ICMC Summer Meeting on Differential Equations 2011 Chapter

Abstracts
(Entries are arranged alphabetically by speaker’s first name)

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Global solutions for Schrödinger-Debye system in $L^p$-spaces

Adan J. Corcho Fernandez - adan@mat.ufal.br
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This talk is concerned with the Initial Value Problem for the Schrödinger-Debye system (SD), which appears in the nonlinear optic. The model is given by the coupled following equations:

\begin{align*}
    i\partial_t u + \frac{1}{2}\Delta u &= uv, \quad t \geq 0, \quad x \in \mathbb{R}^n, \\
    \sigma\partial_t v + v &= \varepsilon |u|^p, \quad \sigma > 0, \quad \epsilon = \pm 1, \quad p > 0, \\
    u(x, 0) &= u_0(x), \quad v(x, 0) = v_0(x),
\end{align*}

where $u = u(x, t)$ is a complex valued function and $v = v(x, t)$ is a real valued function. We obtain global well-posedness results for data with infinite $L^2$-norm. Our results include data such as singular-homogeneous functions and some types of data blowing up at finitely many points. We also study the asymptotic stability of the solutions. Our analysis is performed in the framework weak-$L^p$ spaces.

Joint work with L. C. F. Ferreira (IMECC/UNICAMP).

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Local well-posedness for the 2D generalized Zakharov-Kuznetsov equation

Ademir Pastor - apastor@ime.unicamp.br
Universidade Estadual de Campinas - UNICAMP

We study well-posedness issues for the initial value problem (IVP) associated with the generalized Zakharov-Kuznetsov equation, namely,

\begin{align*}
    u_t + \partial_x \Delta u + u^k u_x = 0, \quad (x, y) \in \mathbb{R}^2, \quad t > 0, \\
    u(x, y, 0) = u_0(x, y).
\end{align*}

For $2 \leq k \leq 7$, the IVP above is shown to be locally well-posed for data in $H^s(\mathbb{R}^2)$, $s > 3/4$. For $k \geq 8$, local well-posedness is shown to hold for data in $H^s(\mathbb{R}^2)$, $s > s_k$, where $s_k = 1 - 3/(2k - 4)$. Furthermore, for $k \geq 3$, if $u_0 \in H^1(\mathbb{R}^2)$ and satisfies $\|u_0\|_{H^1} \ll 1$, then the solution is shown to be global in $H^1(\mathbb{R}^2)$.

Joint work with Felipe Linares (IMPA).

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Stabilization of distributed control systems with delay

Alejandro Roque Caicedo - alejocro@gmail.com
Universidade Federal de Pernambuco - UFPE

In this work the asymptotic stabilization of linear distributed parameter control systems with delay is considered. Specifically, we are concerned with the class of control systems described by the equation $x' = Ax(t) + L(x_t) + Bu(t)$, where $A$ is the infinitesimal generator of a strongly continuous semigroup on a Banach space $X$. Assuming appropriate conditions, we will show that the usual spectral controllability assumption implies the feedback stabilization of the system.

Joint work with H. Henríquez, C. Cuevas and M. Rabello.
Continuity of attractors and of its characterization

ALEXANDRE N. CARVALHO - andcarva@icmc.usp.br
Universidade de São Paulo - ICMC/USP

In this lecture we present some of our recent results on continuity of attractors and of its characterization under autonomous or non-autonomous perturbations. We introduce the class of gradient-like semigroups which contains the class of gradient semigroups (those with a Liapunov function) and prove that a perturbation of a gradient-like semigroup is again a gradient-like semigroup. The notion of gradient-like semigroups can be extended to non-autonomous evolution processes and we prove that a non-autonomous perturbation of a gradient-like semigroup is a gradient-like non-autonomous evolution process.

Existence and stability of periodic traveling waves for dispersive equations of KdV type

ALOÍSIO FREIRIA NEVES - aloisio@ime.unicamp.br
Universidade Estadual de Campinas - UNICAMP

We show the existence of periodic traveling waves to a class of dispersive equations of KdV type. We will study the period of these solutions and how to justify the necessary conditions for stability, according to the theory of Grillakis, Shatah and Strauss.

Joint work with Fábio Natali.

Study of some partial differential equations with fuzzy parameters

ANA MARIA AMARILLO BERTONE - anamaria@famat.ufu.br
Universidade Federal de Uberlândia - UFU

This work is part of an ongoing project aiming to review Partial Differential Equation (PDE) based models using the Fuzzy Set Theory. Physical models often have some uncertainty in their parameters which the estimation of the parameters is usually based on statistical methods and starting from data obtained experimentally. Here we introduced fuzzy parameters on PDE in place of its constant coefficients and develop numerical simulations in order to study the behavior of the fuzzy solution in comparison with the crispy solution. The main difference between the classical model and fuzzy model is that the fuzzy model exploits parameter uncertainty whereas classical model does not. In a sense, the classic model is a particular instance of the fuzzy model [3]. In the case of non stationary equations, like the heat and wave equations, we study the behavior in time of the fuzzy solution. The numerical simulations are based in the Zadeh’s Extension Principle [4] and its continuity [1,2].

This is a joint work with Rosana Sueli da Motta Jafelice.

REFERENCES

Existence and uniqueness of periodic solution of impulsive functional differential equations

André Luiz Furtado - andrelf@icmc.usp.br
Universidade de São Paulo - ICMC/USP

By applying the continuation theorem of coincidence degree theory, we establish results on the existence and uniqueness of periodic solutions for a class of nonlinear nth order impulsive functional differential equations.
Joint work with P. Benevieri and M. Federson.

Qualitative solutions for second order neutral functional differential equations

Andréa Cristina Prokopczyk Arita - andreacp@ibilce.unesp.br
Universidade de São Paulo - ICMC/USP

The study of qualitative solutions for functional differential equations has received much attention in recent years. This is an interesting topic of the theory of differential equations, as well as the study of the neutral functional differential equations, that appear in many areas of applied mathematics. Our objective is study is the existence of qualitative solutions for a specific second order abstract neutral functional differential equation, using different types of fixed point theorems.

Existence of weak solutions of the 3D Euler equations with helical symmetry without swirl

Anne Caroline Bronzi - annebronzi@gmail.com
Universidade federal do Rio de Janeiro - UFRJ

In a recent work, B. Ettinger and E. Titi proved global existence and uniqueness of weak solutions of the 3D Euler equations with helical symmetry without swirl for bounded domains with initial vorticity in \( L^\infty \). We improved this result proving global existence in the whole \( \mathbb{R}^3 \), with initial vorticity in \( L^p \), for \( p > 4/3 \), and compactly supported in the plane.

Dynamic equations on time scales and generalized differential equations

Antonín Slavík - slavik@karlin.mff.cuni.cz
Charles University in Prague, Czech Republic

The aim of this talk is to demonstrate that dynamic equations on time scales of the form
\[
x^\Delta(t) = f(x(t), t)
\]
can be treated in the framework of generalized ordinary differential equations introduced by J. Kurzweil. The corresponding generalized equation has the form
\[
\frac{dx}{d\tau} = DF(x, t),
\]
where \( F \) is obtained by taking the Kurzweil-Stieltjes integral of \( f \) with respect to a suitable function. In this way, it is possible to use existing results on generalized equations to obtain their time scale counterparts (continuous dependence on a parameter, stability, etc.).

We will also indicate the possibility of extending this theory to retarded equations on time scales.
Bifurcation without parameters: theory and examples

BERNOLD FIEDLER - Bernold.Fiedler@googlemail.com
Free University of Berlin, Germany

Standard bifurcation theory is concerned with families of vector fields involving one or several constant real parameters. The constant parameter provides a foliation of the total phase space. Frequently the presence of a trivial equilibrium manifold is also imposed.

Bifurcation without parameters, in contrast, discards the foliation by a constant parameter. Only the trivial equilibrium manifold is preserved. A rich dynamic phenomenology arises when normal hyperbolicity of the trivial equilibrium fails, due to zero or purely imaginary eigenvalues.

Specifically, we address Hopf bifurcation, Takens-Bogdanov bifurcation, and Takens-Bogdanov bifurcation with additional time reversal symmetries, all in absence of parameters.

Examples include coupled oscillators, hyperbolic conservation and balance laws, plane Kolmogorov fluid flows, and work in progress on Gödel-Einstein cosmology of Bianchi type.

The results are joint work with Andrei Afendikov, James C. Alexander, and Stefan Liebscher. For references see

http://dynamics.mi.fu-berlin.de/

Random dynamical systems generated by spde driven by a fractional noise

BJÖRN SCHMALFUSS - schmalfu@math.upb.de
University of Paderborn, Germany

A rather unsolved problem is if an spde with general coefficients generates a random dynamical system. We give a partial solution of this problem using the theory of fractional derivatives. In addition, we discuss several objects like random unstable manifolds for random dynamical systems generated by spde.

Liouville type results for elliptic equations and systems

BOYAN S. SIRAKOV - sirakov@ehess.fr
University Paris Ouest, France

We introduce a new method for proving the nonexistence of positive supersolutions of elliptic inequalities in unbounded domains of \( \mathbb{R}^n \). Our maximum principle-based argument provides for its applicability to many elliptic inequalities and systems, including quasilinear operators such as the \( p \)-Laplacian, and nondivergence form fully nonlinear operators such as Bellman-Isaacs operators. We obtain new and optimal results in terms of the nonlinear functions appearing in the inequalities, considering inequalities holding in the whole space as well as exterior domains and cone-like domains.

Joint work with S. Armstrong.

Asymptotically periodic behavior of a class of second order integro-differential equations

BRUNO DE ANDRADE - bruno00luis@gmail.com
Universidade de São Paulo - ICMC/USP

In this talk we provide sufficient conditions for the existence of asymptotically periodic solutions for a class of second order integro-differential equations.

This is joint work with Giovana Siracusa.
Orbit equivalence of Sturm global attractors

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We consider the global attractor $A_f$ for the semiflow generated by a scalar semilinear parabolic equation of the form $u_t = u_{xx} + f(x, u, u_x)$, defined on the interval, $x \in I$, under Neumann or periodic boundary conditions. In particular we consider the characterization results for the class of nonlinearities of the form $f = f(u)$ – the Hamiltonian class. Using a characterization of the period maps for planar Hamiltonian systems of the form $u'' + g(u) = 0$ we review and discuss questions related to the topological equivalence between global attractors.

Numerics of semi-linear elliptic operators with finite spectral interaction

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In the seminal Ambrosetti-Prodi theorem, the (convex) non-linearity interacts with the smallest eigenvalue of the free Laplacian. This was followed by some sparse results dealing with stronger spectral interaction. Some numerical analysis should help developing intuition.

We present results from the thesis of Eduardo Teles da Silva and José Cal Neto.

Existence and concentration of solutions for a class of elliptic problem with discontinuous nonlinearity

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In this paper, we use variational methods for locally Lipschitz functional to study the existence and concentration of solutions for the following class of elliptic problem

\[
\begin{cases}
-\Delta u + V(\epsilon x)u = H(u - \beta)u^p \quad \text{in} \quad \mathbb{R}^N, \\
u > 0 \quad \text{in} \quad \mathbb{R}^N,
\end{cases}
\]

where $\epsilon, \beta > 0$ are positive parameters, $H$ is the Heaviside function given by

\[
H(t) = \begin{cases}
1 & \text{if } t > 0, \\
0 & \text{if } t \leq 0,
\end{cases}
\]

and $p \in (1, \frac{N+2}{N-2})$ if $N \geq 3$ or $p \in (1, +\infty)$ if $N = 1, 2$. Moreover, $V : \mathbb{R}^N \to \mathbb{R}$ is a positive continuous function verifying the following assumption

\[
V_\infty = \liminf_{|x| \to \infty} V(x) > \inf_{x \in \mathbb{R}^N} V(x) = \gamma > 0.
\]

This is joint work with Rubia G. Nascimento (UFPA).
Strongly coupled elliptic systems with or without weights

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We discuss the existence and the qualitative properties of ground state solutions of Hamiltonian elliptic systems with homogeneous Dirichlet boundary condition. We extend to systems well-known results for a single equation. In symmetric domains, we investigate the inherited symmetry of the ground state solutions. For instance we show that a partial symmetry is preserved in rings while in presence of regular homogeneous weights we prove symmetry breaking in balls. Our results improve a recent paper of Calanchi & Ruf (Calc. Var & PDE 2010). Joint work with dos Santos (USP) & Ramos (UL).

On the stability of filament flows and Schrödinger maps

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The study of vortex rings in incompressible 3D fluids dates back to Kelvin and Helmholtz in the mid 1800’s. In 1906, Da Rios and Levi-Civita derived a geometric flow for filaments of infinitely small cross section and arbitrary shape. This flow is now widely called the binormal curvature flow or the LIA flow. In the talk, I will first review and then present recent results in collaboration with R.L. Jerrard on stability estimates for the filament flow, and their application to so-called Schrödinger maps.

Nonhomogeneous problems for the p-Laplacian

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A nonhomogeneous critical problem for the p-Laplacian is studied. The method of lower and upper solutions is adapted through a variational argument, as well as the Brezis-Nirenberg problem on minimum on $C^1$ versus $W^{1,p}$.

Multiplicity of solutions for gradient systems with strong resonance at higher eigenvalues

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Universidade Federal de Goiás - UFG

We establish existence and multiplicity of solutions for an elliptic system which has strong resonance at higher eigenvalues. In order to describe the resonance we exploit an eigenvalue problem with indefinite weights. In all results we use Variational Methods and the Morse Theory.
Existence and uniqueness of a solution for a class of ODE’s with Perron integrable righthand sides

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In Lectures on the Theory of Integration, World Scientific, Singapore, 1988, Ralph Henstock proved that if the righthand side of an ODE of type \( \dot{x} = f(x, t) \) satisfies Henstock conditions, then it can be written as the sum of a function of time which is Perron integrable and a function of state and time which satisfies the classic Carathéodory conditions. The reciprocal is also true. In the present lecture, we consider Carathéodory-type conditions on the indefinite integral of the function \( f \) instead of \( f \) itself and prove similar results. We also give an existence and uniqueness result by means of the theory of generalized ODEs introduced by Jaroslav Kurzweil.

Joint work with Márcia Federson.

Regularity of linear embeddings into Euclidean spaces

ELEONORA PINTO DE MOURA - eleonoramoura@gmail.com
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This talk will focus on the regularity of linear embeddings of finite-dimensional subsets of Hilbert spaces into Euclidean spaces. Hunt and Kaloshin (1999) proved that it is possible to embed a compact subset of a Hilbert space with upper box-counting dimension \( d \) into \( \mathbb{R}^N \) for any \( N > 2d + 1 \), using a linear map whose inverse is Hölder continuous. I will discuss a simple example of orthogonal sequence that shows that the bound on the Hölder exponent obtained by Hunt and Kaloshin is asymptotically sharp. One can then use an analogous argument to show that the embedding theorems proved by Robinson (2010), in terms of the Assouad dimension for the Hilbert and Banach space case, are asymptotically sharp.

Joint work with James C. Robinson.

Multiplicity of solutions for the p-Laplacian involving a nonlinearity with zeros

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We study existence, multiplicity and the behavior with respect to the parameter \( \lambda \), of the positive solutions of the problem

\[
(P_\lambda) \quad \begin{cases}
-\Delta_p u = \lambda h(x, u) & \text{in } \Omega, \\
u = 0 & \text{on } \partial\Omega,
\end{cases}
\]

where \( \lambda > 0 \) is a real parameter, \( \Omega \) is a bounded domain in \( \mathbb{R}^N \) and \( h \) is a nonnegative nonlinearity with a positive zero, which may vary with the variable \( x \): we denote by \( a(x) \) this zero. We will assume \( h \) to be \( p \)-linear near to 0 and \( p \)-superlinear at infinity.

Using mainly variational techniques, we show, in the subcritical case, the existence of at least one positive solution for \( \lambda > 0 \), and at least two for \( \lambda \) above the first eigenvalue of a related eigenvalue problem with weight.

Later, we study the asymptotical behavior of the solutions, in particular, we show that

\[
\lim_{\lambda \to \infty} u_\lambda(x) = a(x), \quad \text{for every } x \in \Omega.
\]

This asymptotical behavior will allow us to obtain the above result of two solutions for large values of \( \lambda \), but without any restriction on the growth at infinity of the nonlinearity. For this, we need to suppose that the nonlinearity is independent from \( x \in \Omega \) and that \( \Omega \) is convex.
On a class of semilinear elliptic equations

Everaldo Souto de Medeiros - everaldo@mat.ufpb.br
Universidade Federal da Paraíba - UFPB

In this talk we will present some existence results for a class of elliptic problems involving a nonlinear boundary condition on the boundary.

Existence and uniqueness results for the vortex-wave system

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Université Paris-Sud 11, Orsay, France

The vortex-wave system is a coupling of the two-dimensional Euler equations for the vorticity together with the point vortex system. It was introduced by C. Marchioro and M. Pulvirenti to describe the interaction of point vortices moving in a bounded vorticity background. In this talk we will present some uniqueness and existence results for this system. This is based on joint work with Christophe Lacave, Milton C. Lopes Filho and Helena J. Nussenzveig Lopes.

Solvability of vector fields, Half-Reeb components of foliations and injectivity of maps

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Let $F = (f_1, \ldots, f_n) : \mathbb{R}^n \to \mathbb{R}^n$ be a smooth map such that $\det DF$ is nowhere zero. For each $i \in \{1, \ldots, n\}$, define the vector field $V_{f_i} : C^\infty(\mathbb{R}^n) \to C^\infty(\mathbb{R}^n)$ by

$$V_{f_i}(\phi) = \det DG_i,$$

where $G^i : \mathbb{R}^n \to \mathbb{R}^n$ is defined by $G^i = (f_1, \ldots, f_{i-1}, \phi, f_{i+1}, \ldots, f_n)$. Furthermore, given $f : \mathbb{R}^n \to \mathbb{R}$ a smooth submersion, consider $\mathcal{F}(f)$ the $n-1$ foliation given by the level sets of $f$. In this talk, we relate solvability of the vector fields $V_{f_i}$ with the existence or not of Half-Reeb components (to be defined) of $\mathcal{F}(f_j)$ in dimension 2 and 3. These concepts will be related with the injectivity of $F$. Higher dimension results will be mentioned. This is joint study with Marco Antônio Teixeira (Unicamp) and José Ruidival dos Santos Filho (UFSCar).

Existence and decay of solutions in full space to Navier-Stokes equations with delays

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We consider the Navier-Stokes equations with delays in $\mathbb{R}^n, 2 \leq n \leq 4$. We prove existence of weak solutions when the external forces contain some hereditary characteristics and uniqueness when $n = 2$. Moreover, if the external forces satisfy a time decay condition we show that the solution decays at an algebraic rate. Joint work with César J. Niche.
Navier-Stokes equations with Navier boundary conditions for an oceanic model

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University of Minnesota, USA

We consider the Navier-Stokes equations in a thin domain of which the top and bottom surfaces are not flat. The velocity fields are subject to the Navier conditions on these boundaries and the periodicity conditions on the other four sides of the domain. This toy model arises from studies of climate and oceanic flows. We show that the strong solutions exist for all (positive) time provided that the initial data belong to a “large” set in the Sobolev space $H^1$. Furthermore, we show, for both autonomous and nonautonomous problems, the existence of a global attractor for the class of all strong solutions. This attractor is proved to be also the global attractor for the Leray-Hopf weak solutions of the Navier-Stokes equations. One issue that arises here is a nontrivial contribution due to the boundary terms. We show how the boundary conditions imposed on the velocity fields affect the estimates of the (linear) Stokes operator and the (nonlinear) inertial term in the Navier-Stokes equations. This result in a new estimate of the trilinear term, which in turn permits a short and simple proof of the existence of the strong solutions mentioned above, for all time.

This lecture is based on joint work with Luan Hoang.

Reduction of infinite dimensional systems to finite dimensions: Compact convergence approach

GERMAN JESUS LOZADA-CRUZ - german@ibilce.unesp.br
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In this talk we will consider parameter dependent semilinear evolution problems for which, at the limit value of the parameter, the problem is finite dimensional. We introduce an abstract functional analytic framework that applies to many problems in the existing literature for which the study of the asymptotic dynamics can be reduced to finite dimensions via the invariant manifold theory. Some practical models are considered to show the wide applicability of the theory.

Estimates in Sobolev weight spaces to the solutions of the power-law Stokes problem

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Universidade Federal do Amapá - UNIFAP

In this work we study estimates in Sobolev weight spaces to the solutions for the steady Stokes system for incompressible non-Newtonian fluids obeying the Power-Law in domains with noncompact boundaries. This work is part of my PhD Thesis under the supervision of the Dr. Marcelo Santos (IMECC-UNICAMP).

On fractional integro-differential equations with state-dependent delay

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In this work we obtain sufficient conditions for the existence of mild solutions for a class of fractional integro-differential equations with state-dependent delay. A concrete application is given in the theory of heat conduction in materials.

Joint work with Ravi P. Agarwal and Bruno de Andrade.
A result of multiplicity of solutions for a class of quasilinear equations

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In this paper we establish the multiplicity of positive weak solutions for the quasilinear Dirichlet problem $-L_p u + |u|^{p-2}u = h(u)$ in $\Omega_\lambda$, $u = 0$ on $\partial \Omega_\lambda$, where $\Omega_\lambda = \lambda \Omega$, $\Omega$ is a bounded domain in $\mathbb{R}^N$, $\lambda$ is a positive parameter, $L_p u = \Delta_p u + \Delta_p (u^2)u$ and the nonlinear term $h(u)$ has a subcritical growth. We use minimax methods together with the Lusternick-Schnirelmann category theory to get multiplicity of positive solutions. Joint work with Claudianor Alves (UFCG) and Uberlandio Severo (UFPB).

Generalized linear differential equations in a Banach space: Continuous dependence on a parameter

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In this work we present continuous dependence results for integral equations in a Banach space $X$ of the form

$$x(t) = \tilde{x} + \int_a^t d[A] x + f(t) - f(a), \quad t \in [a, b],$$

where $-\infty < a < b < \infty$, $\tilde{x} \in X$, $A: [a, b] \to L(X)$ has a bounded variation on $[a, b]$ and $f: [a, b] \to X$ is regulated. In particular, we give sufficient conditions ensuring that the sequence $\{x_n\}$ of the solutions of generalized linear differential equations

$$x_n(t) = \tilde{x} + \int_a^t d[A_n] x_n + f_n(t) - f_n(a), \quad t \in [a, b], \quad n \in \mathbb{N},$$

tends to the solution $x$ of (2). Among others we present an extension of the classical result by Opial [1] to the case $X \neq \mathbb{R}^n$.

Joint work with M. Tvrdý (Mathematical Institute, Academy of Sciences of Czech Republic) and M. Federson (ICMC/USP).

REFERENCES


A fifth-order evolution equation posed on a bounded interval

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We deal with a fifth-order dispersive equation posed on a finite interval. Models with and without a localized damping term are studied. It is shown that solutions to undamped problems may not decay if the length of the interval is critical. In contrast, the energy associated to the locally damped problems is shown to be exponentially decreased independently of the interval length.
The first eigenpair of the $p$-Laplacian via iteration of sublinear supersolutions

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We introduce an iterative method for computing the first eigenpair $(\lambda_p, e_p)$ for the $p$-Laplacian operator with homogeneous Dirichlet data as the limit of $(\mu_q, u_q)$ as $q \to p^-$, where $u_q$ is the positive solution of the sublinear Lane-Emden equation $-\Delta_p u_q = \mu_q u_q^{q-1}$ with same boundary data. The method is shown to work for any smooth, bounded domain. Solutions to the Lane-Emden problem are obtained through inverse iteration of a super-solution which is derived from the solution to the torsional creep problem. Convergence of $u_q$ to $e_p$ is in the $C^1$-norm and the rate of convergence of $\mu_q$ to $\lambda_p$ is at least $O(p-q)$.

Joint work with Rodney Biezuner and Eder Marinho.

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Extensions of Bochners tube theorem

GUSTAVO HOEPFNER - gushoepfner@gmail.com

Universidade Federal de São Carlos - UFSCAR

Bochners tube theorem states that a holomorphic function of several variables defined on an open tube can be extended to the convex hull of the tube. We will describe some recent CR generalizations of this result.

Joint work with J. Hounie and L. A. C. dos Santos.

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Bifurcation and stability of equilibria of a degenerate parabolic problem

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We analyse the bifurcation and stability structures of equilibria of a degenerate parabolic problem having an indefinite weight and a parameter in the nonlinear boundary condition. The problem is called degenerate because the Crandall-Rabinowitz transversality condition fails at an algebraically simple eigenvalue, what is due to the null average of the boundary weight function. Thus, the bifurcation from simple eigenvalue theorem cannot be applied to get a nontrivial local curve as opposed to the situation of nonzero weight average. To overcome that difficulty in getting the bifurcation curve, which consists of nonconstant stable equilibria to the evolution problem, we combine the Lyapunov-Schmidt reduction method with Morse Lemma.

This is joint work with Arnaldo Simal do Nascimento.
On the overdamping phenomenon

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We study the best possible decay rates for a linear second order dissipative evolution equation in a Hilbert Space. The models we consider are generated by a positive selfadjoint operator $A$ whose spectrum satisfies a “gap” condition. Our discussion applies to important examples such as the classical wave equation, the Schrödinger, the dynamical wave equation with Wentzell boundary conditions and many others important models.

Joint work with J.Goldstein and G.Goldstein.

Positive solutions for the $p$-Laplacian with dependence on the gradient

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We prove a result of existence of positive solutions of the Dirichlet problem for $-\Delta_p u = w(x)f(u,\nabla u)$ in a bounded domain $\Omega \subset \mathbb{R}^N$, where $\Delta_p$ is the $p$-Laplacian and $w$ is a weight function. As in previous results by the authors, and in contrast with the hypotheses usually made, no asymptotic behavior is assumed on $f$, but simple geometric assumptions on a neighborhood of the first eigenvalue of the $p$-Laplacian operator. We start by solving the problem in a radial domain by applying the Schauder Fixed Point Theorem and this result is used to construct an ordered pair of sub- and super-solution, also valid for nonlinearities which are super-linear both at the origin and at $+\infty$. We apply our method to the Dirichlet problem $-\Delta_p u = \lambda u(x)^{q-1}(1 + |\nabla u(x)|^p)$ in $\Omega$ and give examples of super-linear nonlinearities which are also handled by our method.

Joint work with Grey Ercole and W.M. Ferreira.

Differential equations with locally bounded delay

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For differential equations of the general form $x'(t) = g(x_t)$ which include equations with unbounded finite state-dependent delays we construct semiflows of continuously differentiable solution operators on Banach manifolds of functions on the negative real axis, and obtain local stable and unstable manifolds at equilibria. Examples arise in feedback systems with delays caused by signal transmission.
Two-dimensional incompressible flows as limits of 3D helical flows

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It is known that the three-dimensional Navier-Stokes equations are invariant under helical symmetry and that the symmetry-reduced equations are well-posed, globally in time. In this talk we investigate the limit behavior of a family of helical, viscous flows, to their corresponding two-dimensional limits, in two different situations. First, we consider the limit as the helices become straight lines. Next we consider the limit as the helices oscillate strongly and flatten out. In the latter scenario there is an intimate relation between this limit behavior and the limit behavior of the Navier-Stokes equations in a thin domain with vanishing thickness.

This is joint work with Milton C. Lopes Filho, Dongjuan Niu and Edriss S. Titi.

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Weighted asymmetric problems for an indefinite elliptic operator

**HUMBERTO RAMOS QUOIRIN** - humbertoq@gmail.com

Universidad de Santiago de Chile, Chile

We investigate two asymmetric eigenvalue type problems for the linear operator $-\Delta + V$, and, more generally, for its homogeneous quasilinear version $-\Delta_p + V$. The main novelty appears when this operator is indefinite and non-coercive, due to the possible change of structure in its weighted spectrum. We introduce a first non-trivial asymmetric eigencurve for $-\Delta_p + V$, whose first zero provides the first non-principal eigenvalue and allows us to build up a first non-trivial curve in the Fučik spectrum with weights. We partially extend the corresponding results already known when $V \equiv 0$ and obtain some new features in the indefinite case.

Joint work with Liamidi Leadi.

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Some elliptic problems with $L^1$-data and perspectives to study some systems in fluid dynamics

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We present some new results concerning the div, curl, grad operators and elliptic problems in the whole space and in the half-space. The data are in weighted Sobolev spaces and in $L^1$. The results will also be useful in the study of partial differential systems and fluid dynamics with data in $L^1$.

Joint work with Cherif Amrouche.
On initial-boundary value problems for the KdV equation

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Last years appeared publications on solvability of initial-boundary value problems for dispersive equations (which included KdV) in bounded domains, see for example [1,2,3,4]. As a rule, simple boundary conditions at \( x = 0,1 \) such as \( u(0,t) = u(1,t) = u_x(1,t) = 0 \) for the KdV equation were imposed, see [1,3]. In [2], Bubnov considered general mixed problems for the KdV equation posed on a bounded interval and proved local in \( t \) solvability results. Here we study a mixed problem for the KdV equation in a bounded interval with general linear homogeneous conditions and prove the existence and uniqueness of global regular solutions as well as the exponential decay while \( t \to \infty \) of the obtained solution for small initial data.

For a real \( T > 0 \), let \( Q_T = \{ (x,t) \in \mathbb{R}^2 : x \in (0,1), t \in (0,T) \} \). In \( Q_T \) we consider the KdV equation

\[ u_t + D^3 u + Du + uDu = 0 \]  \hspace{1cm} (3)

subject to initial and boundary conditions:

\[ u(x,0) = u_0(x), \hspace{1cm} x \in (0,1), \]  \hspace{1cm} (4)

\[ D^2 u(0,t) = a_1 Du(0,t) + a_0 u(0,t), \hspace{1cm} D^2 u(1,t) = b_0 u(1,t), \]  \hspace{1cm} (5)

where the coefficients \( a_0, a_1, b_0 \) and \( c_0 \) are such that

\[ 2A_0 = -2a_0 - 2a_1^2 - 1 > 0, \hspace{1cm} 2B_0 = 2b_0 - 2c_0^2 + 1 > 0, \]  \hspace{1cm} (6)

and \( D^j = \partial^j / \partial x^j, \ j \in \mathbb{N} \); \( D = D^1 \).

**Theorem.** Let \( u_0 \in H^3(0,1) \), and conditions (6) hold. Then for all finite \( T > 0 \) there exists a positive real constant \( \gamma = \min \{ \frac{1}{4}, \frac{2B_0}{9}, \frac{A_0}{2} \} \) such that if \( \| u_0 \|^2_{L^2(0,1)} < \frac{\gamma^2}{192} \), problem (3)-(5) has a unique regular solution \( u = u(x,t) \):

\[ u \in L^\infty(0, T ; H^3(0,1)) \cap L^2(0, T ; H^4(0,1)), \]

\[ u_t \in L^\infty(0, T ; L^2(0,1)) \cap L^2(0, T ; H^1(0,1)) \]

which satisfies the inequality

\[ \left\| u \right\|^2_{L^2(0,1)}(t) \leq 2\| u_0 \|^2_{L^2(0,1)}e^{-\chi t}, \]

where \( \chi = \frac{\gamma}{4(1+\gamma)} \).

This is a joint work with Nikolai Andreevitch Larkine.

**References**


Finite-dimensional attractors and finite-dimensional dynamics in discrete dynamical systems

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The object of this talk is to show how results from topology and dimension theory can be combined to show that, within a discrete dynamical system, the dynamics on a finite-dimensional attractor is no more complicated than the dynamics on an attractor of an iterated homeomorphism on some finite-dimensional Euclidean space. I will also discuss some of the obstacles to obtaining a similar result for continuous time systems.

Joint work with Jaime J. Sánchez-Gabites.

Averaging method for retarded differential equations

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We consider retarded functional differential equations in the setting of Kurzweil- Henstock integrable functions and we state an averaging result for these equations. Our result generalizes previous ones. Joint work with Márcia Federson.

On a class of critical elliptic systems

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We study the existence of solutions for a class of systems of two coupled semilinear Poisson equations involving critical growth in a two-dimensional Euclidean domain.

Global well-posedness for a critical perturbation of the nonlinear Schrödinger equation

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We consider the initial value problem for the Schrödinger-Debye system (SD), which appears in nonlinear optics:

\begin{align}
  \begin{cases}
    iu_t + \frac{1}{2} \Delta u &= uv, & t \geq 0, & x \in \mathbb{R}^n, \\
    \mu v_t + v &= \lambda |u|^p, & \mu > 0, & \lambda = \pm 1, & p > 0, \\
    u(x, 0) &= u_0(x), & v(x, 0) &= v_0(x),
  \end{cases}
\end{align}

where $u = u(x, t)$ is a complex valued function and $v = v(x, t)$ is a real valued function. We present recent global well-posedness results for the SD system with $p = 2$ (physical case), in the energy space $H^1 \times L^2$ and critical dimension $n = 2$. In particular, we show that, unlike the corresponding limiting model ($\mu \to 0$) Nonlinear Schrödinger equation (NLS):

\begin{align}
  i\partial_t u + \frac{1}{2} \Delta u &= \lambda u|u|^p,
\end{align}

the SD system is globally well-posed in the focusing case ($\lambda = -1$), without smallness assumption on the initial data.

This is a work done in collaboration with Adán Corcho and Filipe Oliveira.
The Dirichlet problem for a compressible system in Lipschitz domains

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Consider the system

\[ \begin{align*}
    u_t - \mu \Delta u - \nu \nabla \div u + \frac{c^2}{\rho} \nabla \eta &= f, \quad \text{in } D_T \\
    \eta_t + \rho \div u &= g, \quad \text{in } D_T \\
    u &= 0, \quad \text{on } S_T \\
    u \big|_{t=0} = 0, \quad \eta \big|_{t=0} = 0, \quad \text{on } D
\end{align*} \]

defined in \((x, t) \in D_T = D \times (0, T)\), where \(D \subset \mathbb{R}^3\), is a bounded domain with Lipschitz boundary \(\partial D\) (see Brown [1]), \(S_T = \partial D \times (0, T)\), \(v = (v^1, v^2, v^3)\) is the fluid velocity, \(\rho\) is the density, \(P = P(\rho)\) pressure and \(f\) external force. The terms of the diffusion \(\mu\) and convection \(\nu\), are such that \(\mu < \nu\).

Through of calculations and constructions, we obtain the fundamental solution

\[ G_{ij}(x, t) = \Gamma_{ij}(x, t) - R_{ij}(\Gamma_1^+ + \Gamma_1^- + \Gamma_2)(x, t) \]

observed that the kernel is a perturbation of the kernel found by Shen [4] and \(R_{ij} = (-\Delta)^{-1} \partial_{ij}\) is a differential operator of order zero. Finally, a modified method of Liu [3] applied to the Helmholtz equation (also a regular perturbation of a basic problem invertible) and thus established the existence of a unique solution in \(L^2(S_T)\) for the Dirichlet problem inside.

This is joint work with Mark Thompson (UFRGS).

REFERENCES


Approximating travelling waves by equilibria of nonlocal equations

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Under an appropriate change of variables we transform a 1-d parabolic problem into an evolution problem containing a non local term. This change of variables transforms a travelling wave (with unknown speed of propagation) into a standing wave (zero speed travelling wave). We analyze the relation between the two problems in the whole real line. We also study the behavior of this non local problem in a bounded interval and show that it has a unique equilibria which is asymptotically stable.

Joint work with Maria López-Fernández and Enrique Zuazua.
How a pullback attractor looks like?

JOSE A. LANGA - langa@us.es
Universidad de Sevilla, Spain

In this review talk we present some of our results in the last years describing the geometrical structure of pullback attractors related to some PDEs models. Pullback attraction describes the asymptotic dynamics of stochastic and non-autonomous dynamical systems. With respect to the classical theory of global attractors for autonomous systems, new concepts and technical results have to be introduced. We will focus on gradient-like dynamical systems, not necessarily given as small perturbations of a given systems, and we will also distinguish some of the important differences between the random and the non-autonomous cases.

On positive solutions for a fourth order asymptotically linear elliptic equation

JOSE VALDO GONÇALVES - goncalves.jva@gmail.com
Universidade Federal de Goiás - UFG

Existence of positive solutions for a fourth order nonlinear elliptic equation under Navier boundary conditions will be discussed. The nonlinear term involved is asymptotically linear both at the origin and at infinity. We shall exploit Topological Degree Theory and Global Bifurcation.
Joint work with Edcarlos D. Silva and Maxwell L. Silva.

Long-time asymptotics of nonlinear diffusion equations with time dependent coefficients

JUSSARA DE MATOS MOREIRA - jussarammoreira@gmail.com
Universidade Federal de Minas Gerais - UFMG

We study the long-time asymptotics of a certain class of nonlinear diffusion equations with time-dependent coefficients which arise, for instance, in the study of transport by randomly fluctuating velocity fields. The analysis employs the Renormalization Group method which is based on finding scale invariant fixed-points of a certain operator whose basin of attraction defines a universality class in the way solutions of initial value problems decay to zero. Here we are mostly interested in nonlinearities classified as critical in the sense that the diffusive term is as important as the nonlinearity in order to determine the asymptotics.
Joint work with Gastão A. Braga.

A nonlinear equation without the Ambrosetti–Rabinowitz type condition

LEONELO ITURRIAGA - leonelo.iturriaga@gmail.com
Univeridad de Tarapacá, Chile

We study the existence of positive solutions of an equation involving the $p-$Laplacian operator, where the nonlinearity also depends on the gradient. For this purpose, we will perform an adequate change of variable to give a variational approach to our problem. The main difficulty here is that this new problem does not verify necessarily the well known Ambrosetti–Rabinowitz condition.
Joint work with Sebastián Lorca and Pedro Ubilla.
Ground state solutions of saturable coupled nonlinear Schrödinger systems

LILIANE DE ALMEIDA MAIA - lilimaia@unb.br
Universidade de Brasília - UNB

We prove the existence of ground states solutions for a class of saturable weakly coupled Schrödinger system. Necessary conditions for the existence of solutions with both positive components are found. In addition some sufficient conditions gives bound states with both positive components. This is joint work with Benedetta Pellacci and Eugenio Montefusco.

Existence and scattering theory for Boussinesq type equations with singular data

LUCAS C. F. FERREIRA - lcff@ime.unicamp.br
Universidade Estadual de Campinas - UNICAMP

We study the initial value problem for the generalized Boussinesq equation and prove existence of local and global solutions with singular initial data in weak-$L^p$ spaces. Long time behavior results are obtained and a scattering theory is proved in that framework. With more structure, we show Sobolev $H^1$ and Lorentz-type $L^{(p,q)}$ regularity properties for the obtained solutions. The approach employed is unified for all dimensions.

Multiplicity of non-radial solutions for a class of elliptic equations with exponential growth

LUCIANA ROZE DE FREITAS - lucianarfreitas@hotmail.com
Universidade Estadual da Paraíba - UEPB

We establish the existence of many rotationally non-equivalent and non-radial solutions for the following class of elliptic problems

\[
\begin{cases}
-\Delta_N u = \lambda f(|x|, u) & x \in \Omega_r, \\
u > 0 & x \in \Omega_r, \\
u = 0 & x \in \partial \Omega_r,
\end{cases}
\]

where $\Omega_r = \{x \in \mathbb{R}^N : r < |x| < r + 1\}$, $N \geq 2$, $N \neq 3$, $r > 0$, $\lambda > 0$, $\Delta_N u = \text{div}(|\nabla u|^{N-2} \nabla u)$ is the N-Laplacian operator and $f$ is a function with exponential critical growth.

Joint work with Claudianor O. Alves.

Causal operators and Dushnik integral on time scales

LUCIANO BARBANTI - barbanti@mat.feis.unesp.br
Universidade Estadual Paulista - FEIS/UNESP

When solving an operator equality in general functional spaces it can take the form of a second order integral Volterra-Stieltjes type equation, depending on the properties of the original operator one. In this work we show this possibility when the operator is causal and the integral involved is of the Dushnik type on general time scales.

This is joint work with Berenice Camargo Damasceno and Marcia Federson.
Boundedness of solutions of functional differential equations with variable impulses via GODE

Luciene Parron Gimenes - lpgarantes@uem.br
Universidade Estadual de Maringá - UEM

We consider a class of functional differential equations with impulse effects acting on variable times. We give sufficient conditions for the boundedness of solutions of such systems. We make use of the generalized differential equations in order to obtain our results.

On pullback attractors continuity

Luis Felipe Rivero - lfeliperiverog@us.es
Universidad de Sevilla, Spain

We are interested in the study of the asymptotic behaviour of the following non-autonomous stronger wave equation, where both damping and strongly damping are time-dependent

\[
\begin{align*}
\begin{cases}
  u_{tt} - \Delta u - \gamma(t)\Delta u_t + \beta_\varepsilon(t) u_t = f(u) \text{ in } \Omega, \\
  u = 0 \text{ on } \partial\Omega,
\end{cases}
\end{align*}
\]

in a sufficiently smooth bounded domain $\Omega \subset \mathbb{R}^n$, $\gamma, \beta_\varepsilon : \mathbb{R} \to (0, \infty)$ verifies $0 < \gamma_0 \leq \gamma(t) \leq \gamma_1 < \infty$, $0 < \beta_0 \leq \beta(t) \leq \beta_1 \varepsilon < \infty$, and $\gamma(t)$ and $\beta_\varepsilon(t)$ are continuously differentiable in $\mathbb{R}$, with bounded derivative uniformly in $\varepsilon$, and $\gamma'(t)$ and $\beta_\varepsilon'(t)$ Hölder continuous uniformly in $\varepsilon$. We will prove the existence of the pullback attractor depending on parameter $\varepsilon$ and the continuity of them when $\varepsilon \to 0$, based on the upper and lower-semicontinuity. The first one needs some regularity of the attractor and, in the second case, we need a gradient-like structure for the limit problem.

Joint work with Tomás Caraballo and José A. Langa.

Global solutions below the energy space for the generalized Boussinesq equation

Luiz Gustavo Farah Dias - farah@impa.br
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We show that the Cauchy problem for the defocusing generalized Boussinesq equation $u_{tt} - u_{xx} + u_{xxxx} - (|u|^{2k} u)_{xx} = 0$, $k \geq 1$, on the real line is globally well-posed in $H^s(\mathbb{R})$ for $s > 1 - (1/3k)$. To this end we use the $I$-method, introduced by J. Colliander, M. Keel, G. Staffilani, H. Takaoka and T. Tao, to define a modification of the energy functional that is “almost conserved” in time. Our result extends the previous one obtained by Farah and Linares for the case $k = 1$.

Stationary flow for power-law fluids in domains with unbounded boundaries

Marcelo Santos - msantos@ime.unicamp.br
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We solve the stationary Navier-Stokes equations for non Newtonian incompressible fluids obeying a power law in domains with unbounded boundaries. The fluid fluxes in the outlets to infinity of the domain assume arbitrary given values, and the Dirichlet integrals of the velocity field grows at most linearly at these outlets. This is joint work with Gilberlandio J. Dias (UNIFAP and IMECC-UNICAMP).
Averaging for impulsive functional differential equations: A new approach

MÁRCIA FEDERSON - federson@icmc.usp.br
Universidade de São Paulo - ICMC/USP

We consider a large class of retarded functional differential equations subject to impulse effects at variable times and we present an averaging result for this class of equations by means of the techniques and tools of the theory of generalized ordinary differential equations introduced by J. Kurzweil.

Asymptotic behavior of solutions of the critical KdV equation with time-oscillating nonlinearity

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Universidade Estadual de Campinas - UNICAMP

We investigate the initial value problem (IVP) associated to the equation

\[ u_t + \partial_x^3 u + g(\omega t) \partial_x(u^5) = 0, \]

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

\[ U_t + \partial_x^3 U + m(g) \partial_x(U^5) = 0, \]

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 \( \|U\|_{L^5_x L^{10}_t} < \infty \), then we prove that the solution \( u_\omega \) is also global provided \( |\omega| \) is sufficiently large.

Joint work with Mahendra Panthee and Xavier Carvajal.

Schrödinger-Poisson equations without the Ambrosetti-Rabinowitz condition

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Universidade Federal de Campina Grande - UFCG

We prove the existence of ground state solutions for the Schrödinger-Poisson system

\[ \begin{cases} 
-\Delta u + V(x)u + \phi u = f(u), & \text{in } \mathbb{R}^3, \\
-\Delta \phi = u^2, & \text{in } \mathbb{R}^3.
\end{cases} \]

The proof is based on the mountain pass theorem and it does not require the Ambrosetti – Rabinowitz condition.

Joint work with Claudianor O. Alves and Sérgio H. M. Soares.
**Piece-wise smooth systems and singular perturbation problem**

**Marco Antonio Teixeira** - teixeira@ime.unicamp.br  
Universidade Estadual de Campinas - UNICAMP

We establish a bridge between Filippov non-smooth systems and singular perturbation theory and we show that there is a correspondence between Sliding Motion and Slow Flow. The main used tools are Regularization Process and Blowup Theory.  
This is joint work with Paulo Ricardo da Silva (Ibíce/Unesp).

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**Error estimates for a Neumann problem on thin domains with oscillating boundary**

**Marcone Correa Pereira** - marcone@usp.br  
Universidade de São Paulo - USP

We consider the Laplace operator with Neumann boundary conditions in a two dimensional thin domain with a highly oscillating boundary. We study the case where the boundary is defined by the graph of an oscillating function. We give an error estimate when we replace the perturbed solution by a second order asymptotic expansion obtained by the *Multiple-Scale Method*.

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**Random fixed points of random differential equations with random delays**

**María J. Garrido-Atienza** - mgarrido@us.es  
University of Sevilla, Spain

We investigate a random differential equation with random and non-bounded delay. First the non–autonomous case is considered. We show the existence and uniqueness of a solution that generates a cocycle. In particular, the existence of an attractor is proved. Secondly we look at the random case. We pay special attention to the measurability. This allows us to prove that the solution to the random differential equation generates a random dynamical system which consists of a random fixed point under particular assumptions. The work presented in this talk is done in collaboration with A. Ogrowsky and B. Schmalfuss (University of Paderborn).

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**Characteristic equations and asymptotic behavior of solutions of FDE**

**Miguel V. S. Frasson** - frasson@icmc.usp.br  
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For an autonomous linear functional differential equation (FDE) one associates its characteristic equation. For nonautonomous linear FDE, the generalized characteristic equation was introduced. We discuss some results on the connection between properties of some solutions of characteristic equations and generalized characteristic equations and the asymptotic behavior of solutions of linear FDE.  
Joint work with Claudio Cuevas.
About one nonlinear mathematical problem of electromagnetoelastic interaction

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Interaction of electromagnetoelastic fields with elastic body is of the subject of many theoretical investigation in mechanics of continua for the last decades. Some variants of direct and inverse problems have been studied leading into determination of some characteristics of medium. It is very interesting to study this phenomena due to the possibility of applying this theory to geophysical prospection. Our communication is dedicated to investigate this interaction. The model consider here is based on a simple variant of combination of Lame and Maxwell equation. We prove well posesness of problem and study the asymptotic behavior of solutions.

Joint work with Viatcheslav Priimenko.

On positive periodic solutions of singular nonlinear boundary value problems

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The contribution deals with the existence of solutions to the problem

\[(P) \quad (\phi_p(u'))' + a(t) \phi_p(u) = f(t, u), \quad u(0) = u(T), \quad u'(0) = u'(T),\]

where \(0 < T < \infty, 1 < p < \infty, \phi_p\) stands for the \(p\)-Laplacian, \(\phi_p(y) = |y|^{p-2} y\) for \(y \in \mathbb{R}\), \(a \in L_\alpha[0,T]\) for some \(\alpha, 1 \leq \alpha \leq \infty,\) and \(f: [0,T] \times (0, \infty) \to \mathbb{R}\) is regular in \([0,T] \times (0, \infty)\), but can have singularity for \(x = 0\). A crucial moment is whether the corresponding quasilinear problem

\[(Q) \quad (\phi_p(u'))' + a(t) \phi_p(u) = h(t), \quad u(0) = u(T), \quad u'(0) = u'(T),\]

satisfies the anti-maximum principle, i.e whether for each \(h \in L_1[0,T]\) such that \(h \geq 0\) a.e. on \([0,T]\), any solution of the problem \((Q)\) is nonnegative on \([0,T]\).

We will present new conditions ensuring that problem \((Q)\) fulfils the anti-maximum principle and therefore a substantial condition ensuring the existence of a positive solution to \((P)\) is satisfied. Our main goal is to include the case that \(a\) can change its sign on the interval \([0,T]\). In a rather classical case that \(a = \infty\) and \(a \geq 0\) a.e. on \([0,T]\) our condition reduces to a well-known condition \(\|a\|_1 \leq \lambda^D_1\), where \(\lambda^D_1\) stands for the first eigenvalue of the related Dirichlet problem.

Contribution is based on joint research with Alberto Cabada, José Ángel Cid and Alexander Lomtatidze.

Moving heat source reconstruction from Cauchy boundary data

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In this work, we consider the problem of reconstruction of an unknown characteristic transient thermal source inside a domain. By introducing the definition of an Extended Dirichlet to Neumann map in the time space cylinder and the adoption of the anisotropic Sobolev-Hilbert spaces, we can treat the problem with methods similar to that used in the analysis of the stationary source reconstruction problem. Further, the finite difference \(\theta\)-scheme applied to the transient heat conduction equation leads to a model based on a sequence of modified Helmholtz equation solutions. For each modified Helmholtz equation the characteristic star-shape source function may be reconstructed uniquely from the Cauchy boundary data. Using representation formula we establish reciprocity functional mapping functions that are solutions of the modified Helmholtz equation to their integral in the unknown characteristic support.

Joint work with Marcelo L. S. Rainha.
Odd homoclinic orbits for a second order Hamiltonian system

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The aim of this talk is to present an odd homoclinic orbit for a class of reversible Hamiltonian systems. The proof is variational and it is employed a version of the splitting lemma due to Struwe. More precisely, we establish the existence of a solution \( q \) for the Hamiltonian system

\[ \dot{q} - L(t)q + b(t)V_q(q) = 0, \]

with \( q(t) \to 0 \) and \( \dot{q}(t) \to 0 \) as \( |t| \to \infty \) such that \( q(-t) = -q(t) \) for all \( t \in \mathbb{R} \). Here \( q \in \mathbb{R}^N \) and we assume the \( N \times N \) matrix \( L(t) \) satisfies

(L1) \( L(t) \in C([\mathbb{R}, \mathbb{R}^{N^2}]) \) is positive definite for each \( t \in \mathbb{R} \);

(L2) \( \lim_{|t| \to \infty} L(t) = L_\infty \), \( L(t)q \cdot q \leq L_\infty q \cdot q \) for all \( q \in \mathbb{R}^N \);

(L3) \( L(t) = L(-t) \) for all \( t \in \mathbb{R} \).

Moreover, the functions \( b \) and \( V \) satisfy respectively:

(b1) \( b \in C([\mathbb{R}, (0, +\infty)]) \);

(b2) \( \lim_{|t| \to \infty} b(t) = b_\infty \), \( b(t) \geq b_\infty \) for all \( t \in \mathbb{R} \);

(b3) \( b(t) = b(-t) \) for all \( t \in \mathbb{R} \).

(V1) \( V \in C^2(\mathbb{R}^N, \mathbb{R}) \);  

(V2) \( V_{qq}(0) = 0 \);

(V3) There exists \( \mu > 2 \) such that

\[ 0 < \mu V(q) \leq V_q(q) \cdot q \quad \text{for all} \quad q \in \mathbb{R}^N \backslash \{0\}; \]

\[ (\mu - 1)V_q(q) \cdot q \leq V_{qq}(q) \cdot q \cdot q \quad \text{for all} \quad q \in \mathbb{R}^N \backslash \{0\}; \]

(V4) \( V \) is even, i.e. \( V(-q) = V(q) \).

Our main result is the following:

**Theorem.** Assume (L1) – (L3), (b1) – (b3) and (V1) – (V4) are satisfied and for some positive number \( \gamma_0 < \sqrt{\lambda_\infty}/2 \), there holds

(L4) \( L(t)q \cdot q \leq L_\infty q \cdot q - Ce^{-\gamma_0|t|}q \cdot q \) for all \( t \in \mathbb{R} \) and \( q \in \mathbb{R}^N \),

where \( \lambda_\infty \) denotes the smallest eigenvalue of \( L_\infty \). Then there exists an odd homoclinic orbit of \( q(t) \), that is, there exists a solution \( q \in W^{1,2}(\mathbb{R}, \mathbb{R}^N) \backslash \{0\} \) such that \( q(-t) = -q(t) \).

Joint work with Liliane A. Maia and Sérgio H. M. Soares.

Riemann solution for general Corey model

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We consider the Riemann problem for two conservation laws representing the injection of two fluids into a oil virgin reservoir containing a third fluid. We assume that the three fluids are immiscible and do not exchange mass. The relative permeabilities are given either by the Corey or Stone models as general saturation powers. For each proportion of the injected fluids the Riemann solution profile and the wave curves are found. The solution consists constant states, rarefaction and shock waves. Typically there are two wave groups: the slower one is composed by a rarefaction adjacent to a shock, in which the three fluid saturations change. Depending on the initial conditions, a constant state can exist between the two wave groups. In the faster wave group there are only two fluids, and it consists either of a rarefaction adjacent to a shock or of a single shock.

We show some results of the behavior for the general Corey model that generalize the quadratic model.

Joint work with Dan Marchesin and Frederico Furtado.
Properties of solutions of a class of planar elliptic operators with degeneracies

Paulo Leandro Dattori da Silva - dattori@icmc.usp.br
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In this talk we will investigate properties of solutions of first and second order elliptic equations that degenerate along a simple closed curve in $\mathbb{R}^2$. These equations are generated by a $C$-valued vector field $L$. To the vector field $L$, we associate the second order operator $P = \text{Re} \left[ L^2 + pL \right]$, where $p$ is a $C$-valued function. We establish a one-to-one correspondence between the solutions of the equation $Pu = 0$ and those of an associated first order equation of type $Lw = Aw + Bw$.

This is joint work with Abdelhamid Meziani (Florida International University).

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Bifurcation curves of a diffusive logistic equation with harvesting

Pedro M. Girão - pgirao@math.ist.utl.pt
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We study the global bifurcation curves of a diffusive logistic equation, for values of the linear growth up to $\lambda_2 + \delta$, examining in detail their behavior as the linear growth rate crosses the first two eigenvalues.

On the asymptotic behaviour of non-autonomous 2D-Navier-Stokes equations with and without delays

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Two-dimensional Navier-Stokes models with non-autonomous force terms, and with and without delays, are considered. Their asymptotic behaviour are studied in the framework of pullback $D$–attractors, for universes of fixed bounded sets and also for those given by tempered conditions. Regularity properties and relationship between these families are established. Joint work with Julia García-Luengo and José Real.

Superlinear elliptic problems with sign changing coefficients

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Via variational methods, we study multiplicity of solutions for the problem

$$\begin{cases}
-\Delta u = \lambda b(x)|u|^{q-2}u + au + g(x,u) & \text{in } \Omega, \\
u = 0 & \text{on } \partial\Omega.
\end{cases}$$

where a simple example for $g(x,u)$ is $|u|^{p-2}u$; here $a, \lambda$ are real parameters, $1 < q < 2 < p \leq 2^*$ and $b(x)$ is a function in a suitable space $L^p$. We obtain a class of sign changing coefficients $b(x)$ for which two non-negative solutions exist for any $\lambda > 0$, and a total of five nontrivial solutions are obtained when $\lambda$ is small and $a \geq \lambda_1$. Note that this type of results are valid even in the critical case. Joint work with Eugenio Massa.
Pullback exponential attractors for reaction-diffusion systems

Radoslaw Czaja - czaja@math.ist.utl.pt
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In this talk we formulate a general theorem on the existence of a pullback exponential attractor. It is a family of compact and positively invariant sets with uniformly bounded fractal dimension which at a uniform exponential rate pullback attract bounded subsets of the phase space under the evolution process.

We state the conditions that guarantee the existence of such a family for nonautonomous semi-linear abstract parabolic Cauchy problems. The abstract theory is illustrated with an example of a nonautonomous system of reaction-diffusion equations satisfying anisotropic dissipativity condition that holds, for example, in the case of the FitzHugh-Nagumo system.

The presented results are joint work with Messoud Efendiev.

Periodic pseudodifferential operators and Hardy spaces

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Universidade Federal de São Carlos - UFSCAR

In this talk we shall present some key results on the calculus periodic pseudodifferential operators, that are useful in the study of continuity on Hardy spaces of the torus $\mathbb{T}^n$.

Joint work with Luis Antônio Carvalho dos Santos.

Nonlinear biharmonic problems with singular potentials

Reginaldo Demarque da Rocha - r.demarque@gmail.com
Universidade Federal Fluminense - UFF

In this paper we consider the semilinear elliptic problem involving the biharmonic operator $\Delta^2$ given by

\begin{equation}
\begin{cases}
\Delta^2 u + V(|x|)u = f(u) \\
u \in D^{2,2}(\mathbb{R}^N; \mathbb{R}), \quad N \geq 5
\end{cases}
\end{equation}

where the potential $V : [0, \infty) \to (0, \infty]$ is a measurable function, the nonlinearity $f : \mathbb{R} \to \mathbb{R}$ is continuous and they satisfy the following assumptions:

(V) There exist $A, \alpha > 0$ such that $V(s) \geq \frac{A}{s^\alpha}$ for almost every $s > 0$.

(f) There exist $M > 0$ and $p > 2$ such that $|f(s)| \leq M|s|^{p-1}$ for all $s \in \mathbb{R}$.

In this paper we extend the results involving the Laplacian and p-Laplacian operators treated in [1] e [2]. We show that problem (10) admits nontrivial radial solution if $\alpha \in (0, 4)$ and $p \in (m_\alpha, 2^{**})$ or $\alpha \in (4, 2N - 4)$ and $p \in (2^{**}, m_\alpha)$ or $\alpha \in (2N - 4, \infty)$ and $p \in (2^{**}, \infty)$, where we denote by $2^{**} := \frac{2N}{N-4}$ the critical exponent for the Sobolev embedding in dimension $N \geq 5$ and we set $m_\alpha := 2 + \frac{4\alpha}{2N-4-\alpha}$ for $\alpha \in (0, 2N - 4)$.

Joint work P. C. Carrião and O. H. Miyagaki.

References

Pullback attractors for a singularly nonautonomous plate equation

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We consider the family of singularly nonautonomous plate equation with structural damping

\[ u_{tt} + a(t, x)u_t + (-\Delta)u_t + (-\Delta)^2u + \lambda u = f(u), \]

in a bounded domain \( \Omega \subset \mathbb{R}^n \), with Navier boundary conditions. When the nonlinearity \( f \) is dissipative we show that this problem is globally well posed in \( H^2_0(\Omega) \times L^2(\Omega) \) and has a family of pullback attractors which is upper-semicontinuous under small perturbations of the damping \( a \).

Joint work with V. L. Carbone, M. J. D. Nascimento and K. Schiabel-Silva.

Advances on Dyson-Phillips expansion to solve integro-differential equations

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In this work we consider differential-integral equations such as

\[ \frac{du(t)}{dt} = a u(t) + \int k(t, s) u(s) \, ds, \]

or equations of the following type furnished by linear transport theory

\[ \frac{\partial u(x, \mu, t)}{\partial t} + \mu \frac{\partial u(x, \mu, t)}{\partial x} + h(x, \mu) u(x, \mu, t) = \int_{-1}^{1} k(x, \mu, \mu') \, d\mu' + q(x, \mu, t), \]

where in both equations \( x, \mu \) and \( t \) represent independent variables, \( u \) the unknown function and \( k \) is the kernel. Certainly the function \( q \) is the source function. Both equations can put in the form

\[ \frac{du(t)}{dt} = Au(t) + Bu(t) \]

where \( A \) is the generator of the semigroup \( W_0(t) \) and \( A + B \) is the generator of the semigroup \( W(t) \). The Dyson-Phillips takes the form [1,2]

\[ W(t) = \sum_{0}^{\infty} W_0^{(n)} t, \quad n \geq 0, \]

where

\[ W_0^{(0)}(t) = W_0(t)/W_0^{(n)}(t) = - \int_{0}^{t} W_0(t - s) B W_0^{(n-1)}(s) \, ds. \]

We solve both problems above with some boundary conditions and give numerical results obtained with a computer algebraic system. Some remarkable extensions are obtained in the framework of the strongly continuous semigroup theory [3]. The results are analytic and numerical.

REFERENCES

Localized hydrodynamic instabilities

SÁVIO RODRIGUES - savio@dm.ufscar.br
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Instabilities of viscous and inviscid fluids with respect to high-frequency disturbances are found using the WKB methods. This asymptotic method reveals several criteria for the existence of instabilities including the well known Rayleigh criterion for centrifugal instability. I explore the linear and nonlinear evolution of high-frequency wavepackets in the neighborhood of unstable elliptical stagnation points using asymptotic and computational methods: the instability of single-phase and multi-phase solutions are addressed.

A priori estimate to a strongly non–linear problems involving the m-Laplacian

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We establish a priori estimates for positive solution of the problem

\[
\begin{aligned}
-D_m u &= f(x, u, \nabla u), & \text{for } x \in \Omega, \\
u(x) &= 0, & \text{for } x \in \partial \Omega
\end{aligned}
\]

where \(1 < m < N\), the function \(f : \Omega \times [0, +\infty) \times \mathbb{R}^N \rightarrow [0, +\infty)\) is continuous, and \(\Omega \subset \mathbb{R}^N\) is a \(C^2\) bounded domain. Here \(D_m u = \text{div} \left( |\nabla u|^{m-2} \nabla u \right)\) denotes the \(m\)-Laplacian operator.

We will assume that for all \((x, u, \eta) \in \Omega \times [u_0, +\infty) \times \mathbb{R}^N\) we have

\[u^q - c_0 |\eta|^\beta \leq f(x, u, \eta) \leq c_1 u^p + c_0 |\eta|^\beta\]

where \(c_0, u_0 > 0, c_1 \geq 1, m-1 < p < m_\ast -1\), and \(\beta < p m/(p+1)\). The constant \(m_\ast\) denotes the Serrin exponent given by \(m_\ast = \frac{m(N-1)}{N-m}\).

Gradient property for equations type neural fields

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In this work we prove the flow generated by non local evolution equation

\[
\frac{\partial u(x,t)}{\partial t} = -u(x,t) + J \ast (f \circ u)(x,t) + h, \quad h \geq 0
\]

is gradient, in \(L^2(S^1)\). In the equation above, the function \(u(x,t)\) denotes the mean membrane potential of a patch of tissue located at position \(x \in (-\infty, \infty)\) at time \(t \geq 0\). The connection function \(J(x)\) determines the coupling between the elements at position \(x\) with the element at position \(y\). The non negative nondecreasing function \(f(u)\) gives the neural firing rate, or averages rate at which spikes are generated, corresponding to an activity level \(u\). The \(\ast\) above denotes convolution product.
Fokker-Planck equations for a free energy functional or Markov process on a graph

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The classical Fokker-Planck equation is a linear parabolic equation which describes the time evolution of probability distribution of a stochastic process defined on a Euclidean space. Corresponding to the stochastic process, there often exists a free energy functional which is defined on the space of probability distributions and is a linear combination of a potential and an entropy. In recent years, it has been shown that Fokker-Planck equation is the gradient flow of the free energy functional defined on the Riemannian manifold of probability distributions whose inner product is generated by a 2-Wasserstein distance. In this talk, we consider similar matters for a free energy functional or Markov process defined on a graph with a finite number of vertices and edges. If \( N \geq 2 \) is the number of vertices of the graph, we show that the corresponding Fokker-Planck equation is a system of \( N \) nonlinear ordinary differential equations defined on a Riemannian manifold of probability distributions. However, in contrast to the case of stochastic processes defined on Euclidean spaces, situation is more subtle for discrete spaces. We have different choices for inner products on the space of probability distributions resulting in different Fokker-Planck equations for the same process. It is shown that there is a strong connection but also substantial differences between the systems of ordinary differential equations and the classical Fokker-Planck equation on Euclidean spaces. Furthermore, each of these systems of ordinary differential equations is a gradient flow for the free energy functional defined on a Riemannian manifold whose metric is closely related to certain Wasserstein metrics. Some examples will also be discussed.

On exponential stability of retarded functional differential equations with variable impulses

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In this work, we describe a class of retarded functional differential equations with impulse effects acting on variable times and we investigate the exponential stability of the trivial solution of such equations. We employ the theory of generalized ordinary differential equations to obtain our result. Joint work with E. M. Bonotto and M. Federson.

Global versus random attractors: Effects of noise on dynamical systems

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The aim of this talk is to present some features concerning the effects of noise on the asymptotic behaviour of dynamical systems. It is well-known now the stabilizing and destabilizing effects which the appearance of different kinds of noise (e.g. Ito or Stratonovich) may have on the stationary solutions (equilibria) of deterministic dynamical systems. Now we will report some results on the appearance of exponentially stable stationary (in the stochastic sense) solutions when some noise is added to the model, as well as, the analysis of the existence of random attractor when the deterministic model is not known to have (or does not have) a global attractor. These results will show some kind of stabilization on global attractors instead of only on equilibria.
Solutions for a class of elliptic problems with indefinite nonlinearities

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This work is concerned with semilinear elliptic problems whose nonlinear term has the form $W(x)f(u)$ where $W(x)$ changes sign. We study the existence of positive solutions and their multiplicity. The important role played by the negative part of $W$ is contained in a condition which is shown to be necessary for homogeneous $f$.

Joint work with Elves A. B. Silva and Everaldo S. Medeiros.

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Global attractor for a model of viscoelastic beam equation with nonlinear damping

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In this paper we obtain a global attractor for the viscoelastic beam equation, with nonlinear damping and source terms,

$$u_{tt} + \Delta^2 u - \int_0^t g(t-\tau)\Delta^2 u(\tau)d\tau + f(u) + \rho(u_t) = h \quad \text{in } \Omega \times \mathbb{R}^+,$$

where $\Omega$ is a bounded domain of $\mathbb{R}^N$ and $h \in L^2(\Omega)$. Here the nonlinearities $f(u)$ and $\rho(u_t)$ are essentially $|u|^\alpha u - |u|^\beta u$ and $|u_t|^r u_t$ respectively, with $\alpha, \beta, r > 0$ and $\beta < \alpha$.

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Recent results on dissipative Lotka-Volterra systems

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The present talk describes some of the main contributions obtained on that class of quadratic systems including results related with the notions of associated graphs and attractors of dissipative and stably dissipative Lotka-Volterra systems.

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Viscous stability in Hamiltonian systems

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We consider a smooth, nearly integrable Tonelli Hamiltonian $H(x,P)$, $x \in T^n, P \in \mathbb{R}^n$ and all its viscosity (weak KAM) solutions $u(x,P)$ of the Hamilton-Jacobi equation $H(x,P + Du(x,P)) = H(P)$. We show that if $P_0$ corresponds to a quasi-periodic invariant torus, then $Du(x,P)$ is Hölder continuous in $P$ at $P_0$ with Hölder exponent arbitrarily close to 1, and if both $H$ and the torus are real analytic and the frequency vector of the torus is Diophantine, then $Du(x,P)$ is Lipschitz continuous in $P$ at $P_0$, i.e., there is a constant $C > 0$ such that $\|Du(x,P) - Du(x,P_0)\|_\infty \leq C\|P - P_0\|$ as $\|P - P_0\| \ll 1$. 

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POSTER SESSION

On the bi-dimensional version of the dynamical Marguerre-Vlasov system with thermal effects

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A bi-dimensional version of the dynamic Marguerre-Vlasov system in the presence of thermal effects is considered. The wellposedness of regular and weak solutions is showed.

Existence and concentration of solutions for a class of biharmonic equations

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Some superlinear fourth order elliptic equations are considered. Ground states are proved to exist and to concentrate at a point in the limit. The proof relies on variational methods, where the existence and concentration of nontrivial solutions are related to a suitable truncated equation.

This is a joint work with Sérgio H. M. Soares.

Positive solutions for a class of elliptic systems with singular potentials

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In this work we deal with the existence of positive solutions for the following class of elliptic system

(S)

where the potentials \( V_i \), \( V_2 \) and \( (K) \), and the function \( Q \) satisfy the following conditions:

(V) \( V_i \in L^1_{loc}(\mathbb{R}^N) \cap C^0(\mathbb{R}^N \setminus S_0^i, [0, \infty]) \) for a bounded Lebesgue measure zero set \( S_0^i \), \( Z \cap S_0^i = \emptyset \), \( i = 1, 2 \), where \( Z = \{ x \in \mathbb{R}^N \mid V(x) = 0 \} \), \( S_0 = S_0^1 \cup S_0^2 \) and \( V(x) = \min \{ V_1(x), V_2(x) \} \); moreover,

(V)_a \( \liminf_{d(x,S_0) \to 0} V(x) \in (0, \infty] \)

and

(V)_b \( \liminf_{|x| \to \infty} |x|^2 V(x) \geq 4\lambda \) for some \( \lambda > 0 \).

(K) \( K \in L^{q_0}_{loc}(\mathbb{R}^N) \) for some \( q_0 \geq \frac{2^*}{2 - (p + 1)} \), \( K \in C^0(\mathbb{R}^N \setminus S, [0, \infty)) \) for a bounded and Lebesgue measure zero set \( S \); \( \limsup_{|x| \to \infty} K(x) |x|^{-\gamma} < \infty \) for some \( \gamma > 0 \), where \( 1 < p < 2^* - 1 \) and \( 2^* = 2N/(N - 2) \) is the critical Sobolev exponent for \( N \geq 3 \).

\( Q \in C^1((0, +\infty) \times [0, +\infty), \mathbb{R}) \) is a homogeneous function of degree \( p + 1 \) and verifies:

(Q) \( \) There exists \( C > 0 \) such that

\( |Q_u(u,v)| \leq C(|u|^p + |v|^p), \forall u, v \geq 0, \)

\( |Q_v(u,v)| \leq C(|u|^p + |v|^p), \forall u, v \geq 0; \)

(Q_1) \( \) There exist \( \rho_1, \rho_2 > 0 \) such that

\( \rho_1(|u|^{p+1} + |v|^{p+1}) \leq Q(u,v) \leq \rho_2(|u|^{p+1} + |v|^{p+1}) \forall u, v > 0; \)

(Q_2) \( \) There exist \( Q_u(0,1), Q_v(1,0) > 0; \)

(Q_3) \( Q(u,v) > 0 \ \forall u, v > 0; \)
(Q5) \( Q_u(u,v), Q_v(u,v) \geq 0 \) \( \forall u, v \geq 0 \).

Here we are interested in the existence of solutions for (S), concentrating near of zeros of the potentials \( V_1, V_2 \) and singularities of \( V_1, V_2 \) and \( K \). The potentials \( V_1 \) and \( V_2 \) may decay at infinity and \( K \) may be unbounded at infinity.

Our main result is the following.

**Theorem.** Suppose that \((Q_1)-(Q_5), (V)\) and \((K)\) hold. Let \( A \subset Z \cup S \) be an isolated compact subset of \( Z \cup S \) such that \( A \cap S_0 \cap S_0 \setminus A = \emptyset \) and \[ \lim_{0<d(x,A)\to 0} W^{2N-(p+1)(N-2)}/K^2(x) = 0, \] where \( W(x) = \max\{V_1(x), V_2(x)\} \).

Then, for \( \varepsilon > 0 \) sufficiently small, \((S)\) has a solution \((u_\varepsilon, v_\varepsilon) \in W^{1,2}(\mathbb{R}^N) \times W^{1,2}(\mathbb{R}^N), u_\varepsilon, v_\varepsilon > 0\), such that

\[ \lim_{\varepsilon \to 0} \|u_\varepsilon\|_{L^\infty(\mathbb{R}^N)} = \lim_{\varepsilon \to 0} \|v_\varepsilon\|_{L^\infty(\mathbb{R}^N)} = 0 \]

and

\[ \liminf_{\varepsilon \to 0} \varepsilon^{-2/(p-1)} \|u_\varepsilon + v_\varepsilon\|_{L^\infty(\mathbb{R}^N)} > 0. \]

Moreover, for each \( \delta > 0 \), there are constants \( C, c > 0 \) such that

\[ u_\varepsilon(x), v_\varepsilon(x) \leq C \exp(-c/\varepsilon)[1 + (|x|/2R_0)^{-\frac{N}{2}}] \quad \forall x \in \mathbb{R}^N \setminus A^\delta, \]

where \( A^\delta \equiv \{ x \in \mathbb{R}^N \mid d(x,A) \leq \delta \} \) and \( R_0 \) is a positive constant given by \((V)\) and \((K)\).

Joint work with Paulo Cesar Carrião and Olímpio Hiroshi Miyagaki.

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**Positive solutions for the critical Klein-Gordon-Maxwell system with potentials**

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In this work we study the Klein-Gordon-Maxwell systems with potentials when the nonlinearity exhibits critical growth. We establish the existence of positive solutions with a periodic potential and also in the case that a nonperiodic potential is introduced.

Joint work with P. C. Carrião and O. H. Miyagaki.