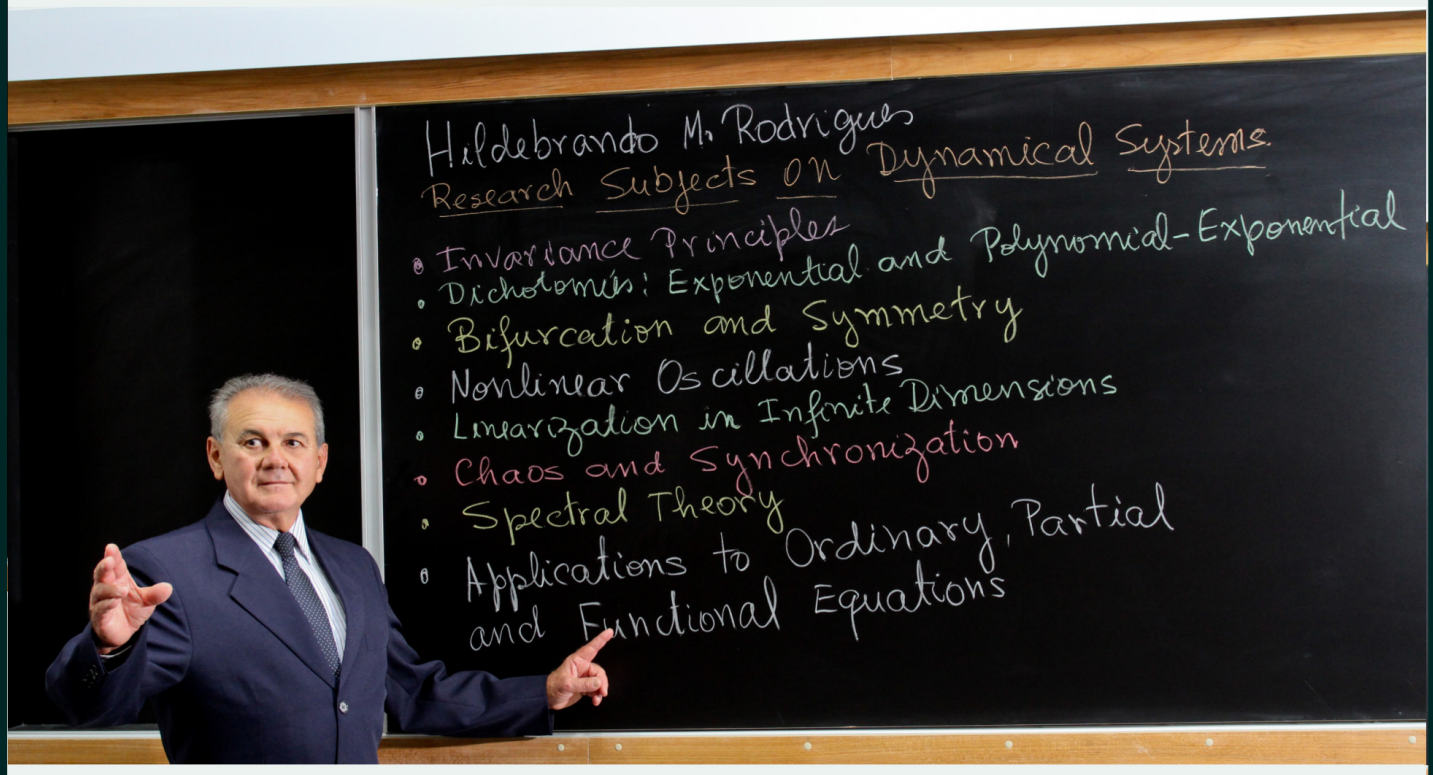
ICMC Summer Meeting on Differential Equations

2013 Chapter

Celebrating the 70th birthday of Hildebrando Munhoz Rodrigues

ICMC USP SÃO CARLOS

Book of Abstracts



Welcome

It is a pleasure to welcome you to the *ICMC Summer Meeting on Differential Equations - 2013 Chapter* and to São Carlos to celebrate the 70^{th} birthday of Hildebrando Munhoz Rodrigues. We wish you a pleasant stay and that you enjoy the meeting.

Organizing committee

Alexandre Nolasco de Carvalho (ICMC / USP)

Ederson Moreira dos Santos (ICMC / USP)

Ma To Fu (ICMC/USP),

Márcia Cristina Anderson Braz Federson (ICMC / USP),

Marcio Fuzeto Gameiro (ICMC / USP),

Sérgio Henrique Monari Soares (ICMC / USP).

Scientific committee

Alexandre Nolasco de Carvalho (Universidade de São Paulo / Brazil),

Carlos Rocha (Instituto Superior Técnico / Portugal),

George R. Sell (University of Minnesota / USA),

Jianhong Wu (York University / Canada),

Joan Solà-Morales (Universitat Politècnica de Catalunya / Spain),

John Mallet-Paret (Brown University / USA),

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

Konstantin Mischaikow (Rutgers University / USA),

Marco Antonio Teixeira (Universidade Estadual de Campinas / Brazil),

Orlando Francisco Lopes (Universidade de São Paulo / Brazil),

Peter Kloeden (Goethe University Frankfurt / Germany),

Sérgio Henrique Monari Soares (Universidade de São Paulo / Brazil),

Shui-Nee Chow (Georgia Tech / USA),

Tomás Caraballo (Universidad de Sevilla / Spain),

Waldyr M. Oliva (Instituto Superior Técnico / Portugal and Universidade de São Paulo / Brazil),

Yingfei Yi (Georgia Tech / USA).

Session Organizers

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

Cláudia B. Gentile (UFSCar): Special Session on Nonlinear Dynamical Systems

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

Márcia Scialom (IMECC / UNICAMP): Special Session on Dispersive Equations

Marcia Federson and Ma To Fu (ICMC / USP): Special Session on Ordinary and Functional Diff. Equations

Milton da Costa Lopes Filho (UFRJ): Special Session on Fluid Dynamics

Address

ICMC Summer Meeting on Differential Equations - 2013 Chapter
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Universidade de São Paulo
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e-mail: summer@icmc.usp.br

ICMC Summer Meeting on Differential Equations

2013 Chapter

Maps

Entrances an Exits of the Campus

1. ICMC entrance
2. Main entrance
3. Observatório's entrance
4. Physics institute's entrance
5. Physics institute's exit

Hotels

1. Hotel Indaiá Residence
2. Parisi Hotel
3. Hotel Indaiá
4. Hotel Anacã
5. San Ciro Apart Hotel
6. Atlantic Inn Residence

Bars

1. Tio Joaquim
2. Boteco Santa Teresa
3. Vila Brasil Botequim
4. Donna Léo Choperia
5. Mosaico Bar e Restaurante
6. Cachaçaria Água Doce
7. Almanach Café e Restaurante
8. Pimentas Bar
9. Seo Gera

Restaurants

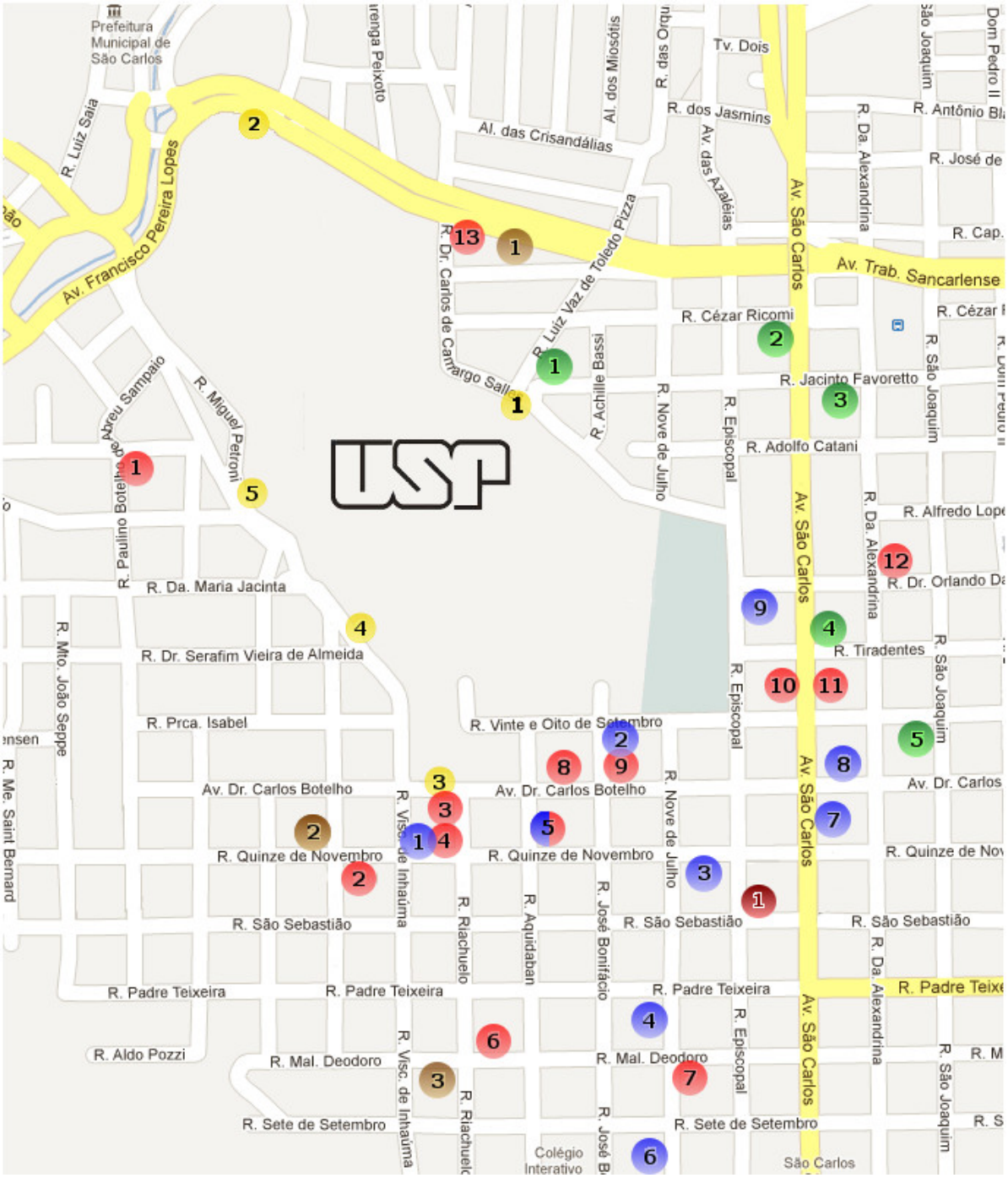
1. Restaurante La Salute (lunch only)
2. Restaurante La Villa
3. Casa do Café
4. Cantina Ciao Bello
5. Mosaico Bar e Restaurante
6. Sabor Oriental
7. Restaurante Mamãe Natureza (lunch only)
8. Restaurante Barone
9. Kalil Cozinha Árabe
10. Roda Chopp
11. Sushi-Ya San
12. Restaurante Panela
13. Restaurante Curinga

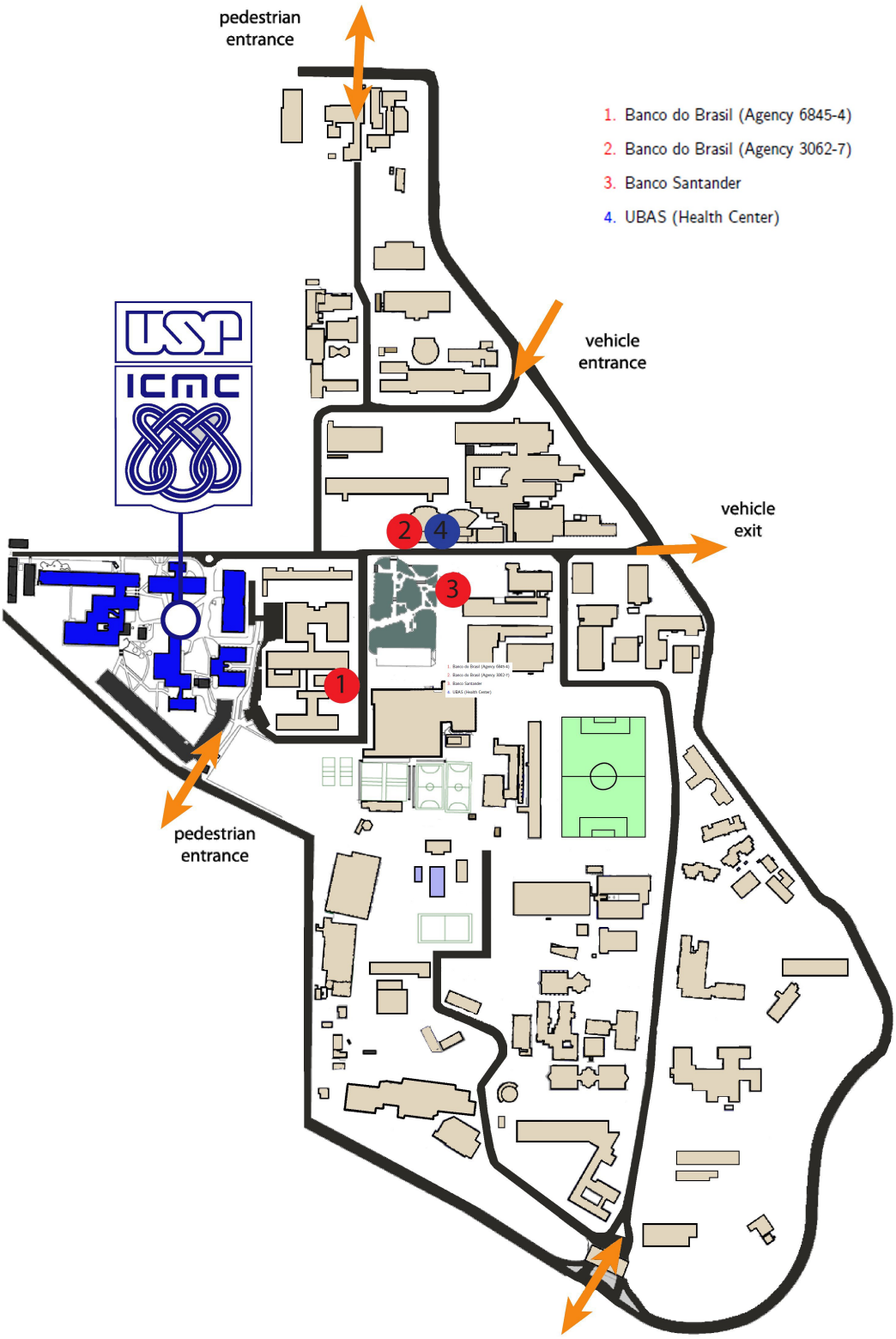
Pizzerias (dinner only)

1. Pizzaria Bom Pedaço
2. Pizzaria Amici
3. Pizzaria Don Raffaele

Money Exchange

1. Fitta Câmbio


Prefeitura Municipal de São Carlos
R. Luiz Saia
Av. Francisco Pereira Lopes
Al. das Crisandálias
R. Dr. Carlos de Carvalho Sallum
R. Luiz Vaz de Toledo Pizza
Al. dos Miosótis
R. dos Jasmins
Av. das Azaléias
Tv. Dois
Av. São Carlos
Av. Trab. Sancarlense
R. Cézar Ricomi
R. Jacinto Favoretto
R. Adolfo Catani
R. Achille Bassi
R. Nove de Julho
R. Episcopal
R. São Joaquim
R. Da. Alexandrina
R. Antônio Bla
R. José de
R. Cap.
R. Cézar
R. Dom Pedro II
R. Alfredo Lope
R. Dr. Orlando Da
R. Tiradentes
R. Abreu Sampaio
R. Miguel Petroni
R. Paulino Botelho
R. Da. Maria Jacinta
R. Dr. Serafim Vieira de Almeida
R. Mto. João Seppe
R. Me. Saint Bernard
R. Prca. Isabel
R. Vinte e Oito de Setembro
Av. Dr. Carlos Botelho
R. Quinze de Novembro
R. Visc. de Inhaúma
R. Riachuelo
R. Aquidaban
R. José Bonifácio
R. São Sebastião
R. Padre Teixeira
R. Aldo Pozzi
R. Mal. Deodoro
R. Sete de Setembro
Colégio Interativo
São Carlos
USP


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
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Contents

ICMC Summer Meeting on Differential Equations

2013 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 Elliptic Equation in room 5-003 (Building 5)

Special session on Ordinary and Funct. Diff. Equations in room 5-001 (Building 5)

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

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

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

Special session on Linear Partial Differential Equations in room 5-103 (Building 5)

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

Registration

The registrations will be made in the following schedule:

Sunday, February 3^{rd} From 17:00hs to 18:00hs in the lobby of Anacã Hotel.

Monday, February 4^{th} From 8:00hs to 8:20hs in the entrance of the Auditorium (Building 6).

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

The Event's Office (number 3, map at page 11) will be at your disposal for any questions and informations.

Financial support

The financial support payment is planned to be made on Tuesday, February 5^{th} in the Financial Office (number 4, map on page 11).

You are requested to fulfill your information at the on-line form available at `www.icmc.usp.br/~summer/user_summer/` , this is mandatory in order to receive the payment.

Meals and refreshments

There are several restaurants near the campus. You can find them by looking at the city map located on page 5, the restaurants are in red. There are also three choices of pizzerias, which are in brown. At night, there are many bars around the city and they can be found in the map in the color blue.

There is also available a canteen on the campus (look for building (7) at the ICMC map located in page 11) where you can have either snacks or lunch.

Social events

Monday, February 4^{th}: Musical presentation at 18:30hs in the Auditorium.

Monday, February 4^{th}: Cocktail at 19:30hs at ICMC.

Tuesday, February 5^{th}: Photo of the meeting at 12:10hs at ICMC.

Tuesday, February 5^{th}: Conference Banquet at 20:30hs in Anacã Hotel.

Health emergencies

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

Money exchanges

In case you need to exchange your money, we recommend you to look for Fitta Câmbio, located in Rua Episcopal, 1931. The work hour is from 9:00hs to 17:30hs. You can locate it at the map in page 7.

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 room 5-002 (look for building (5) at the ICMC map located in page 11).

In order to access the wireless connection at the University you need to follow the steps:

1. Enable wireless on your device.
2. Join the ICMC-PORTAL wireless network.
3. Open a browser and attempt to visit a website (for example your home page).
4. Click on the button in the page to proceed.
5. You will be redirected to a login page. Enter the login and password as follows:

   login: *summer13@icmc.usp.br*

   password: summer13
6. 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

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Plenary talks

Singular solutions to a class of subcritical elliptic equations

Alfonso Castro, Victor Ardila, Jose Caicedo
Harvey Mudd Collge

We prove the existence of uncountably many radial singular solutions to elliptic boundary value problems with subcritical nonlinearities, sub-super critical nonlinearities, and jumping nonlinearities when $f(u) \tilde{=} u^p$ for u large and $p \in (N/(N-2), (N+2)/(N-2))$. Here N denotes the dimension of the space variable.

Generic properties for the eigenvalues of the Neumann Laplacian in symmetric regions

A. L. Pereira, M. A. M. Marrocos
Universidade de São Paulo-Campus São Paulo

We discuss the generic situation of the eigenvalue problem for the Neumann Laplacian, under the presence of symmetry. The results obtained constitute a partial answer to a conjecture implicitly formulated by V. I. Arnold in [1] and stated more explicitly in [3]. The main tools are the general framework developed by Henry in [2] for boundary perturbation problems and some basic results from the representation theory of compact groups.

1. V.I. Arnold, Modes and Quasimodes, *Funct. An. and Appl.*,**6**, 94-101, 1972.
2. D.B. Henry, *Perturbation of the boundary in boundary value problems*, Dunod-Gauthier Villars, Paris, First edition, 1969.
3. A. L. Pereira, Eigenvalues of the Laplacian on symetric regions, *NoDEA*, **2**, 63-109, 1995.

Diffusibility-geometry induced patterns on surfaces of revolution

Arnaldo Simal do Nascimento, Maicon Sonego
UFSCar

We address two questions:

1. How should be the interaction of diffusibility and the geometry of a surface of revolution in order to have patterns (nonconstant stable stationary solutions) formation on this surface?

2. Creation of patterns in a singularly perturbed reaction-diffusion equation in case of intersection of the roots of the degenerated equation. These roots depend on the spatial variable.

Random dynamical systems for spde driven by a fractional Brownian motion

Björn Schmalfuss
Friedrich Schiller Universität Jena

We consider a stochastic evolution equation driven by an infinite fractional Browninian motion with Hurst parameter larger than 1/2. In front of this noise we have a nontrivial coefficient. We show the existence of a cocycle-version of this equation with paths in the space of Hölder continuous functions. In addition, we derive condition for the existence of a random attractor.

Morse decompositions for Sturm global attractor

Carlos Rocha
Instituto Superior Técnico

We review recent results on the characterization of global attractors for semiflows generated by scalar reaction diffusion equations defined on an interval with periodic boundary conditions.

A non-commutative mutation of the Poncelet porism

Carlos Tomei
PUC-Rio

The standard Poncelet porism in the plane admits some extensions to higher dimension which are naturally related to discrete and continuous integrable systems. In this talk we present recent work of Gibson (U. York, Canada), Saldanha and myself (PUC-Rio). As an example, consider two ellipsoids I and O, where $I \subset O \subset R^n$, and search for *tight simplexes*: their vertices are in O and faces are tangent to I. Either there are no such polytopes, or the solution space is naturally parameterized by $SO(n)$.

Metastable periodic patterns in singularly perturbed state dependent delayed equations

X. Pellegrin, C. Grotta-Ragazzo, **C. P. Malta** and K. Pakdaman
USP

We consider the scalar delayed differential equation $e_p\dot{x}(t) = -x(t) + f(x(t-r))$, where $e_p > 0$, $r = r(x, e_p)$ and f represents either a positive feedback $df/dx > 0$ or a negative feedback $df/dx < 0$. When the delay is a constant, i.e. $r(x, e_p) = 1$, this equation admits metastable rapidly oscillating solutions that are transients whose duration is of order $\exp(c/e_p)$, for some $c > 0$. In this paper we investigate whether this metastable behavior persists when the delay $r(x, e_p)$ depends non trivially on the state variable x. Our conclusion is that for negative feedback, the persistence of the metastable behavior depends only on the way $r(x, e_p)$ depends on e_p and not on the feedback f. In contrast, for positive feedback, for metastable solutions to exist it is further required that the feedback f is an odd function and the delay $r(x, e_p)$ is an even function. Our analysis hinges upon the introduction of state dependent transition layer equations that describe the profiles of the transient oscillations. One novel result is that state dependent delays may lead to metastable dynamics in equations that cannot support such regimes when the delay is constant.

Differential variational inequalities

David E. Stewart
University of Iowa

Differential variational inequalities are a class of dynamical systems that generalizes differential equations, and includes many types of differential inclusions. These systems have many applications where discontinuous or nonsmooth behavior is expected, including mechanical impact problems, Coulomb friction, electrical circuits with diodes, dynamic queuing networks, and dynamic traffic flows. Their structure also allows existence and uniqueness proofs for many classes of problems. The talk will explain what these dynamical systems are and how they can be understood and applied.

Semilinear elliptic systems

Djairo Guedes de Figueiredo
IMECC - UNICAMP

Using variational and topological techniques we discuss the questions of existence, non-existence and multiplicity of solutions for semilinear elliptic systems. Nonlinearities involving the gradient and the presence of weights, which change the notions of criticality will be considered.

Dichotomies (exponential and others) with applications

George Sell
Minnesota

This lecture will focus on the legacy of Lyapunov in the area of Dichotomies. While the use of the Lyapunov-Perron theory of exponential dichotomies in the study of ODEs and PDEs is well-understood, there is a potential for more insight to be gained by combining the Lyapunov-Perron theory with the related recent work of others in the area of Lyapunov Exponents and the Multiplicative Ergodic Theorem. As we will show, there is much to be gained on problems where both theories are applicable.

Complicated motion caused by variable delay

Hans-Otto Walther
Universitaet Giessen

For $\frac{\pi}{2} < \alpha < \frac{5\pi}{2}$ the simple linear equation

$$x'(t) = -\alpha x(t-1) \qquad \in I\!R$$

has only non-real characteristic values, 2 in the right halfplane and the others in the left halfplane. We construct a state-dependent delay

$$d_U : C \supset U \to (0,2)$$

with $d_U(\phi) = 1$ for ϕ close to $0 \in C = C([-2,0], I\!R)$ in such a way that the equation

$$x'(t) = -\alpha x(t - d_U(x_t))$$

has a homoclinic solution $x = h$,

$$h(t) \to 0 \quad \text{as} \quad |t| \to \infty, 0 \neq h_t = h(t+\cdot) \in C^1 = C^1([-2,0], I\!R).$$

The flowline

$$\begin{aligned} I\!R \ni t \mapsto h_t &\in X \\ &= \{\phi \in U \cap C^1 : \phi'(0) = -\alpha\phi(-d_U(\phi))\} \end{aligned}$$

is a minimal intersection of the stable and unstable manifolds at equilibrium in the solution manifold X. This should imply chaotic motion close to the homoclinic loop.

Canard cycles in predator-prey systems

Huaiping Zhu

York University

There have been bifurcation studies of predator-prey systems, yet the study of canard cycles of such systems is rather limited due to technical difficulties in dealing with the degenerate singularities and degenerate graphics limit periodic sets. In this talk, by using center manifolds and geometric singular perturbation theory, I will present bifurcation studies of canard cycles in predator-prey systems, and apply the results to obtain canard cycles in models with different Holling types of functional responses. This is a joint work with Chengzhi Li.

A generalised Ladyzhenskaya inequality for a coupled parabolic-elliptic problem

David McCormick, **James C. Robinson**, Jose L. Rodrigo

University of Warwick

I will talk about the system

$$B_t + \varepsilon \Delta B + (u \cdot \nabla) B = (B \cdot \nabla) u,$$

where u is the solution of the elliptic Stokes problem

$$-\Delta u + \nabla p = (B \cdot \nabla) B \qquad \text{with} \qquad \nabla \cdot u = 0.$$

These equations are related to Moffatt's method of 'magnetic relaxation' for constructing stationary solutions of the Euler equations with non-trivial topology, and when $\varepsilon = 0$ there are interesting analogies with the 3D Euler equations.

Weak Lebesgue spaces arise naturally in the analysis of this problem. I will introduce these, discuss some of their useful properties, and prove the global existence of weak solutions for $\varepsilon > 0$, using the generalised Ladyzhenskaya inequality

$$\|u\|_{L^4} \leq c \|u\|_{L^{2,\infty}} \|\nabla u\|_{L^2},$$

where $L^{2,\infty}$ is the weak-L^2 space.

Energy asymptotics for waves with strong damping

Jerome A. Goldstein

University of Memphis

We study second order (in time) wave equations with a friction term described by a postive selfadjoint unbounded operator. Of concern are asymptotic equipartition of energy, overdamping, and asymptotic parabolicity.

Hyperbolic-parabolic systems with delay: existence and stability of wavefronts

Jianhong Wu

York

We consider a hyperbolic-parabolic equation with non-local delay terms, that arises from the population dynamics of a structured single species population where the spatial movement of the mature individual follows the Fick's diffusion law but with a time lag. We develop a hybrid iterative scheme to establish the existence of a family of traveling wave fronts with the minimal wave speed determined by solving a transcendental equation. We then utilize various energy functionals to obtain the asymptotic stability of the traveling wave fronts under perturbations in appropriate weighted Sobolev spaces. This is based on joint work with G. Raugel from CNRS et University de Paris-Sud.

A review of results on linearization in Banach spaces

J. Solà-Morales

Universitat Politècnica de Catalunya

In this communication we will review results on infinite-dimensional linearization obtained during the past ten years in collaboration with Hildebrando M. Rodrigues. These are results of a joint project that is still going on.

The main results obtained have to do with class C^1 smooth linearization around a fixed point for an invertible map, and there are both in the positive and negative direction, since negative counterexamples have been also obtained. These results can be applied to some partial differential equations like damped wave equations.

Other results have to do with extensions of the classical Hartman-Grobman continuous linearization theorem, strongly influenced by the classical proof due to Ch. Pugh.

The main references are the following:

Rodrigues, H.M., Solà-Morales, J.: *Linearization of Class C^1 for contractions on Banach spaces*. J. Differ. Equ. 201(2), 351-382 (2004).

Rodrigues, H.M., Solà-Morales, J.: *Invertible contractions and asymptotically stable ODEs that are not C^1-linearizable*. J. Dyn. Differ. Equ. 18(4), 961-974 (2006)

Rodrigues, H.M., Solà-Morales, J.: *On the Hartman-Grobman Theorem with Parameters*. J. Dyn. Differ. Equ. 22, 473-489 (2010).

Domain perturbation and boundary oscillations for some high order selfadjoint operators

José M. Arrieta

Universidad Complutense de Madrid

We will consider fourth order selfadjoint elliptic operators with different boundary conditions and will analyze its behavior when the domain is perturbed. We will obtain conditions for the stability of this operator with Dirichlet and Neumann boundary conditions. We will also pay special attention to the more delicate "intermediate" boundary condition and its behavior when the boundary presents some oscillatory behavior. This is a join work with Pier D. Lamberti, Univ. of Padova, Italy.

Some aspects in vibrating nanobeams

Julio Ruiz Claeyssen

UFRGS

Vibrating nanobeams are formulated in their physical space. Their responses are determined by using the initial value Green operator. Modal analysis, noise removal and initialization values are discussed with matrix models.

Uniform decay rate estimates for Schrödinger and Plate equations with nonlinear locally distributed damping

M. M. Cavalcanti, C. A. Bortot, W. J. Corrêa and V. N. Domingos Cavalcanti

Universidade Estadual de Maringá

On a compact $n-$dimensional Riemannian manifold $(\mathcal{M}, \mathbf{g})$, we establish uniform decay rate estimates for the linear Schrödinger and plate equations subject to an internal nonlinear damping locally distributed on the manifold. Our approach can be also employed for other equations provided that inverse inequality for the linear model occurs. In the particular case of the wave equation, where the well known geometric control condition (GCC) is equivalent to the observability inequality, our method generalizes the results due to Cavalcanti et. al. [1,2] regarding the optimal choice of dissipative regions.

1. M. M. Cavalcanti, V. N. Domingos Cavalcanti, R. Fukuoka, J. A. Soriano, Asymptotic stability of the wave equation on compact manifolds and locally distributed damping: a sharp result. *Arch. Ration. Mech. Anal.* 197 (2010), no. 3, 925-964.

2. M. M. Cavalcanti, V. N. Domingos Cavalcanti, R. Fukuoka, J. A. Soriano, Asymptotic stability of the wave equation on compact surfaces and locally distributed damping-a sharp result. *Trans. Amer. Math. Soc.* 361 (2009), no. 9, 4561-4580.

Simultaneous linearization of some diffeomorphims

Marco Antonio Teixeira, Solange Mancini, Miriam Manoel

UNICAMP

In this paper we discuss a simultaneous linearization for a class of pairs of involutions whose composition is normally hyperbolic. Inside the class of pairs with normally hyperbolic composition, we obtain a characterization theorem for the composition to be hyperbolic. In addition, related to the class of interest, we present the classification of pairs of linear involutions via linear conjugacy.

Towards homological persistence in computational dynamics

Marian Mrozek, Herbert Edelsbrunner, Grzegorz Jablónski

Jagiellonian University

In recent years persistent homology developed by H. Edelsbrunner, D. Letscher and A. Zomorodian gained a lot of attention and found many applications. When a topological space is known only from sampling, persistence provides a useful tool to study its homological properties. In many applications one can sample not only the space, but also a map acting on the space. The understanding of the topological features of the map is often of interest, in particular in the analysis of time series dynamics but also in the dynamics of a map or differential equation given explicitely when the rigorous study is computationally too expensive and only numerical experiments are available.

We will present an extension of persistent homology to the case of a continuous map together with the associated algorithm and numerical examples based on the implementation of the algorithm. We will also discuss the possible applications which range from the study of dynamical systems given by time series to developing measures of stability of topological invariants in dynamics such as the Conley index.

Transient and robust oscillations in immune response dynamics

Michael Li

University of Alberta

Immune responses to viral infections, antibody responses or cytotoxic T cell (CTL) responses, tend to be oscillatory. In many cases, these oscillations only last for finite time (transient), but they are repeatable in animal experiments or observable among many patients (robust). In this talk, we present a simple mechanism, using a mathematical model of viral infection, for producing transient while robust periodic oscillations.

An algorithm for computing the Conley index of a Poincaré map. Part I: theoretical aspects

Roman Srzednicki, Marian Mrozek, Frank Weilandt

Jagiellonian University

The homological Conley index of the Poincaré map provides essential information on qualitative behavior of a flow. In particular, it can be applied in proofs of the existence of periodic orbits or chaotic dynamics. In order to determine the index one usually follows numerically trajectories of the flow. That rises to technical difficulties caused by exponentially growing error of calculations. In the talk, I will present theoretical aspects of a quite different approach, based on a construction of an index pair and the corresponding singular chains in the suspension of the Poincaré map. The discretization of the flow for a relatively small time-step is needed only; no computation of trajectories in a long range of time is required. The poster presented by Frank Weilandt provides algorithmic aspects of our method and an evidence of its advantages with respect to the usual approach.

Agent-based modelling for disease dynamics *in-silico* populations

Seyed M. Moghadas
York

Modelling and computational approaches provide powerful tools in the study of disease dynamics at both the micro and macro levels. Recent analytical developments, coupled with advances in information and communications technologies, have opened up novel vistas and presented new challenges in mathematical epidemiology. Key challenges involve ways to deal with the collective dynamics of heterogeneous ensembles of individuals, and to analyze data that are less coarse and more complex. The evolution of dynamic modelling is typified by the agent-based modelling (ABM) paradigm, a lattice-distributed collection of autonomous decision-making entities (i.e., agents), the interactions of which unveil the dynamics and emergent properties of an infectious disease outbreak. The flexibility of ABMs permits an effective representation of the complementary interactions between individuals characterized by localized properties and populations at a global level. In this talk, we discuss the importance of ABMs in understanding epidemic spread, and identifying optimal intervention strategies in different population settings with distinct demographic characteristics.

Hopf bifurcation for non-densely defined Cauchy problems and applications

Shigui Ruan
University of Miami

Several types of differential equations, including functional differential equations, age-structured models in population dynamics and epidemiology, some partial differential equations, and evolution equations with nonlinear boundary conditions, can be written as non-densely defined semilinear Cauchy problems. We establish a Hopf bifurcation theorem for abstract Cauchy problems in which the linear operator is not densely defined and is not a Hille-Yosida operator. The theorem is proved by using the center manifold theory for non-densely defined Cauchy problems associated with the integrated semigroup theory. As applications, we study the existence of Hopf bifurcation in a size-structured reaction-diffusion model with Ricker type birth function and an age-structured malaria model of infected red blood cells.

Finding the shortest path by evolving junctions on obstacle boundaries

Shui-Nee Chow, Jun Lu, Haomin Zhou
Georgia Institute of Technology

We propose a new fast algorithm for finding a global shortest path connecting two points while avoiding obstacles in a region by solving a finite set of initial value problems for ordinary differential equations under random (white noise) perturbations. The idea is based on the fact that every shortest path possesses a simple and the same geometric structure. This enables us to restrict our search to a set of feasible paths that share a common structure. Each of the search set is based on a union of finite dimensional compact manifolds representing the obstacle boundaries. Comparing to the existing methods, such as combinatorial methods or partial differential equations methods, our algorithm seems to be faster and easier to implement. We can also handle cases in which obstacle shapes are arbitrary and/or the dimension of the base space is three or higher. In addition, we can also consider similar problems with obstacles that are not necessary stationary. This is joint work with Jun Lu and Haomin Zhou.

Oscillatory motions in the restricted circular planar three body problem

Tere M. Seara, Marcel Guardia, Pau Martin
Universitat Politecnica de Catalunya

We consider the circular restricted three body problem which models the motion of a masless body under the influence of the Newtionan gravitational force caused by two other bodies, the primaries, which move along cicular planar Keplerian orbits. In a suitable system of coordinates, this system has two degrees of freedom and the conserved energy is usually called the Jacobi constant. In 1980, J. Llibre and C. Simáo proved the existence of oscillatory motions for the restricted planar circular three body problem, that is, of orbits which leave every bounded region but which return infinitely often to some fixed bounded region. To prove their existence they had to assume the ratio between the masses of the two primaries to be exponentially small with respect to the Jacobi constant. In this talk, we generalize their work proving the existence of oscillatory motions for any value of the mass ratio. To obtain such motions, we show that, for any value of the mass ratio and for big values of the Jacobi constant, there exist transversal intersections between the stable and unstable manifolds of infinity which guarantee the existence of a symbolic dynamics that creates the oscillatory orbits. The main achievement is to rigorously prove the existence of these orbits without assuming the mass ratio small since then this transversality can not be checked by means of classical perturbation theory respect to the mass ratio. We also detect a curve in the parameter space, formed by the mass ratio and the Jacobi constant, where cubic homoclinic tangencies between the invariant manifolds of infinity appear.

Lattice dynamical systems with delays: existence of solutions and their asymptotic behavior

Tomás Caraballo
Universidad de Sevilla

The aim of this talk is to analyze a class of lattice differential equations containing some hereditary characteristics (delays). First we establish some results ensuring existence of solutions, and uniqueness when we impose stronger assumptions. Next we prove the existence of a global attractor for the dynamical system generated by the model. We will use techniques from set-valued or multi-valued dynamical systems since we will only impose rather general hypotheses which do not guarantee, in principle, the uniqueness of solutions. Finally, some illustrative applications will be shown.

Transient motions in dynamical networks

Valentin Afraimovich

Universidad Autonoma de San Luis Potosi

Complex networks such as the neuronal ones composed of neurons coupled by chemical synapses are known to exhibit a large variety of forms of activity. Certain neurophysiological experiments have shown that neuronal processes are accompanied by short transient activity of individual elements. Such a behavior is called the sequential dynamics. In the framework of dynamical systems theory this behavior is related to the existence of a collection of metastable invariant sets joined by transient (often heteroclinic) trajectories in the phase space. The sequential dynamics can be treated as a process of successive switchings among these sets. Such a treatment allows one to explain temporal order in which the elements become activated and to single out parameters of the system responsible for its prediction. In the talk it is supposed to speak about the situations where metastable sets are just equilibrium points or limit cycles and where they are more complex sets.

A survey on the asymptotic behavior of repelling particles

Waldyr Muniz Oliva

Instituto Superior Técnico

Some aspects of the asymptotic behavior, for infinite time, of a system on N particles in Rn which repell each other with an interaction potential.

The talk is based on two published papers (joint works with Giorgio Fusco) :

1- Integrability of a system of N electrons subjected to Coulombian interactions (JDE vol 135, 1977)

and

2- Formation of symmetric structures in the dynamics of repelling particles (ARMA vol 151, 2000)

Stationary measures of Fokker-Planck equations

Yingfei Yi

Georgia Institute of Technology and Jilin University

We consider white noise perturbations of a system of ordinary differential equations. By relaxing the notion of Lyapunov functions associated with the stationary Fokker-Planck equations, new existence and non-existence results of stationary measures in a general domain including the entire space will be presented for both non-degenerate and degenerate noises. Limiting behaviors of stationary measures will be discussed along with applications to problems of stochastic stability and bifurcations.

ICMC Summer Meeting on Differential Equations

2013 Chapter

Special Sessions

Elliptic Equations

Organizer: Claudianor Oliveira Alves

Saturable Schrödinger equations: existence and concentration phenomena

Benedetta Pellacci

Napoli "Parthenope"

We will focus on the new aspects of the saturable Schrödinger equations and systems. In particular, we will address the problem of existence of solutions of minimum energy in the case of systems and the concentration phenomena for the single equations highlighting the differences with the most studied nonlinear Schrödinger equations.

Existence and multiplicity for elliptic problems with quadratic growth in the gradient

Boyan Sirakov, Louis Jeanjean

PUC-Rio

We show that a class of divergence-form elliptic problems with quadratic growth in the gradient and non-coercive zero order terms are solvable, under essentially optimal hypotheses on the coefficients in the equation. In addition, we prove that if the equation is not coercive the solutions are not unique, in contrast with the well-studied case of coercive equations.

On existence and concentration of solutions for an elliptic problem with discontinuous nonlinearity via penalization method

Claudianor O. Alves, Giovany M. Figueiredo, R'ubia G. Nascimento

Universidade Federal de Campina Grande

In the present paper, we establish existence and concentration of positive solution for a class of elliptic problems in $\mathbb{R}^N$ whose nonlinearity is discontinuous.

Results like Strauss and Lions for a class of Orlicz-Sobolev spaces and applications

Jefferson Abrantes dos Santos, Claudianor O. Alves, Giovany M. Figueiredo

Universidade Federal de Campina Grande

The main goal this work is to prove two results like Strauss and Lions for Orlicz-Sobolev spaces. After, we use these results for study the existence of solutions for a class of quasilinear problem in $\mathbb{R}^N$.

Multiplicity of self-similar solutions for a critical equation

Pinheiro, João Pablo; Furtado, Marcelo Fernandes; Xavier, Magda Soares

Universidade Federal do Pará

We consider the equation

$$-\Delta u - \frac{1}{2}(x \cdot \nabla u) = f(u) + \beta |u|^{2^*-2}u, \ quadx \in \mathbb{R}^N$$

with $\eta > 0$, f superlinear and $2^* = 2N/(N-2)$ for $N \geq 3$. We prove that, for each $k \in \mathbb{N}$, there existis $\beta^* = \beta^*(k) > 0$ such that the equation has a least k pairs of solution provided $\beta \in (0, \beta^*)$. In the proof we use variational methods for the (even) funcional associated the equation

Key words: critical problems; symmetric functionals; self-similar solutions.

Estimates for fully nonlinear elliptic equations and eigenvalue problems

Leonardo Prange Bonorino

Universidade Federal do Rio Grande do Sul

In this work we obtain L^∞ estimates for the fully nonlinear eigenvalue problem

$$\begin{cases} -F(D^2u, x) = \mu^+ u, & \text{in } \Omega \\ u > 0, & \text{in } \Omega \\ u = 0, & \text{on } \partial\Omega, \end{cases}$$

where Ω is an open bounded set of $\mathbb{R}^n$, F is a real valued function defined on $\mathcal{S} \times \mathbb{R}$, $\mathcal{S}$ is the space of real symmetric matrices, F is uniformly elliptic, and μ^+ is some sort of eigenvalue of F. More precisely, we prove that the maximum of a solution to this problem is bounded by the product of some power of μ^+, the L^p norm of u and some constant $C = C(n, \lambda, \Lambda, |\Omega|)$, where $\lambda \leq \Lambda$ are the constants of ellipticity of F and $|\Omega|$ is the measure of Ω.

We study also the problem

$$\begin{cases} -\Delta u = \lambda u^-, & \text{in } \Omega \\ u = c > 0, & \text{on } \partial\Omega \\ \int_{\partial\Omega} u dS = I > 0, & \text{on } \partial\Omega, \end{cases}$$

that arises in the plasma problem, where $\lambda > 0$ and I are given and c is some suitable constant, and obtain optimal L^p estimates for the solution. Using the results of the previous problem, we get some estimates for the fully nonlinear version of this problem, where the original equation is replaced by $-F(D^2u) = \lambda^- u^-$.

A sign-changing solution for an asymptotically linear Schrödinger equation

Liliane A. Maia, Olimpio H. Miyagaki, Sergio H. M. Soares
Universidade de Brasília

The aim of this talk is to present a sign-changing solution for a class of radially symmetric asymptotically linear Schrödinger equations. The proof is variational and the Ekeland variational principle is employed. It includes the special model case

$$-\Delta u + \lambda u = \frac{u^3}{1+su^2} \quad \text{in } \mathbb{R}^N,$$

for $N \geq 3$ and $\lambda > 0$. In nonlinear optics this equation models the propagation of a light-beam in a saturable medium under self-focusing effect.

Homogenization in thin domains with a locally periodic oscillatory boundary

Manuel Villanueva, José M. Arrieta
Universidad Complutense de Madrid

We analyze the behavior of solutions of a Neumann problem for the Laplace equation in a thin domain where the boundary is highly oscillatory. Our thin domains are given by

$$R^\epsilon = \{(x,y) \in \mathbb{R}^2; |; x \in (0,1),, 0 < y < \epsilon, G(x, x/\epsilon)\}$$

where G is a smooth function and $G(x,\cdot)$ is $l(x)-$periodic with $l(\cdot)$ not necessarily constant. Observe that, instead of the usual periodic case, we consider domains where the amplitude and frequency of the oscillations depend on x.

We will give the limit behavior of the solutions as $\epsilon \to 0$. Our main tool is the recent Unfolding Method. We will introduce an appropriate unfolding operator for this situation and we will study its main properties.

On Hardy type inequalities and applications to Schrödinger equations

Marco Souto
Universidade Federal de Campina Grande

We consider the Schrödinger equation

$$\left\{ \begin{array}{l} -\Delta u + V(x)u = K(x)|u|^{p-1}u,,, mboxin \mathbb{R}^N, \\ \int_{\mathbb{R}^N} V(x)u^2 dx < infty, \\ u \in \mathcal{D}^{1,2}(\mathbb{R}^N), \end{array} \right. \qquad (P)$$

where V is a nonnegative potential, $K > 0$ and $1 < p < 2^* - 1$.

Its Euler-Lagrange functional is

$$J(u) = \frac{1}{2}\int_{\mathbb{R}^N} (|\nabla u|^2 + V(x)u^2)dx - \frac{1}{p+1}\int_{\mathbb{R}^N} K(x)|u|^{p+1}dx.$$

In order to use the variational method on the problem (P), we need some results about Sobolev imbedding involving some Banach spaces. We will consider $2 \leq q < 2^*$ and the following spaces:

$$L^q_K(\mathbb{R}^N) = \{u : \mathbb{R}^N \to \mathbb{R} : \text{ measurable s.t. } \int_{\mathbb{R}^N} K(x)|u|^q dx < \infty\},$$

and

$$E = \left\{ u \in \mathcal{D}^{1,2}(\mathbb{R}^N) : \int_{\mathbb{R}^N} V(x)u^2 dx < +\infty \right\},$$

endowed, respectively, with the usual norms:

$$||u||_{K,q} = \left[\int_{\mathbb{R}^N} K(x)|u|^q dx \right]^{\frac{1}{q}} \text{ and } ||u||^2 = \int_{\mathbb{R}^N} (|\nabla u|^2 + V(x)u^2) dx.$$

Our main question in this talk is: under which assumptions on V and K we have that E is continuously embedded in $L^q_K(\mathbb{R}^N)$? (J is a C^1 functional in E). And, of course, when this imbedding is compact? (existence of ground state solutions).

This kind of imbedding is called Hardy type inequalities.

Radial sign-changing solutions to biharmonic nonlinear Schrödinger equations

Marcos Tadeu de Oliveira Pimenta

FCT - UNESP

In this work we obtain three radial solutions of a biharmonic stationary Schrödinger equation, being one positive, one negative and a nodal one. The *Dual Decompostion Method* is necessary to split the natural second order Sobolev space considered in order to apply the appropriate variational approach.

Positive solutions for asymptotically linear fourth order elliptic problem

Gonccalves, J.V, Silva, E.D., **Silva, M. L**

Universidade Federal de Goiás

It is establish existence of positive solutions for a fourth order semilinear elliptic problem under asymptotically linear conditions. In the proof of main results we apply global bifurcation theory.

Existence of traveling waves for heat equation in the half plane with boundary reaction

Neus Cónsul

Universitat Politècnica de Catalunya

We prove the existence of a traveling wave solutions for the heat equation in the half plane with a boundary reaction term of non balanced bistable type. The existence of a monotone traveling wave and of its propagation speed are obtained via a variational method and a rearrangement of the minimizer. The uniqueness of this traveling wave, for a given propagation speed, relies on maximum principles and the sliding method. Finally, we show that some of our results and techniques also work for combustion type nonlinearities. This is a joint work with X. Cabré and J.V. Mandé.

Some geometric and regularity estimates for problems driven by the fractional Laplacian

Olivaine S. de Queiroz

UNICAMP

I will present some geometric and regularity estimates for problems driven by the fractional Laplacian with applications in free boundary problems and Conformal Geometry. Special attention will be given to some extension results proved by Caffarelli & Silvestre (Euclidean case) and by Chang & González (manifold case), whereby the fractional Laplacian can be realized as a Dirichlet-to-Neumann map for a family of degenerate elliptic problems.

Singular limits for Liouville-type equations on the flat two-torus

Pablo Figueroa

Pontificia Universidad Catolica de Chile

In a two dimensional flat torus Ω, we consider the problem

$$-\Delta u = \varepsilon^2 e^u - \frac{1}{|\Omega|}\int_\Omega \varepsilon^2 e^u + \frac{4\pi N}{|\Omega|} - 4\pi N\delta_p, \text{ in } \Omega, \quad \int_\Omega u = 0$$

where u is doubly periodic on $\partial\Omega$, $\varepsilon > 0$, $|\Omega|$ is the area of Ω, $N \geq 0$ and δ_p is a Dirac mass at $p \in \Omega$. We prove that if $1 \leq m < N+1$ then there exists a family of solutions $u_{\varepsilon\varepsilon}$ st $\varepsilon^2 e^{u_\varepsilon} \rightharpoonup 8\pi \sum_{i=1}^m \delta_{q_i}$ as $\varepsilon \to 0$ in measure sense, with different points $q_i \in \Omega$ $i = 1, \ldots, m$. Furthermore, in case $N = 0$ we show that for any $m \geq 2$ there exists a family of blowing-up solutions $u_{\varepsilon\varepsilon}$ concentrating at m different points q_i, $i = 1, \ldots, m$ of the domain. Moreover, in both cases points $q_1, \ldots, q_m$ are different from p.

The influence of diffusion on critical quasilinear elliptic problems

Renato José de Moura, Marcos Montenegro

Universidade Federal de São Carlos

In this talk we discuss the effect of the diffusion coefficient $a(x)$ on the existence of a positive solution for the quasilinear elliptic problem involving critical exponent

$$\begin{cases} -\text{div}(a(x)|\nabla u|^{p-2}\nabla u) &= u^{p^*-1} + \lambda u^{p-1} & \text{in } \Omega, \\ u &= 0 & \text{on } \partial\Omega \end{cases}$$

where Ω is a smooth bounded domain in $\mathbb{R}^n$, $n \geq 2$, $1 < p < n$, $p^* = np/(n-p)$ is the critical exponent from the viewpoint of Sobolev embedding, λ is a real parameter and $a : \overline{\Omega} \to \mathbb{R}$ is a positive continuous function. We prove that if the function $a(x)$ has an interior global minimum point x_0 of order σ, then the range of values λ for which the problem above has a positive solution relies strongly on σ. In particular we prove that the picture changes drastically from $\sigma > p$ to $\sigma \leq p$. Some sharp answers are also provided.

An existence result to a generalized Boussinesq equation

Sebastián Lorca
Universidad de Taparacá

The equations governing the coupled mass and heat flow of a viscous incompressible fluid in a generalized Boussinesq approximation are

$$\begin{aligned} u_t - \operatorname{div}\left(u\left(T\right)\nabla u\right) + u\cdot\nabla u - f\left(u,T,x\right) + \nabla p &= 0, \\ \operatorname{div} u &= 0, \\ T_t - \operatorname{div}\left(k\left(T\right)\nabla T\right) + u\cdot\nabla T - g\left(u,T,x\right) &= 0 \qquad x\in\Omega. \end{aligned} \tag{1}$$

The equations governing the coupled mass and heat flow of a viscous incompressible fluid in a generalized Boussinesq approximation are

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The vector $u\left(x,t\right)\in\mathbb{R}^N$ denotes the velocity of the fluid; $p\left(x,t\right)\in\mathbb{R}$ is the hydrostatic pressure; $T\left(x,t\right)\in\mathbb{R}$ is the temperature; f is a force (which can be external) and g represents a nonlinear heat sources. The functions $u\left(\cdot\right)>0$ and $k\left(\cdot\right)>0$ are kinematic viscosity and thermal conductivity (temperature dependent).

The boundary conditions are

$$u=0 \text{ and } T=T_0 \text{ on } \partial\Omega,$$

where T_0 is a given function on $\partial\Omega$.

The classical Boussinesq equations correspond to the special case where u and k are positive constants, $f=\left(0,0,\alpha T\right)$ and $g=g\left(x\right)$. This case has been much studied.

The general case corresponds to the physical situation where we cannot disregard the variation of viscosity (and thermal conductivity) with temperature, this being important in the determination of the details of the flow. It is found, for example, that liquid usually rises in the middle of a polygonal convection cell, while a gas falls. We consider here the case $u=cte$ and $k=0$ on $\partial\Omega$.

Linear Partial Differential Equations

Organizer: Adalberto Panobianco Bergamasco

Perturbation and regularization of some fourth order parabolic differential equations

Carlos Quesada González, Aníbal Rodríguez-Bernal
Universidad Complutense de Madrid

We solve the parabolic bi-Laplacian equation for several classes of initial data in $\mathbb{R}^N$. We also consider perturbations to the problem, obtaining a perturbed semigroup and showing the robustness of the result with respect to the perturbation. We adapt for the bi-Laplacian a general existence and regularity theory for parabolic equations developed in [1]. Then, we use some results in [2] to handle the perturbations. In particular, we can solve the problems of the type

$$\begin{cases} u_t + \Delta^2 u + \sum_{j=0}^{J} P_j u = 0 \quad x \in \mathbb{R}^N, ; t > 0, ; j = 1, ..., J \\ u(0) = u_0, \end{cases}$$

where the perturbations P_j are of the form $Pu = D^a(d(x)D^b u)$, with $a, b \in \mathbb{N}$, $a + b \leq 3$ and d belong to the uniform space $L^p_U(\mathbb{R}^N)$, which is made of the functions $d \in L^p_{loc}(\mathbb{R}^N)$ such that for all $x_0 \in \mathbb{R}^N$,

$$\int_{B(x_0,1)} |d(x)|^p \leq C.$$

The solutions are given by a strongly continuous analytic semigroup with strong regularizing properties. The continuous dependence of the solution with respect to the perturbations is also discussed.

1. Amann, H. *Linear and quasilinear parabolic problems. Vol. I*. Birkhäuser Boston Inc., 1995.

2. Rodríguez-Bernal, A. *Perturbation of analytic semigroups in scales of Banach spaces and applications to parabolic equations with low regularity data*, Bol. Soc. Esp. Mat. Apl., 2011.

Half-Reeb components and injectivity in $\mathbb{R}^3$

Francisco Braun, Jean Venato-Santos
UFSCar

Let $F : \mathbb{R}^n \to \mathbb{R}^n$ be a smooth local diffeomorphism, and consider the following problems:

1. *Nollet-Xavier Conjecture:* If $F^{-1}(\pi)$ is connected for each affine hyperplane π then F is globally injective.

2. *Chamberland type Conjecture:* If $\text{Spec}(F) \cap (-\varepsilon, \varepsilon) = \emptyset$, for some $\varepsilon > 0$, then F is globally injective.

Here Spec(F) stands for the set of eigenvalues of $DF(x)$ when x varies in $\mathbb{R}^n$.

If $n = 2$, it is simple to prove the validity of (1). Now it is a remarkable result due to Gutierrez et al. that (yet for $n = 2$) if Spec$(F) \cap (0, \varepsilon) = \emptyset$ then F is globally injective. In particular, (2) is also true in dimension 2.

On the other hand, when $n > 2$, Conjecture (1) is an open problem, whereas Conjecture (2) is false when n is "big' enough (n certainly bigger than 3).

In this talk we shall survey this subject and present results related to the conjectures in dimension 3.

Recent results on Simultaneous controllability for ditributed systems

Gustavo Perla Menzala, B.Kapitonov

Laboratorio Nacional de Computação Científica

In recent years the Problem of simultaneous controllability suggested by J.L.Lions and D.Russell about 35 years ago has became of interest for several teams in Analysis of PDEs We will present some of our recent work on the subject for models arising in quasi-electrotatic piezoelectric systems,Maxwell equationsand hyperbolic models in fluid mechanics and elasticity systems with Maxwell equations as well.

Controllability of semilinear cascade systems in $H = L^2(\Omega)$

Hugo Leiva

Universidad de Los Andes

In this paper we study the interior approximate controllability of the following semilinear cascade systems of m coupled evolution equations in the Hilbert space $H = L^2(\Omega)$

$$\begin{cases} \dot{z}_1 = -Az_1 + 1_\omega u(t) + f_1(t, z_1, u(t)), tin(0, \tau], \quad \tau > 0 \\ \dot{z}_i = -Az_i + f_i(t, z_i, z_{i-1}), \quad i = 2, 3, \ldots, m, \end{cases}$$

where Ω is a bounded in $\mathbb{R}^N (N \geq 1)$, ω is an open nonempty subset of Ω, 1_ω denotes the characteristic function of the set ω, control u belongs to $L^2(0, \tau; L^2(\Omega))$ and the operator $A : D(A) \subset H \to H$ is an unbounded linear operator with the spectral decomposition $A\xi = \sum_{j=1}^{infty} \lambda_j \sum_{k=1}^{\gamma_j} < \xi, \phi_{j,k} > \phi_{j,k}$ with $0 < \lambda_1 < \lambda_2 < \cdots < \lambda_j < \cdots \lambda_n \to infty$ and $\{\phi_{j,k}\}$ is a complete orthonormal set of analytic functions in H, and the nonlinear functions $f_i : [0, \tau] \times H \times H \to H$, are smooth enough and there are constant $a_i, c_i \in \mathbb{R}$ and $\xi_i \in \mathbb{Z}$, with $c_1 \neq -1$, $a_i < \lambda_1, i = 1, 2, 3, \ldots, m$, such that

$$\sup_{(t,\zeta,\eta) \in H_\tau} |f_i(t, \zeta, \eta) - a_i\zeta - c_i\eta - \xi_i|_H < \infty, \quad i = 1, 2, 3, \ldots, m,$$

where $c_i \neq 0, \quad i = 2, 3, \ldots, m$, $H_\tau = [0, \tau] \times H \times H$. Under these conditions we prove the following statement: The system is approximately controllable on $[0, \tau]$. Moreover, we exhibit a sequence of controls steering the system from an initial state to a ϵ-neighborhood of final state in a prefixed time τ. Our result can be apply to the semilinear nD heat equation, the Ornstein-Uhlenbeck equation, the Laguerre equation, the Jacobi equation, amount others.

Local solvability of a class of abstract underdetermined systems

Luís Cláudio Yamaoka, Paulo Domingos Cordaro
UNIFESP

In this work we present a necessary and sufficient condition for a class of abstract underdetermined systems to be solvable. We develop J.F.Treves' ideas, presenting the so called condition (ψ) and its connection with the study of the solvability in consideration. In fact, the sufficiency of condition (ψ) is proved by using the abstract method to get the solvability. On the other hand, to prove the necessity of condition (ψ) we present a lemma due to Härmander and adapt the technique sugested by Treves in the article *Concatenations of second-order evolution equations applied to local solvability and hypoellipticity*, Communications on Pure and Applied Mathematics **26** (1973), 201-250.

Linear decay estimates for semilinear damped waves

Marcello D'Abbicco
Brescia

In this talk we will summarize some recent results about the application of Matsumura-type estimates for linear wave equations with time dependent damping to semilinear problems. We obtain global existence of small data solutions with a decay rate which is the same of the linear problem.

Hyperbolic-like estimates for higher order equations

Marcello D'Abbicco, **Marcelo Rempel Ebert**
Universidade de São Paulo - FFCLRP

The main goal of this talk will to derive long time estimates of the energy for a class of higher order hyperbolic equations with time-dependent coefficients. In some cases, these estimates produce a dissipative effect on the energy.

L^1 estimates for elliptic complexes

Tiago Picon
Universidade Federal de São Carlos

In this lecture we will discuss a local version of L^1 div-curl estimate associated a involutive structure given by a complex elliptic systems of vector fields with smooth coefficients. We will present, within the local setup, a study similar to the previous estimate for the pseudo-complex. This is joint work with Jorge Hounie (UFSCar).

Nonlinear Dynamical Systems

Organizer: Cláudia B. Gentile

Minimal periods of semilinear evolution equations with Lipschitz nonlinearity

Alejandro Vidal-López, James C. Robinson
University of Warwick

It is known that any periodic orbit of a Lipschitz ordinary differential equation $\dot{x} = f(x)$ must have a period at least $2\pi/L$ where L is the Lipschitz constant of f. We will show that a similar bound holds for semilinear evolution equations $u_t + Au = f(u)$ on a Hilbert space.

Rate of convergence of attractors for Morse-Smale flows

Esperanza Santamaría Martín, José M. Arrieta
Universidad Complutense de Madrid

We consider a family of dynamical systems in a Banach space X generated by the iteration of maps $T_\varepsilon : X \to X$. For example, these maps can be the finite time maps of a partial differential equation. We assume that $T_\varepsilon \to T$ uniformly in bounded sets of X and that the estimate $|T_\varepsilon - T| \leq h(\varepsilon)$ is satisfied, with $h(\varepsilon) > 0$ an increasing function of ε and $h(\varepsilon) \to 0$. It is well known that if the systems are dissipative and they have some compact properties, then there exists an attractor $\mathcal{A}_\varepsilon$ for each $\varepsilon \geq 0$. Moreover, if the limit system is a gradient system with a finite number of equilibrium points, all of them hyperbolic, we can prove the continuity of attractors and obtain an estimate for the distance of attractors of order $h^\beta(\varepsilon)$ for some $\beta < 1$. In general, it is not possible to obtain the expected estimate, with $\beta = 1$.

In this work we study some technical tools related to the shadowing concepts which allow us to obtain an estimate of the distance of attractors of order $h(\varepsilon)$, that is $\beta = 1$ for Morse-Smale flows. We apply this result to a problem in a thin domain.

Dynamics of a logistic equation with unbounded time depend coefficients

Felipe Rivero, Juan Carlos Jara
Universidad Nacional Autónoma de México

The aim of this talk is the study of the following non-autonomous logistic ODE

$$\begin{cases} x'(t) = \rho(t)x(t) - \eta(t)x^2(t), & t \in \mathbb{R} \\ x(s) = x_s, & x_s \in \mathbb{R}, \end{cases}$$

where both functions $\rho, \eta : \mathbb{R} \to \mathbb{R}$ are not necessary bounded, $\eta(t) > 0$ and $\rho(t)$ can be negative in a bounded subset. The main idea in this case is to use the well known techniques in the autonomous case to obtain a function that gives us information about the dynamic of the system in a very simple way. Then we will apply that to a non-autonomous prey-predator system to obtain the permanence of solutions.

On asymptotic stability of solutions of nonlinear systems of differential equations

German Lozada-Cruz
UNESP/IBILCE/São José do Rio Preto

In this talk we will treat about the asymptotic stability of systems of the form:

$$\begin{cases} \dot{x}_1 = af_1^{\lambda}(x_1) + bf_2^{\mu}(x_2) \\ \dot{x}_2 = cf_1^{\eta}(x_1) + df_2^{\zeta}(x_2). \end{cases} \tag{2}$$

Here a, b, c and d are positive constants, λ, μ, η and ζ are positive rational numbers with odd numerators and denominators, and the functions $f_i : (-h, h) \to \mathbb{R}$, $h > 0$, are continuous and satisfy the conditions:
(**i**) $f_i(0) = 0$, $i = 1, 2$ and
(**ii**) $x_i f_i(x_i) > 0$, for $x_i \neq 0, i = 1, 2$.

Associated to the system (2) we consider the following function

$$V = \alpha \int_0^{x_1} f_1^{\xi}(\tau)d\tau + \int_0^{x_2} f_2^{\theta}(\tau)d\tau, \tag{3}$$

where ξ and θ are positive rational numbers with odd numerators and denominators and α is a positive constant.

Our main goal is find some conditions on the constants a, b, c, d and $\alpha > 0$ for V defined in (3) be a strict Liapunov function for the zero solution of the system (2), thus we conclude the asymptotic stability.

Bifurcation of stable steady-states and nonlinear flux boundary condition with indefinite weight

Gustavo F. Madeira
UFSCar

In this talk we present the bifurcation/stability diagrams of steady-states of a parabolic problem. Such solutions are harmonic functions satisfying a nonlinear Neumann boundary condition having a parameter and an indefinite weight. While discussing mainly a degenerate case when the Crandall-Rabinowitz transversality condition does not hold, diagrams corresponding to degenerate and nondegenerate situations are drawn.

Variational electrodynamics

Jayme De Luca
UFSCAR

The electromagnetic variational principle involves minimization of the *integral* of a (Lagrangian) function of velocities multiplied at (different) times along continuous orbits further satisfying boundary conditions in past and future. We construct *periodic* critical points near a C^{∞} circular orbit of the two-body problem, using solutions of the (linearized) neutral differential delay equations along regular segments and a variational approximation involving velocity discontinuities along (spiky) boundary-layer segments. Along the regular (C^2) segments, these *broken extrema* satisfy Euler-Lagrange equations which are *neutral differential delay* equations with state-dependent deviating arguments. At points

where velocities are *discontinuous*, spiky orbits satisfy Weierstrass-Erdmann corner conditions. We discuss a condition for a *finitely measured* family of (spiky) orbits to exist near a (given) unperturbed circular orbit because of the Weierstrass-Erdmann stabilization of explosive tangent modes.

Regularity results of pullback attractors for a two-dimensional Navier-Stokes model with finite delay

Julia Garcia-Luengo, Pedro Marin-Rubio, José Real

Universidad de Sevilla

We strengthen some results on the existence and properties of pullback attractors for a 2D Navier-Stokes model with finite delay formulated in [Caraballo and Real, J. Differential Equations **205** (2004), 271–297]. Actually, we prove that under suitable assumptions, pullback attractors not only of fixed bounded sets but also of a set of tempered universes do exist. Moreover, thanks to regularity results, the attraction from different phase spaces also happens in $C([-h,0];V)$. Finally, from comparison results of attractors, and under an additional hypothesis, we establish that all these families of attractors are in fact the same object.

A nonlinear Plate equation with thermal memory

Ma To Fu

Universidade de São Paulo

We study the existence of a finite dimensional global attractor for the nonlinear plate equation with thermal memory

$$u_{tt} + \Delta^2 u + \alpha\,\mathrm{div}(|\nabla u|^{p-2}\nabla u) + f(u) - \Delta u_t + \nu\Delta v = h(x) \text{ in } \Omega\times\mathbb{R}^+,$$
$$v_t - c\Delta v - (1-c)\int_0^\infty k(s)\Delta v(t-s)ds - \nu\Delta u_t = 0 \text{ in } \Omega\times\mathbb{R}^+,$$

defined in a bounded domain $\Omega\subset\mathbb{R}^2$ with simply supported boundary condition. The case $c=1$ corresponds to the Fourier's low of heat conduction. The case $0\le c<1$ corresponds to the theory of finite speed heat flow.

Stochastic porous media equation driven by fractional Brownian motion B^H with $H > 1/2$

María José Garrido-Atienza, Jan Bártek , Bohdan Maslowski

Universidad de Sevilla

The aim of this talk is to study the existence and uniqueness of solutions of stochastic porous media equations driven by fractional Brownian motion, when the Hurst parameter $H > 1/2$. It is shown that there is a one-to-one correspondence between solutions to the stochastic equation and solutions to its deterministic counterpart. By means of this correspondence and exploiting properties of the deterministic porous media equation, the existence, uniqueness, regularity and long-time properties of the solution is established. We also prove that the solution forms a random dynamical system in an appropriate function space.

Skew product semiflows and Morse decomposition

M. C. Bortolan, T. Caraballo, A. N. Carvalho, J. A. Langa

ICMC-USP

This work is devoted to investigate the dynamics of non-autonomous differential equations. We emphasize that the asymptotics of non-autonomous problems are in fact described by a set (usually infinite) of processes each of them corresponding to a limiting non-autonomous differential equation for which one can define an evolution process. We are interested in the study of the Morse Decomposition of attractors for these non-autonomous problems. In particular, we derive a Morse Decomposition for the global attractors of skew product semiflows (and thus for pullback attractors of non-autonomous dynamical systems) from a Morse Decomposition of the attractor for the driving system associated to the non-autonomous terms in the equations. Our theory is well suited to describe the asymptotic dynamics of non-autonomous differential equations defined on the whole line or just for positive times, or for differential equations generally described as driving systems.

Global solvability of DVP for nondiagonal parabolic systems

Mikhail Vishnevski, Wladimir Neves

Universidade Estadual do Norte Fluminense

In this comunication we study the quasy-linear nondiagonal parabolic type systems. We assume that the principal elliptic operators, which is part of parabolic system, has a divergence structure. Under certain conditios it is proved the well-posedness of classical solution which exists global in time.

Local and global supersolutions for semilinear heat equations with convex nonlinearties

Mikolaj Sierzega, James C. Robinson

Warwick, UK

In this talk we will describe a construction of local and global supersolutions for the model problem $u_t = \Delta u + f(u)$ posed on a bounded domain with Dirichlet boundary conditions, nonnegative initial data and $f : [0, \infty) \mapsto [0, \infty)$ convex. Particular attention will be given to the case $f(0) \neq 0$. This work is an extension of methods presented in J.C. Robinson, M. Sierzega *Supersolutions for a class of semilinear heat equations*, Revista Matemática Complutense, October 2012. Joint work with James C. Robinson.

Attractors for a double time-delayed 2D-Navier-Stokes model

Pedro Marín-Rubio, Julia García-Luengo, Gabriela Planas

Universidad de Sevilla

A double time-delayed 2D-Navier-Stokes model is considered. It includes delays in the convective and the forcing terms. Existence and uniqueness results are established, extending some previous ones in the literature, and allowing to define a suitable dynamical system. We also analyze the existence of pullback attractors for the model in several phase-spaces and the relationship among them.

Non-smooth dynamical systems having a torus or a sphere as the sliding manifold

Ricardo Miranda Martins
Unicamp

In this talk we discuss piecewise vector fields (in the sense of Filippov) giving rise to sliding motion on the torus and on the sphere.

We consider the class of inelastic vector fields, which are a special class of vector fields with the additional property that the discontinuity manifold is composed only of stable and unstable sliding regions (separated by tangency curves). Inelastic vector fields are widely used in mechanical and relay models. We show that almost of the sliding trajectories are closed or formed by singular points.

Continuity of pullback attractors for a semilinear reaction-diffusion equation in a thin non-cilyndrical domain

Ricardo Parreira da Silva, J. V. Pereira
Universidade Estadual Paulista - IGCE - Unesp

In this talk we present our studies about continuity properties of pullback attractors for a semilinear reaction-diffusion equation posed in a family of time dependent thin domains.

Pyragas control of delay equations by delays

Sergio Oliva, Bernold Fiedler
USP

We summarize recent attempts to stabilize slowly and rapidly oscillating periodic solutions differential equations with or without delays by further delays of Pyragas type. In particular we show how to stabilize periodic orbits near Hopf bifurcation in spite of their arbitrarily high unstable dimension.

This is joint work with Bernold Fiedler (Berlin)

Nonlinear nonlocal reaction-diffusion equations

Aníbal Rodríguez-Bernal, **Silvia Sastre-Gómez**
Universidad Complutense de Madrid

Let $\Omega \subset \mathbb{R}^N$, and J be a nonnegative function defined in $\Omega \times \Omega$. We consider the problem

$$\begin{cases} u_t(x,t) &= \displaystyle\int_\Omega J(x,y)u(y,t)dy - h(x)u(x,t) + f(x,u(x,t)), \qquad x \in \Omega \subset \mathbb{R}^N \\ u(x,0) &= u_0(x), \quad x \in \Omega, \end{cases} \tag{4}$$

with $h \in L^\infty(\Omega)$, $u_0 \in L^p(\Omega)$ and the function f defined as $f : \Omega \times \mathbb{R} \to \mathbb{R}$, that maps (x,s) into $f(x,s)$. We assume f locally Lipschitz in the variable $s \in \mathbb{R}$, uniformly with respect to $x \in \Omega$, and f satisfies that there exist a function $f_0 \in \mathcal{C}^1(\mathbb{R})$, and s_0, $\delta > 0$ such that

$$f(\cdot,s)s \leq f_0(s)s \leq -\delta|s|, \ \forall |s| > s_0, \tag{5}$$

We study the existence and uniqueness and we give some asymptotic estimates of the norm $L^p(\Omega)$ of the solution u of the problem (4), following the ideas of [1], and we prove the existence of two ordered extremal equilibria, like in [2], which give some information about the set that uniformly attracts the dynamics of the semigroup $S(t)u_0$, for all u_0 in $L^p(\Omega)$.

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2. Rodríguez-Bernal, A., Vidal-Lopez, A., Extremal equilibria for nonlinear parabolic equations in bounded domains and applications, J. Differential Equations 244 (2008) 2983-3030.

Upper semicontinuity of attractors and continuity of equilibrium sets of a parabolic problem with a degenerate p-Laplacian

Simone M. Bruschi, Cláudia B. Gentile, Marcos Roberto T. Primo

Universidade de Brasilia - UnB

In this work we obtain some continuity properties on the parameter q at $q = p$ for the Takeuchi-Yamada problem which is a degenerate p-Laplacian version of the Chafee-Infante problem. We prove the continuity of the flows and the equilibrium sets, and the upper semicontinuity of the global attractors.

Pullback exponential attractors for evolution processes in Banach spaces

Stefanie Sonner, Alexandre N. Carvalho, Messoud A. Efendiev

Basque Center for Applied Mathematics

We present an existence result for pullback exponential attractors for asymptotically compact evolution processes in Banach spaces and derive estimates on the fractal dimension of the attractor. Pullback exponential attractors are families of time-dependent compact, semi-invariant subsets of the phase space, their fractal dimension is uniformly bounded and they pullback attract all bounded subsets at an exponential rate. If an exponential pullback attractor exists, it contains the global pullback attractor of the evolution process and immediately implies its existence and finite fractal dimension. We generalize previous results and construct exponential pullback attractors, which are not necessarily bounded in the past.

Almost automorphic processes in stochastic differential equations

Zhenxin Liu, Miaomiao Fu, Kai Sun

Jilin University, School of Mathematics

Almost automorphic dynamics plays an important role in the study of differential equations and dynamical systems. In this talk, almost automorphic processes will be introduced to study stochastic differential equations. The concept of Poisson almost automorphy is also introduced. The existence and uniqueness of almost automorphic solutions to some linear and semilinear stochastic differential equations with infinite dimensional Levy noise are established provided the coefficients satisfy some suitable conditions. The global asymptotic stability of the unique almost automorphic solution is discussed.

Ordinary and Functional Differential Equations

Organizers: Márcia Federson and Ma To Fu

Almost automorphic solutions of partial differential equations with delay

Hernán R. Henríquez, Claudio Cuevas, **Alejandro Caicedo**
Universidade de São Paulo- Ribeirão Preto

In this work we study the existence of almost automorphic solutions of linear retarded functional differential equations with finite delay and values in a Banach space.

Existence solutions for a class of abstract neutral functional differential equations

Andrea Prokopczyk, Eduardo Hernandez, Michelle Pierri
UNESP

By using the theory of semigroups of growth α we study the existence of mild solutions for a class of neutral functional differential equations of the form

$$\begin{aligned} &\tfrac{d}{dt}[x(t)+g(t,x_t)] = Ax(t)+f(t,x_t), \;\; t\in[0,a],\\ &x_0=\varphi\in\Omega\subset\mathcal{B}, \end{aligned}$$

where $A : D(A) \subset X \to X$ is an almost sectorial operator, X is a Banach space, $\mathcal{B}$ is a phase space, Ω is open and $f, g : [0, a] \to X$ are suitable functions.

On abstract integro-differential equations with state-dependent delay

Giovana Siracusa, Bruno de Andrade
Universidade Federal de Pernambuco

Using topological tools we ensure that the solution set of an abstract integro-differential equation with state-dependent delay is a nonempty, compact and connected set. As application we consider our abstract results in the framework of integro-differential equations coming from viscoelasticity theory.

In-host modelling of infectious diseases

Jane Heffernan
York University

The mathematical modelling of infectious disease can occur on two scales, within a host, and between hosts in a population. In this talk I will present models of in-host disease pathogenesis and discuss how these can be connected to between host and epidemiological dynamics.

Lower semicontinuity and relaxation of signed functionals with linear growth in the context of $\mathcal{A}$-quasiconvexity

José Matias
Instituto Superior Técnico

We will discuss lower semicontinuity results with respect to weak-$*$ convergence of measures for functionals of the form

$$\mu \in \mathcal{M}(\Omega, \mathbb{R}^d, d) \to \int_\Omega f(\mu^a(x))\, dx + \int_\Omega f^\infty \left(\frac{d\mu^s}{d|\mu^s|}(x) \right) d|\mu^s|(x),$$

where $\mu = \mu_a(x)dx + \mu_s$ is the Radon-Nikodym decomposition of the bounded Radon measure μ with respect to the Lebesgue measure, along sequences constrained by a first order partial differential operator of constant coefficients and constant rank. The integrand f has linear growth and L^∞-bounds from below are not assumed.

Joint work with Margarida Baía, Milena Chermisi and Pedro M. Santos.

Resolvent operators for fractional functional integro-differential equations and applications

José Paulo Carvalho dos Santos
footnotesizeUniversidade Federal de Alfenas

We will study the existence and qualitative properties of an resolvent operator for an abstract fractional integro-differential problem

$$\begin{aligned} D_t^\alpha x(t) &= Ax(t) + \int_0^t B(t-s)x(s)ds, \quad t > 0, \\ x(0) &= x_0, \quad x'(0) = 0, \end{aligned}$$

where $\alpha \in (1,2)$; $A, (B(t))_{t\geq 0}$ are closed linear operators defined on a common domain which is dense in a Banach space X. The existence of mild and classical solutions for the non homogeneous equation is also studied. We apply the resolvent theory in the existence of mild solutions for an fractional neutral integro-differential system with unbounded delay. This talk is based on recent works with Claudio Cuevas, R. P. Agarwal, Bruno de Andrade and M. Arjunan.

Oscillating and non-oscillating solutions of linear delayed equations

J. Diblík
Brno University of Technology

New non-oscillation and oscillation criteria are derived for scalar delay differential equations

$$\dot{x}(t) + a(t)x(h(t)) = 0,\ a(t) \geq 0,\ h(t) \leq t,\ t \geq t_0$$

and

$$\dot{x}(t) + \sum_{k=1}^{m} a_k(t)x(h_k(t)) = 0,\ a_k(t) \geq 0,\ h_k(t) \leq t,\ t \geq t_0$$

in the critical case including equations with several unbounded delays, without the usual assumption that the functions a, h, a_k and h_k of the equations are continuous functions. These conditions improve and extend some known oscillation results in the critical case for delayed differential equations.

Measure neutral functional differential equations as generalized ODEs

Marcia Federson, M. Frasson , J. G. Mesquita, P. Tacuri
Universidade de São Paulo

We introduce a class of measure neutral functional differential equations of type

$$D[N(x_t, t)] = f(x_t, t)Dg(t)$$

through the relation with a certain class of generalized ordinary differential equations (we write generalized ODEs). By means of the correspondence with generalized ODEs, we state results on the existence, uniqueness and continuous dependences of solutions for our equation of neutral type.

Global stability in systems of coupled chemostats

Marion Weedermann, Gail Wolkowicz, Gunog Seo
Dominican University

We study certain systems consisting of several coupled chemostats. The systems were introduced as models for anaerobic digestion. We will discuss several global stability results that were proved using differential inequalities.

On the dynamics of a SIRS model

Mayrelly J. Valera B., Sael Romero
Universidad Centroccidental Lisandro Alvarado

This research deals with the dynamics of the model

$$\begin{aligned} S' &= B(N) + \gamma R - bS - H(I,S)IS \\ I' &= H(I,S)IS - (b+v)I \\ R' &= vI - (b+\gamma)R, \end{aligned} \tag{6}$$

given in [4], describing an epidemiological model ([1,2,3]), here $H(I,S)$ is a smooth function with some properties, N represents the population, B is a function of N, b, v, and γ are positive constants. We study stability (local y global), and characterize invariant region for (6), all these is done by using Poincare-Bendixon's theorem and Dulac's Criterium basically. Finally, we illustrate this situation with two particular examples, study their dynamics and bifurcation.

1. F. Brauer and C. Castillo, *Mathematical Models in Population Biology and Epidemiology*, Springer, 2nd ed, September(2011).

2. J. M. Cushing, *Differential Equations and Applied Approach*, Pearson-Prentice Hall, New Jersey, (2004).

3. H. W. Hethcote and T. G. Hallam and L. Gross and S. A. Levin, *Three basic epidemiological models*, Applied Mathematical Ecology, Springer-Verlag, Berlin, (1989).

4. M. Lizana and J. Rivero, *Multiparametric bifurcations for a model in epidemiology*, J. Math. Biol., **35** (1996), 21–36.

Simultaneous reconstruction of coefficients and sources in inverse problems modeled with many boundary problems

Nilson C. Roberty
Universidade Federal do Rio de Janeiro

Most engineering applications of inverse problems consists of models based in systems of partial or integro-differential equations. Coefficients and source for system of this kind gives physical information about the model and eventually are only partially known. In this situation engineering faces the problem of to solve this kind of problem by compensating the missing information with over specification of boundary conditions. So, Cauchy data, processed from experimental measurements conducted with the model, or even synthesized from numerical experiments, can be prescribed in an many boundary value problems context, forming the algebraic system to be solved in order to infer simultaneously about the fields in the vector u and other partially known functions. An arbitrary Lipschitz boundary dissection can be used to split each Cauchy data to formulate two direct well posed problems with mixed boundary data for each Cauchy data. The discrepancy observed in the solutions of these problems are used to guess coefficients and sources and solve the inverse problem. The methodology introduced here for solve this kind of inverse problem based on over specification of boundary conditions has the advantage that it can be implemented by using solvers for the direct problem, and also in association with unconstrained optimization algorithm such as the Nelder-Mead Simplex method. Other non differentiable optimization algorithm can also be adopted without major changes in the methodology. The main topics discussed are:

1. Numerical two dimensional experiments in Cartesian and polar geometry for identification of sources, conductivity, absorption and advection coefficients in simple and composites medium;
2. Theoretical questions related with nullity of the discrepancy in the two direct problems resulting from one particular Lipschitz dissection of the Cauchy data;
3. The sensitivity of the optimization reconstruction problem to different Lipschitz dissection of the same Cauchy data pair; item Some aspects of implementation of the present methodology to transient problems.

Existence of bounded solutions of non homogeneous RFDEs

Patricia H. Tacuri, Miguel Frasson
ICMC-USP

We show that exponential dichotomy of the solution operator of non autonomous retarded functional differential equations (RFDEs) implies the existence of bounded solutions to the associated non homogeneous RFDEs.

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

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

We consider periodic parametrized retarded functional differential equations, with infinite delay, on (possibly) noncompact manifolds, of the form

$$x'(t) = \lambda f(t, x_t).$$

Using a topological approach, based on the notions of degree of a tangent vector field and the fixed point index, we prove existence and global continuation result for periodic solutions of such equations.

Wavelet approach for integro-differential equations

Ruben Edgardo Panta Pazos

Universidade de Santa Cruz do Sul

The treatment of data and results of experiments is a remarkable problem in engineering. The manipulation of experimental data includes many technical aspects. For this, the contribution of wavelet theory means a strong tool of data analysis.

The fundamental idea behind wavelets is to analyze according to scale. The increasing interest of the theory of wavelets nowadays is due to the capacity for representing signals that have different characteristics for different instants or spatial domains. In addition, as it can be seen more ahead, the computer implementation is efficient, thanks to which is denominated multiresolution analysis. [1, 5]

In this work it is applied the wavelet approach in order to solve some transport problems, such as the following

$$\frac{\partial \varphi}{\partial t}(\mathbf{r},\mathbf{v}) + \mathbf{v}\cdot\nabla\varphi(\mathbf{r},\mathbf{v}) + h\,\varphi(\mathbf{r},\mathbf{v}) = \int_S k\,\varphi(\mathbf{r}',\mathbf{v}') + q(\mathbf{r},\mathbf{v}) \tag{7}$$

where $\mathbf{r} \in \mathbf{X}$ (the *configuration space*), $\mathbf{v} \in \mathbf{S}$, (*the velocity space*), $h(\mathbf{r},\mathbf{v})$ is the collission function, φ represents the density flux function and $q(\mathbf{r},\mathbf{v})$ the source function.

First of all, different treatments are furnished for the variables of the neutron transport equation, specially for angular discretization. Furthermore, the integro-differential equation is solved by means of the associated matrix equation, involving operational matrices derived from each type of wavelet family. The approximation obtained by the wavelet approach is standard. [3]

Some discrete wavelet transforms are used in order to compare two transport problems; Haar wavelets expansion in the angular discretization is used to solve the neutron transport theory for 1D and 2D geometries [4]. Also the Legendre wavelet are introduced for the same problems. In this paper it is intended the employment of other wavelet expansion, and it is compared for efficiency and optimal benchmark. There are proposed two basic problems [2]. The appropriate choice of a family of wavelets that hangs of the set of conditions of the problem can be used. Finally, the evolution of the 2D flux of a problem governed by the neutron transport theory depending of the time can be registered only with the time series of sub images of type a_n, after the decomposition of the images with a 2D wavelet transform. Some results obtained with an algebraic computer system and high level language are included in this paper.

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2. Kobayashi, K., Sugimura, N. and Nagaya, Y., *2D Radiation Transport Benkmark Problems and Results for Simple Geometries with Void Region*, Progress in Nuclear Energy, vol **39**, n. 2, p 119-144, (2001).

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On the interaction between ants and homopteran

Teodoro Lara, Sael Romero, Edgar Rosales
Universidad de los Andes

In this work we address the dynamics of the model of interaction involving ants and aphids. We study local and global stability of critical points. It is known that ants benefit from their interactions with aphids, because the latter provide certain secretions which are rich in sugars and aminoacids; ants at the same time provide protection to aphis from their natural predators. However, the magnitude of these benefits depends on the relative densities of the two populations involved: at low aphid densities, benefits for them are high, but at higher densities such benefits are low, none or even negative ([1,2,3]). very interesting and rich dynamics is observed when model parameters and the functional responses vary. Local and global dynamics of equilibria is considered by means of Dulac and Routh-Hurwitz criteria and Poincar'e-Bendixon Theorem, no periodic orbits shows up in this approach. We show existence and uniqueness of positive components equilibrium, additionally some numerical implementations are performed for particular values of parameters. The model under consideration is given, after some transformations, by

$$\begin{aligned} \frac{dx}{dt} &= x\left[1 - x + \theta_1 y - \theta_2 xy + \theta_3 \frac{y^2}{1+\alpha y}\right] \\ \frac{dy}{dt} &= y\left[r - y + \theta_4 \frac{x^2}{1+\beta x}\right], \end{aligned}$$

Where $x(t) \geq 0$, $y(t) \geq 0$ stand for the population densities of homopteran and ants respectively, the other parameters involved are positive.

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2. M. Hernandez, *Spatiotemporal dynamics in variable population interaction with density-dependent interaction coefficients*, Ecol. Modelling **214** (2008), 3–16.

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Efficient computational algorithms for solving differential and functional differential equations

Zdenek Smarda
Brno University of Technology

Efficient modifications of the Adomian decomposition method and the differential transform method are introduced for certain classes of ordinary differential equations and functional differential equations. Some new differential tranformation formulas are derived. The approximate and exact solutions of these equations are calculated in the form of a series with easily computable terms. The results obtained with the proposed methods are in good agreementw with those obtained by other methods. The advantages of this technique are shown as well. Solution algorithms are illustrated with few examples.

Dispersive Equation

Organizer: Márcia Scialom

On stabilization and control for the critical Klein-Gordon equation on a 3-D compact manifold

Camille Laurent
IMPA/CNRS, Paris 6

We study the internal stabilization and control of the critical nonlinear Klein-Gordon equation on 3-D compact manifolds. Under a geometric assumption slightly stronger than the classical geometric control condition, we prove exponential decay for some solutions bounded in the energy space but small in a lower norm. The proof combines profile decomposition and microlocal arguments. This profile decomposition, analogous to the one of Bahouri-Gérard on $\mathbb{R}^3$, is performed by taking care of possible geometric effects. It uses some results of S. Ibrahim on the behavior of concentrating waves on manifolds.

On properties of solutions to the Benjamin-Ono equation and generalizations

Felipe Linares, German Fonseca, Gustavo Ponce
IMPA

In this talk we will discuss recent results regarding the initial value problem associated to the dispersion generalized Benjamin-Ono equation. Our aim is to present well posedness results in weighted Sobolev spaces and to deduce from them some sharp unique continuation properties of solutions to this equation. In particular, we shall establish optimal decay rate for the solutions of this model.

Finite-time blowup for a complex Ginzburg-Landau equation

Thierry Cazenave,**Flavio Dickstein**, Fred Weissler
UFRJ

We prove that negative energy solutions of the complex Ginzburg-Landau equation $e^{-i\theta}u_t = \Delta u + |u|^\alpha u$ blow up in finite time, where $\alpha > 0$ and $-\pi/2 < \theta < \pi/2$. For a fixed initial value $u(0)$, we obtain estimates of the blow-up time $T^\theta_{\max}$ as $\theta \to \pm\pi/2$. It turns out that $T^\theta_{\max}$ stays bounded (respectively, goes to infinity) as $\theta \to \pm\pi/2$ in the case where the solution of the limiting nonlinear Schrödinger equation blows up in finite time (respectively, is global).

Control of Korteweg-de Vries in $[0, L]$

Ivonne Rivas, Bingyu Zhang, Eduardo Cerpa
IMPA

In 2001, Colin and Ghidaglia [1] proposed a model for propagation of surface water waves in a flat tank which can be represented by the Korteweg-de Vries (KdV) equation

$$u_t + u_x + u_{xxx} + u_x u = 0$$

in a bounded domain $[0, L]$ with the boundary conditions

$$u(0,t) = h_1(t),\ u_x(L,t) = h_2(t) \text{ and } u_{xx}(L,t) = h_3(t).$$

In this talk, I will present a well-posedness and controllability results (See,citeCG,RCZ) for the same control system with one left control input $h_2 \neq 0$ and $h_1 = h_3 = 0$ and two left control inputs $h_2 \neq 0, h_3 \neq 0$ and $h_1 = 0$ and a brief sketch of the proofs.

1. T. Colin and J.-M. Ghidaglia, An initial-boundary-value problem for the Korteweg-de Vries Equation posed on a finite interval, *Adv. Differential Equations* **6** (2001), 1463-1492.

A refinement of the Strichartz inequality with applications to the linear and nonlinear wave equations

Javier Ramos

IMPA

We prove a refinement of the Strichartz inequality for the wave equation in dimensions $d \geq 2$. As applications, we prove the existence of maximizers for the linear $\dot{H}^{\frac{1}{2}} \times \dot{H}^{-\frac{1}{2}}(\mathbb{R}^d)$ wave equation, and that if the solution of the critical $\dot{H}^{\frac{1}{2}} \times \dot{H}^{-\frac{1}{2}}(\mathbb{R}^d)$ nonlinear wave equation with for $d \geq 3$ blows up, then the $\dot{H}^{\frac{1}{2}} \times \dot{H}^{-\frac{1}{2}}(\mathbb{R}^d)$ norm of the solution concentrates in space time as the solution approaches the blow up time.

On well-posedness and wave operator for the gKdV equation

Luiz Gustavo Farah, Ademir Pastor

Universidade Federal de Minas Gerais

We consider the generalized Korteweg-de Vries (gKdV) equation $\partial_t u + \partial_x^3 u + \mu \partial_x (u^{k+1}) = 0$, where $k > 4$ is an integer number and $\mu = \pm 1$. We give an alternative proof of the Kenig, Ponce, and Vega result, which asserts local and global well-posedness in $\dot{H}^{s_k}(R)$, with $s_k = (k-4)/2k$. As a consequence, we also construct a wave operator in the critical space $\dot{H}^{s_k}(R)$, extending the results of Côte.

On the supercritical KdV equation with time-oscillating nonlinearity

Marcia A. G. Scialom

Universidade Estadual de Campinas

For the initial value problem (IVP) associated to the generalized Korteweg-de Vries (gKdV) equation with supercritical nonlinearity,

$$u_t + \partial_x^3 u + \partial_x (u^{k+1}) = 0, \qquad k \geq 5,$$

numerical evidence [2,3] shows that, there are initial data $\phi \in H^1(\mathbb{R})$ such that the corresponding solution may blow-up in finite time. Also, with the evidence from numerical simulation [1,4], it has been claimed that a periodic time dependent coefficient in the nonlinearity would disturb the blow-up solution, either accelerating or delaying it.

In this work, we investigate the IVP associated to the gKdV equation

$$u_t + \partial_x^3 u + g(\omega t)\partial_x(u^{k+1}) = 0,$$

where g is a periodic function and $k \geq 5$ is an integer. We prove that, for given initial data $\phi \in H^1(\mathbb{R})$, as $|\omega| \to \infty$, the solution u_ω converges to the solution U of the initial value problem associated to

$$U_t + \partial_x^3 U + m(g)\partial_x(U^{k+1}) = 0,$$

with the same initial data, where $m(g)$ is the average of the periodic function g. Moreover, if the solution U is global and satisfies $\|U\|_{L_x^5 L_t^{10}} < \infty$, then we prove that the solution u_ω is also global provided $|\omega|$ is sufficiently large.

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Fluid Dynamics

Organizer: Milton da Costa Lopes Filho

Flow for shear thickening fluids in channels with unbounded cross sections

Gilberlandio Jesus Dias
Unifap

We study the stationary Stokes and Navier-Stokes equations for non-Newtonian fluids incompressible with shear thickning viscosity, i.e., the viscosity is given by shear rate raised to the power $p-2$, with $p>2$. The domain is coposed of several infinite channels with unbounded cross sections. The results obtained are extensions of some results obtained by O. A. Ladyzhenskaya e V. A. Solonnikov [O. A. Ladyzhenskaya, V. A. Solonnikov, Determination of the solutions of boudary value problems for stationary Stokes and Navier-Stokes equations in domains having an unbounded Dirichelet integral, J. Soviet Math. 21 (1983) 728-761] for Newtonian fluids ($p=2$).

Vesicles in a α-Navier-Stokes fluid

Jos'e Luiz Boldrini, Ariane Piovezan Entringer
Universidade Estadual de Campinas

We consider the existence and uniqueness of solutions of a system of coupled nonlinear partial differential equations modeling the motion of a vesicle in a incompressible viscous fluid. The vesicle position is determined by a phase field variable and the fluid motion is governed by a variant of a α-Navier-Stokes equations; the coupling is obtained by using a penalized bending energy of the membrane.

Global well-posedness and symmetries for active scalar equations with singular velocity

Lucas C.F. Ferreira, Lidiane S. M. Lima
Unicamp

We are concerned with dissipative active scalar equations with velocity fields coupled via a large class of multiplier operators, which contain very singular integral ones and morally behave as positive derivatives of $(\beta-1)$-order with $\beta>1$. We prove global well-posedness and decay for initial data belonging to the critical Lebesgue space $L^{\frac{n}{2\gamma-\beta}}(\mathbb{R}^n)$ and without smallness assumptions. Symmetry properties of solutions are investigated depending on symmetry of initial data and coupling operators. Conditions on the coupling terms allow us to employ the results for a number of important active scalar PDEs like generalized surface quasi-geostrophic equations, Burgers equations, log-Navier-Stokes, and many others.

Weak solutions of the incompressible 2D Euler equations without decay at infinity

Milton da Costa Lopes Filho
UFRJ

In this talk we discuss existence and uniqueness of weak solutions to the incompressible 2D Euler equations in the full plane and on an exterior domain when the initial velocity and the initial vorticity are bounded, but no additional decay assumption is made.

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Posters

Multiple positive solutions for a Schr̈odinger-Poisson with critical exponent

Alcionio S. Oliveira, Marco A. S. Souto

Universidade Federal de Campina Grande

In this work we investigate the existence and multiplicity of positive solutions for the Schrödinger-Poisson equations with a critical Sobolev exponent below.

$$(P_\lambda) \qquad \begin{cases} -\Delta u + u + \phi u = \lambda g(x)|u|^{p-2}u + f(x)u^5, & \text{in} \quad \mathbb{R}^3, \\ -\Delta \phi = u^2, & \text{in} \quad \mathbb{R}^3, \end{cases}$$

where $4 < p < 6$ and $\lambda > 0$.

The second spectrum of the Timoshenko model for a supported beam by using a fundamental response

Daniela de Rosso Tolfo, Julio Cesar Ruiz Claeyssen

Universidade Federal do Rio Grande do Sul

We study the eigenanalysis of a bi-supported beam described by the model of Timoshenko in terms of a basis generated by a fundamental matrix response. It is found a critical frequency above which all eigenfunctions are oscillatory. The smallest root of the frequency equation underestimates the value predicted by the model of Euler-Bernoulli, while the largest root has been identified in the literature as being a new frequency branch, called second spectrum. By using a scalar function that determines the behaviour of the fundamental response, we have characterized the geometric multiplicity of eigenvalues and their occurrence is characterized when there is a common frequency for the two spectra.

On non-smooth perturbations of linear planar centers

Douglas Duarte Novaes

Universidade Estadual de Campinas

Recently, Llibre, Novaes and Teixeira, have extended the averaging method for studying the periodic orbits of a class of differential equations with discontinuous second member. Certainly these results represent new insights in averaging, in particular its relation with non smooth dynamical systems theory.

In this present work, we provide sufficient conditions for the existence of limit cycles of a linear planar center perturbed by piecewise continuous functions as following

$$\begin{aligned} x'(t) &= y + \epsilon F^1(x,y), \\ y'(t) &= -x + \epsilon F^2(x,y), \end{aligned}$$

with $F^i(x,y) = F_1^i(x,y) + \text{sgn}\,(h(x,y))\, F_2^i(x,y)$, where $F_j^i : \mathbb{R}^2 \to \mathbb{R}^2$ for $i,j = 1,2$ and $h : \mathbb{R}^2 \to \mathbb{R}^2$ are continuous functions. We also suppose that h is a C^1 function such that the set of discontinuity $M = h^{-1}(0)$ contains a bounded set of non–regular points.

Particularly, It is provided a technique to work with discontinuous planar systems whose the discontinuity set contains auto-intersections. This technique also works for higher dimensional systems.

Nonlinear Schrödinger equations with unbounded or decaying radial potentials and involving exponential critical growth in $\mathbb{R}^2$

Francisco S. B. Albuquerque, Claudianor O. Alves, Everaldo S. de Medeiros

Universidade Federal da Paraíba

In this paper we study the existence and multiplicity of solutions for the following class of nonlinear Schrödinger equations

$$-\Delta u + V(|x|)u = Q(|x|)f(u), \text{ in } \mathbb{R}^2,$$

where V and Q are unbounded or decaying radial potentials, and the nonlinearity $f(s)$ has exponential critical growth. The approaches used here are based on a version of the Trudinger–Moser inequality and a minimax theorem.

An algorithm for computing the Conley index of a Poincare map. Part II: numerical aspects

Frank Weilandt, Marian Mrozek, Roman Srzednicki

Jagiellonian University

We investigate the numerical aspects of the algorithm based on the theory presented in the talk by Roman Srzednicki. The theory requires the existence of index pairs and of certain singular chains. We construct these numerically using strict bounds for the local behavior of the flow.

The method only requires following the flow for a short time, not until its first return to the Poincare section. We apply tools for computer-assisted proofs in dynamics. The method is still under development but we are already able to produce some very promising output.

A nonlinear elliptic problem with terms concentrating in the boundary

Gleiciane S. Aragão, Antônio L. Pereira, Marcone C. Pereira

Universidade Federal de São Paulo

We investigate the behavior of a family of steady-state solutions of a nonlinear reaction diffusion equation when some reaction and potential terms are concentrated in a ϵ-neighborhood of a portion Γ of the boundary. We assume that this ϵ-neighborhood shrinks to Γ as the small parameter ϵ goes to zero. Also, we suppose the upper boundary of this ϵ-strip presents a highly oscillatory behavior. Our main goal here is to show that this family of solutions converges to the solutions of a limit problem, a nonlinear elliptic equation that captures the oscillatory behavior. Indeed, the reaction term and concentrating potential are transformed into a flux condition and a potential on Γ, which depends on the oscillating neighborhood. This work is published in [1]. FAPESP support: 2010/51829-7.

1. G. S. Aragão, A. L. Pereira, M. C. Pereira, *A nonlinear elliptic problem with terms concentrating in the boundary*, Mathematical Methods in the Applied Sciences **35** (2012), 1110-1116.

Implementation and use of .NET and Silverlight class library for the numerical investigation of dynamical control systems

Ivan Samylovskiy

Lomonosov Moscow State University

Computational base: Microsoft Research Solvers library Microsoft Research Solvers is a .NET and Silverlight class library for numerical solution of several types of differential equations. It provides subroutines to integrate vector initial value problem from time t_0 with initial conditions given by vector x_0. Together with DynamicDataDisplay library Solvers allows to construct browser applications that implements different computational models. Interesting feature of Solvers library is that solution is represented as IEnumerable object and next integration step is performed only when next solution point is requested by application code. This allows us to use full potential of LINQ technology to filter and query IVP solution while performing only required amount of computations. While Microsoft Research Solvers is in process of publication you may take information about it from [2]. Information about DynamicDataDisplay including link for downloading is available at [1].

Using Microsoft Research Solvers library to solve optimal control problems In this work we use Microsoft Research Solvers as a computational base to implement class library for optimal control problems solving. As a first step we implement a gradient projection based subroutine to solve optimal control problem in Pontryagin form with free right end:

$$\begin{cases} \dot{x} = f(x,t,u), \quad x(t_0) = x_0, \\ x \in \mathbb{R}^n, \quad u \in U \subset \mathbb{R}^r, \\ J = \int_{t_0}^{T} f_0(t,x,u)dt + \Phi(x(T)) \to min_{u \in U}. \end{cases} \tag{8}$$

Using Microsoft Research Solvers library to determine boundaries of the singular subarc of the optimal trajectory We also present an example of BVP-based algorithm to compute start and end times of the singular subarc of the optimal trajectory in the following optimal control problem for different forms of friction function $\varphi(x)$.

$$\begin{cases} \dot{s} = x, & s(0) = 0, & s(T) \to \max, \\ \dot{x} = u - \varphi(x), & x(0) = 0, & x(t) \text{ is free}, \\ \dot{m} = -u, & m(0) = m_0, & m(T) \geqslant m_T, \\ u \in [0,1]. \end{cases} \tag{9}$$

1. *DynamicDataDisplay*, available at

   http://research.microsoft.com/en-us/projects/ddd/default.aspx.

2. *Microsoft Research Solvers overview*, available at

   http://microsoft.cs.msu.su/eng/projects/Pages/Solvers.aspx.

Local structural stability of piecewise-smooth vector fields in $\mathbb{R}^4$

Jesus Achire

Universidade Estadual de Campinas

In recent years has been rapidly developed the theory of discontinuous vector fields (piecewise-smooth), this is because of many applications in physics and engineering and its mathematical beauty. A main difference of the discontinuous case with the classic continuous case is that there is not uniqueness of solutions. We use Filippov convention to define orbits solutions of discontinuous vector fields and we are interested in to classify those which are structurally stables, i.e., those which do not undergo qualitative changes by small perturbations.

In this work we describe generic properties necessary for structural stability and thus we give a partial classification of discontinuous vector fields that are structurally stable.

Existence and multiplicity of solutions for a $p(x)$-Laplacian equation with critical growth

Claudianor O. Alves, **José Lindomberg P. Barreiro**

Universidade Federal de Campina Grande

In this work, we study the existence and multiplicity of solutions for a class of problems involving the $p(x)$-Laplacian operator in a bounded domain, where the nonlinearity has a critical growth. The main tool used is the variational method combined with the genus theory for even functionals.

Bifurcation diagram of some typical singularity of non-smooth dynamical systems

Juliana Fernandes Larrosa, Marco Antonio Teixeira

Universidade Estadual de Campinas

Suppose $f \in \mathcal{C}^\infty(\mathbb{R}^2, \mathbb{R})$ and $\{0\} \in \mathbb{R}$ is a regular value of f. A Filippov Planar System $Z = (X, Y)$ is a piece-wise system defined on a open domain $\mathcal{U} \subset \mathbb{R}^2$ with discontinuity curve Σ, where $\Sigma = f^{-1}(\{0\}) \cap \mathcal{U}$. We define $Z(p) = X(p)$, if $f(p) > 0$ and $Z(p) = Y(p)$, if $f(p) < 0$. This way, the dynamics on which open set $\Sigma^+ = \{p \in \mathcal{U} : f(p) > 0\}$ and $\Sigma^- = \{p \in \mathcal{U} : f(p) < 0\}$ is determined by X and Y, respectively, and over the curve Σ it is given by the Filippov convention.

In this work, we use qualitative methods of bifurcation theory to study local and global bifurcation of $Z = (X, Y)$ when it has a typical codimension three singularity. Suppose, for example, that $0 \in \Sigma$ is at the same time, a saddle-node singularity for X and a fold point for Y or the case of $0 \in \Sigma$ is a fold for X and a fourth order tangency for Y. Under some conditions, this situations raise generic codimension three bifurcations.

Our aim is to describe the bifurcation diagram derived from for "normal forms" of such systems and also investigate the appearance of sliding cycles (closed orbits) on systems sufficient close to $Z = (X, Y)$.

Method for determining positively invariant sets containing discrete nonlinear dynamical systems attractors and their applications for the Hénon attractor

Luís Roberto Almeida Gabriel Filho, Hildebrando Munhoz Rodrigues, Camila Pires Cremasco Gabriel
UNESP - Campus Experimental de Tupã

Given the wide range of applications, applied areas scientists have concentrated efforts in the study of nonlinear dynamical systems. The objective of this work is to develop mathematical and computational methods to study the asymptotic behavior of nonlinear discrete systems and make applications for the Hénon Attractor. The study of the behavior of the orbit of a dynamical system, which constitute the set of points x_n, with $x_{n+1} = f(x_n)$, is of fundamental interest to understand precisely the convergence of subsequences of x_n, these limit points that form the set $\Omega(x_0)$.The fact that this orbit remains in a certain region can also be considered as a measure of the convergence system. In general, studies on a limited set of points in a region M of dynamic systems can be performed by determining the sets containing them and that are positively invariant, namely, $f(x) \in M$, for $x \in M$, or $f(M) \subset M$. By simulations for the Hénon attractor, determined positively invariant sets in smallest ball containing the attractor using the concepts developed in the theoretical results. Moreover, was determined a partition of this ball consisting of a set H of this type (positively invariant), another set H_1 such that $T^{n_0}(H_1)$ is positively invariant (for some $n_0 \in \mathbb{N}$), and a set H_2 with points that do not converge to the attractor of Hénon classic. It was also possible to prove that the set H, being nonempty, compact and positively invariant, then $(H) = \bigcap_{n=0}^{\infty} T^n(H)$ is not empty, compact, invariant and is the largest invariant set contained in H.

Nonlinear perturbations of a $p(x)$-laplacian equation with critical growth in $\mathbb{R}^N$

Claudianor O. Alves, **Marcelo C. Ferreira**
UFCG

We prove the existence of solution for a class of $p(x)$- laplacian equations where the nonlinearity has a critical growth. Here, we consider two cases: the first case involves the situation where the variable exponents are periodic functions. The second one involves the case variable exponents are nonperiodic perturbations.

On the local solvability in Morrey spaces of the Navier-Stokes equations in a rotating frame

Marcelo Fernandes de Almeida , Lucas Catão de Freitas Ferreira
Unicamp - IMECC

We prove local-in-time (non-uniform) solvability for the rotating Navier-Stokes equations in Morrey spaces $\mathcal{M}^{\sigma}_{p,\mu}(\mathbb{R}^3)$. Theses spaces contain singular and nondecaying functions which are of interest in statistical turbulence. We give an algebraic relation between the size of existence time and angular velocity Ω. The evolution of velocity u is analyzed in suitable Kato-Fujita spaces based in Morrey spaces. We show the asymptotic behavior $u_\Omega \to w$, in $L^\infty(0,T;\mathcal{M}^{\sigma}_{p,\mu}(\mathbb{R}^3))$ as $\Omega \to 0$, where w is the solution for the Navier-Stokes equations with the same data u_0. Particularly, for $\mu = 3 - p$, the solution is approximately self-similar for small $|\Omega|$, when u_0 is homogeneous of degree -1.

Three time scale singular perturbation problems

Pedro Toniol Cardin

Universidade Estadual Paulista

Systems in nature, which are modeled by ordinary differential equations, often involve two or more different time scales. For instance, in biological literature we can find many examples of models which present such features.

In this poster we study three time scale singular perturbation problems

$$\epsilon x' = f(\mathbf{x}, \epsilon, \mu), \qquad y' = g(\mathbf{x}, \epsilon, \mu), \qquad z' = \mu h(\mathbf{x}, \epsilon, \mu),$$

where $\mathbf{x} = (x, y, z) \in \mathbb{R}^n \times \mathbb{R}^m \times \mathbb{R}^p$, ϵ and μ are two independent small parameter ($0 < \epsilon$, $\mu \ll 1$), and f, g, h are C^r functions, where r is big enough for our purposes. We establish conditions for the existence of compact invariant sets (singular points, periodic and homoclinic orbits) when $\epsilon, \mu > 0$. Our main strategy is to consider three time scales which generate three different limit problems.

Variational characterization of the Fučík spectrum for systems with Laplacian operator

Rafael Antônio Rossato, Eugenio Massa

Universidade de São Paulo

We study the Fučík Spectrum for the case of a coupled system of two elliptic equations, in order to obtain a variational characterization for regions above the first nontrivial curve. For this purpose we apply a classical Linking Theorem using sets obtained by a suitable deformation of the eigenspaces.

Long-time behavior of a quasilinear viscoelastic equation with past history

Rawlilson de Oliveira Araújo, Ma To Fu, Yuming Qin

ICMC - USP

This work is concerned with a class of quasilinear wave equations with memory

$$|u_t|^\rho u_{tt} - \alpha\Delta u - \Delta u_{tt} + \int_a^t \mu(t-s)\Delta u(s)ds - \gamma\Delta u_t + f(u) = h, \quad \rho > 0,$$

Several authors wrote about global existence, energy decay, existence with small data and blow-up of solutions for this class of quasilinear wave equations with $a = 0$, since 2001. However uniqueness seems to be an open problem. The objective of this work is to provide some results on the global well-posedness, exponential stability and the existence of a global attractor to a more general model with past history, that is, taking $a = -\infty$.

Upper semicontinuity of attractors for a parabolic problem discretized via finite element

Rodiak Nicolai Figueroa López
UNESP-IBILCE

In this paper we consider the parabolic problem

$$\begin{cases} u_t = Lu + f(u), ; t > 0, x \in Omega \\ u(t,x) = 0, \quad t > 0, ; x \in \partial\Omega \\ u(0,x) = u^0(x), \ x \in \Omega, \end{cases} \tag{10}$$

where

$$Lu = \sum_{i,j=1}^{n} \frac{\partial}{\partial x_i}\big(a_{ij}(x)\frac{\partial u}{\partial x_j}\big) + \sum_{j=1}^{n} b_j(x)\frac{\partial u}{\partial x_j} + (c(x) + \lambda)u$$

is a second order operator with uniformly strongly elliptic condition, $u^0 \in H_0^1(\Omega)$, $\Omega \subset \mathbb{R}^n$ is a bounded domain with smooth boundary, $n \geq 1$, $a_{ij}, b_j, c : \overline{\Omega} \to \mathbb{R}$ are smooth functions, $\lambda \in \mathbb{R}$ and $f \in C^2(\mathbb{R})$. Under certain growth and dissipativity conditions we have the existence of an global attractor $\mathcal{A}$ for (10) in a Banach space $L^2(\Omega)$.

Our interest in this work to study the robustness of attractor $\mathcal{A}$ under discretization by finite element method. In particular to study the upper semicontinuity family of attractors when the global step size goes to zero. For this we use the concept of $\mathcal{P}-$convergence given in [1].

1. Vainikko G., *Funktionalanalysis der Diskretisierungsmethoden*, Teubner-Texte zur Mathematik, Verlagsgesellschaft, Leipzig, 1976.

Multiplicity of solutions for a Schrödinger equation involving a magnetic field with mixed boundary condition

Claudianor O. Alves, **Rodrigo Cohen Mota Nemer**, Sérgio H. Monari Soares
ICMC - USP

In this work we are concerned with the existence of nontrivial solutions for the following nonlinear Schrödinger equation involving a magnetic field with mixed boundary condition:

$$\begin{cases} \left(-i\nabla - A(\frac{x}{\lambda})\right)^2 u + u = f(|u|^2)u, & \text{in } \Omega_\lambda \\ u = 0, & \text{on } \Gamma_{1,\lambda} \\ \frac{\partial u}{\partial \eta} = 0, & \text{on } \Gamma_{2,\lambda} \end{cases}$$

where λ is a positive real parameter, $\Omega_\lambda = \lambda\Omega$, Ω is a bounded domain in $\mathbb{R}^N$ with smooth boundary $\partial\Omega = \overline{\Gamma_1} \cup \overline{\Gamma_2}$, $\Gamma_{1,\lambda} = \lambda\Gamma_1$ and $\Gamma_{2,\lambda} = \lambda\Gamma_2$ are smooth $(N-1)$-dimensional submanifolds of $\partial\Omega_\lambda$ with positive measures such that $\Gamma_{1,\lambda} \cap \Gamma_{2,\lambda} = \emptyset$. The function f is a $q/2$-homogeneous function with $2 < q < 2N/(N-2)$ for $N \geq 3$.

Using Morse theory, we prove that there exists $\lambda^* > 0$ such that, for any $\lambda \geq \lambda^*$, the above problem has at least $2P_1(\Gamma_2) - 1$, where $P_t(\Gamma_2)$ is the Poincaré polynomial of Γ_2.

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Programme

	Sunday 03	Monday 04	Tuesday 05	Wednesday 06	Thursday 07
Anacã	**Registration**				
Hotel	17:00-18:00				
Auditorium		**Registration**			
		8:00 - 8:20			
	Chairman	**A.N. Carvalho**	**M. Gameiro**	**J. Arrieta**	**J. Solà-Morales**
Auditorium	8:20-9:00	**Opening**	S.N. Chow	G. Sell	H.O. Walther
Auditorium	9:00-9:40	Jianhong Wu	M. Mrozek	D.G. Figueiredo	C. Tomei
Auditorium	9:40-10:20	J. Solà-Morales	Yingfei Yi	A. Castro	C. Rocha
	10:20-10:50		Coffee		
	Chairman	**C. Rocha**	**J.C. Robinson**	**T. Caraballo**	**W.M. Oliva**
Auditorium	10:50-11:30	W.M. Oliva	T. Caraballo	M. A. Teixeira	B. Schmalfuss
Auditorium	11:30-12:10	V. Afraimovich	R. Srzednicki	J. Goldstein	Shigui Ruan
	12:10-14:00		Lunch		
	Chairman	**Yingfei Yi**	**M. Mrozek**	**C. Tomei**	**A. Pereira**
Auditorium	14:00-14:30	Michael Li	A. Pereira	J. Arrieta	M. Cavalcanti
Auditorium	14:30-15:00	Huaiping Zhu	J. Clayessen	T.M. Seara	D. Stewart
Auditorium	15:00-15:30	S.M. Moghadas	C. Malta	J. Robinson	A.N. Simal
	15:30-16:00		Coffee		

Special Session on Nonlinear Dynamical Systems					
	Chairman	**P. Marín-Rubio**	**Zhenxin Liu**	**M.J. Garrido**	**S. Oliva**
Auditorium	16:00-16:30	M.J. Garrido	P. Marín-Rubio	Ma To Fu	J. de Luca
Auditorium	16:30-17:00	Zhenxin Liu	R. Martins	M. Sierzega	G. F. Madeira
Auditorium	17:00-17:30	M.C. Bortolan	E.S. Martín	S.S. Goméz	J.G. Luengo
Auditorium	17:30-18:00	S.M. Bruschi	S. Oliva	R.P. Silva	F. Rivero
Auditorium	18:00-18:30	S. Sonner	G. Lozada-Cruz	M. Vishnevskii	A.V. López

Special Session on Elliptic Equations					
	Chairman	**M. A. S. Souto**	**L. Maia**	**C. Alves**	**O.S. Queiroz**
Room 5-003	16:00-16:30	C. Alves	B. Pellaci	N. Cónsul	M.V. Pesqueira
Room 5-003	16:30-17:00	B. Sirakov	O.S. Queiroz	L. Maia	J. P. P. Silva
Room 5-003	17:00-17:30	S. Lorca	M.L. Silva	J. Abrantes Santos	M. A. S. Souto
Room 5-003	17:30-18:00	L. Bonorino	P. S. F. Salgado	M.T.P. Oliveira	R.J. Moura

	Monday 04	Tuesday 05	Wednesday 06	Thursday 07

Special Session on Dispersive Equations			
	Chairman	**M. Scialom**	**F. Dickstein**
Room 5-004	16:00-16:30	F. Linares	M. Scialom
Room 5-004	16:30-17:00	J. Ramos	C. Laurent
Room 5-004	17:00-17:30	I.R. Triviño	L.G. Farah
Room 5-004	17:30-18:00	F. Dickstein	

Special Session on Ord. and Func. Diff. Equations					
	Chairman	**J.P.C. Santos**	**J. Diblik**	**J. Heffernan**	**P. Benevieri**
Room 5-001	16:00-16:30	P. Benevieri	J. Heffernan	J. Diblik	T. Lara
Room 5-001	16:30-17:00	A.C. Prokopczyk	M. Weedermann	A. Caicedo	N.C. Roberty
Room 5-001	17:00-17:30	Z. Smarda	J.C.P.C. Matias	J.P.C. Santos	M.J.V. Brinceño
Room 5-001	17:30-18:00	G. Siracusa	M. Federson	P.H. Tacuri	R.E.P. Pazos

Special Session on Linear Partial Diff. Equations			
	Chairman	**P.L. Dattori**	**A. P. Bergamasco**
Room 5-103	16:00-16:30	G. Perla Menzala	M. R. Ebert
Room 5-103	16:30-17:00	C. Q. González	M. D'Abbicco
Room 5-103	17:00-17:30	H. Leiva	T. H. Picon
Room 5-103	17:30-18:00	L. C. Yamaoka	F. Braun

Special Session on Fluid Dynamics		
	Chairman	**M. Lopes Filho**
Room 5-101	16:00-16:30	M. Lopes Filho
Room 5-101	16:30-17:00	G. Dias
Room 5-101	17:00-17:30	L.C.F. Ferreira
Room 5-101	17:30-18:00	J. Boldrini

	Monday 04	Tuesday 05	Wednesday 06	Thursday 07
Posters				
10:20-10:50		F.S. Albuquerque	D.D. Novaes	
		R.C.M. Nemer	J.E.A. Quispe	
		M.C. Ferreira	J.F. Larrosa	
		R.A. Rossato	P.T.Cardin	
		J.L.P. Barreiro		
		A.S. Oliveira		
15:30-16:00		G.S. Aragão	F. Weilandt	
		R.O. Araújo	I. Samylovskiy	
		R.N.F. López	L.R.A.G. Filho	
		D.R.Tolfo	M.F. Almeida	

Social Events			
	12:10	Official Photo	
Auditorium	18:30	Musical Presentation	
ICMC	19:30	Cocktail	
Anacã Hotel	20:30	Conference Banquet	

ICMC Summer Meeting on Differential Equations

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List of Speakers

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

ICMC Summer Meeting on Differential Equations

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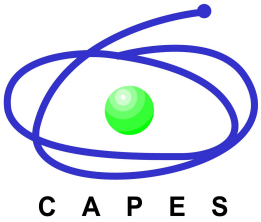

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