ICMC Summer Meeting on Differential Equations 2015 Chapter

February 02-04, 2015

São Carlos SP, Brazil

List of sessions and their organizers:

Conservation laws and transport equations (Wladimir Neves - UFRJ)
Dispersive equations (Márcia Scialom - UNICAMP)
Elliptic equations (Claudianor O. Alves - UFCG)
Fluid dynamics (Gabriela Planas - UNICAMP)
Linear equations (Adalberto P. Bergamasco - USP)
Nonlinear dynamical systems (Sergio M. Oliva Filho- USP)
Ordinary/Functional diff. equations (Bruno de Andrade - UFS, Jaqueline G. Mesquita - USP)
Poster Session (Edgard A. Pimentel- UFC)

Scientific committee:

Alexandre N. de Carvalho (USP/Brazil)
Djairo G. de Figueiredo (UNICAMP/Brazil)
Hildebrando M. Rodrigues (USP/Brazil)
Joan Solà-Morales (UPC/Spain)
José Arrieta (UCM/Spain)
Shui-Nee Chow (GaTech/USA)
Tomás Caraballo (US/Spain)
Yingfei Yi (GaTech/USA and JLU/China)

Organizing committee:

Alexandre N. de Carvalho (USP/Brazil)
Ederson M. dos Santos (USP/Brazil)
Everaldo M. Bonotto (USP/Brazil)
Hildebrando M. Rodrigues (USP/Brazil)
Ma To Fu (USP/Brazil)
Márcia Federson (USP/Brazil)
Marcio Gameiro (USP/Brazil)
Matheus C. Bortolan (UFSC/Brazil)
Rodolfo Collegari (USP/Brazil)
Sérgio H. Monari Soares (USP/Brazil)

FAPESP

CAPES

summer.icmc.usp.br

Welcome

It is a pleasure to welcome you to the *ICMC Summer Meeting on Differential Equations - 2015 Chapter* and to São Carlos. We wish you a pleasant stay and that you enjoy the meeting.

Organizing committee

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Shui-Nee Chow (GaTech/USA)

Tomás Caraballo (US/Spain)

Yingfei Yi (University of Alberta/Canada & Jilin University/China)

Session Organizers

Adalberto P. Bergamasco (USP): Special Session on Linear Equations

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

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

Edgard A. Pimentel (UFC): Posters Sessions

Gabriela Planas (UNICAMP): Special Session on Fluid Dynamics

Márcia A. G. Scialom (UNICAMP): Special Session on Dispersive Equations

Sergio M. Oliva Filho (USP): Special Session on Nonlinear Dynamical Systems

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

Address

ICMC Summer Meeting on Differential Equations - 2015 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

2015 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: _____

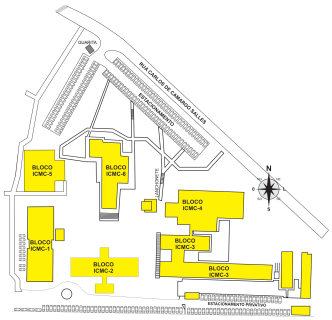
USEFUL NUMBERS

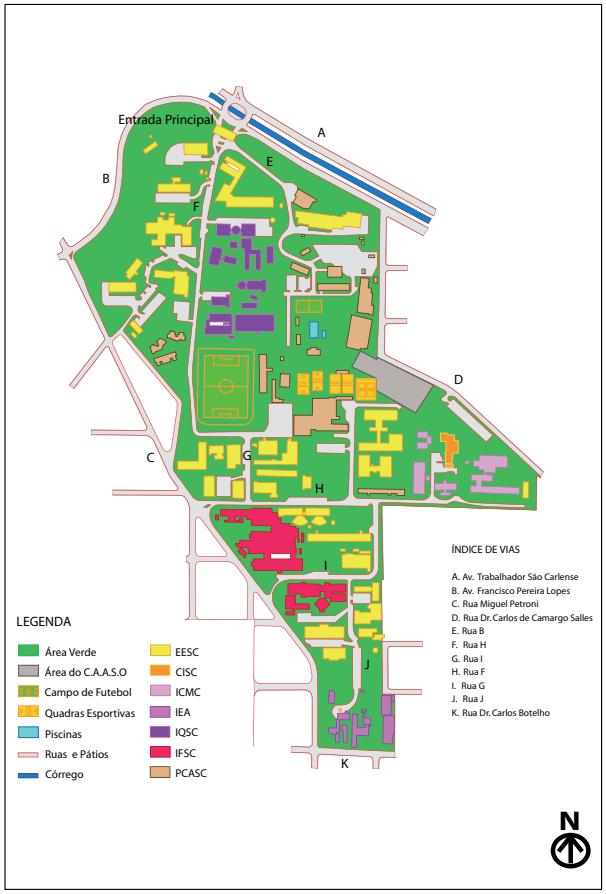
3373-9700	ICMC-USP
3373-9112	Campus Security Staff
190	Police Dept.
192	Medical Emergency
193	Fire Dept. and Rescue
0800-560159	National Courier Service
3371-2171	Local Post Office
3415-6005	Taxi-Cab Co.

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. San Ciro Apart Hotel
R. 28 de setembro, 2.222

H8. Central Park Apart Hotel
Av. Francisco Pereira Lopes, 2.600

H9. Hotel Acaccio
Av. São Carlos, 1.981

H10. Atlantic Inn Royale
R. Conde do Pinhal, 1.630

H11. Hotel Caiçara
R. Conde do Pinhal, 2.217

H12. Ibis Hotel
Av. 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. Piazza Amici Pizza & Cibo
R. 28 de Setembro, 2238 - 3307.7149 - DINNER ONLY

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 - ONLY DINNER

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

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 - ONLY DINNER

R28. Cabanha Steakhouse & Bar
R. Episcopal, 1661 - 3364.3067 - LUNCH/DINNER

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

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

R31. Donna Léo Chopperia & Happy Hour
R. Nove de Julho, 1643 - 3415.4560 - ONLY DINNER

R32. Don Raffaele Pizze & Ristorante
R. Marechal Deodoro, 1758 - 3371.1478 - ONLY DINNER

R33. Subway
Av. São Carlos, 2911 - 3416.4000 - 24 hours

R34. Kalil Cozinha Árabe
R. Dr. Carlos Botelho, 1737 - 3372.1696
ARABIC AND VEGETARIAN FOOD - LUNCH/DINNER

R35. Café Sete - Café Gastrobar
R. Sete de Setembro, 1447 - 3415.1026 - DINNER ONLY

R36. Churrascaria Tabajara
Av. São Carlos, 3677 - 3361.4282 - STEAKHOUSE - LUNCH/DINNER

R37. Churrascaria Trevo
Av. Prof. Luis Augusto de Oliveira, 385
(extension of the Av. São Carlos) - 3361.3052 - STEAKHOUSE - LUNCH/DINNER

R38. Restaurante e Buffet Cantos e Contos
Rua Major José Inácio, 2211 - 3372.6661

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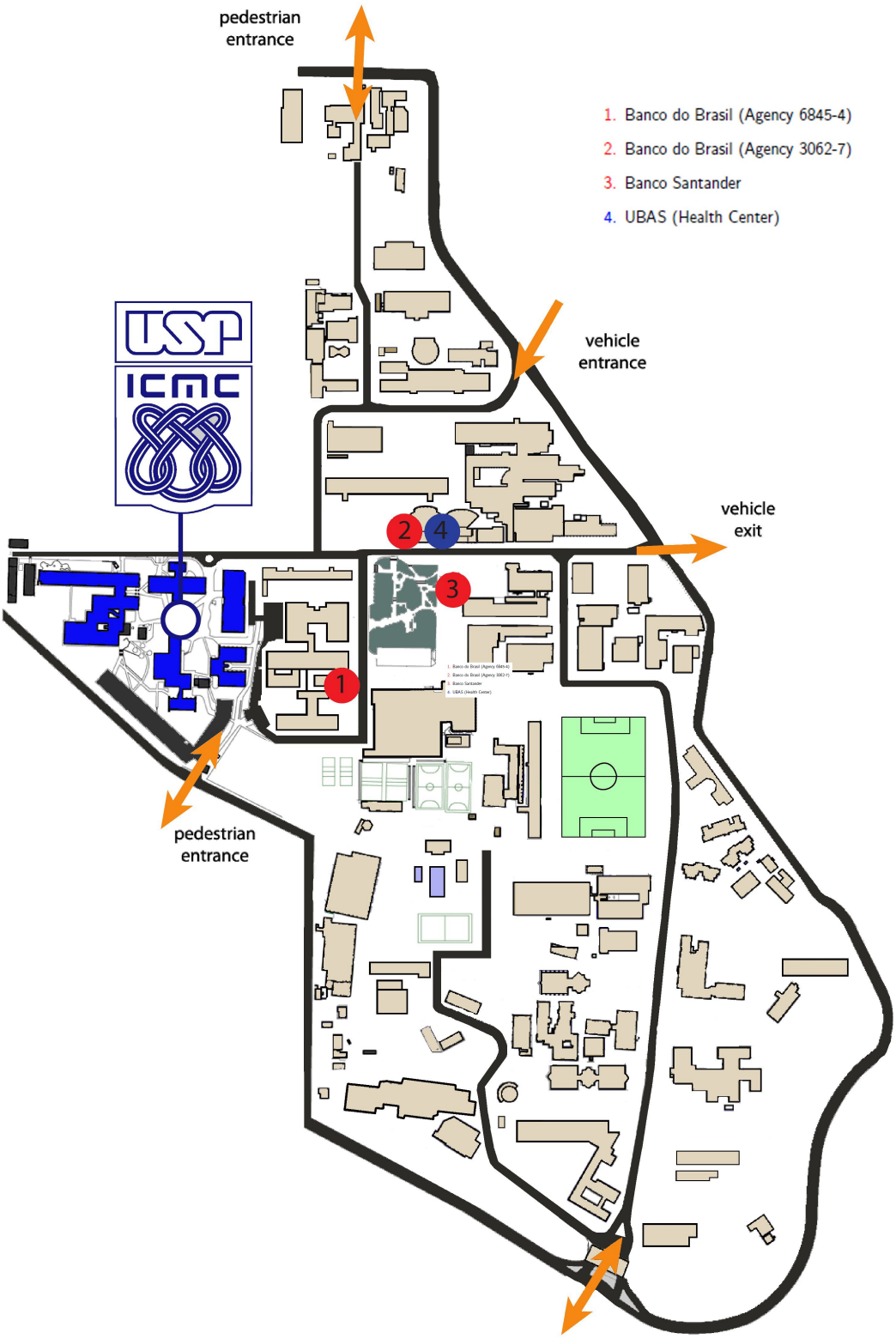
ICMC USP SÃO CARLOS


Rodovia Washington Luiz
UFSCAR
Churrascaria Trevo (R37)
Churrascaria Tabajara (R36)
USP (campus 2)
Café Tropical
Shopping Center
Ibis Hotel (H12)
Av. Comendador
Alfredo Maffei
USP - São Carlos
Campus 1
Al. dos Crisântemos
R. Alvarenga Peixoto
R. W. Curry
Av. Trabalhador Sãocarlense
Al. das Hortências
Al. das Crisandálias
Av. das Azaléias
Av. Prof. Luis A. Oliveira
R. Antonio Blanco
R. Dna. Alexandrina
R. São Joaquim
R. Salomão Dibbo
R. 9 de Julho
R. Achile Bassi
R. Cezar Ricomi
R. Jacinto Favoretto
Rodoviária
(Bus Station)
R. Episcopal
R. Adolfo Cattani
R. Alfredo Lopes
R. Orlando Damiano
R. Tiradentes
R. 28 de Setembro
R. Miguel Petrone
Rua Dr. Carlos de Camargo Salles
Bank of Brazil AG 6845-4
11h00m to 16h00m
MON to FRI
PAPELARIA
CAASO
PRAÇA
BIBLIOTECA
ICMC-USP
(ZOOM UP AT THE BACK OF THIS PAGE)
Bank of Brazil AG 3062-7
11h00m to 16h00m
MON to FRI
R. Conselheiro João Alfredo
R. Dna. Maria Jacinta
R. Dr. Serafim Vieira de Almeida
R. Princesa Isabel
Santa Casa
(Hospital)
R. Maestro João Seppe
R. Paulino Botelho de Abreu Sampaio
R. Paulino Botelho A. Sampaio
R. Cap. Adão Pereira de Souza Cabral
Praça
XV de
Novembro
Av. Dr. Carlos Botelho
Av. São Carlos
R. 15 de Novembro
Fitta Currency Exchange
9h30m to 17h30m
MON to FRI
R. São Sebastião
R. Visconde de Inhaúma
R. Aquidaban
R. José Bonifácio
Escola
Dr. Álvaro
Guião
R. Padre Teixeira
R. Riachuelo
R. Marechal Deodoro
R. 7 de Setembro
Praça
dos
Pombos
R. Major José Inácio
R. Conde do Pinhal
Catedral
Praça
da
Catedral
Av. Comendador Alfredo Maffei
Centro
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


pedestrian entrance
1. Banco do Brasil (Agency 6845-4)
2. Banco do Brasil (Agency 3062-7)
3. Banco Santander
4. UBAS (Health Center)
vehicle entrance
vehicle exit
pedestrian entrance
USP
ICMC
1
2
3
4


pedestrian
entrance
1. Library
2. Coffee Room
3. Events office
4. Financial office
5. Building 5
6. Building 6 (Auditorium)
7. Canteen
WC. Toilets
WC
WC
WC
WC
1
2
3
4
5
6
7

Contents

ICMC Summer Meeting on Differential Equations

2015 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 11.

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

Special session on Conservation Laws and Transport Equations in room 5-101 (Building 5)

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

Special session on Elliptic Equations in room 5-003 (Building 5)

Special session on Fluid Dynamics in room 5-103 (Building 5)

Special session on Linear Equations in room 5-104 (Building 5)

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

Special session on Ordinary and Functional Differential Equations in room 5-001 (Building 5)

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

Registration

The registrations will be made in the following schedule:

Sunday, February 1^{st}: From 18:00hs to 19:00hs in the lobby of Anacã Hotel.

Monday, February 2^{nd}: From 8:00hs to 8:45hs 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 11) 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 3^{rd}, at the Financial Office (4, map of page 11). 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 5. 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 11) where you can have either snacks or lunch.

Social events

Monday, February 2^{nd}: Cocktail at 18:30hs at ICMC.

Tuesday, February 3^{rd}: Photo of the meeting at 12:10hs in Coffee Room (ground floor of the Library).

Tuesday, February 3^{rd}: Conference Banquet at 20:30hs at Café Tropical.

Health emergencies

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

Money exchanges

In case you need to exchange your money, we recommend Fitta Câmbio, located in Rua Episcopal, 1931. The working hours are from 9:00 to 17:30. You can locate it at the map in page 7. Another option, at Shopping Center Iguatemi, is Confidence Câmbio.

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: smode15!
5. You may freely browse the internet after logging in. You may occasionaly need to re-authenticate using the above procedure.

ICMC Summer Meeting on Differential Equations

2015 Chapter

Plenary Talks

Plenary Speaker

Existence of heteroclinic solution for a class of non-autonomous second-order equation.

Claudianor O. Alves
Universidade Federal de Campina Grande

In this talk, we use variational methods to prove the existence of heteroclinic solutions for a class of non-autonomous second-order equation.

On Trudinger-Moser type inequalities

Djairo Guedes de Figueiredo
Universidade Estadual de Campinas

In analogy with the results in dimension N lager than 3, where weights increase the critical Sobolev powers, we discuss the role of weights in imbeddings in dimension 2, increasing the exponents of Trudinger-Moser.

On the geometry of free boundary problems in random environments

Eduardo Teixeira
Universidade Federal do Ceará

I will discuss about geometric aspects of a family free boundary problems modeled within discontinuous media. Classical examples where such an issue appear naturally are in composite materials, theory of homogenization, linearization processes of nonlinear phenomena, etc. Under rough conditions on the media, solutions to elliptic PDEs are merely Holder continuous – this is the contents of DeGiorgi-Nash-Moser and Krylov-Safonov Theorems. Hence, a key issue in the program is to obtain improved geometric estimates along the free boundaries. We will discuss about new methods that allow improved estimates along physical and non-physical free boundaries.

Shilnikov chaos due to state-dependent delay

Hans-Otto Walther, Bernhard Lani-Wayda
Universitaet Giessen

We construct a delay functional d so that the otherwise most simple scalar delay differential equation $x'(t) = -\alpha x(t - d(x_t))$ has chaotic solutions close to a homoclinic loop in its solution manifold $X \subset C^1([-2, 0])$. The scenario is similar to L. P. Shilnikov's configuration of a vectorfield v in dimension 4, $v(0) = 0$, with complex conjugate pairs of eigenvalues of $Dv(0)$ in each open halfplane and a phase curve which is homoclinic to $0 \in \mathbb{R}^4$ and satisfies a transversality condition. Our result involves further regularity properties, for the linearization of the semiflow along the homoclinic loop, which in case of flows of smooth vectorfields come for free. The final embedding of the Bernoulli shift into a return map on a transversal to the homoclinic is based on covering relations and computations of fixed point indices, the method going back to work of P. Zgliczinsky in finite dimensions.

Relative asymptotic equivalence between difference equations

Hugo Leiva, Edgar Medina, Nelson Merentes
Universidad de Los Andes

In this paper we study the relative asymptotic equivalence between the solutions of the following two difference equations in a Banach space Z

$$y(n+1) = A(n)y(n), \quad x(n+1) = A(n)x(n) + f(n, x(n)),$$

where $y(n), x(n) \in Z$, $A \in l^\infty(\mathbb{N}, L(Z))$ and the function $f : \mathbb{N} \times Z \to Z$ is small enough in some sense. The discrete dichotomy definition and a discrete version of Rodrigues Inequality are the main tools reaching our results, which is the following: Given a solution $y(n)$ of the unperturbed system, we provide sufficient conditions to prove that there exist a family of solutions $x(n)$ for the perturbed system such that

$$\|y(n) - x(n)\| = o(\|y(n)\|), \quad \text{as} \quad n \to \infty.$$

Conversely, given a solution $x(n)$ of the perturbed system having Lyapunov number $\alpha \in \mathbb{R}$, we prove that, under certain conditions, there exist a family of solutions $y(n)$ for the unperturbed system, such that

$$\|y(n) - x(n)\| = o(\|x(n)\|), \quad \text{as} \quad n \to \infty.$$

Equipartition of energy for non autonomous wave equations

Jerome A. Goldstein, Gisele Goldstein, Fabiana Travessini de Cezaro
University of Memphis

Consider wave equations of the form

$$u(t) + Bu(t) + Au(t) = 0$$

where A, B are nonnegative commutiong selfadjoint operators on a Hilbert space with A injective. Energy is conserved when $B = 0$; otherwise energy decays. Asymptotic equipartition of energy (in the sense that the ratio of the kinetic to potential energy tends to 1 as $t \to \infty$ for all nonzero finite energy solutions) has been a topic of interest since the 1960s. But no such results had been established for the corresponding nonautonomous equations, problems where A,B depend on t and the equation reduces to the displayed equation above when the t-dependence is not present. We present the first results of this nature. This is joint work with Gisele Goldstein (Memphis) and Fabiana Travessini de Cezaro (Rio Grande).

Analyticity and nonanalyticity in delay-differential equations

John Mallet-Paret
Brown University

We study solutions of a class of analytic delay-differential equations, obtaining sufficient conditions both for analyticity and for non-analyticity (but C^∞ smoothness) of solutions. In fact such conditions may occur for the same solution, but in different regions of its domain, thereby exhibiting co-existence of analyticity and non-analyticity; and in one case, the set of non-analytic points is a generalized Cantor set. As a special case, a class of integral equations is considered, and the analysis leads naturally to questions about the spectral radius of positive operators and related Krein-Rutman issues.

This is joint work with Roger Nussbaum.

An estimate on the distance of attractors in thin domains

José M. Arrieta

Universidad Complutense de Madrid

In the spirit of the seminal paper by J. Hale and G. Raugel, J. Math. Pures Appl. (1992), we consider a nonlinear reaction-diffusion equation in a thin domain $\Omega_\epsilon \subset \mathbb{R}^d$, of thickness ϵ, which degenerates to a line segment and impose appropriate conditions on the nonlinearities so that the equation have an attractor in $H^1(\Omega_\epsilon)$. After transforming all the equations to a fixed domain Ω, we obtain an estimate on the distance of attractors in $H^1(\Omega)$ which is of order $\epsilon \ln(\epsilon)$. In order to obtain this estimate we will need sharp estimates on the distance of inertial manifolds and apply some shadowing techniques. The fact that the limiting equation generates a Morse-Smale gradient flow is essential for the analysis. This is a joint work with Esperanza Santamaria.

Pullback attractors for wave equations in a noncylindrical domain

Ma To Fu, Christian Surco-Chuño

Universidade de São Paulo

In this work we study a weakly dissipative wave equation defined on time-varying domains. In a context of evolution process defined on time-varying metric spaces we prove the existence of a pullback attractor.

Exponential decay estimates for the damped defocusing Schrödinger equations in exterior domains

Marcelo M. Cavalcanti, Nicolas Burq, Valéria N. D. Cavalcanti, Wellington J. Corrêa

Universidade Estadual de Maringá

This talk is concerned to the study of the existence as well as the exponential stability in H^1-level for the damped defocusing Schrödinger equation posed in a two dimensional exterior domain Ω with smooth boundary $\partial\Omega$. The proofs of the existence are based on properties of pseudo-differential operators and a Strichartz estimate, while the exponential stability is achieved combining arguments firstly considered for the wave equation adapted to the present context and a global uniqueness theorem.

Some direction in nonsmooth dynamical systems

Marco Antonio Teixeira

Universidade Estadual de Campinas

In this talk we address some qualitative and geometric aspects of non-smooth dynamical systems theory. The birth of typical limit cycles is focused for 2D-Systems.

The Beverton-Holt quantum difference equation

Martin Bohner

Missouri University of Science and Technology

The Beverton-Holt model is a classical population model which has been considered in the literature for the discrete-time case. Its continuous-time analogue is the well-known logistic model. In this talk, we consider a quantum calculus analogue of the Beverton-Holt equation. We use a recently introduced concept of periodic functions in quantum calculus in order to study the existence of periodic solutions of the Beverton-Holt q-difference equation. Moreover, we present proofs of quantum calculus versions of two so-called Cushing-Henson conjectures.

On the Hardy-Sobolev problem

Massimo Grossi, Francesca Gladiali

Universitá di Roma, Sapienza

We study the problem

$$\begin{cases} -\Delta u - \frac{\lambda}{|x|^2} u = u^p & \text{in } D \\ u \geq 0 & \text{in } D \end{cases}$$

where $D = I\!R^N$ or $D = B_1$, $N \geq 3$, $p > 1$ and $\lambda < \frac{(N-2)^2}{4}$.

Oscillations with impulses of energy

Plácido Zoega Táboas, Miguel V.S. Frasson, Marta C. Gadotti, Selma H.J. Nicola

Universidade de São Paulo

Considering a damped linear oscillator, we impose that whenever a solution reaches a certain level of energy, it undergoes an instantaneous fixed increase in the velocity. For small amplitude, we show that positive simple periodic solutions are unstable and, for large amplitude, they are orbitally asymptotically stable. We show the family of such solutions undergoes a period doubling bifurcation.

A new approach to optimal control with constraints

Shui-Nee Chow, Wuchen Li, Jun Lu, Haomin Zhou

Georgia Insitute of Technology

We design a new fast algorithm for a class of infinite dimensional optimal control problems with constraints on both state and control variables. Instead of searching global minimizer(s) from all feasible paths, we consider the subset of paths with structure of optimal paths. By leveraging these paths, we transfer our infinite dimensional optimal control problem with constraints to a set of finite and different dimensional optimization problems with constrains. Moreover, for each of these finite dimensional optimal control problems, we apply methods from stochastic differential equations in order to find numerically all possible global minimizers of our original optimal control problem. Comparing to the existing methods, our method is fundamentally easier and faster. Examples for some shortest path problems, fogger problem and generalized Nash equilibrium will be presented.

Random and non-autonomous dynamics of chemostats

Tomás Caraballo
Universidad de Sevilla

Chemostat refers to a laboratory device used for growing microorganisms in a cultured environment, and has been regarded as an idealization of nature to study competition modeling of mathematical biology. The simple form of chemostat model assumes that the availability of nutrient and its supply rate are both fixed. However, these assumptions largely limit the applicability of chemostat models to realistic competition systems. In this work, we relax these assumptions and study the chemostat models with random and/or non-autonomous nutrient supplying rate or input nutrient concentration. This leads the models to random or non-autonomous dynamical systems and requires the concept of global random or pullback attractors. We will report on the existence of uniformly bounded non-negative solutions, existence of random and pullback attractors and some details of their geometrical structures for different value of parameters.

The content of this talk is mainly based in the following joint works:

[1] T. Caraballo, X. Han, P. Kloeden: *Chemostats with random inputs*, Math. Meth. Appl. Sci. (to appear)

[2] T. Caraballo, X. Han, P. Kloeden: *Chemostats with time-dependent inputs and wall-growth*, Appl. Math. Inf. Sci. (to appear)

On a class of stochastic transport equations for L2loc vector fields

Wladimir Neves, Ennio Fedrizzi, Christian Olivera
Universidade Federal do Rio de Janeiro

We study in this talk the existence and uniqueness of solutions to a class of stochastic transport equations with irregular coefficients. Asking only boundedness of the divergence of the coefficients (a classical condition in both the deterministic and stochastic setting), we can lower the integrability regularity required in known results on the coefficients themselves and on the initial condition, and still prove uniqueness of solutions. Our results appear to be well-adapted to the study of the so called Stochastic Muskat Problem, and could constitute a first essential step towards the solution of this important and hard problem. This inaugural type of perturbation of the original Muskat problem may open new research directions, with applications in particular to numerical simulations related to the planning and operation of oil industry.

Quasi-periodic motions in multi-scaled Hamiltonian systems

Yingfei Yi
University of Alberta & Jilin University

Multi-scaled, nearly integrable Hamiltonian systems arise actually in problems of celestial mechanics such as non-restricted 3-body problems. Like usual nearly integrable Hamiltonian systems, the existence of quasi-periodic motions is an important issue in the metric stability of multi-scaled Hamiltonian systems. In this lecture, we will present various results concerning the existence of both full and lower-dimensional quasi-periodic motions under suitable non-degenerate conditions of Bruno-Rüssmann type. Some technical difficulties beyond the standard KAM theory will be discussed.

ICMC Summer Meeting on Differential Equations

2015 Chapter

Special Sessions

Conservation Laws and Transport Equations

Organizer: Wladimir Neves

Invariant analysis for the time fractional Korteweg-de Vries equation

Adrian Ricardo Gómez Plata, Edmundo Capelas de Oliveira
Universidade Estadual de Campinas

Lie symmetries are used in the time fractional generalized Korteweg-de Vries equation (KDV), to show that each one of them led us to a corresponding nonlinear differential equation of fractional order, in a new independent variable, where the time derivative is known as the Erdélyi-Kober fractional derivativee. We present some necessary mathematical tools such as theoretical calculation fractional elements and Lie symmetries, that will be used in reducing our KDV equation of fractional order to fractional nonlinear ordinary differential equations.

Keywords: *Fractional partial differential equation, Fractional ordinary differential equation, Lie symmetries, Erdelyi-Kober operators.*

Riemann solutions for nonstrictly hyperbolic systems of conservation laws

Aparecido Jesuino de Souza
Universidade Federal de Campina Grande

In this work we discuss how to construct the Riemann solution for a non strictly hyperbolic system of conservation laws by the wave curve method. Using analytical and computational tools we show how to find the wave curves that generalize the rarefaction and the shock curves in the classical method of Lax, how to analyze the viscous profile entropy condition for shocks and the speed compatibility between successive waves in the Riemann solution. We illustrate the construction for a system of three-conservation laws that appears in a three-phase flow in a porous media.

Time dependent mean-field games with logarithmic nonlinearities

Edgard Almeida Pimentel
Universidade Federal do Ceará

In this talk, we report recent developments in the regularity theory of time dependent mean-field games (MFG, for short). Namely, we consider MFG systems in the presence of a logarithmic nonlinearity. This class of problems poses substantial mathematical challenges, since the nonlinearity is unbounded by below. The existence of smooth solutions is established, provided the Hamiltonian satisfies certain growth conditions. This result is proven by carefully combining a-priori estimates for the norms of the nonlinearity in suitable Lebesgue spaces with Lipschitz regularity for the Hamilton-Jacobi equation. The former estimates are produced by exploring concavity properties of the logarithmic function, along with the structure of the Fokker-Planck equation, whereas Lipschitz regularity for the Hamilton-Jacobi is investigated by recurring to the nonlinear adjoint method. This is based on a joint work with D. Gomes (KAUST).

Onsager conjecture and smallest scale of motion: The Burgers case.

Fabio T. Ramos

Universidade Federal do Rio de Janeiro

The Onsager conjecture concerns necessary and sufficient conditions for a weak solution of the 3D inviscid Euler equations to conserve energy. Its aim is to explain the power-law scaling for turbulent flows. In this talk, I will introduce some known results related to the conjecture, and I will show some new results for a version of the Onsager conjecture for the 1d Burgers equations. I will also discuss some open questions concerning the Kolmorov's theory of turbulence in the context of dyadic models of Burgers.

Integration of coupled stochastic oscillators driven by external random forces

Hugo de la Cruz, J. C. Jimenez

Fundação Getúlio Vargas - Escola de Matemática Aplicada

Studying the influence of random forces on oscillatory dynamical systems has become important in various fields of applied science and engineering. In this work we propose numerical integrators for the effective simulation of coupled stochastic oscillators driven by additive white noise. We study the performance of the proposed integrators, including the reproduction of some dynamical properties of stochastic harmonic oscillators and paths of nonlinear oscillators in general. Computer experiments illustrate the theoretical findings and the advantages of the proposed methods in comparison with other conventional ones.

Keywords: stochastic oscillator, stochastic differential equations, numerical methods, long-term integration, local linearization method, additive noise.

Existence of strong trace for quasi-solution of conservation laws: non-homogeneous case

Jean Silva, Wladimir Neves, E. Yu. Panov

Universidade Federal do Rio de Janeiro

In this talk, we consider a non-homogeneous conservation laws in a domain with smooth boundary and we stablished conditions in order to obtain the existence of strong trace for the normal components. Non-degeneracy conditions on the flux are required.

Lagrangian structure for compressible viscous flow

Marcelo M. Santos, D. Hoff

Universidade Estadual de Campinas

We shall discuss the lagrangian structure (uniqueness of trajectories) for log-lipschitzian vector fields and for the solutions obtained by D. Hoff for compressible viscous flow, in the cases of isentropic fluid in $\mathbb{R}^2$ and $\mathbb{R}^3$, in the half space in $\mathbb{R}^3$ with Navier boundary condition, and of nonisentropic fluid in $\mathbb{R}^3$.

Asymptotic behaviour of a porous medium equation with fractional pressure

Matheus C. Santos, José A. Carrillo, Yanghong Huang, Juan L. Vázquez
Universidade Estadual de Campinas

Transport inequalities have been used to show the exponential convergence towards the stationary state for many evolution equations. In this talk, we will use this approach to analyse the asymptotic behaviour of solutions to the one dimensional fractional version of the porous medium equation introduced by Caffarelli and Vázquez, where the pressure is obtained as a Riesz potential associated to the density. We take advantage of the displacement convexity of the Riesz potential in one dimension to show a functional inequality involving the entropy, entropy dissipation, and the Euclidean transport distance.

Nonuniqueness results for the transport equation

Olivier Kneuss, Wladimir Neves
Universidade Federal do Rio de Janeiro

I will summarize what has been done for nonuniqueness (and uniqueness) for the transport equation and give a new result in this direction.

Dispersive Equations

Organizer: Márcia Scialom

Orbital instability of standing waves for the quadratic-cubic Klein-Gordon-Schrödinger system

Fábio Natali

Universidade Estadual de Maringá

We consider the Klein-Gordon-Schrödinger system with quadratic and cubic interactions. Smooth curves of periodic- and solitary-wave solutions are obtained via the implicit function theorem. Orbital instability of such waves is then established. This is joint work with A. Pastor.

Existence and uniqueness of solution for a generalized nonlinear derivative Schrödinger equation

Gleison do Nascimento Santos

Universidade Estadual de Campinas

In this work we study the well-posedness for the initial value problem associated to a generalized derivative Schrodinger equation for small size initial data in Sobolev space. The technique used include parabolic regularization method combined with sharp linear estimates. An important point in our work is that the contraction principle argument is likely to fail but gives us inspiration to obtain certain uniform estimates that are crucial to obtain the result. To prove such uniform estimates we assume smallness on the initial data in weighted Sobolev spaces.

The Cauchy problem for the Schrödinger-Benjamin-Ono system

Leandro Domingues

Universidade Federal do Rio de Janeiro

This work is concerned with the Cauchy problem for a coupled Schrödinger-Benjamin-Ono system

$$\begin{cases} i\partial_t u + \partial_x^2 u = \alpha uv, & t\in[-T,T],\ x\in\mathbb{R}, \\ \partial_t v + \nu\mathcal{H}\partial_x^2 v = \beta\partial_x(|u|^2), & \\ u(0,x)=\phi,\ v(0,x)=\psi, & (\phi,\psi)\in H^s(\mathbb{R})\times H^{s'}(\mathbb{R}). \end{cases}$$

In the *non-resonant* case ($|\nu|\neq 1$), we prove local well-posedness for a large class of initial data. This improves the results obtained by Bekiranov, Ogawa and Ponce (1998). Moreover, we prove C^2*-ill-posedness* at *low-regularity*, and also when the difference of regularity between the initial data is large enough. As far as we know, this last ill-posedness result is the first of this kind for a nonlinear dispersive system. Finally, we also prove that the local well-posedness result obtained by Pecher (2006) in the *resonant* case ($|\nu|=1$) is sharp except for the end-point.

Sharp local well-posedness of KdV type equations with dissipative perturbations

Mahendra Panthee, Xavier Carvajal

Universidade Estadual de Campinas

In this work, we study the initial value problems associated to some linear perturbations of the Korteweg-de Vries (KdV) equations. Our focus is in the well-posedness issues for the initial data given in the L^2-based Sobolev spaces. We derive bilinear estimate in a space with weight in the time variable and obtain sharp local well-posedness results.

Comparison between model equations for long waves and blow-up phenomena

Marcia Assumpção Guimarães Scialom, Mahendra Panthee, Xavier Carvajal

Universidade Estadual de Campinas

The purpose of this work is two-fold. The first one is to compare solutions of the fifth-order KDV-BBM type model

$$\begin{cases} \eta_t + \eta_x - \frac{1}{6}\eta_{xxt} + \delta_1\eta_{xxxxt} + \delta_2\eta_{xxxxx} + \frac{3}{4}(\eta^2)_x + \gamma(\eta^2)_{xxx} - \frac{1}{12}(\eta_x^2)_x - \frac{1}{4}(\eta^3)_x = 0, \\ \eta(,0) = \eta_0(x), \end{cases}$$

to that of the fifth-order KdV model that appear to describe the propagation of long waves in shallow water. The second one is to study the possibility of bow-up phenomenon of the fifth-order KDV-BBM type model under certain restrictions on the coefficients.

General boundary conditions for the Kawahara equation on bounded intervals.

Márcio Hiran Simões, Nikolai A. Larkin
Universidade Tecnológica Federal do Paraná

We study mixed problems for the Kawahara equation on bounded intervals with general linear homogeneous boundary conditions and prove the existence and uniqueness of global regular solutions as well as exponential decay while $t \to \infty$ for small initial data.

Nonlinear wave equation with scale invariant damping term

Sandra Lucente
Universitá di Bari

In the present talk we discuss the global existence theory for some wave equation of kind

$$u_{tt}(t,x) - a(t)\Delta u(t,x) + b(t)u_t(t,x) = \Gamma(t,x)f(u(t,x)) \quad t > 0,\ x \in I\!R^n$$

with positive a, b and $|f(u)| \simeq |u|^p$ with $p > 1$.

It is well known that such kind of results depends on the size of the initial data and on the growth of the nonlinear term. In some lucky situations, there exist a range for p in which a global existence result is established and a complementary range of p in which one gains a non-existence result. These range are intervals and the separator $\bar{p}$ between such ranges is called *critical exponent*. The same equation can admit different critical exponents according to the kind of solution we are looking for. For constant $a = b = \Gamma$ the critical exponents depend on the space dimension n. In the variable coefficient setting, the critical exponents may depend from the growth or from the zero order of the coefficients.

After a brief review of the literature on this problem, we shall present in detail the case $b(t) = \frac{\mu}{1+t}$ where the critical exponent depends on the size of μ.

This analysis is contained in some joint works with Marcello D'Abbicco (Sao Paulo University Brasil) and Michael Reissig (TU University Freiberg Germany)

Local well-posedness of high dimensional KdV-type equations

Xavier Carvajal, Amin Esfahani, Mahendra Panthee
Universidade Federal do Rio de Janeiro

Considered in this work is a n-dimensional dissipative version of the KdV equation. Our goal here is to investigate the well-posedness issue for the associated initial data problem in the anisotropic Sobolev spaces. We also study well-posedness behavior of this equation when the dissipative effects are reduced.

Elliptic Equations

Organizer: Claudianor O. Alves

Large and entire large solutions for a class of quasilinear elliptic systems

Angelo Holanda
Universidade Federal de Campina Grande

In this talk, the main goal is to prove the existence of large and entire large solutions for a class of weighted quasilinear elliptic systems. The weight functions are non-negative and allowed to be unbounded. We combine variational methods with the existence of sub- and supersolution to get the large and entire large solutions.

Standing waves for a system of nonlinear Schrödinger equations with vanishing potential

Cláudia Santana, João Marcos Bezerra do Ó, Olimpio H. Miyagaki
Universidade Federal de Pernambuco

In this paper we study the existence of bound state solutions for stationary Schrödinger systems

$$\begin{cases} -\Delta u + V(x)u = K(x)F_u(u,v) & \text{in} \quad \mathbb{R}^N, \\ -\Delta v + V(x)v = K(x)F_v(u,v) & \text{in} \quad \mathbb{R}^N, \end{cases} \tag{S}$$

where $N \geq 3$ and $F(u,v)$ is a C^1 and p-homogeneous function with $2 < p < 2N/(N-2)$. We are interested when the potential V is not bounded away from zero. We give a special attention to the case when V may eventually vanish at infinity. Our arguments are based on penalization techniques, variational methods and Moser iteration scheme.

Mathematics Subject Classification 2000: 35J60, 35J20, 35Q55.
Key words. Elliptic systems, variational methods, vanishing potential, nonlinear Schrödinger equations, bounded states.

Existence and nonexistence of least energy nodal solutions for a class of elliptic problem in $\mathbb{R}^2$

Denilson S. Pereira, Claudianor O. Alves
Universidade Federal de Campina Grande

In this work we prove the existence of least energy nodal solutions for the following class of elliptic problem:

$$-\Delta u + V(x)u = f(u), \quad \text{in} \quad \Omega$$

where $\Omega \subset \mathbb{R}^2$ is a smooth domain which is not necessary bounded, $V : \overline{\Omega} \to \mathbb{R}$ is a continuous potential satisfying some growth conditions and the nonlinearity has exponential critical growth in $\mathbb{R}^2$. Moreover, we also prove a nonexistence result of least energy nodal solutions for the autonomous case in whole $\mathbb{R}^2$.

Nodal solutions of a NLS equation concentrating on lower dimensional spheres

Giovany Figueiredo, Marcos Pimenta

Universidade Federal do Pará

In this work we deal with the following nonlinear Schrödinger equation

$$\begin{cases} -\epsilon^2\Delta u + V(x)u = f(u) \ \text{ in } \mathbb{R}^N \\ u \in H^1(\mathbb{R}^N), \end{cases}$$

where $N \geq 3$, f is a subcritical power-type nonlinearity and V is a positive potential satisfying a local condition. We prove the existence and concentration of nodal solutions which concentrate around a $k-$dimensional sphere of $\mathbb{R}^N$, where $1 \leq k \leq N-1$, as $\epsilon \to 0$. The radius of such sphere is related with the local minimum of a function which takes into account the potential V. Variational methods are used together with the penalization technique in order to overcome the lack of compactness.

Radial solutions of quasilinear equations in Orlicz-Sobolev type spaces

Jefferson A. Santos, Sergio H. M. Soares

Universidade Federal de Campina Grande

In this work is devoted to prove the existence of a nontrivial nonnegative radial solution for the quasilinear elliptic equation

$$-\mathrm{div}\,(\varphi(|\nabla u|)\nabla u) + |u|^{\alpha-2}u = |u|^{s-2}u \quad \text{in } \mathbb{R}^N$$

where $N \geq 2$, $1 < \alpha \leq \frac{l^* m'}{l'}$, $\max\{m, \alpha\} < s < l^*$, being $l, m \in (1, N)$, $l^* = \frac{lN}{N-l}$ and m' and l' the respective conjugate exponents of m and l. The function φ is allowed to belong to a larger class, which includes the special cases appearing in mathematical models in the fields of physics, for instance, nonlinear elasticity, plasticity and generalized Newtonian fluids. The proof is based on variational methods in the Orlicz-Sobolev spaces.

Reconstruction of coefficients and sources in elliptic systems

Nilson Costa Roberty

Universidade Federal do Rio de Janeiro

Most of the stationary engineering models can be represented as elliptic system of partial differential equations. Those models are mathematically elaborated with continuous thermomechanics and the constitutive theories of materials. Frequently we have incomplete information about coefficients and sources. We analyses this kind of boundary value problems in Lipschitz domains with many Cauchy data at the boundary. The main techniques are boundary integral equations and Calderon projector. To estimate those coefficients and sources we propose an optimization methodology based on internal discrepancy observed when wrong parameters values are inserted in the constitutive equations. Numerical finite elements experiments are presented.

Free boundary problems with supercharacteristic growth

Olivaine S. de Queiroz

Universidade Estadual de Campinas

I am going to present some regularity results for elliptic and parabolic problems whose solutions exhibit supercharacteristic growth (in space variable) like $r^2|\log r|$ close to a free boundary point. In the elliptic case nondegeneracy is also obtained and some aditional information on the free boundary can be proved.

A semilinear elliptic problem with a singularity in u=0

Pedro J. Martínez-Aparicio, Daniela Giachetti, François Murat

Universidad Politécnica de Cartagena

In this joint work with Daniela Giachetti (Sapienza Università di Roma, Rome, Italy) and François Murat (Université Pierre et Marie Curie, Paris, France), motivated by [1] and [2], we consider the problem

$$\begin{cases} -\operatorname{div} A(x)Du = F(x,u) & \text{in } \Omega, \\ u = 0 & \text{on } \partial\Omega, \end{cases}$$

(namely an elliptic semilinear equation with homogeneous Dirichlet boundary condition), with Ω an open bounded set of $\mathbb{R}^N$, $N \geq 1$, $A \in L^\infty(\Omega)^{N\times N}$ a coercive matrix, where the nonlinearity $F(x,u)$ is singular in $u = 0$, with a singularity of the type

$$F(x,u) = \frac{f(x)}{u^\gamma} + g(x)$$

with $\gamma > 0$ and f and g nonnegative (which implies that also u is nonnegative).

The main difficulty is to give a convenient definition of the solution of the problem, in particular when $\gamma > 1$. We give such a definition and prove the existence and stability of a solution, as well as its uniqueness when $F(x,u)$ is "almost nonincreasing" in u.

We also consider the homogenization problem where Ω is replaced by Ω_ε, with Ω_ε obtained from Ω by removing many very small holes in such a way that passing to the limit when ε tends to zero the Dirichlet boundary condition leads to an homogenized problem where a "strange term" μu appears.

[1] L. Boccardo, L. Orsina: *Semilinear elliptic equations with singular nonlinearities*, Calc. Var. Partial Differential Equations, **37** (2010), no. 3-4, 363–380.

[2] D. Cioranescu, F. Murat: *A strange term coming from nowhere*, Topics in the mathematical modelling of composite materials, 45–93. Progr. Nonlinear Differential Equations Appl., **31**, Birkhäuser Boston, Boston, MA, 1997.

Weak solutions of a nonlinear degenerate elliptic equation

Sebastián Lorca
Universidad de Taparacá

We consider the problem

$$\begin{aligned} -\mathrm{div}\left(k\left(T\left(x\right)\right)\nabla T\left(x\right)\right)+u\left(x\right)\cdot\nabla T\left(x\right) &= f\left(T\left(x\right)\right), \quad x\in\Omega \\ u\left(x\right) &= 0, \qquad\quad x\in\partial\Omega. \end{aligned}$$

where $\Omega\subset\mathbb{R}^N$ is a bounded and smooth domain. We do not assume that the function k is strictly positive. We study the existence of weak solution under conditions of superlinearity for the function f .

On the finite space blow up of the solutions of the Swift-Hohenberg equation

Vanderley Alves Ferreira Junior, Ederson Moreira dos Santos
Universidade de São Paulo

We study the finite space blow up of the solutions for a class of fourth order differential equations. Our results answer a conjecture in [F. Gazzola and R. Pavani. Wide oscillation finite time blow up for solutions to nonlinear fourth order differential equations. Arch. Ration. Mech. Anal., 207(2):717-752, 2013] and they have implications on the nonexistence of beam oscillation given by traveling wave profile at low speed propagation.

Fluid Dynamics

Organizer: Gabriela Planas

Parallel code to obtain a numerical fuzzification for a model of miscible displacement in porous media

César Guilherme de Almeida, Gustavo Henrique Garcia Silva, Ana Maria Amarillo Bertone

Universidade Federal de Uberlândia

The model of a incompressible miscible displacement of the mixture of a solvent, with concentration c, and oil in a mean free of gravitational effects is given by the system

$$\operatorname{div}(u) = q, \qquad u = \frac{-\mathcal{K}}{\mu(c)}\nabla p, \tag{1}$$

$$\phi\frac{\partial c}{\partial t} + \operatorname{div}(uc - D(u)\nabla c) = \widetilde{c}q, \tag{2}$$

where u is the Darcy's velocity; $\mathcal{K} = \mathcal{K}(\mathbf{x})$ is the absolute permeability of the rock at $\mathbf{x} = (x, y) \in \mathbb{R}^2$; $\mu = \mu(c)$ is the viscosity of the fluid, which depends on the solvent concentration, $c = c(\mathbf{x}, t)$; the pressure gradient is given by $\nabla p = \nabla p(\mathbf{x})$; the porosity of the medium is ϕ, which we consider as a positive constant; $q = q(\mathbf{x}, t)$ is the total volumetric flow rate at the well; $\widetilde{c}$ is the specified concentration at an injection well and the resident concentration at a producer; D is the diffusion-dispersion tensor given by:

$$D = D(u) = \phi d_m I +$$

$$\frac{d_\ell}{|u|}\begin{pmatrix} u_1^2 & u_1u_2 \\ u_1u_2 & u_2^2 \end{pmatrix} + \frac{d_t}{|u|}\begin{pmatrix} u_2^2 & -u_1u_2 \\ -u_1u_2 & u_1^2 \end{pmatrix}.$$

In this tensor, $d_\ell \gg d_t$ and $d_t \geq 0$ are longitudinal and transverse dispersion coefficients, respectively, and $d_m > 0$ is the molecular diffusion coefficient.

It has been proved (Almeida and Bertone) that the solution of the equations system depends continuously on the parameters d_m, d_ℓ and d_t, in the sense of $L^\infty(J, L^2(\Omega))$.

In this work we have considered d_ℓ as a fuzzy parameter. Based on the continuity of the solution operator that assigns d_ℓ to c (the unique analytic (semi-classical) solution of the system - due to Feng), it is possible to built a fuzzification using the extension principle (due to Zadeh). In order to obtain a numerical fuzzification of the system, we introduce a parallel code which is an alternative algorithm to the well known Vertex method.

This is a joint work with Gustavo Henrique Garcia Silva and Ana Maria Bertone.

Singular limits of the Stokes and Navier–Stokes equations in a punctured periodic domain

Gabriela Planas, James C. Robinson, Michel Chipot, Wei Xue

Universidade Estadual de Campinas

We consider two problems on a two-dimensional punctured periodic domain: we take $\Omega_r = (-L, L)^2 \setminus D_r$, where $D_r = B(0, r)$ is the disc of radius r centred at the origin. We impose periodic boundary conditions on the boundary of the box $\Omega = (-L, L)^2$, and Dirichlet boundary conditions on the circumference of the disc. In this setting we consider the Stokes equations and the time-dependent Navier–Stokes equations, all with a fixed forcing function f (which must satisfy $\int_\Omega f = 0$ for the stationary problem), and examine the behaviour of solutions as $r \to 0$. In all the cases we show convergence of the solutions to those of the limiting problem, i.e. the problem posed on all of Ω with periodic boundary conditions.

Stability of global large solutions to the Hall-magneto-hydrodynamics system

Maicon José Benvenutti, Lucas Catão de Freitas Ferreira

Universidade Estadual de Campinas

We prove a stability theorem for global large solutions to the three-dimensional incompressible Hall-magneto-hydrodynamics system that have a suitable integrable hypothesis. Combining this with prior known results, we present a class of three-dimensional global large solutions with approximately symmetric initial velocity and approximately irrotational initial magnetic field.

Navier-Stokes equations and fractional calculus

Paulo M. de Carvalho-Neto, Gabriela Planas

Universidade Estadual de Campinas

The aim of this lecture is to analyse the fractional version of the Navier-Stokes equations, with Caputo's fractional derivative of order $\alpha \in (0, 1)$. More specifically, we address this matter using the theory of fractional abstract Cauchy problems, proving that it possesses an unique global mild solution with certain interesting decay properties. Then we discuss the integrability in time of this solution and show that it has a non expected regularity. Finally, we use all the obtained information to "relate" these fractional solutions with the classical one. This is a joint work with Gabriela Planas.

Hydrodynamic stability and high-frequency approximations

Sávio B. Rodrigues
Universidade Federal de São Carlos

High-frequency approximations have been extensively used for studying short-wave instabilities in many physical settings including viscous flows. The solution of the Navier-Stokes equation is approximated using WKB asymptotics and the resulting dynamic is addressed. This technique can be used to show that 2D base flows are generally unstable with respect to 3D disturbances when the Reynolds number is sufficiently high. I explain why WKB approximation sometimes gives surprisingly accurate numerical approximations. For example, in elliptical vortices the approximation is superconvergent which means it converges one order faster than expected. Unfortunately, superconvergence does not hold for general base flows. I provide a connection between the approximation accuracy and the Hessian of the base flow. I also explain the connection between bypass transition and high-frequency disturbances. Bypass transition is commonly observed in shear flows where small disturbances can be sustained by a coupling of linear transients with nonlinear effects even though the base flow is linearly asymptotically stable.

A symmetry transformation for trajectories of an ideal steady fluid flow determined by a potential function

Vladimir Grebenev, Martin Oberlack, Alexander Megrabov, Irina Starikova
Institute of Computational Technologies RAS

We study a transformation Ξ of 3D trajectories (fluid particle pathes) of inviscid steady flows using the dual stream function approach for the (local) representation of velocity fields $\vec{u}(x, y, z)$ of the stationary Euler equations. This representation together with choosing moving frame for trajectories enables us to derive the equation governing the deformation of trajectories. In fact, Ξ is a symmetry transformation and it looks formally like the filament equation after reparametrization. Moreover, the corresponding infinitesimal operator admits the so-called conformally Hamiltonian form at least locally. For toroidal flows, we investigate in details the fine structure of a Lie algebra associated with an extension of the transformation Ξ. In particular, the minimal set of generating differential invariants is found and the operators of invariant differentiating are constructed. This minimal set consists of a single invariant which coincides with the Hamiltonian function of the governed equation for Ξ. The Hamiltonian turns out to be the length functional on the trajectories under consideration.
Keywords: Euler equations, dual stream functions, symmetry transformation, filament equation

Linear Equations

Organizer: Adalberto P. Bergamasco

Globally solvable systems

Giuliano Angelo Zugliani, Adalberto P. Bergamasco, Sérgio L. Zani, Alberto Parmeggiani
Universidade de São Paulo

We present involutive systems of partial differential equations associated with a closed non-exact Morse 1-form b defined on a closed orientable surface M of genus greater than 1. We also consider some examples where b is real analytic.

The global solvability holds for the bitorus, or for any genus provided that b is a generic Morse form. If we call B a primitive of b on a covering space of M, in all these cases, B is not bounded on its sublevels and superlevels.

Joint work with Adalberto Bergamasco and Sérgio Zani from ICMC-USP, and Alberto Parmeggiani from Universitá di Bologna. We thank CNPq and FAPESP for the financial support.

A dissipative term for higher order hyperbolic equations

Marcello D'Abbicco, Enrico Jannelli
Universidade de São Paulo

In this talk, we will show how to explicitly construct a homogeneous dissipative term of order $m-1$, given any strictly hyperbolic homogeneous equation $Lu=0$, of order $m \geq 3$, with constant coefficients. We derive long-time decay estimates for the solution to the Cauchy problem related and we show that no better dissipative effect can be obtained with a different homogeneous term of order $m-1$.

Two variables "fighting" for solvability

Rafael Borro Gonzalez
Universidade de São Paulo

We are concerned with the global solvability for the following two classes of complex vector fields on the $3-$torus $\mathbb{T}^3$:

$$\frac{\partial}{\partial t}+[a(x)+ib(x)]\left(\frac{\partial}{\partial x}+\frac{\partial}{\partial y}\right)$$

and

$$\frac{\partial}{\partial t}+[a(t)+ib(t)]\left(\frac{\partial}{\partial x}+\frac{\partial}{\partial y}\right),$$

where $a,b\in\mathcal{C}^\infty(\mathbb{T}^1,\mathbb{R})$, and (x,y,t) are the coordinates in $\mathbb{T}^3$.

We are going to answer the following questions: Under which conditions are these operators globally solvable? Are these conditions the same for the two operators?

$L^p - L^q$ estimates for radial solutions of the wave equation and application

Tiago Henrique Picon, Marcelo Ebert, Rafael Kapp
Universidade de São Paulo

It is well known that, for space dimension $n > 3$, one cannot generally expect $L^1 - L^p$ estimates for the solution of

$$u_{tt} - \triangle u = 0\,, \qquad u(0,x) = 0\,, \quad u_t(0,x) = g(x)\,,$$

where $(t,x) \in \mathbb{R}_+ \times \mathbb{R}^n$. In this lecture, we investigate the benefits in the range of $1 \leq p \leq q$ such that $L^p - L^q$ estimates hold under the assumption of radial initial data. In the particular case of odd space dimension, we prove $L^1 - L^q$ estimates for $1 \leq q < \frac{2n}{n-1}$ and apply these estimates to study the global existence of small data solutions to the semilinear wave equation with power nonlinearity $|u|^q$, $q > q_K(n) = \frac{n+1}{n-1}$, where the critical exponent $q_K(n)$ is the Kato index.

Nonlinear Dynamical Systems

Organizer: Sergio Muniz Oliva Filho

Attractors met X-elliptic operators: an introduction to X-elliptic operators

Alessia E. Kogoj, Ermanno Lanconelli, Stefanie Sonner
Universitá di Bologna

We briefly survey current research regarding X-elliptic Partial Differential Operators, a class of degenerate elliptic operators endowed with an underlying metric structure of Carnot-Carathéodory type. We will focus on local and global properties of solutions, such as scale invariant Harnack inequalities on the metric balls, Hölder continuity and Liouville Theorems. We will also show how these results apply to the particular class of the so called Δ_λ-Laplacians, a class of Partial Differential Operators containing the Grushin-type operators as well as the cylindrical version of the Heisenberg-type sub-Laplacians.

Regularization approaches for quantitative photoacoustic tomography

Fabiana Travessini de Cezaro, Adriano de Cezaro
Universidade Federal do Rio Grande

We will physically motivate this medical imaging modality and prove properties of the forward operator that associate optical parameters from measurements of a reconstructed Photoacoustic image. This is often referred to as the optical inverse problem, that turns out to be nonlinear and ill-posed. The properties of the forward operator provide sufficient conditions to show regularized properties of approximated solutions obtained by Tikhonov-type approaches.

Pullback attractors for non-autonomous evolution equations with spatially variable exponents

Jacson Simsen, Peter E. Kloeden
Universidade Federal de Itajubá

We considered the following non-autonomous evolution equations with spatially variable exponents

$$\frac{\partial u_\lambda}{\partial t}(t) - \operatorname{div}\left(D_\lambda(t)|\nabla u_\lambda(t)|^{p(x)-2}\nabla u_\lambda(t)\right) + |u_\lambda(t)|^{p(x)-2}u_\lambda(t) = B(t, u_\lambda(t))$$

on a bounded smooth domain Ω in $\mathbb{R}^n$, $n \geq 1$, with a homogeneous Neumann boundary condition, where the exponent $p(\cdot) \in C(\bar{\Omega}, \mathbb{R}^+)$ satisfying $p^- := \min p(x) > 2$, and $\lambda \in [0, \infty)$ is a parameter. The existence and upper semicontinuity of pullback attractors are established for the equation under the assumptions, amongst others, that B is globally Lipschitz in its second variable and $D_\lambda \in L^\infty([\tau, T] \times \Omega, \mathbb{R}^+)$ is bounded from above and below, is monotonically nonincreasing in time and continuous in the parameter λ.

Heteroclinics to equilibria and periodic orbits at infinity for unbounded attractors

Juliana F. S. Pimentel
Universidade de São Paulo

Non-compact global attractors may arise in the context of certain non-dissipative partial differential equations. Their characterization has been recently approached in the setting of a class of scalar reaction-diffusion equations. In the case of Dirichlet or Neumann separated boundary conditions the limiting objects for the grow-up solutions consist of equilibria at infinity. We put forward a description of the unbounded attractor for the case of periodic boundary conditions, which provides a more interesting dynamical structure as it also includes periodic orbits at infinity. This is partially based on joint works with C. Rocha.

Pullback attractor for a non-classical diffusion equation with delay

Felipe Rivero, Tomás Caraballo, Antonio M. Márquez-Durán
Universidade Federal Fluminense

In this talk we are going to show the analysis of the following non-classical non-autonomous diffusion equation with delays, written in an abstract functional formulation,

$$\begin{cases} \frac{\partial u}{\partial t} - \gamma(t)\Delta\frac{\partial u}{\partial t} - \Delta u = g(u) + f(t, u_t), & \text{in } (s, +\infty) \times \Omega, \\ u = 0, & \text{on } (s, +\infty) \times \partial\Omega \\ u(t, x) = \phi(t - s, x), & t \in [s - h, s], x \in \Omega. \end{cases}$$

First, the well-posedness and the existence of a local solution is proved by using a fixed point theorem. Then, the existence of solutions defined globally in future is ensured. The asymptotic behaviour of solutions is analyzed within the framework of pullback attractors as it has revealed a powerful theory to describe the dynamics of non-autonomous dynamical systems. One difficulty in the case of delays concerns the phase space that one needs to consider to construct the evolution process. This yields to the necessity of using a version of the Ascoli-Arzelà theorem to prove the compactness.

Thin domains and reactions concentrated on boundary

Marcone Corrêa Pereira
Universidade de São Paulo

In this talk we discuss the behavior of a family of steady state solutions of a semilinear reaction-diffusion equation with homogeneous Neumann boundary condition posed in a two-dimensional thin domain when some reaction terms of the problem are concentrated in a narrow oscillating neighborhood of the boundary. We assume that the domain, and so, the oscillating neighborhood, degenerates to an interval as a small parameter ϵ goes to zero.

Our main goal here is to show that this family of solutions converges to the solutions of an one-dimensional limit equation capturing the geometry and oscillatory behavior of the open sets where the problem is established adapting methods and techniques developed in [1,2,3] and [4].

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[3] G. S. Aragão, A. L. Pereira and M. C. Pereira, *A nonlinear elliptic problem with terms concentrating in the boundary*, Math. Methods Appl. Sci. 35 (9) (2012) 1110-1116.

[4] J. M. Arrieta and S. M. Bruschi, *Rapidly varying boundaries in equations with nonlinear boundary conditions. The case of a Lipschitz deformation*, Math. Models and Meth. in Appl. Sciences 17 (10) (2007) 1555-1585.

Recent results on impulsive dynamical systems

Matheus C. Bortolan, Alexandre N. Carvalho, Everaldo M. Bonotto, Radoslaw Czaja

Universidade Federal de Santa Catarina

Impulsive dynamical systems describe evolution processes in which we have abrupt changes of state, and can be used to model several real world problems. In this talk we will discuss some of the recent results on the theory of asymptotic behaviour for impulsive dynamical systems.

Pullback attractors for a nonlocal PDE

Pedro Marín-Rubio, Tomás Caraballo, Marta Herrera-Cobos

Universidad de Sevilla

A parabolic equation with diffusion coefficient of nonlocal type is considered. Existence, uniqueness, and regularization results are provided. Since the problem contains non-autonomous terms, the long-time behaviour is studied in the framework of pullback attractors.

This is a joint work with Tomás Caraballo and Marta Herrera-Cobos.

The Cauchy problem for two classes of parabolic equations with nonstandard growth

Sergey Shmarev

Universidad de Oviedo

The talk addresses the question of solvability of the Cauchy problem for the evolution equations with nonstandard growth conditions. The following equations are considered:

$$\begin{aligned} &(a) \qquad u_t - \operatorname{div}(|\nabla u|^{p(x)-2}\nabla u) = f(x,t), \\ &(b) \qquad u_t - \operatorname{div}(D(x)|\nabla u|^{p(x)-2}\nabla u) + A(x)|u|^{q(x)-2}u = f(x,t,u) \end{aligned}$$

with given exponents $p(x)$, $q(x)$. The coefficients $A(x)$, $D(x)$ grow as $|x| \to \infty$ and may vanish on a set of zero measure in $\mathbb{R}^n$, the function $f(x,t,s)$ is globally Lipschitz-continuous with respect to $s \in \mathbb{R}$.

We derive sufficient conditions for the existence of weak solutions of the Cauchy problem in suitable weighted spaces of Orlicz-Sobolev type.

The results were obtained in collaboration with Prof. S. Antontsev (Univ. de Lisboa, Portugal), Prof. C.O. Alves (Univ. Federal de Campina Grande, Brazil), Prof. J. Simsen and M. S. Simsen (Univ. Federal de Itajubá, Brazil). The work was supported by the Research project MTM2010-18427, Spain,

and the program "Science Without Borders", Brazil, CAPES - PVE - Process 88881.0303888/2013-01.

Attractors met X-elliptic operators: global attractors for semilinear degenerate problems

Stefanie Sonner, Alessia E. Kogoj

University of Kaiserslautern

We show that the theory of semigroups and global attractors extends to a large class of semilinear degenerate evolution equations. In particular, we consider degenerate parabolic and damped hyperbolic equations involving an operator that is X-elliptic with respect to a family of locally Lipschitz continuous vector fields $X = \{X_1, ..., X_m\}$. This class contains, as particular cases, on the one hand Δ_λ-Laplacians (i.e., Grushin-type operators) and on the other hand, Sub-Laplacians on Carnot groups (i.e., the Kohn Laplacian on the Heisenberg group).

The local well-posedness is established under subcritical growth restrictions on the nonlinearity f, which are determined by the geometry and functional setting naturally associated to the family of vector fields X. Assuming additionally that f is dissipative, the global existence of solutions follows, and we can characterize their longtime behavior using methods from the theory of infinite dimensional dynamical systems.

An direct and inverse problem for the Biot system

Mikhail Vishnevskii, Viacheslav Primenko

Universidade Estadual do Norte Fluminense

In applied problems of elastic waves propagation, it is often necessary to consider the porous properties of medium. In particular, such questions arise in seismology, exploration geophysics and reservoir characterization. By this reason the porous media studies have attracted scientists'attention rather recently. The first papers in this field are due to Biot . The Biot theory for porous media describes the elastic wave propagation in a porous saturated medium, i.e., a medium made of a solid matrix (skeleton or frame), fully saturated with a fluid.

In this work we consider an identification problem related to the elastic wave propagation in the porous media governed by the Biot equations (low frequency range).

Ordinary and Functional Differential Equations

Organizer: Bruno de Andrade & Jaqueline Godoy Mesquita

Almost periodicity for a nonautonomous discrete dispersive population model

Filipe Dantas, Claudio Cuevas
Universidade Federal de Sergipe

In this work, we study the almost periodicity profile for nonautonomous difference equation on Banach space $\mathbb{X}$

$$u(n+1) = T(n)u(n) + f(n), n \in \mathbb{Z} \tag{3}$$

using the theory of separated sequences. We use these results to study the existence of almost periodic solutions for a problem of dispersive population discribed by the integro-difference equation

$$\varphi_{n+1}(x) = \int_{\Omega} k(x-y)F(n,y,\varphi(y))dy, n \in \boldsymbol{Z}, x \in \Omega \tag{4}$$

and its perturbed version

$$\varphi_{n+1}(x) = \int_{\Omega} k(x-y)\left[F(n,y,\varphi(y)) + g_n(y)\right]dy, n \in \boldsymbol{Z}, x \in \Omega. \tag{5}$$

On the Hale's problem for impulsive systems

Ginnara M. Souto, Everaldo M. Bonotto, Luciana P. Gimenes
Universidade de São Paulo

In this work we consider in this paper a class of systems whose continuous dynamics are interrupted by abrupt changes of state and we present sufficient conditions to obtain the existence of a maximal compact invariant set for a system in this class.

Semigroup on time scales and applications to abstract Cauchy problems

Jaqueline G. Mesquita, Hernan Henríquez, Carlos Lizama
Universidade de São Paulo

This is a joint work with Hernan Henríquez and Carlos Lizama. In this paper, we introduce a definition of C_0-semigroup on time scales, which unifies the continuous and discrete cases and extends the theory of operator semigroups to the quantum and hybrid cases, among others. We study the relationship between the semigroup and its infinitesimal generator. We apply our theory to study the homogeneous and nonhomogeneous abstract Cauchy problem in Banach space. Finally, we present some examples to illustrate this new concept on a wide class of time scales.

Some qualitative behaviours of certain third order nonlinear nonautonomous ordinary differential equation

James Gbenga Alaba, Babatunde S. Ogundare

Obafemi Awolowo University

In this study, we established sufficient criteria for uniform asymptotic stability and boundedness of solutions of certain class of third order nonlinear non autonomous ordinary differential equations using a complete Lyapunov function. Our results extend some existing one in the literature.

Variational principle for electrodynamics

Jayme de Luca

Universidade Federal de São Carlos

We extend the variational problem of Wheeler-Feynman electrodynamics by putting the action functional in a local space of absolutely continuous trajectories having velocities of bounded variation. We prove that the critical-point conditions for the two-body problem in the extended local space are Euler-Lagrange equations holding Lebesgue-almost everywhere plus a condition that the Weierstrass-Erdmann momenta are absolutely continuous functions.

Peridynamics and Gateaux derivative when modelling elastic materials

Luciano Barbanti, Berenice Camargo Damasceno

Universidade Estadual Paulista

Peridynamics as stated by S.A. Silling from the Sandia Laboratory is a nonlocal extension of the classical theory (based on PDE) from the Solid Mechanics allowing the integration of non- smooth functions and /or discontinuous solutions. In Peridynamics, the force state (that maps bonds onto bond forces densities) are defined in the case of elastic materials by means of the Fréchet derivative. We propose in this work a reinterpretation of the force state by using the Gateaux (directional) derivative, instead that the Fréchet one, with the consequent introduction of fractional derivatives in the environment.

Bifurcation in second order impulsive retarded differential equations with state dependent delay

Marcos Napoleão Rabelo, Pierluigi Beneviere

Universidade Federal de Goiás

In this work we analyze the existence of bifurcation of solutions of a second order functional differential equations with impulse at fixed times. Based on the papers [1]-[4] we introduce the concept of orientation of Fredholm operators of index zero in Banach spaces. With the help of this concept we give a generalization of the Leray-Schauder degree theory for maps in finite Banach spaces in the context of functional differential equations with impulses

Keywords: Abstract differential equation; abstract Cauchy problem of first order; mild solutions; classical solutions; fractional powers of operators; non linear semi groups, convex functions, differential inclusions.

[1] Beneviere, P., Furi, M.: *A simple notion of orientability of Fredholm maps of index zero between Banach manifolds and degree theory*, Ann. Sci. Math., Québec **22** (1998), 131-148

[2] Benevieri, P., Furi, M.: *On the concept of orientability for Fredholm maps between real Banach manifolds*, Topol. Methods Nonlinear Anal., **16** 2(2000), 279-306.

[3] Benerieri, P., Furi, M.: *Bifurcation Results for Families of Fredholm Maps of Index Zero between Banach Spaces*, Nonlinear Analysis Forum, **6**, 1(2001), 35-47.

[4] Benevieri, P., Furi, M.: *A degree theory for locally compact perturbations of Fredholm maps in Banach Spaces*, (preprint).

Non absolute integration and stochastic differential equations

Márcia Federson, Jaqueline G. Mesquita, Everaldo M. Bonotto, Matheus C. Bortolan, Rodolfo Collegari

Universidade de São Paulo

We describe the path integral defined by R. Henstock, we define a new J. Kurzweil-type integral, which encompasses Feynman integral, and we present a new generalized differential equation which handles well the framework of stochastic processes.

Continuation results for retarded functional differential equations on manifolds

Pierluigi Benevieri, Alessandro Calamai, Massimo Furi, Maria Patrizia Pera

Universidade de São Paulo

We consider T-periodic parametrized retarded functional differential equations, with infinite delay, on (possibly) noncompact manifolds. Using a topological approach, based on the notions of degree of a tangent vector field and of the fixed point index, we prove a global continuation result for T-periodic solutions of such equations. As corollaries we obtain a Rabinowitz type global bifurcation result and a continuation principle of Mawhin type.

Dynamics of stochastic fast-slow chemical reaction networks

Xiaoying Han, Najm Habib
Auburn University

Motivated by the need for dynamical analysis and model reduction in stiff stochastic chemical systems, we focus on the development of methodologies for analysis of the dynamical structure of singularly-perturbed stochastic dynamical systems. We outline a formulation based on random dynamical system theory. We demonstrate the analysis for a model two-dimensional stochastic dynamical system built on an underlying deterministic system with a tailored fast-slow structure, and an analytically known slow manifold, employing multiplicative Brownian motion noise forcing.

Poster

Organizer: Edgard Almeida Pimentel

Multiplicity and concentration of positive solutions for a class of quasilinear problems through Orlicz-Sobolev space

Ailton Rodrigues da Silva, Claudianor O. Alves

Universidade Federal de Campina Grande

In this work, we study existence, multiplicity and concentration of positive solutions for the following class of problem:

$$-\Delta_\Phi u + V(\epsilon x)\phi(|u|)u = f(u) \quad \text{in} \quad \mathbb{R}^N,$$

where $\Phi(t) = \int_0^{|t|} \phi(s)sds$ is an N-function, Δ_Φ is the Φ-Laplacian operator, ϵ is a positive parameter, $N \geq 2$, $V : \mathbb{R}^N \to \mathbb{R}$ is a continuous function and $f : \mathbb{R} \to \mathbb{R}$ is a function of C^1 class.

The spectrum of Dirichlet Laplacian operator in deformed tubes

Carlos Ronal Mamani Mamani

Universidade Federal de São Carlos

Let Ω be a deformed tube in $\mathbb{R}^3$ and $-\Delta_D^\Omega$ the Dirichlet Laplacian operator in Ω. In this work, we are going to study the spectrum $\sigma(-\Delta_D^\Omega)$ of the operator $-\Delta_D^\Omega$. More precisely, we are going to analize how the geometrical characteristics of Ω can influence in the set $\sigma(-\Delta_D^\Omega)$. Firstly, we are going to show that, under certain conditions, the essential spectrum $\sigma_{\text{ess}}(-\Delta_D^\Omega)$ of $-\Delta_D^\Omega$ is the same, independent if the tube is straight, curved or twisted. In regard to the discrete spectrum $\sigma_{\text{dis}}(-\Delta_D^\Omega)$ of $-\Delta_D^\Omega$, we are going to show that if Ω is a curved tube, then $\sigma_{\text{dis}}(-\Delta_D^\Omega)$ is a non empty set. Furthermore, if Ω is a twisted tube, then $\sigma_{\text{dis}}(-\Delta_D^\Omega)$ is a empty set. In the case where Ω is smoothly curved and twisted simultaneously, we are going to see that the discrete spectrum remains empty.

Stochastic Transport Equation with Random Coefficients

David Alexander Chipana Mollinedo

Universidade Estadual de Campinas

In the present work, we study the stochastic transport equation given by:

$$\begin{cases} \partial_t u(t,x,\omega) + \big(b(t,x,\omega) + \dfrac{dB_t}{dt}(\omega)\big) \cdot \nabla u(t,x,\omega) = 0\,, \\ u|_{t=0} = u_0 \in L^2(\mathbb{R}^d) \cap L^\infty(\mathbb{R}^d)\,. \end{cases}$$

where $(t,x) \in [0,T] \times I\!R^d$, $\omega \in \Omega$, $b : \Omega \times I\!R_+ \times I\!R^d \to I\!R^d$ is a random vector field and $B_t = (B_t^1, ..., B_t^d)$ is a standard Brownian motion in $\mathbb{R}^d$. Indeed, considering the new definition of solution of the recent result [2]and helped of the results of [1] and [3] we study the existence and uniqueness of solutions to a class of stochastic transport equations with random irregular coefficients.

[1] P. L. Chow: *Stochastic partial differential equations*. Chapman-Hall/CRC, Boca Raton, FL, 2007.

[2] E. Fedrizzi, W. Neves and C. Olivera: *On a Class of Stochastic Transport Equation for L^2_{loc} Vector Fields*, Preprint available on Arxiv: 1410.6631, 2014.

[3] F. Flandoli, M. Gubinelli and E. Priola: *Well-posedness of the Transport Equation by Stochastic Perturbation*, Invent. Math., 180, 1-53, 2010.

Spontaneous chiral symmetry breaking for finite systems

Emerson Boscheto, Alejandro López-Castillo

Universidade Federal de São Carlos

A theoretical reaction network based on the Plasson et al. APED model is proposed and studied. Basically, modifications were included, to explore the consequences of autocatalysis, the flow of matter, and the sensibility of statistical fluctuations, for finite systems on the chiral symmetry breaking process. In the extended IF-APED-ACT (Initiation, Fluctuation, APED, Auto-Catalysis, and Termination) model, the fluctuations lead the system to break the chiral symmetry autonomously, i.e., without any a priori initial enantiomeric excess or external influence. Numerically obtained stability diagrams were used to identify the regions of parametric space, corresponding to racemic, homochiral, chiral oscillatory, and chaotic regimes. The dependencies of the final concentrations, in the racemic and homochiral regimes, on the parameters, were determined analytically and are discussed.

Applied mathematics in convection-radiation coupling a medium participant flow using the generalized integral transformed technique

Francisco Camilo da Silva, Carlos Antonio Cabral Santos, Laurivan da Silva Diniz

Instituto Federal de Educação, Ciência e Tecnologia do Ceará

In this paper a study carried out where convection and radiation, are related to heat transfer in the flow ducts in the parallel plate technique of applying the Generalized Integral Transform (GITT) to produce a hybrid solution for convective transfer mode and radiative. Then results of practical interest are calculated and graphically displayed as the scattering law has on the local Nusselt number and the temperature range where the effects of radiation, conduction and convection occur simultaneously and show great complexity of both the physical point of view as a mathematician being raised over the years great interest of researchers, which is in many applications in industry and other sectors of engineering. The main objective of this work is to make a theoretical study of the influence of radiation on the distribution of the middle temperature, while the influence of the radiation is determined by the method of analytic approach associated Legendre polynomial, and analyzed for convergence, stability and computational time. In addition, a study of the influence on the thermal field is done, some parameters such as albedo for single scattering, optical thickness and the coupling factor of radiation-convection.

Mean-field nonlinear dynamics of driven two-level atoms in environments with a structured density of modes

Gilberto A. Prataviera, Salomon S. Mizrahi
Universidade de São Paulo

We consider N driven two-level atoms interacting with a environment having a non flat structure of modes. By dressing the collective operators, within a semiclassical approach, and eliminating the environment degrees of freedom we derive a markovian master equation and a mean-field single-particle effective Hamiltonian that contains new terms due the environment structure of modes. Hence, the atomic dynamics is described by a set of coupled nonlinear differential equations for the atomic operators mean values. The effects of the environment structure of modes over the atomic nonlinear dynamics is displayed by solving numerically the system of nonlinear differential equations.

Limit of nonlinear elliptic equations with concentrated terms and varying domains: non uniformly Lipschitz case

Gleiciane da Silva Aragão, Simone Mazzini Bruschi
Universidade Federal de São Paulo

In this work, we analyze the limit of the solutions of nonlinear elliptic equations with Neumann boundary conditions, when nonlinear terms are concentrated in a region which neighbors the boundary of domain and this boundary presents a highly oscillatory behavior which is not uniformly Lipschitz. More precisely, if the Neumann boundary conditions are nonlinear and the nonlinearity in the boundary is dissipative, then we obtain a limit equation with homogeneous Dirichlet boundary conditions. Moreover, if the Neumann boundary conditions are homogeneous, then we obtain a limit equation with nonlinear Neumann boundary conditions, which captures the behavior of the concentration' region. Indeed, in both cases, we prove the upper semicontinuity of the families of solutions.

A priori bounds for elliptic problems using the Hardy-Sobolev inequality

Jose Miguel Mendoza Aranda
Universidade Federal de São Carlos

In this work we study a priori bounds for positive solutions of a class of nonlinear elliptic equations. More precisely, we establish a priori bounds for positive solutions of the problem:

$$\begin{cases} -\Delta u &= g(x,u,Du) &, \quad x \in \Omega \\ u &= 0 &, \quad x \in \partial\Omega \end{cases}$$

where $\Omega \subset \mathbb{R}^N$, $N \geq 3$, is a bounded smooth domain. The technique used in this work was developed by Brezis and Turner ([1]). We also provide existence of priori bounds of positive solutions for semilinear elliptic systems and polyharmonic problems ([2]).
In this work, the main tool used is the Hardy-Sobolev inequality to estimate the L^∞-norm of positive solutions.

[1] H. Brezis, R. E. L. Turner:, *On a Class of Superlinear Elliptic Problems*, Comm. In Partial Differential Equations, 2(6), 601-614 (1977).

[2] Clément, Ph.; de Figueiredo, D. G.; Mitidieri, E.:, *A priori estimates for positive solutions of semilinear elliptic systems via Hardy-Sobolev inequalities*. Nonlinear partial differential equations, Pitman Res. Notes Math. Ser. 343, (1996) 73-91.

Numerical computation of internal waves in a system of two fluids

Mateus T. de Sousa, Daniel G. Alfaro Vigo
Universidade Federal do Rio de Janeiro

In this work we present a numerical method to compute the propagation of internal waves in the interface between two layers of inviscid, immiscible, irrotational fluids limited by flat rigid boundaries at the top and the bottom. The physical problem is formulated in terms of the velocity potential for each fluid layer which are coupled at the interface through cinematic conditions and Bernoulli integrals.

The numerical method is obtained through a discretization, along the interface, of the boundary integral equations associated with the velocity potentials [1,2]. This results in discretized versions of the corresponding Dirichlet-Neumann and Neumann-Dirichlet operators associated with the Laplace equations [1]. We use a leap-frog time discretization of the cinematic conditions and Bernoulli integrals to approximate the time evolution of the velocity potentials and the interface location. The spatial derivatives appearing in the resulting equations are discretized using spectral methods [3].

We present some numerical simulations illustrating the propagation and interaction of nonlinear periodic internal waves.

[1] K. Atkison, W. Han: *Theoretical Numerical Analysis. A Functional Analysis Framework*. New York:Springer, 2009.

[2] J. L. Blue: *Boundary Integral Solutions of Laplace's Equation*, Bell Syst. Techn. Journal, No. 8, 2797–2822, 1978.

[3] L. N. Trefethen: **Spectral methods in Matlab**. [S.l.]: SIAM, 2000.

Periodic orbits in piecewise smooth singularly perturbed systems

Pedro Toniol Cardin
Universidade Estadual Paulista

In this work we deal with piecewise smooth singularly perturbed systems

$$\dot{x} = \begin{cases} F(x,y,\varepsilon) & \text{if} \quad h(x,y,\varepsilon) \leq 0, \\ G(x,y,\varepsilon) & \text{if} \quad h(x,y,\varepsilon) \geq 0, \end{cases} \qquad \varepsilon\dot{y} = H(x,y,\varepsilon), \tag{6}$$

where $\varepsilon \in \mathbb{R}$ is a non-negative small parameter, $x \in \mathbb{R}^n$ and $y \in \mathbb{R}$ denote the slow and fast variables, respectively, and F, G, h and H are C^r maps, with $r \geq 1$. We investigate how the dynamics of piecewise smooth systems is affected by singular perturbation. More specifically, we focus on the case when the phase portrait of the reduced problem has periodic orbits with sliding or sewing points. The persistence of those objects are investigated.

Multiple solutions for an elliptic system near resonance

Rafael Antônio Rossato, Eugenio Massa
Universidade Federal de Uberlândia

We consider an elliptic system with linear part depending on two parameters and a sublinear perturbation. We obtain the existence of at least two solutions when the linear part is near resonance. The system is associated with a strongly indefinite functional and the solutions are obtained through saddle point theorem and Galerkin approximation.

Mathematical modeling and simulation of antibiotic fermentation with differential equations

Samuel Conceição de Oliveira

Universidade Estadual Paulista

In the study of fermentation kinetics, the logistic law

$$\frac{dy_1}{dt} = k_1 y_1 \left(1 - \frac{y_1}{k_2}\right) \tag{1}$$

has been used frequently to describe the dynamics of cell growth.

The term $(1 - \frac{y_1}{k_2})$ in the logistic law accounts for cessation of growth due to a limiting nutrient.

The logistic law has been used successfully in modeling the growth of *penicillium chrysogenum*, a penicillin-producing organism.

Penicillin (y_2) is produced at a rate proportional to the concentration of the cell (y_1) and is degraded by hydrolysis, which is proportional to the concentration of the penicillin itself. Thus, the dynamic of production of penicillin has been mathematically represented by the equation

$$\frac{dy_2}{dt} = k_3 y_1 - k_4 y_2 \tag{2}$$

While that equation (1) can be easily integrated to give $y_1 = y_1(t)$, equation (2) is more complicated to solve, involving a solution in terms of hypergeometric functions. For this reason, relatively simpler numerical solutions have frequently been used for practical applications.

In this study, the system of differential equations is solved analytically and the solution is simulated for typical values of the kinetic parameters, initial conditions and time of cell growth.

ICMC Summer Meeting on Differential Equations

2015 Chapter

Programme

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

Auditorium	MONDAY 2	TUESDAY 3	WEDNESDAY 4
08:00 - 08:45	**Registration**		
08:45 - 09:00	**Opening**		

Auditorium	Plenary Talks		
Chairman	*Hildebrando M. Rodrigues*	*Shui-Nee Chow*	*Plácido Z. Táboas*
09:00 - 09:40	Shui-Nee Chow	John Mallet-Paret	Hans-Otto Walther
09:40 - 10:20	Marcelo M. Cavalcanti	Djairo G. de Figueiredo	Jerome A. Goldstein
10:20 - 10:50	Coffee Break	Coffee Break & Poster Session	Coffee Break
Chairman	*Massimo Grossi*	*Hans-Otto Walther*	*Eduardo Teixeira*
10:50 - 11:30	Tomás Caraballo	Yingfei Yi	José M. Arrieta
11:30 - 12:10	Eduardo Teixeira	Plácido Z. Táboas	Claudianor O. Alves
12:10 - 14:10	Lunch		
Chairman	*José M. Arrieta*	*Marcelo M. Cavalcanti*	*Yingfei Yi*
14:10 - 14:50	Martin Bohner	Massimo Grossi	Marco A. Teixeira
14:50 - 15:30	Ma To Fu	Wladimir Neves	Hugo Leiva
15:30 - 16:00	Coffee Break	Coffee Break & Poster Session	Coffee Break

Auditorium	Special Session on Nonlinear Dynamical Systems		
Chairman	*Pedro Marín-Rubio*	*Ma To Fu*	*Sergio Muniz Oliva Filho*
16:00 - 16:30		Sergey Shmarev	Pedro Marín-Rubio
16:30 - 17:00	Alessia E. Kogoj	Fabiana T. de Cezaro	Luis Felipe Rivero
17:00 - 17:30	Stefanie Sonner	Matheus C. Bortolan	Jacson Simsen
17:30 - 18:00	Marcone C. Pereira	Vishnevski Mikhail	Juliana F. S. Pimentel

Room 5-001	Special Session on Ordinary and Functional Differential Equations		
Chairman	*Jaqueline Godoy Mesquita*	*Bruno de Andrade*	*Martin Bohner*
16:00 - 16:30	Márcia Federson	Pierluigi Benevieri	Jaqueline Godoy Mesquita
16:30 - 17:00	Luciano Barbanti	Marcos Napoleão Rabelo	Filipe Dantas dos Santos
17:00 - 17:30	Jayme Vicente de Luca	Ginnara Mexia Souto	James Gbenga Alaba
17:30 - 18:00	Xiaoying Han		

Room 5-103	Special Session on Fluid Dynamics		
Chairman	*Gabriela Planas*	*Paulo Mendes Carvalho*	
16:00 - 16:30	Paulo Mendes Carvalho	Vladimir Grebenev	
16:30 - 17:00	César G. Almeida	Maicon J. Benvenutti	
17:00 - 17:30	Sávio Rodrigues	Gabriela Planas	

Room 5-104	Special Session on Linear Partial Differential Equations		
Chairman		*Adalberto P. Bergamasco*	
16:00 - 16:30		Tiago H. Picon	
16:30 - 17:00		Rafael Borro Gonzalez	
17:00 - 17:30		Giuliano A. Zugliani	
17:30 - 18:00		Marcello D'Abbicco	

Room 5-003	Special Session on Elliptic Equations		
Chairman	*Sebastián Lorca*	*Claudianor O. Alves*	*Olivaine S. de Queiroz*
16:00 - 16:30	Giovany M. Figueiredo	Olivaine S. de Queiroz	Sebastián Lorca
16:30 - 17:00	Jefferson Abrantes Santos	Nilson C. Roberty	Angelo Holanda
17:00 - 17:30	Cláudia R. Santana	Pedro J. Martínez Aparicio	Vanderley A. Ferreira Jr.
17:30 - 18:00	Denilson da Silva Pereira		

Room 5-004	Special Session on Dispersive Equations		
Chairman	*Marcia A. G. Scialom*	*Xavier Carvajal*	
16:00 - 16:30	Xavier Carvajal	Fábio Natali	
16:30 - 17:00	Leandro Domingues	Gleison N. Santos	
17:00 - 17:30	Márcio Hiran Simões	Sandra Lucente	
17:30 - 18:00	Mahendra Panthee	Marcia A. G. Scialom	

Room 5-101	Session on Conservation Laws and Transport Equations		
Chairman	*Wladimir Neves*	*Fabio T. Ramos*	*Hugo de La Cruz*
16:00 - 16:30	Fabio T. Ramos	Hugo de La Cruz	Marcelo Martins dos Santos
16:30 - 17:00	Olivier Kneuss	Aparecido J. de Souza	Jean Silva
17:00 - 17:30	Edgard A. Pimentel	Matheus Correia dos Santos	
17:30 - 18:00	Adrian R.Gómez Plata		

Coffee Area	Posters Sessions
10:20 - 10:50	Ailton Rodrigues da Silva
	Carlos R. Mamani Mamani
	David A. Chipana Mollinedo
	Emerson Boscheto
	Francisco Camilo da Silva
	Gilberto A. Prataviera
15:30 - 16:00	Gleiciane da Silva Aragão
	Jose M. Mendoza Aranda
	Mateus Torres de Sousa
	Pedro Toniol Cardin
	Rafael Antônio Rossato
	Samuel C. de Oliveira

	Social Events	
18:30	**Cocktail** (Coffee Area)	
12:10		**Photo** (ICMC)
20:30		**Conference Banquet** (Café Tropical)

ICMC Summer Meeting on Differential Equations

2015 Chapter

List of Speakers

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

ICMC Summer Meeting on Differential Equations

2015 Chapter

Sponsors

The ICMC Summer Meeting on Differential Equations - 2013 Chapter is grateful to the following organizations for providing the financial support.

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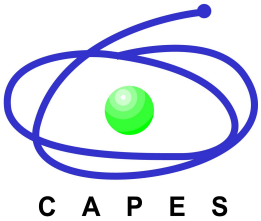

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