq 1$.

In this talk, we will present results concerning decay and asymptotic behaviour for the *modified* dissipative quasigeostrophic equation, i.e. $u = \nabla^{\perp}(-\Delta)^{\frac{1}{2}(\beta-2)}, 0 < \beta \leq 1$. We will show the basic ideas behind the proof of these results, compare them to those for DQGE and discuss some relevant, related open problems.

This is joint work with Lucas C.F. Ferreira and Gabriela Planas.

Hydrodynamic vortex on surfaces

Clodoaldo Grotta Ragazzo
Universidade de São Paulo

The equations of motion for a system of point vortices on an oriented Riemannian surface of finite topological type is presented.

The equations are obtained from a Green's function on the surface. The uniqueness of the Green's function is established under hydrodynamic conditions at the surface's boundaries and ends. The hydrodynamic force on a point vortex is computed using a new weak formulation of Euler's equation adapted to the point vortex context. An analogy between the hydrodynamic force on a massive point vortex and the electromagnetic force on a massive electric charge are presented as well as the equations of motion for massive vortices. Any noncompact Riemann surface admits a unique Riemannian metric such that a single vortex in the surface does not move (Steady Vortex Metric). Some examples of surfaces with steady vortex metric isometrically embedded in R3 are presented.

On the control of Euler-Boussinesq's equations

Diego A. Souza, Enrique Fernández-Cara, Maurício C. Santos
Universidade Federal de Pernambuco

The aim of this talk is to present some control results of the Euler equation for perfect incompressible fluids for which thermal effects are important, modeled through the so called Boussinesq approximation (buoyancy). Precisely, we prove that we can steer our dynamical system from any initial profile of velocity and temperature to any target profile of velocity and temperature in finite time, using a variable called control that can be freely chosen to act on the system. We construct

solutions of the controllability problem using a technique, introduced by J.-M. Coron as the return method, which consists in exploiting the nonlinearities of the equations for control purposes. This talk is based on a recent joint work in collaboration with E. Fernández-Cara and M. C. Santos.

Global solutions to the α-Navier-Stokes-Vlasov Equations

Gabriela Planas, Cristyan C. V. Pinheiro
Universidade Estadual de Campinas

We consider the α-Navier-Stokes equations coupled with a Vlasov type equation to model the flow of an incompressible fluid containing small particles. We prove the global existence of weak solutions to the coupled system subject to periodic boundary conditions. The convergence of its solutions to that of the Navier-Stokes-Vlasov equations when α tends to zero is also established.

Local theory for the surface quasi-geostrophic equation in exterior domains

Leonardo Kosloff
Universidade Estadual de Campinas

We study the exterior problem with Dirichlet boundary conditions for the SQG equation via a spectral representation of the fractional Laplacian $(-\Delta)^s$, $0 < s < 1$, based on a generalization of the Fourier transform for exterior domains. We then implement a localized version of $(-\Delta)^s$ due to Caffarelli and Silvestre, as improved by Stinga and Torrea.

We give applications to the problem of existence of weak solutions of the two dimensional dissipative quasi-geostrophic equation and the the large-time decay of these solutions in the L^2-norm through a modified version of the Fourier splitting technique due to M. Schonbek.

Lastly, we explore local well-posedness of this system in critical spaces using Littlewood-Paley localizations based on precise pointwise estimates for the heat kernel of the Dirichlet Laplacian. This allows one to import the paraproduct rules from the theory in the whole space, in a certain range of spaces, but is not enough to obtain global well-posedness due to the loss of regularity in commutator estimates.

Fractional regularity for evolutive equations

Luís Henrique de Miranda, J. Boldrini, M. Montenegro, G. Planas, A. Presoto
Universidade de Brasília

In this talk we are going to discuss some results concerning the questions on the regularity of solutions for the following degenerate equations:

$$\begin{aligned} \alpha(u_t) - \Delta_p u \quad &\ni \quad f \ \text{ in } Q = \Omega \times (0,T), \\ \frac{\partial u}{\partial \nu} = 0 \quad &\text{on} \quad \partial\Omega \times (0,T), \\ u(.,0) = u_0 \quad &\text{in} \quad U, \end{aligned} \tag{5}$$

and

$$\begin{aligned} u_t - \Delta_p u \quad &= \quad f \ \text{ in } Q = U \times (0,T), \\ \frac{\partial u}{\partial \nu} = 0 \quad &\text{on} \quad \partial U \times (0,T), \\ u(.,0) = u_0 \quad &\text{in} \quad U, \end{aligned} \tag{6}$$

where Δ_p denotes the p-Laplacian with $p > 2$.

This problem goes back to solidification processes of certain polymers and has been investigated by several authors in the past years, and our interest in proving regularity results for (7) and (8) appeared while investigating such processes.

The main difficulty of problem (7) is concentrated in handling the interaction between the p-Laplacian and the nonlinearity $\alpha(u_t)$, what makes of (7) a doubly nonlinear differential inclusion. It is our aim to obtain the existence of "strong" solutions for our problem, and for this purpose we combine the so-called Rothe Method and regularity theory on sobolev spaces of fractional order.

We are going to recall and explore regularity results for the solutions of (7)-(8) with respect to the so-called Nikoslkii spaces in order to obtain improved $C^1(0, T; W)$, regularity, where W is a intermediate dual space.

We intent to show the basic energy estimates and to discuss certain key lemmas used in the proof of the main result.

Steady periodic Water Waves

Silvia Sastre-Gomez, David Henry
Universidade Federal de Pernambuco

In this work we study steady two-dimensional periodic water waves problems over a fixed depth with the vorticity discontinuous. We consider a modified height function, which explicitly introduces the mean depth into the rotational water wave problem. Since the vorticity is discontinuous, the equations are expressed in a weak form and the solutions are considered in the sense of distributions. We use Crandall-Rabinowitz local bifurcation to prove the existence of weak solutions.

Linear Equations

Organizer: Rafael Fernando Barostichi

Topological transitivity and mixing of the composition operator on Lp spaces

Benito Pires, Udayan Darji
Universidade de São Paulo

Let $X = (X, \Sigma, \mu)$ be a σ-finite measure space and $f : X \to X$ be an one-to-one bimeasurable transformation satisfying $\mu(f(B)) \geq c_1\mu(B)$ for some constant $c_1 > 0$ and every measurable set B, then $T_f : \varphi \mapsto \varphi \circ f$ is a bounded linear operator acting on $L^p(X, \Sigma, \mu)$, $1 \leq p < \infty$, called the *composition operator* induced by f. We provide necessary and sufficient conditions on f for T_f to be topologically transitive or topologically mixing. We also give two examples of one-to-one bimeasurable transformations whose composition operators are topologically transitive but not topologically mixing. Finally, we show that the composition operator induced by a bi-Lipschitz μ-contraction (or more generally, by a μ-dissipative transformation) defined on a finite measure space is always topologically mixing. Joint work with Udayan Darji.

Regularity and solvability of linear differential operators in Gevrey spaces

Gabriel Araújo
Universidade de São Paulo, Univesp

I will talk about two questions regarding regularity and solvability of linear PDEs in the setting of Gevrey ultradistributions.

The first one, inspired by a classical result of Treves, is to determine, loosely speaking, when regularity properties of a linear differential operator imply solvability of its transpose in the sense of Gevrey ultradistributions. We study this question for a class of abstract operators that contains the usual differential operators with real-analytic coefficients, obtaining a new proof of a global result on compact manifolds, as well as some results in the non-compact case by means of the so-called property of non-confinement of singularities.

We also analyze a conjecture stated in a recent paper of Malaspina and Nicola (2014), which asserts that, in differential complexes naturally arising from locally integrable structures, local solvability in the sense of ultradistributions implies local solvability in the sense of distributions. We establish the validity of the conjecture when the cotangent structure bundle is spanned by the differential of a single first integral.

L1 estimates for a doubly dissipative wave equation

Marcello D'Abbicco
Universidade de São Paulo

In this talk, we will show how it is possible to obtain in a simple way L1 estimates for the solution to the forward Cauchy problem for a wave equation with a frictional and a viscoelastic dissipation, in any space dimension. As an application, we find the critical exponent for global in time solutions to the problem with power nonlinearity with small data in Sobolev spaces.

Regularity theory and global existence solutions to semi-linear de Sitter models

Marcelo Rempel Ebert, Michael Reissig
Universidade de São Paulo

In this talk we discuss the Cauchy problem for semi-linear de Sitter models with power non-linearity. The model of interest is

$$\phi_{tt} - e^{-2t}\Delta\phi + n\phi_t + m^2\phi = |\phi|^p, \quad (\phi(0,x), \phi_t(0,x)) = (f(x), g(x)),$$

where m^2 is a non-negative constant. This model describes the de Sitter model for the expansion of the universe. We derive results about global (in time) existence of small data solutions. In particular, we show the interplay between the power p, admissible data spaces and admissible spaces of solutions (in weak sense, in sense of energy solutions or in classical sense).

A Mean Value Theorem for metric spaces

Paulo Liboni, Paulo Carvalho Neto
Universidade Estadual de Londrina

We present a form of the Mean Value Theorem (MVT) for a continuous function f between metric spaces, connecting it with the possibility to choose the $\varepsilon \longmapsto \delta(\varepsilon)$ relationship of f in a homeomorphic, maximum way.

We will present two applications of such methods. First, we will compare our formulation of the MVT with the classic one when the metric spaces are actually Banach spaces. As a consequence, we derive a version of the Mean Value Property for measure spaces that also possesses a compatible metric structure.

After that, we investigate the following inverse problem: let $\mathcal{I}(\varepsilon) \subset \mathbb{R}$ be a collection of sets indexed in $\varepsilon > 0$. We wish to find a continuous function $f : U \subset (M_1, d_1) \to (M_2, d_2)$ such that it satisfies some initial value data $f(x_0) = y_0$ and, besides that, the continuity relation of f at x_0 matches some prescribed function $\varepsilon \mapsto \mathcal{I}(\varepsilon)$ for, at least, small ε.

This is a joint work with Dr. Paulo Carvalho Neto, from Universidade Federal de Santa Catarina.

Global hypoellipticity of smooth planar vector fields

Renato A. Laguna, Sérgio Luís Zani
Universidade de São Paulo

A smooth, complex vector field L on a smooth manifold M is said to be *globally hypoelliptic* (GH) when

$$Lu \in \mathcal{C}^\infty(M) \implies u \in \mathcal{C}^\infty(M),$$

for every complex-valued distribution $u \in \mathcal{D}'(M)$.

Let L be a nonsingular (that is, nowhere vanishing) field. In the case of M being a compact, connected surface, necessary and sufficient conditions for L to be GH were given by Hounie (1982) in *Globally hypoelliptic vector fields on compact surfaces*, Communications in Partial Differential Equations, 7:4, 343–370.

What happens when $M = \mathbb{R}^2$? Sometimes the global hypoellipticity of L is analogous to how it was in compact surfaces, but not always. The case of an (essentially) real GH field never occurs, though it did in the torus. On the other hand, we may have 1-D orbits that extend infinitely at both ends without dividing the plane, giving some exotic cases that we don't know yet if they are GH.

A condition sufficient for L to be GH is given, as well as a few for L not to be GH.

$\mathcal{L}$ strong charges for elliptic systems of complex vector fields

Tiago Picon, Laurent Moonens
Universidade de São Paulo

In this talk, we characterize all the distributions $F \in \mathcal{D}'(U)$ such that there exists a continuous weak solution $v \in C(U, \mathbb{C}^n)$ with $U \subset \Omega$ to the divergence-type equation

$$L_1^* v_1 + ... + L_n^* v_n = F,$$

where $\{L_1, \ldots, L_n\}$ is an elliptic system of linearly independent vector fields with smooth complex coefficients defined on $\Omega \subset \boldsymbol{R}^N$. In case where $(L_1, \ldots, L_n)$ is the usual gradient field on $\boldsymbol{R}^N$, we recover the classical result for the divergence equation proved by T. De Pauw and W. Pfeffer.

Nonlinear Dynamical Systems

Organizer: Juliana F. S. Pimentel and Matheus C. Bortolan

Structural stability of uniform attractors under non-autonomous perturbations

Alexandre N. Carvalho, Matheus C. Bortolan, José A. Langa, Geneviève Raugel
Universidade de São Paulo

We prove under suitable assumptions that the global attractor of an autonomous Morse Smale Semigroup has the same dynamical structure as the uniform attractor of a 'small' non-autonomous perturbation of it.

Bifurcation from infinity for a semilinear wave equation

Sanjuán, Arturo, Castro, Alfonso, Caicedo, José Francisco
Universidad Distrital Francisco José de Caldas

We present a result of existence of weak solutions for a semilinear wave equation depending on a parameter λ and subject to Dirichlet-periodic boundary conditions. We assume the nonlinear term to be asymptotically linear and not necessarily monotone. The solutions in L^∞ tend to $+\infty$ when the bifurcation parameter approaches eigenvalues of finite multiplicity of the wave operator. In other words, there is birufcation at infinity in each finite multiplicity eigenvalue. For simple eigenvalues the solutions describe a curve and for odd multiplicity eigenvalues there is a continuum of solutions.

Finite time syncronization of spatiotemporal nonlinear dynamical systems using local coupling

Antonio Acosta, Pedro García, Hugo Leiva, Antonio Merlitti
Yachay Tech University, Ecuador

We consider two reaction-diffusion equations conected by an one-directional coupling function and study the the synchronization problem in the case of the coupling fuction affect the driven system in some specific regions. We derive condition that ensure that the evolution of the driven closely track the evolution of the driven system. The framework built to achieve our results is based on the study of an abstract ordinary differential equation. A numerical simulation is used to show the performance of our strategy.

Periodic oscillations in nonmonotonic smooth negative feedback systems

Camille Poignard, Madalena chaves, Jean-Luc Gouzé
Universidade de São Paulo

Negative feedback circuits are a recurrent motif in regulatory biological networks, strongly linked to the emergence of oscillatory behavior. The theoretical analysis of the existence of oscillations is a difficult problem and typically involves constraints on the monotonicity of the activity functions. Here, we study the occurrence of periodic solutions in an n-dimensional class of negative feedback systems

defined by smooth vector fields with a window of not necessarily monotonic activity. Our method consists in circumscribing the smooth system by two piecewise linear ones, each admitting a periodic solution. It can then be shown that the smooth negative feedback system also has a periodic orbit, inscribed in a torus constructed from the two piecewise linear orbits. The interest of our approach lies in: first, adopting a general class of functions, with a non monotonicity window, which permits a better fitting between theoretical models and experimental data, and second, establishing a more accurate localization for the periodic solution.

In this talk I will show the existence of a periodic orbit for such non monotonic smooth models, and then discuss its uniqueness in a particular symmetric case.

Bifurcation and dynamics in models for mosquito-borne diseases

Huaiping Zhu
York University

In this talk I will talk about dynamical models to investigate the impact of limited health resources on the endemic and recurrence of mosquito-borne diseases. By considering a nonlinear recovery rate in a compartment model, I will present the bifurcations of nilpotent singularities of high codimension and complex dynamics of the models, and discuss the interplay between the nonlinear incidence rate and the nonlinear recovery rate due to limited health resources. Using the results from this study I will explain the mechanisms which may have triggered the largest outbreak of dengue fever in Guangzhou China, 2014.

Existence of solutions for a class of semilinear evolution equations with impulses and delays

Hugo Leiva, P. Sundar
Yachay Tech University, Ecuador

We prove the existence and uniqueness of the solutions for the following class of semilinear evolution equations with impulses and delays:

$$\begin{cases} \dot{z} = -Az + F(t, z_t), & z \in Z, \quad t \in (0, \tau], t \neq t_k, \\ z(s) = \phi(s), \quad s \in [-r, 0], & \\ z(t_k^+) = z(t_k^-) + J_k(z(t_k)), & k = 1, 2, 3, \ldots, p, \end{cases}$$

where $0 < t_1 < t_2 < t_3 < \cdots < t_p < \tau$, Z, a Banach space, z_t defined as a function from $[-r, 0]$ to Z by $z_t(s) = z(t+s), -r \leq s \leq 0$, and $J_k : Z^\alpha \to Z^\alpha$, $F : [0, \tau] \times C(-r, 0; Z^\alpha) \to Z$. In the above problem, $A : D(A) \subset Z \to Z$ is a sectorial operator in Z with $-A$ being the generator of a strongly continuous compact semigroup $\{T(t)\}_{t \geq 0}$, and $Z^\alpha = D(A^\alpha)$. The novelty of this work is that our class of evolution equations contain nonlinear terms that involve spatial derivatives. Our framework includes several important partial differential equations such as Burgers Equation with impulses and delays.

A system generalising Camassa-Holm and Novikov equations

Igor Leite Freire, Diego Catalano Ferraioli
Universidade Federal do ABC

In this talk we discuss a system of equations generalising the Camassa-Holm and Novikov equations. Point symmetries and low order conservation laws are shown. Peakon and multipeakon solutions are also considered. In particular, when the system has cubic nonlinearities, we show that the 1-peakons exhibit a different behavior when compared with the 1-peakons of the Novikov equation.

Asymptotically autonomous multivalued problems with variable exponents

Jacson Simsen
Universidade Federal de Itajubá

This talk is based on the paper [1] where the authors proved the existence of a pullback attractor and studied the asymptotic upper semicontinuity of the elements of the pullback attractor $\mathfrak{A} = \{\mathcal{A}(t) : t \in \mathbb{R}\}$ as $t \to \infty$ for the non-autonomous evolution inclusion

$$\frac{\partial u}{\partial t}(t) - \operatorname{div}(D(t)|\nabla u(t)|^{p(x)-2}\nabla u(t)) + |u(t)|^{p(x)-2}u(t) + F(t, u(t)) \ni 0$$

on a bounded smooth domain Ω in $\mathbb{R}^n$, $n \geq 1$ with a homogeneous Neumann boundary condition, where the exponent $p(\cdot) \in C(\overline{\Omega})$ satisfies $p^- := \min p(x) > 2$ and F is a measurable multifunction and $D \in L^\infty([\tau, T] \times \Omega)$ is bounded above and below and is monotonically nonincreasing in time.

Acknowledgements: Thanks to CAPES, FAPEMIG and CNPq for the Supports.

[1] P.E. Kloeden, J. Simsen, M.S. Simsen, Asymptotically autonomous multivalued Cauchy problems with spatially variable exponents, J. Math. Anal. Appl. 445 (2017), no. 1, 513-531.

A PDE of variational electrodynamics

Jayme De Luca, Jayme De Luca
Universidade Federal de São Carlos

The electromagnetic two-body problem is an infinite-dimensional problem with four state-dependent delays of neutral type. In this talk we relate the two-body problem to another infinitie-dimensional PDE problem by postulating a distribution that implies orbits with vanishing far-fields, here called the Chemical Principle. We discuss the distributional construction and the various forms the Chemical distribution can have in $\mathbb{W}^{2,2}(\mathbb{R}^3)$.

Stability of laminated Bresse-Timoshenko beams

Ma To Fu, Julio Santiago Prates Filho
Universidade de São Paulo

This talk is concerned with energy stability of a model of laminated Timoshenko beams proposed by Hansen and Spies. It explores the damping property given by the slip effect produced by a thin adhesive layer uniting the structure. It is known that the sole slip effect is not sufficient to stabilize the system exponentially. Here, we study the exponential stability of the system by adding locally distributed nonlinear weak damping.

An approach to spatial spread in thin structures

Marcone C. Pereira, Julio D. Rossi
Universidade de São Paulo

In this talk we discuss an approach to considerer spatial spread in N-dimensional thin structures. We introduce equations with nonlocal diffusion and defined in tight domains contrasting it with its corresponding local diffusion equation with Neumaan and Dirichlet boundary conditions. Here the thin structure effect is modeled by an ϵ-parameter family of open sets which squeezes to a lower dimension open set as $\epsilon \to 0$. The asymptotic behavior of the solutions is analyzed and the results are compared with classical situations to elliptic equations in thin domains.

Existence of periodic solutions for periodic-parabolic problem

Mikhail Vishnevski
UENF. CCT. LCMAT

In this communication we consider the boundary value problem for parabolic-periodic equation of the form:

$$u_t = L(x,t)u + \lambda f(x,t,u) \quad (x,t) \in Q = \Omega \times (0,\infty) \tag{7}$$

with boundary condition:

$$B(x,t)u = \beta(\frac{\partial u}{\partial \nu} + b(x,t)u) + (1-\beta)u, \quad (x,t) \in \Gamma = \partial\Omega \times (0,\infty) \tag{8}$$

and initial data:

$$u(x,0) = u_0(x). \tag{9}$$

Here $\Omega \in R^n$ is a bounded domain with smooth boundary $\partial\Omega$, $L(x,t)$ is an elliptic operator $L(x,t+\omega) = L(x,t)$, $b(x,t)$ is nonnegative function and $B(x,t+\omega) = B(x,t)$, $\quad f(x,t+\omega,u) = f(x,t,u)$. We also assume that all coeficients and function f are smooth function and $u_0(x) \in C^{2+\alpha}(\Gamma)$, $\quad B(x,0)u_0(x) = 0, \quad x \in \Gamma$.

$$L(x,t) = \sum_{i,j=1}^{n} a_{ij}(x,t)\frac{\partial^2}{\partial x_i \partial x_j} + \sum_{i=1}^{n} a_i(x,t)\frac{\partial}{\partial x_i} + a_0(x,t), \quad a_0(x,t) < 0.$$

About the function f we assume:

$$f(x,t,0) > 0, \quad \frac{f(x,t,\zeta) - f(x,t,\eta)}{\zeta - \eta} < \frac{K}{(1+\eta^{1+\varepsilon})}, \quad \varepsilon > 0, \quad 0 \le \eta < \zeta. \tag{10}$$

The main result of this comunication is:

There is a positive number λ_0 such that for all $\lambda > \lambda_0$ the problem (09)-(11) under the condition (12) has a unique positive globally stable ω-periodic solution.

Note that if we have autonomous (independent of t) parabolic problem it follows from our result that for $\lambda > \Lambda_0$ corresponding elliptic problem has unique globally stable solution.

We also consider the Semenov approximation of periodic-parabolic problem.

The chainsaw chaos in systems with hysteresis

N. Begun, D. Rachinskii, H. Lamba, M. Arnold, E. Kwame, P. Gurevich
Free University of Berlin

We consider a dynamical system with hysteresis. The system is motivated by modifications of general-equilibrium macroeconomic models that attempt to capture risks and memory dependence of realistic economic agents. Global dynamics and bifurcations of this system are studied depending on two parameters. We show that for a certain open set of parameter values, the system exhibits chaotic behavior. To understand the nature of this type of chaos, we introduce a map, which we call the chainsaw mapping, and discuss its properties.

Einstein constraints: A dynamical approach

Phillipo Lappicy
Free University Berlin

The Einstein constraint equations describe the space of initial data for the evolution equations, dictating how space should curve within spacetime. Under certain assumptions, the constraints reduce to a scalar quasilinear parabolic equation on the sphere with various singularities, and nonlinearity being the prescribed scalar curvature of space. We focus on self-similar solutions of Schwarzschild type. Those describe, for example, the initial data of black holes. We give a detailed study of the axially symmetric solutions, since the domain is now one dimensional and nodal properties can be used to describe certain asymptotics of the rescaled self-similar solutions. In particular, we mention examples for certain prescribed scalar curvatures.

Conservation laws and peakon solutions for an equation unifying Camassa-Holm and Novikov equations

Priscila L. da Silva, Stephen C. Anco, Igor L. Freire
Universidade Federal do ABC

In this talk we discuss a family of one-parameter family of equations, deduced from an inverse problem, unifying the Camassa-Holm and Novikov equations. We consider point symmetries and low order conservation laws, as well as peakon solutions.

Homoclinic and heteroclinic orbits in non-smooth dynamical systems

Ricardo M Martins, Anna Paula Machado, Jaume Llibre
Universidade Estadual de Campinas

We study the existence of homoclinic and heteroclinic cycles in families of piecewise vector fields in dimensions 2 and 3. We provide conditions for the existence and stability of these cycles, using the Filippov conventions over the discontinuity manifold. We also discuss the existence of limit cycles in these families and Shilnikov-like theorems.

Multiscale analysis for a vector-borne epidemic model

Sergio Oliva, Tchouaga, K. L.
Universidade de São Paulo

Traditional studies about disease dynamics have focused on global stability issues, due to their epidemiological importance. We study a model for Dengue in two different directions: we begin by determining the basics properties of the model. In the sequel, we take a different view and we argue that vectors and hosts can have very distinctive intrinsic time-scales, and that such distinctiveness extends to the disease dynamics. Under these hypothesis, we show that two asymptotic regimes naturally appear: the fast host dynamics and the fast vector dynamics. The former regime yields, at leading order, a SIR model for the hosts. In this case, the vector disappears from the model, and the dynamics is similar to a directly contagious disease. The latter yields a SI model for the vectors, with the hosts disappearing from the model.

Exponential attractors for random dynamical systems

Stefanie Sonner, Tomás Caraballo
Karl-Franzens-Universität Graz

Analyzing the longtime dynamics of infinite dimensional dynamical systems can often be reduced to the study of the dynamics on the global attractor. The global attractor is a compact, strictly invariant set that attracts all bounded subsets of the phase space. Since the rate of convergence is usually unknown and the global attractor is generally not stable under perturbations, the notion of an exponential attractor has been introduced. Exponential attractors are compact, finite dimensional subsets that contain the global attractor and attract all bounded subsets at an exponential rate.

In the autonomous setting exponential attractors have been studied for several decades. More recently, the theory has been extended to non-autonomous and random problems. We present general existence results for random exponential attractors in Banach spaces and derive explicit estimates on their fractal dimension. As an application a stochastic semilinear damped wave equation is considered.

Ordinary-Functional Differential Equations

Organizer: Jaqueline G. Mesquita

The Radon Transform for time scale calculus in the plane

Berenice Camargo Damasceno, Luciano Barbanti
Universidade Estadual Paulista

Through the gradient and integral concepts for time scale calculus in the plane, we present the Radon integral transform and its applications.

Rigorous construction of manifolds solutions of 3-dimensional ODEs

Camila Leão Cardozo, Marcio Fuzeto Gameiro
Universidade de São Paulo

Our goal is introduce a rigorously compute implicitly defined manifolds of solutions of n-dimensional nonlinear equations. Using a multi-parameter continuation method on a finite dimensional projection, a triangulation of the manifold is computed and is then used to construct local charts of the global manifold in the n-dimensional domain of the operator. We apply the method to compute portions of a three-dimensional manifold of equilibria of a ODE.

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[2] M. L. Brodzik; The computation of simplicial approximations of implicitly defined p-dimensional manifolds, Comput. Math. Appl., 36(6), 1998, 93-113.

Almost automorphic solutions of Volterra equations on time scales

Eduard Toon, Carlos Lizama, Jaqueline G. Mesquita, Rodrigo Ponce
Universidade Federal de Juiz de Fora

The existence and uniqueness of almost automorphic solutions for linear and semilinear non-convolution Volterra equations on time scales is studied. The existence of asymptotically almost automorphic solutions is proved. Examples that illustrate our results are given.

Controllability and observability in the modelling autonomous oscillations in the human pupil light reflex using non-linear delay-differential equations

Fernanda Andrade da Silva, Márcia Cristina Anderson Braz Federson
Universidade de São Paulo

A differential system is said to be controllable if it is possible to do what we want with any transition state in a finite time and it is observable whether the values of the state variables can be deduced through the state of output variables. Consider the differential system

$$\frac{dx}{dt} = A(t)x(t) + B(t)u(t), \qquad y(t) = C(t)x(t) + D(t)u(t), \tag{11}$$

where $A : X \to X$, $B : U \to X$, $C : X \to Y$, e $D : U \to Y$ are continuous functions and X, U, e Y are vector spaces of dimensions n, m, l respectively. From a consequence of the Kalman decomposition theorem, we know that a differential system (11) is controllable and observable if and only if, the transfer function associated with this system does not contain poles. The objective of this work is to study if the non-linear differential system with delay given by the modelling of the light reflex in the human pupil is controllable or observable using the above result.

The infinitely many zeros of stochastic coupled oscillators driven by random forces

Hugo de la Cruz, J.C. Jimenez, R. Biscay
FGV - Escola de Matemática Aplicada

In this work, previous results concerning the infinitely many zeros of single stochastic oscillators driven by random forces are extended to the general class of coupled stochastic oscillators. We focus on three main subjects: 1) the analysis of this oscillatory behavior for the case of coupled harmonic oscillators; 2) the identification of some classes of coupled nonlinear oscillators showing this oscillatory dynamics and 3) the capability of some numerical integrators - thought as discrete dynamical systems - for reproducing the infinitely many zeros of coupled harmonic oscillators driven by random forces.

Transmutation operators for the Schrödinger operator

Hugo M. Campos
Yachay Tech University, Ecuador

In linear algebra, square matrices A and B are called similar if there exists an invertible matrix T such that $A = TBT^{-1}$, or equivalently $AT = TB$. As it is well known, similar matrices share many properties, for example, both have the same eigenvalues. Another interesting property is that T maps the eigenvectors of B onto the eigenvectors of A.

In this talk we are going to consider the analogue of this relation for the pair of differential operators

$$A = -\frac{d^2}{dx^2} + q(x) \quad \text{and} \quad B = -\frac{d^2}{dx^2},$$

where q is an integrable function. In this case, the operator T satisfying

$$\left[-\frac{d^2}{dx^2} + q(x)\right] Tu = T\left[-\frac{d^2}{dx^2}u\right]$$

is called transmutation operator. We will present results about the existence and construction of the transmutation operators [1], [3], [4] and also we will provide applications of the transmutation operators in the solution of boundary and eigenvalue problems for the two-dimensional stationary Schrödinger operator [2], [3].

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[4] V. A. Marchenko, Sturm-Liouville operators and applications. Basel: Birkhäuser, 1986.

Self-accessible states for linear systems on time scales

Jaqueline G. Mesquita, Hernan Henriquez
Universidade de Brasília

This paper is a joint work with Hernan Henriquez. In this work, we study the linear control systems on time scales. We prove results concerning self-accessible states of control systems on time scales and present some examples.

A necessary and sufficient condition for well-posedness of initial value problems of retarded functional differential equations

Junya Nishiguchi
Kyoto University

We introduce the retarded functional differential equations (RFDEs) with general delay structure to treat various delay differential equations (DDEs) in a unified way and to clarify the delay structure in those dynamics. We are interested in the question as to which space of histories is suitable for the dynamics of each DDE, and investigate the well-posedness of the initial value problems (IVPs) of the RFDEs. A main theorem is that the IVP is well-posed for any "admissible" history functional if and only if the semigroup determined by the trivial RFDE $\dot{x} = 0$ is continuous. We clarify the meaning of the Hale–Kato axiom (Hale & Kato (1978)) by applying this result to RFDEs with infinite delay. We also apply the result to DDEs with unbounded time- and state-dependent delays.

Time scale differential fractional equation

Luciano Barbanti, Berenice Camargo Damasceno
Universidade Estadual Paulista

This paper deals with a fractional calculus definition present in the literature, for which we introduce the usual calculus on time scales. Properties concerning this type of calculus will be presented, as well as examples of time scale differential fractional equations and solutions.

Non-oscillation criterion for impulsive differential equations with delay

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

Consider the impulsive measure differential equation with delay

$$\begin{cases} Dy = p(t)y(t-\tau)Dg \\ y(t_k^+) - y(t_k) = b_k y(t_k), \quad k \in \mathbb{N}, \end{cases} \tag{12}$$

in which $g : [t_0, \infty) \to \mathbb{R}$ is a regulated left-continuous function, under the following hypotheses :

(i) $0 \leq t_0 < t_1 < \ldots < t_k < \ldots$ are fixed points with $\lim_{k\to\infty} t_k = \infty$.

(ii) $p : [t_0, \infty) \to \mathbb{R}$ is a Perron integrable function with respect to g and $\tau > 0$ is constant.

(iii) $b_k \in (-\infty, -1) \cup (-1, \infty)$ are constants for $k \in \mathbb{N}$.

The objective of this work is to present a new criterion for the existence of a non-oscillatory solution of equations (12).

Applications of the generalized Feynman integral

Márcia Federson
Universidade de São Paulo

The objective of this talk is to explore some applications of the generalized Feynman integral.

On Riesz representation theorem for regulated functions on time scales

Patricia H. Tacuri, Jaqueline Mesquita, Rodolfo Collegari, Marcia Federson
Universidade Estadual Paulista

In this work we present a new version of the representation theorem for linear bounded operator on the Banach space of regulated function on time scales $G^+([a,b]_{\mathbb{T}})$. We use generalizations of bounded semivarition functions and the Δ-Kurzweil-Cauchy integral.

On general properties of N-th order retarded functional differential equations

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

Consider the second order RFDE (retarded functional differential equation)

$$x''(t) = f(t, x_t),$$

where f is a continuous real-valued function defined on the Banach space $\mathbb{R}\times C^1([-r,0],\mathbb{R})$. The weak assumption of continuity on f, due to the strong topology of $C^1([-r,0],\mathbb{R})$, makes not convenient to transform this equation into a first order RFDE of the type $z'(t) = g(t, z_t)$. In fact, in this case, the

associated $\mathbb{R}^2$-valued function g could be discontinuous with the C^0-topology and, in addition, not necessarily defined on the whole space $\mathbb{R} \times C([-r, 0], \mathbb{R}^2)$. Consequently, in spite of what happens for ODEs, the classical results regarding existence, uniqueness, and continuous dependence on data for first order RFDEs could not apply. Motivated by this obstruction, we provide results regarding general properties, such as existence, uniqueness, continuous dependence on data and continuation of solutions of RFDEs of the type $x^{(n)}(t) = f(t, x_t)$, where f is an $\mathbb{R}^k$-valued continuous function on the Banach space $\mathbb{R} \times C^{n-1}([-r, 0], \mathbb{R}^k)$. Actually, for the sake of generality, our investigation will be carried out in the case of infinite delay. This is a joint work with A. Calamai, M. Furi, M. P. Pera.

Non-autonomous lattice systems with switching effects and delayed recovery

Xiaoying Han, Peter Kloeden
Auburn University

The long term behavior of a type of non-autonomous lattice dynamical systems is investigated, where these have a diffusive nearest neighborhood interaction and discontinuous reaction terms with recoverable delays. This problem is of both biological and mathematical interests, due to its application in systems of excitable cells as well as general biological systems involving delayed recovery. The problem is formulated as an evolution inclusion with delays and the existence of weak and strong solutions is established. It is then shown that the solutions generate a set-valued non-autonomous dynamical system and that this non-autonomous dynamical system possesses a non-autonomous global pullback attractor.

Poster Session

Organizer: Rodolfo Collegari

Optimal control of spherical tumors with necrotic core: the elliptic case

Adeval Lino Ferreira, Enrique Fernández-Cara
Universidade Estadual de Londrina

In this work we study some systems of partial differential equations that describe the growth of a spherical tumour under the influence of a therapeutic treatment. A variety of PDE models for tumor growth have been developed in the last three decades; see for instant [1], [5]. First, we present some existence, regularity and asymptotic stability results. Then, we analyse some related optimal control problem, as make in [2], [4]. After, we study is primarily based on achieving an optimal control, where we choose an appropriate cost functional. We prove existence results, deduce the associated optimality systems and we present iterative algorithms for the computation of the solution. We focus on the evolution of a MCS (Multicellular Spheroids System) growing in response to a single, externally-supplied nutrient, such as oxygen or glucose, and a growth inhibitor. Below we present our model studied,

$$\epsilon\frac{\partial\sigma}{\partial t} - \nabla^2\sigma + f_1(\sigma) = 0 \tag{13}$$

$$\epsilon\frac{\partial v}{\partial t} - \nabla^2 v + f_2(v) = w \tag{14}$$

$$w_t + cw = u \tag{15}$$

where $\sigma = \sigma(x,t)$, $v = v(x,t)$, $w = w(t)$ and $u = u(t)$ are, respectively, the nutrient concentration, the density of antibodies, the amount of processed drug and the control. Here ϵ is a small positive coefficient given by the quotient

$$\epsilon = \frac{T_{\text{diffusion}}}{T_{\text{growth}}}, \tag{16}$$

where $T_{\text{diffusion}}$ is the diffusion time scale and T_{growth} is the tumor-doubling time scale. Typically, ϵ is 1 minute over 1 day, so that $\epsilon \ll 1$. Since ϵ is small, we take it equal to zero and then, we obtain the ***elliptic case***.

Model I, nonecrotic core with $\varepsilon = 0$

Considering a spherical shape $\Omega(t) = \{x;\ |x| < R(t)\}$ at each time t, the boundary Γ_t of the tumor is given by $r = R(t)$, where R is the radius of the tumor. In this case we study the optimal control problem for the following free boundary problem

$$\begin{cases} \dot{R} = H(t,R;u), \quad t \in (0,T) \\ R(0) = R_0, \end{cases} \tag{17}$$

for an appropriate H given by

$$H(t,R;u) = \frac{1}{R^2(t)}\int_0^{R(t)} G(\sigma,v)r^2 dr \tag{18}$$

where $G(\sigma, v) = \mu(\sigma - \sigma^*) - k(v - v^*)_+$.

Model II, with necrotic core and $\varepsilon = 0$

Now we have two free boundaries, given by the unknown functions $\rho = \rho(t)$ and $R = R(t)$. Let us introduce the sets $\Omega_N(t) = \{x : \ r < \rho(t)\}$ (the necrotic core) and $\Omega_P(t) = \{x : \ \rho(t) < r < R(t)\}$ (the proliferating region) , where $|x| = r$. We solve the same problem (17) where, here, H given by

$$H(t, R; u) = \frac{A\rho^3(t)}{3R^2(t)} + \frac{\mu}{R^2(t)} \int_{\rho(t)}^{R(t)} (\sigma - \sigma^*) r^2 dr - \frac{k}{R^2(t)} \int_{\rho(t)}^{R(t)} (v - v^*)_+ r^2 dr. \qquad (19)$$

Some numerical simulations

We make some numerical simulations with the considered systems. In a first moment, let's consider the system without control and then we will see what happens when we introduced a control.

[1] Araujo, R. P.; Mcelwain, D. L. S.; A History of the Study of Solid Tumour Growth: The Contribution of Mathematical Modelling, Bulletin of Mathematical Biology (2004) 66, pp. 1039–1091.

[2] Camacho, G.; Fernández-Cara, E.; Optimal control of some simplified models of tumor growth, International Journal of Control, vol.84, No.3, (2011), pp. 540–550.

[3] Fernández-Cara, E., Ferreira, A. L.; Optimal control of spherical tumors with necrotic core: the elliptic case, 2016, (preprint).

[4] Fernández-Cara, E.; Prouveé, L.; Optimal control of mathematical models for the radiotherapy of gliomas: the scalar case, (2014), pp. 1–19.

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Optimal rates for curvature flows on the circle

Andrés Felipe Galindo Olarte, Jean Carlos Cortissoz Iriarte
Universidad de los Andes

Our aim is to present an stability result for the convergence of the solutions of the normalized p-*curve shortening flow* (p-CSF), this is an example Cauchy problem for a quasilinear parabolic equation which is equivalent to study the problem of the evolution of a family of smooth immersed curves in $\mathbb{R}^2$. We make an smallness assumption on the initial condition allowing us to control the Fourier coefficients of the solutions thus enabling us to overcome the complications presented by the presence of a negative eigenvalue in the linearization of the equation around the stable solution $\omega \equiv 1$. The normalized solution to the p-CSF converges at a rate of $e^{-(3p-1)}$ towards 1; what is really interesting is that $3p - 1$ is the second eigenvalue of the linearization of the original problem. In fact this is the optimal rate.

Elliptic equations in thin domains with reaction terms concentrated on the oscillatory boundary

Ariadne Nogueira, Marcone C. Pereira, José M. Arrieta
Universidade de São Paulo

In this work we analyze the behavior of the solutions of elliptic problems with Neumann boundary conditions defined in a thin domain of the type $R_\varepsilon = \{(x_1, x_2);\ 0 < x_1 < 1,\ 0 < x_2 < \varepsilon g(x_1/\varepsilon)\}$, where g positive, smooth, bounded, L_g-periodic and with bounded derivatives, when we have a reaction concentrated in a neighborhood of the oscillatory boundary $o_\varepsilon = \{(x_1, x_2);\ 0 < x_1 <$

$1,\ \varepsilon(g(x_1/\varepsilon) - \varepsilon^\gamma h(x_1/\varepsilon)) < x_2 < \varepsilon g(x_1/\varepsilon)\}$, with $\gamma \geq 1$ and h also positive, L_h-periodic and bounded, such that the problem is well posed. Then we prove that this family of solutions converge when ε goes to 0, in certain Sobolev and Lebesgue-Bochner spaces, to the solution of the unidimensional limit case using the oscillating test function method of L. Tartar and the analysis of the concentrated integrals, also studying its dependence with respect to the geometry of the domain.

Hénon elliptic equations in $\boldsymbol{R}^2$ with subcritical and critical exponential growth

Eudes Mendes Barboza, João Marcos Bezerra do Ó
UFPE/UPE

We study the Dirichlet problem in the unit ball B_1 of $\boldsymbol{R}^2$ for the Hénon-type equation of the form

$$\begin{cases} -\Delta u &= \lambda u + |x|^\alpha f(u) \quad \text{in} \quad B_1, \\ u &= 0 \qquad\qquad\quad\ \ \text{on} \quad \partial B_1, \end{cases} \tag{20}$$

where $f(t)$ is a C^1-function in the critical growth range motivated by the celebrated Trudinger-Moser inequality. Under suitable hypotheses on constant λ and $f(t)$, by variational methods, we study the solvability of this problem in appropriate Sobolev Spaces.

We divide our results in seven theorems, which are considered depending on the growth conditions of the nonlinearity and also on the interval where λ is. In the critical case, since the weight $|x|^\alpha$ has an important role on the estimate of the minimax levels, the variational setting and methods used in $H_0^1(B_1)$ and $H_{0,\text{rad}}^1(B_1)$ are different and, therefore, are given in separate theorems. Another aspect, which we should consider in this case, is an asymptotic hypothesis on $f(t)t/e^{\beta_0 t^2}$ at infinity. We can suppose a certain kind of asymptotic behavior of $f(t)t/e^{\beta_0 t^2}$ at infinity, if $\lambda < \lambda_1$ and $\alpha \geq 0$, in order to find a solution in $H_0^1(B_1)$ or in $H_{0,\text{rad}}^1(B_1)$. If $\lambda > \lambda_1$ and $\alpha > 0$, an analogous hypothesis can be assumed, ensuring, thus, the existence of a solution in $H_0^1(B_1)$. However, if we search a solution for (20) in $H_{0,\text{rad}}^1(B_1)$ or in $H_0^1(B_1)$, when we are supposing $\lambda > \lambda_1$ and $\alpha \geq 0$, we demand a stronger hypothesis on the behavior of $f(t)t/e^{\beta_0 t^2}$. Then, we have the following results.

Theorem 0.0.2. *(The subcritical case, local minimum at 0). Assume $(H_1) - (H_3)$ and that $f(t)$ has subcritical growth (SG) at both $+\infty$ and $-\infty$. Furthermore, suppose that $0 < \lambda < \lambda_1$ and*

(H_4) $\limsup_{t\to 0} \dfrac{2F(t)}{t^2} \leq \lambda_1 - \lambda.$

Then, problem (20) *has a nontrivial (radially symmetric) solution. Moreover, if $f(t)$ is an odd function, then problem* (20) *has infinitely many solutions.*

Theorem 0.0.3. *(The subcritical case, saddle point at 0). Assume $(H_1) - (H_3)$ and that $f(t)$ has subcritical growth (SG) at both $+\infty$ and $-\infty$. Furthermore, suppose that $\lambda_k < \lambda < \lambda_{k+1}$ and*

(H_5) *There exist $\delta > 0$ and $0 < \mu < \lambda_{k+1} - \lambda$, such that*

$$F(t) \leq \frac{\mu}{2} t^2, \quad \textit{for all} \quad |t| \leq \delta.$$

Then, problem (20) *has a nontrivial (radially symmetric) solution. Moreover, if we assume that $f(t)$ is an odd function, then* (20) *has infinitely many solutions.*

For the next two theorems, we will use the following notations: for $0 \leq \varepsilon < 1$ let us consider

$$M_\epsilon = \lim_{n\to\infty} \int_0^1 n e^{n((1-\varepsilon)t^2 - t)}\, dt \quad \text{and} \quad \widehat{M} = \lim_{\varepsilon \to 0} M_\varepsilon.$$

We use the notation M_0 for M_ϵ with $\varepsilon = 0$, and using calculus, one can see that $M_0 = 2$ and $\widehat{M} = 1$. We also consider constants $0 < r, d < 1$ such that there exists a ball $B_r \subset B_1$ so that $|x| > d$ for all $x \in B_r$.

Theorem 0.0.4. *(The critical case, local minimum at 0). Assume $(H_1) - (H_4)$ and that $f(t)$ has critical growth (CG) at both $+\infty$ and $-\infty$. Furthermore, suppose that $0 < \lambda < \lambda_1$ and*

$$(H_6) \quad \lim_{t\to+\infty} \frac{f(t)t}{e^{\beta_0 t^2}} \geq \xi, \quad \xi > \frac{4}{\beta_0 M_0 d^\alpha r^2} \text{ with } d > 0.$$

Then, problem (20) *has a nontrivial solution.*

Theorem 0.0.5. *(The critical case, saddle point at 0 with $\alpha > 0$). Assume $(H_1) - (H_3)$, (H_5) and that $f(t)$ has critical growth (CG) at both $+\infty$ and $-\infty$. Furthermore, suppose that $\lambda_k < \lambda < \lambda_{k+1}$, $\alpha > 0$ and*

$$(H_7) \ \lim_{t\to+\infty} \frac{f(t)t}{e^{\beta_0 t^2}} \geq \xi, \text{ with } \xi > \frac{4}{\beta_0 r^{2+\alpha}} \left[\left(\frac{d}{r}\right)^\alpha - \frac{2}{2+\alpha} \right]^{-1},$$

where $0 < r \leq d < 1$ are such that

$$\left(\frac{d}{r}\right)^\alpha > \frac{2}{2+\alpha}.$$

Then problem (20) *has a nontrivial solution.*

Theorem 0.0.6. *(The critical case, saddle point at 0 with $\alpha \geq 0$). Assume $(H_1) - (H_3)$, (H_5) and that $f(t)$ has critical growth (CG) at both $+\infty$ and $-\infty$. Furthermore, suppose that $\lambda_k < \lambda < \lambda_{k+1}$ and $\alpha \geq 0$ and for all $\gamma \geq 0$ there exists $c_\gamma \geq 0$ such that*

(H_8) $\dfrac{f(t)t}{e^{\beta_0 t^2}} \geq \gamma h(t)$ *for all $t > c_\gamma$, where $h : \boldsymbol{R} \to \boldsymbol{R}^+$ is a Carathéodory function satisfying* $\liminf_{t\to+\infty} \dfrac{\log(h(t))}{t} > 0.$

Then problem (20) *has a nontrivial solution.*

Theorem 0.0.7. *(The radial critical case, local minimum at 0). Assume $(H_1) - (H_4)$ and that $f(t)$ has critical growth (CG) at both $+\infty$ and $-\infty$. Furthermore, suppose that $0 < \lambda < \lambda_1$ and*

$$(H_{6,\mathrm{rad}}) \quad \lim_{t\to+\infty} \frac{f(t)t}{e^{\beta_0 t^2}} \geq \xi, \quad \xi > \frac{8}{(2+\alpha)\beta_0 e}.$$

Then, problem (20) *has a nontrivial radially symmetric solution.*

Theorem 0.0.8. *(The radial critical case, saddle point at 0). Assume $(H_1) - (H_3)$, (H_5) and that $f(t)$ has critical growth (CG) at both $+\infty$ and $-\infty$. Furthermore, suppose that $\lambda_k < \lambda < \lambda_{k+1}$ and for all $\gamma \geq 0$ there exists $c_\gamma \geq 0$ such that (H_8) holds for all $t > c_\gamma$, then problem* (20) *has a nontrivial radially symmetric solution.*

Stability of sets on impulsive systems

Ginnara Mexia Souto, Everaldo de Mello Bonotto
Universidade de São Paulo

The present work deals with stability and attraction of sets on impulsive dynamical systems. There exists an important class set features attraction and stability but this set is not compact neither closed. We establish necessary and sufficient conditions to obtain uniform and orbital stability for this class of sets. The results are achieved by means of Lyapunov functions.

Approximating traveling waves from the FitzHugh-Nagumo system by equilibria of non local equations

Glauce Barbosa Verão, Luiz A. F. de Oliveira, Cosme E. R. Mercedes
Universidade de São Paulo

The FitzHugh-Nagumo systems have a special kind of solution named traveling wave which has a form $u(x,t) = \phi(x+ct)$ and $w(x,t) = \psi(x+ct)$ and furthermore it is a stable solution. It is our interest to obtain a characterization of its profile (ϕ, ψ) and speed of propagation c. Changing variables, we transform the problem of finding those solutions in the problem of finding an equilibria in a nonlocal equation. We show that the solutions of this non local equation exponentially converge to a traveling wave of the original problem and the non local term exponentially converge to the speed of propagation. Such results are illustrated through an example using Matlab.

Optimality conditions for scalar linear differential equations with multiple delays

Demchenko Hanna, Diblík Josef
Brno University of Technology

In the contribution, for linear differential equations with delays

$$x'(t) = ax(t) + \sum_{i=1}^{n} b_i x(t-\tau_i) + cu(t), \;\; t \geq t_0$$

where $a, c \in \mathbb{R}$, $b_j \in \mathbb{R}$, $j = 1, \ldots, n$, $0 < \tau_1 < \cdots < \tau_n$, $x\colon [t_0 - \tau, \infty) \to \mathbb{R}$, $\tau := \tau_n$ and $u\colon [t_0, \infty)$ is a control function, a problem of minimizing a functional

$$\min_u \int_{t_0}^{\infty} \left[\alpha_0 x^2(t) + \sum_{i=1}^{n} \alpha_i x^2(t-\tau_i) + 2x(t) \sum_{i=1}^{n} \beta_i x(t-\tau_i) + \gamma u^2(t) \right] \mathrm{d}t$$

where α_j, $j = 0, \ldots, n$, β_j, $j = 1, \ldots, n$ and γ are suitable constants, is considered. To solve the problem, Malkin's approach and Lyapunov's second method are utilized.

Multiple solutions for an inclusion quasilinear problem with non-homogeneous boundary condition through Orlicz Sobolev spaces

Jefferson A. Santos, Rodrigo C. M. Nemer
Universidade Federal de Campina Grande

In this work we study multiplicity of nontrivial solution for the following class of differential inclusion problems with non-homogeneous Neumann condition through Orlicz-Sobolev spaces,

$$\begin{cases} -div\big(\phi(|\nabla u|)\nabla u\big) + \phi(|u|)u \in \lambda\partial F(u) \text{ in } \Omega, \\ \frac{\partial u}{\partial \nu} \in \mu\partial G(u) \text{ on } \partial\Omega, \end{cases}$$

where $\Omega \subset \mathbb{R}^N$ is a domain, $N \geq 2$ and $\partial F(u)$ is the generalized gradient of $F(u)$. The main tools used are Variational Methods for Locally Lipschitz Functional and Critical Point Theory.

Topological structural stability and $\mathcal{P}-$continuity of global attractors

Rodiak Nicolai Figueroa Lopéz, German Jesus Lozada Cruz, Éder Ritis Aragão Costa, José Antonio Langa Rosado
Universidade Estadual Paulista

In this work we study topological structural stability for a family of nonlinear semigroups $T_h(\cdot)$ on Banach space X_h depending on the parameter h. For this we use the concept of $\mathcal{P}-$convergence given in [4]. Our results shows the robustness of the internal dynamics and characterization of global attractor $\mathcal{A}_h$ on a projected Banach space X_h, generalizing previous results for small perturbations of partial differential equations. We apply the results to an abstract semilinear equation with Dumbbell type domains.

We would like to thank FAPESP (Process: 2013/21155-2) by supported this project.

[1] Aragão-Costa, E.R.; Figueroa-López, R.N.; Langa, J.A.; Lozada-Cruz, G., Topological structural stability of partial differential equations on projected spaces, Journal of Dynamics and Differential Equations, accepted - 2016.

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[3] Arrieta, J. M.; Carvalho, A. N.; Lozada-Cruz, G. J., Dynamics in dumbbell domains II: the limiting problem. *Journal of Differential Equations*, New York, v. 247, n. 1, (2009), p. 174–202.

[4] Vainikko G., Funktionalanalysis der Diskretisierungsmethoden, Teubner-Texte zur Mathematik, Verlagsgesellschaft, Leipzig, 1976.

Combining linear and fast diffusion in a nonlinear elliptic equation

Willian Cintra, Cristian Morales-Rodrigues, Antonio Suárez
Universidade Federal do Pará

In this work we analyse an elliptic equation that combines linear and nonlinear fast diffusion with a logistic type reaction function. We prove existence and non-existence results of positive solutions using bifurcation theory and sub-supersolution method. Moreover, we apply variational methods to obtain a pair of ordered positive solutions.

Hamiltonian elliptic systems in dimension two with potentials which can vanish at infinity

Yony Raúl S. Leuyacc, Sergio H. Monari Soares
Universidade de São Paulo

In this work, we focus on the existence of nontrivial solutions to the following Hamiltonian elliptic system

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

where V is a positive function which can vanish at infinity and be unbounded from above and f and g have exponential growth range. The proof involves a truncation argument combined with the linking theorem and a finite-dimensional approximation.

ICMC SUMMER MEETING on DIFFERENTIAL EQUATIONS

2017 Chapter

Programme

Sunday 05 from 18:00 to 19:00, Registration at Anacã Hotel

Auditorium	MONDAY 6	TUESDAY 7	WEDNESDAY 8
08:00 – 08:50	**Registration**		
08:50 – 09:00	**Opening**		

Auditorium	Plenary Talks		
Chairman	*Hildebrando M. Rodrigues*	*Shui-Nee Chow*	*John Mallet-Paret*
09:00 - 09:40	Shui-Nee Chow	John Mallet-Paret	Djairo G. de Figueiredo
09:40 - 10:20	Hans-Otto Walther	Michel M. Chipot	Jerome A. Goldstein
10:20 - 10:50	Coffee Break	Coffee Break & Poster Session	Coffee Break
Chairman	*Yingfei Yi*	*Hans-Otto Walther*	*Tomás Caraballo*
10:50 - 11:30	José M. Arrieta	Tomás Caraballo	Martin Bohner
11:30 - 12:10	Claudianor O. Alves	Yingfei Yi	Marcelo M. Cavalcanti
12:10 - 12:50	Marian Mrozek	Michael Li	Sergey Shmarev
12:50 - 14:30		Lunch	

Auditorium	Special Session on Nonlinear Dynamical Systems		
Chairman	*Juliana F. S. Pimentel*	*Ma To Fu*	*Sergio Muniz Oliva Filho*
14:30 - 15:00	Alexandre N. Carvalho	Huaiping Zhu	Hugo Leiva
15:00 - 15:30	Stefanie Sonner	Igor Leite Freire	Phillipo Lappicy
15:30 - 16:00	Antonio Acosta	Jayme Vicente De Luca	Mikhail P. Vishnevski
16:00 – 16:30	Coffee Break	Coffee Break & Poster Session	Coffee Break
16:30 – 17:00	Camille Poignard	Sergio Muniz Oliva Filho	Ma To Fu
17:00 – 17:30	Ricardo M. Martins	Nikita Begun	Alvaro Arturo Sanjuan
17:30 – 18:00	Jacson Simsen	Priscila Leal da Silva	Marcone Correa Pereira

Room 5-001	Special Session on Elliptic Equations		
Chairman	*Claudianor O. Alves*	*Olímpio H. Miyagaki*	*Giovany M. Figueiredo*
14:30 - 15:00	Olímpio H. Miyagaki	Liliane A. Maia	canceled
15:00 - 15:30	Marcos T. O. Pimenta	Edgard A. Pimentel	Cristian Morales-Rodrigues
15:30 - 16:00	Leandro da Silva Tavares	Marcelo C. Ferreira	Flávio Almeida Lemos
16:00 - 16:30	Coffee Break	Coffee Break & Poster Session	Coffee Break
16:30 - 17:00	Francisco Odair de Paiva	Giovany M. Figueiredo	
17:00 - 17:30	Gustavo Madeira	Augusto César dos Reis Costa	

Room 5-002	Special Session on Linear Partial Differential Equations	
Chairman	*Rafael Fernando Barostichi*	*Marcello D'Abbicco*
14:30 - 15:00	Tiago Henrique Picon	Gabriel C. C. Soares de Araújo
15:00 - 15:30	Benito Frazão Pires	Renato Andrielli Laguna
15:30 - 16:00	Marcello D'Abbicco	Marcelo Rempel Ebert
16:00 - 16:30	Coffee Break	Coffee Break & Poster Session
16:30 - 17:00	Paulo Antônio Liboni Filho	

Room 5-003	Special Session on Ordinary and Functional Differential Equations		
Chairman	*Martin Bohner*	*Jaqueline G. Mesquita*	*Pierluigi Benevieri*
14:30 - 15:00	Eduard Toon	Pierluigi Benevieri	Márcia Federson
15:00 - 15:30	Jaqueline G. Mesquita	Junya Nishiguchi	Marielle Aparecida Silva
15:30 - 16:00	canceled	Fernanda A. da Silva	Hugo Miguel Campos
16:00 - 16:30	Coffee Break	Coffee Break & Poster Session	Coffee Break
16:30 - 17:00	canceled	Xiaoying Han	Camila Leão Cardozo
17:00 - 17:30	Patrícia Hilário Tacuri	Hugo de La Cruz	

Room 5-004	Special Session on Dispersive Equations		
Chairman	*Mahendra Panthee*	*Marcia A. G. Scialom*	*Ademir Pastor*
14:30 - 15:00	Xavier Carvajal	Ademir Pastor	Fábio Natali
15:00 - 15:30	Nataliia Goloshchapova	Adán J. Corcho Fernández	Isnaldo Isaac Barbosa
15:30 - 16:00	Wanderley N. do Nascimento	Ricardo Ariel Pastrán	Raphael Antunes Santos
16:00 - 16:30	Coffee Break	Coffee Break & Poster Session	
16:30 - 17:00	Juan Carlos Cordero	Mahendra Panthee	Roberto Capistrano Filho
17:00 - 17:30	Lucas C. F. Ferreira		Marcia A. G. Scialom

Room 5-101	Special Session on Fluid Dynamics	
Chairman	*Gabriela Planas*	*Clodoaldo Grotta Ragazzo*
14:30 - 15:00	Clodoaldo Grotta Ragazzo	Diego A. Souza
15:00 - 15:30	Silvia Sastre-Gomez	Leonardo Kosloff
15:30 - 16:00	César J. Niche	Gabriela Planas
16:00 - 16:30	Coffee Break	Coffee Break & Poster Session
16:30 - 17:00	Luís Henrique de Miranda	

Room 5-103	Session on Conservation Laws and Transport Equations
Chairman	*Wladimir Neves*
14:30 - 15:00	Gerardo J. Huaroto Cardenas
15:00 - 15:30	Marcelo Martins dos Santos
15:30 - 16:00	Tiago dos Santos Domingues
16:00 - 16:30	Coffee Break & Poster Session
Chairman	*Marcelo Martins dos Santos*
16:30 - 17:00	Wladimir Neves

Coffee Area	Poster Session
10:20-10:50	Adeval Lino Ferreira
	Andrés Felipe Galindo Olarte
	Ginnara Mexia Souto
	Glauce Barbosa Verão
	Hanna Demchenko
	Rodiak N. Figueroa López

Coffee Area	Poster Session
16:00 - 16:30	Ariadne Nogueira
	Eudes Mendes Barboza
	Jefferson Abrantes Santos
	Willian Cintra da Silva
	Yony Raúl Santaria Leuyacc

	Social Events
18:00	**Cocktail** (Coffee Area)
12:50	**Photo** (ICMC)
20:00	**Conference Banquet** (Café Sete)

ICMC SUMMER MEETING on DIFFERENTIAL EQUATIONS

2017 Chapter

List of Speakers

List of speakers (ordered by first name)

ICMC SUMMER MEETING on DIFFERENTIAL EQUATIONS

2017 Chapter

Sponsors

The ICMC Summer Meeting on Differential Equations - 2017 Chapter is grateful to the following organizations for providing the financial support.

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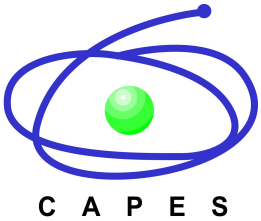

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