UNIVERSIDADE FEDERAL FLUMINENSE
INSTITUTO DE MATEMÁTICA E ESTATÍSTICA

II Workshop On Control Theory and Partial Differential Equations

October 25 to 28, 2022

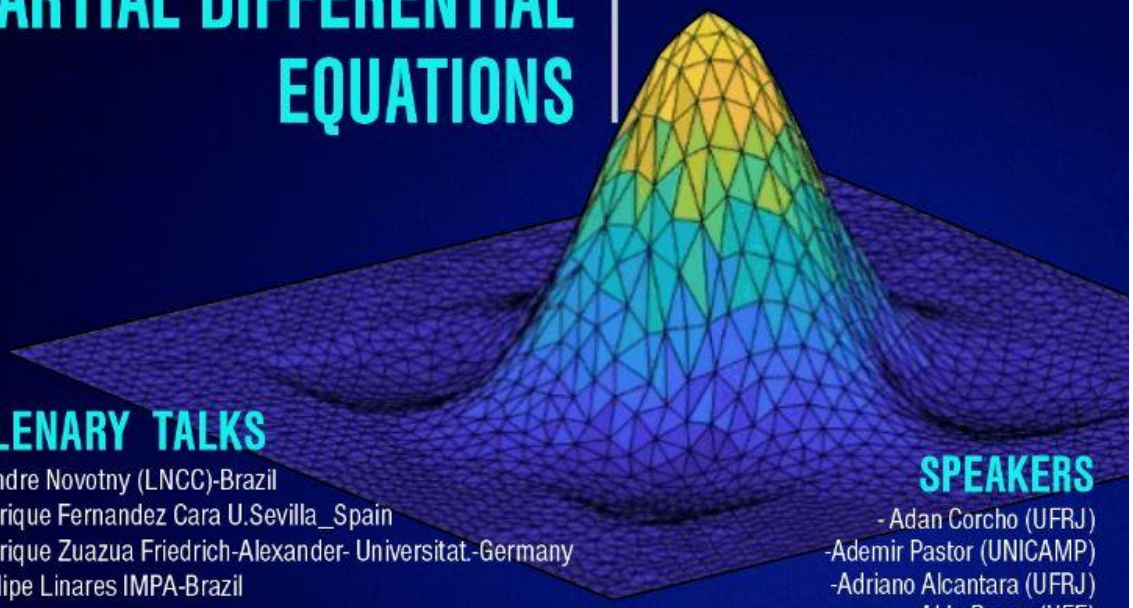
Book of Abstracts

Niterói - RJ

II WORKSHOP ON CONTROL THEORY AND PARTIAL DIFFERENTIAL EQUATIONS

Universidade Federal Fluminense
Niterói - RJ-Brazil

OCTOBER
25 to 28 - 2022



PLENARY TALKS

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-Enrique Fernandez Cara U.Sevilla_Spain
-Enrique Zuazua Friedrich-Alexander- Universitat.-Germany
-Felipe Linares IMPA-Brazil

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- Marcelo Cavalcanti - UEM

COORDINATOR

- Juan Bautista Límaco Ferrel

https://grupoedp.uff.br/?page_id=33

SPEAKERS

- Adan Corcho (UFRJ)
-Ademir Pastor (UNICAMP)
-Adriano Alcantara (UFRJ)
-Aldo Bazan (UFF)
-Amaury Alvarez (UFRJ)
-Ana Fasarella (UFF)
- Bruna Sozzo (LNCC)
- Bruno Araújo (UFCG)
-Denilson Menezes (UFERSA)
- Felipe Chaves - Silva (UFPB)
- Grigori Chapiro (UFJF)
- Josiane Faria (UEM)
- Juliana Fernandez (UFRJ)
-Lucas Campos (UFMG)
- Luiz Farah (UFMG)
Marcelo Goulart (UFRJ)
- Maria Soledad Aronna(FGV)
- Mauro Rincon (UFRJ)
- Max Souza (UFF)
- Patricia Nunez da Silva (UERJ)
- Ricardo Fuentes (UFF)
- Rodrigo Madureira (UFRJ)
- Sergio Almaraz (UFF)
- Tiago Roux Oliveira (UERJ)
- Viatcheslav Priimenko (UENF)
- Wladimir Neves (UFRJ)
Yuri Saporito (FGV)

INCTMat FAPERJ

General Information

The Fluminense Federal University, in partnership with UFF's graduate pro- gram in mathematics, will promote the II workshop on EDP and Control Theory, en- titled Workshop on Control Theory and Partial Differential Equations, which will take place from october 25th to 28th, 2022 in the auditorium of the Institute of Mathematics and Statistics of the Universidade Federal Fluminense Bloco G-Campus Gragoata-Niteroi. This work- shop will be a scientific meeting with the purpose of creating a discussion forum between students, teachers and researchers from educational and research institu- tions, having as areas of interest: Partial Differential Equations and Control Theory for system governed by EDPs. In addition to the presentation of recent works by researchers, the event also features the promotion of plenary lectures with interna- tionally renowned researchers.

Coordinator

Juan Límaco (Universidade Federal Fluminense - Brazil)

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Instituto Nacional de Ciência e Tecnologia de Matemática (INCTMat).

II WORKSHOP ON CONTROL THEORY AND PARTIAL DIFFERENTIAL EQUATIONS

OUTUBRO 25 - 28, 2022 IME - UFF

DIA E HORÁRIO	TERCA 25 OUT	QUARTA 26 OUT	QUINTA 27 OUT	SEXTA 28 OUT
09:20 - 09:30	ABERTURA	ALDO BAZAN (UFF)	RICARDO FUENTES (UFF)	
09:30 - 09:50				ANA MARIA FASSARELLA (UFF)
10:00 - 10:10	ANDRE NOVOTNY (LNCC)	ENRIQUE ZUAZUA (U. GERMANY)	ENRIQUE FERNANDEZ (U. Sevilla)	
10:10 - 10:50				GRIGORI CHAPIRO (UFJF)
10:50 - 11:10	LANCHE			
11:10 - 11:50	RODRIGO MADUREIRA (UFRJ)	BRUNA SOZZO (LNCC)	ADAN CORCHO (UFRJ)	ADEMIR PASTOR (UNICAMP)
12:00 - 12:40	MARCELO GOULART (UFRJ)	VIATCHESLAV PRIMENKO (UENF)	WLADIMIR NEVES (UFRJ)	PATRICIA NUNES (UERJ)
12:40 - 14:10	ALMOÇO			
14:10 - 14:20			FELIPE LINARES (IMPA)	
14:20 - 15:00	SERGIO ALMARAZ (UFF)	MAURO RINCON (UFRJ)		MARIA SOLEDAD (FGV)
15:10 - 15:50	YURI SAPORITO (FGV)	JOSIANE FARIA (UEM)	LUIZ FARAH (UFMG)	BRUNO ARAUJO (UFCG)
15:50 - 16:10	LANCHE			
16:10 - 16:50	FELIPE CHAVES-SILVA (UFPB)	TIAGO OLIVEIRA (UERJ)	AMAURY ALVAREZ (UFRJ)	MAX SOUZA (UFF)
17:00 - 17:25	JULIANA FERNANDEZ (UFRJ)	DENILSON MENEZES (UFERSA)	LUCCAS CAMPOS (UFMG)	ADRIANO ALCANTARA (UFRJ)
17:25 - 17:40		POSTER I	POSTER II	ENCERRAMENTO

COMITÊ ORGANIZADOR: JUAN LIMACO, REGINALDO DEMARQUE, LUIZ VIANA, CARLOS GUZMAN, FAGNER ARARUNA, MARCELO CAVANCANTE

LOCAL: CAMPUS GRAGUATÁ, BLOCO G, IME-UFF, AUDITÓRIO

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Plenary Talks

Topological Derivative Method: Theory and Applications

Antonio André Novotny
Laboratório Nacional de Computação Científica

The topological derivative is defined as the first term (correction) of the asymptotic expansion of a given shape functional with respect to a small parameter that measures the size of singular domain perturbations, such as holes, inclusions, source-terms and cracks. This relatively new concept has applications in many different fields such as shape and topology optimization, inverse problems, image processing, multi-scale material design and mechanical modeling including damage and fracture evolution phenomena. In this talk the topological derivative method is presented, together with a portfolio of applications in the context of topology optimization, inverse problems and fracture mechanics.

Some results concerning the control of free-boundary problems

Enrique Fernández-Cara
Universidad de Sevilla

The aim of this talk is to recall some theoretical and numerical results dealing with the exact controllability of free-boundary systems. In particular, we will consider one-phase and two-phase 1D Stefan problems, with boundary controls devised to steer the solution to an uncontrolled trajectory. The results can be found in several papers written in collaboration with several people (R.K. Araújo, J.A. Bárcena, J. Limaco and D.A. Souza among others). Also, several open questions and interesting applications will be mentioned.

Dissipation, Decay and Hypocoercivity for Hyperbolic Systems

Enrique Zuazua
Friedrich–Alexander University

We will discuss the time-asymptotic behavior of linear hyperbolic systems under localized partial dissipation. We will show how the problem can be handled using Fourier analysis and
propagation along characteristics. A sharp understanding of the decay rates requires the employment of concepts in conttrol teorey, such as the classical rank condition for controllability. Avoiding the use of the Fourier transform in the proofs, something that is relevant when aiming for more general results, in particular for nonlinear systems, requires the use of hypocoercivity tools.

On solutions to Interaction equations for short and long dispersive waves

Felipe Linares
Instituto de Matemática Pura e Aplicada (IMPA)

In this lecture we will be concerned with properties of solutions to two nonlinear dispersive models called the Schrödinger-Korteweg-de Vries and Schrödinger-Benjamin-Ono systems.
First we will describe the decay of long-time solutions of the initial value problem (IVP) associated with the Schrödinger-Korteweg-de Vries system. We use recent techniques in
order to show that solutions of this system decay to zero in the energy space. Our result is independent of the integrability of the equations involved and it does not require any size assumptions.
In the second part of the talk we will discuss the local well-posedness of the IVP associated with the Schrödinger-Benjamin-Ono system.

Speakers

On the Cauchy Problem associated to a Nonequilibrium Bose-Einstein Condensate

Adan Corcho
Universidade Federal de Rio de Janeiro

We study a non-equilibrium Gross-Pitaevskii type system recently proposed to model exciton-polariton condensates. The coupled dispersive-dissipative equations present numerous mathematical challenges, and the known previous methods do not seem to apply in a standard way to study the global dynamics and singularity formation. We consider initial data in Sobolev spaces defined on euclidean and periodic domains and we prove global in-time existence results for small data (in all dimensions) with regularity above the algebra structure under some extra hypotheses. By using Strichartz estimates, we obtain global well-posedness in the one-dimensional case in the space L2xL2 (with exponential decay in some physical cases), which can not be applied to higher dimensions. Furthermore, under some physical assumptions, we show the existence of initial data, in both cases (euclidean and periodic), such that the corresponding solutions blow-up in finite or infinite time, with exponential rate. We also present an interesting result about the existence of initial data with higher regularity, in periodic domains, such that the corresponding solutions either blow-up in finite time or have unboundedness Sobolev norms with vanishing.

On the controllability and stabilization for the dispersion generalized Benjamin equation

Ademir Pastor
Universidade Estadual de Campinas (UNICAMP)

In this talk we discuss some results on the controllability and stabilization for the dispersion generalized Benjamin equation on a periodic domain. First, by assuming the control input acts on all the domain, it is proved the exact controllability in the usual Sobolev spaces of positive index. Second, by providing a locally-damped term added to the equation as a feedback law, it is shown that the resulting equation is globally well-posed and locally exponentially stabilizable in the space in L2.

Análise e simulação numérica para um equação de ondas não linear com condições de fronteira do tipo Dirichlet, Acústica e Impenetrabilidade

Adriano Alcantara
Universidade Federal de Rio de Janeiro (UFRJ)

Análise e simulação numérica para uma equação de ondas não linear com com condições de Dirichlet, Acústica e Impenetrabilidade. Na parte espacial, usamos o método de elementos finitos (com bases linear e quadrática) e no tempo o método de Crank-Nicolson. Para cada tempo discreto, usamos o método de Newton para resolver o sistema algébrico não linear.

Desigualdades tipo Caffarelli-Kohn-Nirenberg com expoentes fixos e expoentes variáveis

.Aldo Bazan
Universidade Federal Fluminense (UFF)

Uma desigualdade tipo Caffarelli-Kohn-Nirenberg (CKN) é uma desigualdade funcional de interpolação envolvendo o gradiente no lado direito da desigualdade. São conhecidas diferentes versões desta desigualdade na literatura, considerando derivadas de ordem superior, integrais definidas em domínios limitados, e outros. Nesta palestra consideramos o domínio das funções o Rn, e apresentamos uma análise da relação entre os expoentes, e os seus efeitos na CKN quando estes são constantes, e quando eles são variáveis.

Nonlinear wave interactions in geochemical modeling

Amaury Alvarez
Instituto de computação da UFRJ

I will talk about the main wave interactions in a system of conservation laws in geochemical modeling. We study the modeling of the chemical complexes on the rock surface. The presence of stable surface complexes affects the relative permeability. We add terms representing surface complexes to the accumulation function to the model. This addition allows one to take into account the interaction of ions with the rock surface in the modeling of the oil recovery by the injection of carbonated water. Compatibility hypotheses with the modeling are made on the coefficients of the system to obtain meaningful solutions. We developed a Riemann solver taking into account the complexity of the interactions and bifurcations of nonlinear waves. Such bifurcations occur at the inflection and resonance surfaces. We present the solution of a generalized eigenvalue problem in a (n+1)-dimensional case, which allows the construction of rarefaction curves. A method to find the discontinuous solutions is also presented. We find the solution path for some examples.

Stable and unstable steady states for the HMF model

Ana Maria Luz
Universidade Federal Fluminense

The Hamiltonian Mean-Field (HMF) model is a simplified 1D version of the gravitational Vlasov-Poisson system. I will present an overview of recent works on the stability and instability of steady states for this model. These results were obtained in collaboration with Mohammed Lemou and Florian Méhats from the Univesité de Rennes 1.

Null controllability for some two-dimensional degenerate parabolic equations

Bruno Araujo
Universidade Federal de Campina Grande

In this work, we will stablish null controllability results for the following problem in two spatial dimensions:

$$\begin{cases} u_t - \operatorname{div}(A\nabla u) + bu = g1_\omega & \text{in} \quad Q, \\ B.C. & \text{on} \quad \Sigma, \\ u(\cdot,0) = u_0 & \text{in} \quad \Omega, \end{cases} \tag{0.1}$$

where $\Omega := (0,1)\times(0,1)$, $\Gamma := \partial\Omega$, $T > 0$, $Q := \Omega \times (0,T)$, $\Sigma := \Gamma \times (0,T)$, $\omega \subset \Omega$ is a non-empty open set and 1_ω is the corresponding characteristic function, $b \in L^\infty(Q)$, $g \in L^2(Q)$, $u_0 \in L^2(\Omega)$, the matrix-valued function $A : \overline{\Omega} \mapsto M_{2\times 2}(\mathbb{R})$ is given by

$$A(x) = diag(x_1^{\alpha_1}, x_2^{\alpha_2}),$$

the boundary conditions are

$$B.C. := \begin{cases} u = 0 \ \text{ on } \ \Sigma & \text{if} \quad \alpha_1,\ \alpha_2 \in [0,1), \\ u = 0 \ \text{ on } \ \Sigma_{3,4} \ \text{ and } \ (A\nabla u)\nu = 0 \ \text{ on } \ \Sigma_{1,2} & \text{if} \quad \alpha_1,\ \alpha_2 \in [1,2], \\ u = 0 \ \text{ on } \ \Sigma_{1,3,4} \ \text{ and } \ (A\nabla u)\nu = 0 \ \text{ on } \ \Sigma_2 & \text{if} \quad \alpha_1 \in [0,1) \ \text{ and } \ \alpha_2 \in [1,2], \\ u = 0 \ \text{ on } \ \Sigma_{2,3,4} \ \text{ and } \ (A\nabla u)\nu = 0 \ \text{ on } \ \Sigma_1 & \text{if} \quad \alpha_1 \in [1,2] \ \text{ and } \ \alpha_2 \in [0,1), \end{cases}$$

with $\alpha = (\alpha_1, \alpha_2) \in [0,2]\times[0,2]$, $\Sigma_{i,j,l} := (\Gamma_i \cup \Gamma_j \cup \Gamma_l)\times(0,T)$, $\nu = \nu(x)$ being the outward unit normal to Ω at the point $x \in \Gamma$ and, finally,

$$\Gamma_1 := \{0\}\times[0,1],\ \Gamma_2 := [0,1]\times\{0\},\ \Gamma_3 := \{1\}\times[0,1],\ \Gamma_4 := [0,1]\times\{1\}.$$

The system (0.1) appear in financial problems of option pricing. Hance, controllability results for this system is a interesting question. This results can be obtained by the HUM method, which can be applied by using the Carleman estimates that we will prove in this work. The main di_cult of obtain Carleman estimates to (0.1) is that the di_erential operator degenerates only in a part of the boundary which is connected to the rest of border. The Carleman estimates present in literature consider di_erential oparators which degenerate on the whole border.

Qualitative properties of localized dissipative system

Bruna Sozzo
Laboratório Nacional de Computação Científica (LNCC)

Abstract. In this presentation I will talk about the study of some qualitative properties of the Euler-Bernoulli beam model with localized dissipative mechanism. We consider the beam composed of two components, one of which is a thermoelastic material and the other an elastic material that does not generate dissipation. The beam is configured over $\mathcal{I} = (0, \ell_0) \cup (\ell_0, \ell) = \mathcal{I}_E \cup \mathcal{I}_T$. The Euler-Bernoulli beam model we consider here is given by

$$\begin{aligned} \rho u_{tt} + (\alpha u_{xx})_{xx} + (m\theta)_{xx} &= 0, \quad \text{in} \quad (0, \ell_0) \cup (\ell_0, \ell) \times \mathbb{R}_0^+ \\ c\theta_t - \kappa\theta_{xx} - m u_{txx} + k\theta &= 0, \quad \text{in} \quad (\ell_0, \ell) \times \mathbb{R}_0^+, \end{aligned}$$

where $u : \mathcal{I} \times [0, +\infty) \to \mathbb{R}$ represents the transversal displacement of the beam and $\theta : (\ell_0, \ell) \times [0, +\infty) \to \mathbb{R}$ represents the temperature deviation from its reference. Over $\mathcal{I}_T := (\ell_0, \ell)$, the constants $\rho, \alpha, m, c, \kappa$, and k are positive, in $\mathcal{I}_E := (0, \ell_0)$, $m = k = \kappa = c = 0$. In this case we have a transmission problem. The Figure 1 describes this situation.

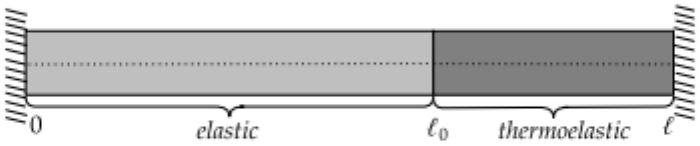

FIGURE 1. Beam model with thermoelastic dissipation.

The boundary conditions, initial conditions, and transmission conditions are given by

$$\begin{gathered} u(0,t) = u(\ell,t) = u_x(0,t) = u_x(\ell,t) = 0, \quad \theta_x(\ell_0,t) = \theta_x(\ell,t) = 0, \\ u_t(x,0) = u_1(x), \quad u(x,0) = u_0(x), \quad \theta(x,0) = \theta_0(x), \\ u(\ell_0^-) = u(\ell_0^+), \quad u_x(\ell_0^-) = u_x(\ell_0^+), \quad M(\ell_0^-) = M(\ell_0^+), \quad M_x(\ell_0^-) = M_x(\ell_0^+), \end{gathered}$$

where

$$M(s) = (\alpha u_{xx} + m\theta)(s), \quad \forall s \in \mathcal{I}.$$

We use the results of semigroup theory to show that the semigroup associated with this model is differentiable. In particular, our proof implies the following properties of the semigroup: 1) It is of Gevrey class 12. 2) It is exponentially stable. 3) It has the property of linear stability and has a regularizing effect on the initial data.

Local null controllability of a quasi-linear system

Denilson Menezes
UFERSA

This work concerns the null control of quasi-linear parabolic systems where the diffusion coefficient depends on the gradient of the state variable. In our main theoretical result, with some assumptions on the regularity and growth of the diffusion coefficient and regular initial data, we prove that local null controllability holds. To this purpose, we consider the null controllability problem for the linearized system, we deduce new estimates on the control and the state and, then, we apply a Local Inversion Theorem.

Global controllability for the Boussinesq system

Felipe Chaves-Silva
Universidade Federal de Paraiba

In this talk, we consider the global exact controllability problem to the trajectories for the Boussinesq system. We show that it is possible to drive the solution to the prescribed trajectory in small time by acting

on the system through the velocity and the temperature on an arbitrary small part of the boundary. The proof relies on three main arguments. First, we transform the problem into a distributed controllability problem by using a domain extension procedure. Then, we prove a global approximate controllability result by following a strategy of Coron and collaborators, which deals with the Navier-Stokes equations and relies on the controllability of the inviscid Boussinesq system and asymptotic boundary layer expansions. Finally, we conclude with a local controllability result that we establish with the help of a linearization argument and appropriate Carleman estimates.

wave solution profiles for the foam flow in porous media

Grigori Chapiro
Universidade Federal de Juiz de Fora

Foam is used in enhanced oil recovery to improve sweep efficiency by controlling gas mobility. A common way to describe the foam displacement is by using population balance models of partial differential equations, which consider the foam texture as part of the gas phase. Numerical simulation of such equations presents serious difficulties connected to the high non-linearity in the fractional flow. In this talk, we address the different simplifications for the capillary pressure in the foam flow in porous media and investigate its solutions in the context of traveling waves. Mainly, we are interested in the case of one-dimensional incompressible two-phase gas-liquid flow in a porous medium in the presence of foam. We show two physically admissible intuitive simplifications resulting in qualitatively inaccurate solutions in the variable describing foam texture. Besides these examples, we also show one procedure that produces qualitatively accurate solution approximation. In order to sustain that our conclusions are not connected to any numerical error, we investigate the existence of the traveling wave solutions in all examples. We stress that the profile differences are related to the dynamical system behavior in the phase space. All semi-analytical results were verified through direct numerical simulations, evidencing the applicability of the presented analysis.

Wellposedness and exponential stability for a klein-gordon system with locally distributed viscoelastic dampings in a past-history framework

Josiane Cristina De Oliveira Faria
Universidade Estadual de Maringa

In this talk the main goal is to show the well-posedness as well as the exponential stability for a strongly coupled Klein-Gordon system posed on a bounded domain of the two-dimensional Euclidean space with smooth boundary, subject to locally distributed viscoelastic effects. More precisely, we consider a general version in the history context of the coupled Klein-Gordon system in the null history scenario. We prove a exponential stability result to the model with nonlinearities of the form $|u|^{p-2}u|v|^p$, $|v|^{p-2}v|u|^p$, and subject to locallydistributed viscoelastic effects driven by nonnegative functions $a(x)$ and $b(x)$ acting on aregion A of Ω, where $a = b = 0$ in A.
This is a joint work with A. Y. Souza Franco.

Grow-up and bounded solutions for a degenerate logistic equation

Juliana Fernandes
Universidade Federal de Rio de Janeiro

We apply comparison principle and variational methods to a class of semilinear parabolic equations. The ultimate goal is to analyze the behavior of solutions as the initial data varies in the phase space. In particular, we exploit the relation between the Nehari manifold and the fibrering maps (defined by the

related Euler functional) in order to separate the phase space into regions of initial data where uniform boundedness or grow-up (infinite time blow-up) behavior may occur.

Threshold Behavior in Schrödinger-type Problems

Luccas Campos
Universidade Federal de Minas Gerais (UFMG)

In the context of nonlinear, focusing dispersive and wave equations, the associated ground state often gives a quantitative threshold, under which the long-time behavior is well-understood. Such thresholds arise from sharp Gagliardo-Nirenberg-Sobolev inequalities, and initial data below these quantities are subject to the so-called \textit{energy trapping}, which guarantees coercivity for quantities related to the associated potential and kinetic energies. Combined with the concentration-compactness approach, the energy trapping can be used to prove a dichotomy for the asymptotic behavior of H^1 solutions. In this talk, we discuss recent results for Schrödinger-type problems with initial data \textit{exactly} at the mass-energy threshold in the L^2-critical and H^1 subcritical setting.

Sobre a equação de Schrodinger não-linear a não-homogenea

Luiz Gustavo Farah
Universidade Federal de Minas Gerais (UFMG)

Nessa palestra consideramos a equação de Schrodinger não-linear e não homogênea

$$i\partial_t u + \Delta u + |x|^{-b}|u|^{2\sigma}u = 0, \ \ x \in \mathbb{R}^N,$$

onde $N \geq 1$, 0 < b < min {2, N/2}. Estamos particularmente interessados nos casos L^2-crítico e L^2-supercrítico, isto é,

$$\frac{2-b}{N} \leq \sigma < \begin{cases} \frac{2-b}{N-2}, & N \geq 3, \\ \infty, & N = 1, 2. \end{cases}$$

O modelo acima é uma generalização da equação clássica de Schrodinger não-linear (NLS), obtida tomando b = 0. Nosso principal objetivo será apresentar resultados recentes de boa colocação local e global, comportamento assintotico das soluções, existência e concentração de soluções de explosão obtidos em colaboração com Luccas Campos (UFMG), Mykael Cardoso (UFPI), Carlos Guzmán (UFF) e Jason Murphy (Missouri S&T).

Some results on the numerical modeling of rock-salt

Marcello Goulart Teixeira
Universidade Federal de Rio de Janeiro

Com uma das maiores reservas de petróleo do mundo, sendo a maior parte na chamada camada pré-sal, é de extrema importância para o país o entendimento e o domínio de modelos numéricos para a rocha-sal que apresentem bons resultados. Nesta apresentação mostraremos alguns resultados obtidos pelo grupo de pesquisa em dinâmica salífera da UFRJ, em particular a aplicação do Método das Aproximações Lineares Sucessivas, desenvolvido especialmente para obter bons resultados numéricos considerando a rocha-sal como um sólido termo-viscoelástico.

On the computation of singular arcs in Optimal Control

Maria Soledad Aronna
(Escola de Matemática Aplicada, FGV EMAp, Rio de Janeiro, Brazil)

Singular arcs appear naturally in optimal control problems when the dynamics is affine with respect to some of the control components. In this talk I will discuss results concerning the computation of feedback expressions for optimal singular controls. I will illustrate the applicability of the results with a numerical example.

Numerical Solution for a 2D-wave equation with dynamical boundary control

Mauro Antônio Rincon
Universidade Federal do Rio de Janeiro (UFRJ)

We study the 2D linear wave equation with dynamical control on the boundary. New mathematical difficulties appear due to the boundary conditions. By adding some artificial viscosity term, we introduce a penalized problem, and the well posedness is done by using the Faedo-Galerkin method. A numerical scheme is pro-posed and the decay of the associated discrete energy is obtained. At the end, an a priori error estimate is obtained and some numerical results are presented.

A mathematical framework for dissimulate dynamical social interactions

Max Souza
Universidade federal Fluminense

Modeling social interactions is a challenging task that requires flexible frameworks. For instance, dissimulation and externalities are relevant features influencing such systems --- elements that are often neglected in popular models. This paper is devoted to investigating general mathematical frameworks for understanding social situations where agents dissimulate, and may be sensitive to exogenous objective information. Our model comprises a population where the participants can be honest, persuasive, or conforming. Firstly, we consider a non-cooperative setting, where we establish existence, uniqueness and some properties of the Nash equilibria of the game. Secondly, we analyze a cooperative setting, identifying optimal strategies within the Pareto front. In both cases, we develop numerical algorithms allowing us to computationally assess the behavior of our models under various settings. Joint work with Y Saporito and Y Thamsten.

Conjunto de comprimentos críticos para a equação de Kawahara

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Universidade Estadual do Rio de Janeiro

Discutimos a introdução de uma família de funções complexas para caracterização dos comprimentos dos intervalos para os quais a equação linear de Kawahara possui uma solução não trivial, cuja energia é estacionária. Caracterizar os comprimentos equivale a decidir quais membros dessa família são funções inteiras. A nossa abordagem baseia-se essencialmente na determinação da existência de determinadas transformações de Moebius.

Controle dinâmico na fronteira de uma equação de ondas não linear

Ricardo Fuentes Apolaya
Universidade Federal Fluminense

In this work, we are interested in studying the stability of a vibrating beam of finite length

which is fixed at one end and free at the other end and with a dynamical boundary control. The position u(x, t) of the point x of the beam, at the instant t, is governed by the following wave equation

$$\begin{cases} u_{tt}(x,t) - u_{xx}(x,t) + |u(x,t)|^{\rho} u(x,t) = 0,\ x \in (0,1),\ t > 0 \\ u(0,t) = 0,\ \ u_x(1,t) = -\xi(t),\ \ t > 0 \\ \xi_t(t) + \xi(t) = u_t(1,t),\ t > 0 \\ u(x,0) = u_0(x),\ u_t(x,0) = u_1(x),\ 0 < x < 1,\ \xi(0) = \xi_0 \in \mathbb{R} \end{cases}$$

Análise e Simulação Numérica de Um Problema de Difusão Termoelástica com Fronteira Móvel

Rodrigo Madureira
PPGI-Universidade Federal de Rio de Janeiro

Neste trabalho, serão mostradas a análise e simulação numérica de um modelo linear de difusão termoelástica com fronteira móvel, considerando a condição de fronteira nula. O sistema linear é resolvido através de três métodos que serão apresentados: Acoplado, Desacoplado e Desacoplado com Preditor-Corretor. Tais métodos corroboram as ordens de convergência obtidas pelas estimativas de erro.

Energy bounds of sign-changing solutions to Yamabe equations on manifolds with boundary

Sergio Almaraz
Universidade Federal Fluminense

We study the Yamabe equation in the Euclidean half-space. We prove that any sign-changing solution has at least twice the energy of a standard bubble. Moreover, a sharper energy lower bound of the sign-changing solution set is also established via the method of moving planes. This bound increases the energy range for which Palais–Smale sequences of related variational problem has a non-trivial weak limit. This is a joint work with Shaodong Wang (Shanghai Jiao Tong University).

Extremum Seeking Boundary Control for PDE Systems

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(State University of Rio de Janeiro - UERJ, Brazil)

Exactly a century since its invention and first application, and more than two decades since the proof of its convergence, the extremum seeking control has been recognized as one of the most important model-free real-time optimization tools. However, until recently extremum seeking has been restricted to dynamic systems represented by connections of Ordinary Differential Equations (ODEs) and non-linear convex maps with unknown extremum points. This talk presents the first collection of results on the theory and design of extremum seeking boundary control strategies for infinite-dimensional systems governed by Partial Differential Equations (PDEs). The main ideas for the design of the Gradient-Newton methods and the stability analysis for infinite-dimensional systems will be discussed considering a wide class of parabolic and hyperbolic PDEs: delay equations, wave equation and reaction-advection-diffusion models. Moreover, engineering applications are presented, including problems of noncooperative games, neuromuscular electrical stimulation, biological reactors, oil-drilling systems and flow-traffic control for urban mobility.

Dynamic poroelasticity: forward and inverse problems

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The classic poroelastic theory of Biot, developed in 1950's, describes the propagation of elastic waves through a porous media containing a fluid [1,2]. This theory has been extensively used in various fields dealing with porous media: continuum mechanics, oil/gas reservoir characterization, environmental geophysics, earthquake seismology, etc.

We study the propagation of elastic waves in porous media governed by the Biot equations in the low and high frequency ranges. In the low frequency case we establish the existence and uniqueness result both for the forward problem and the inverse one, which consists in identifying the unknown scalar function f(t) in the body density force f(t)g(x, t) acting on a poroelastic body when some additional measurement is available [4,5].

In the case of the high frequency range (Biot-JKD approach) we prove the uniqueness and continuous dependence on the data of a weak solution both in unbounded and bounded time intervals and in all space dimensions [3,5].

REFERENCES

1. Biot M. A., Theory of propagation of elastic waves in fluid saturated porous solid. I. Low-frequency range, J. Acoust. Soc. Amer., 28, No. 2, 168–178 (1956).
2. Biot M. A., Theory of propagation of elastic waves in fluid saturated porous solid. II. Higher frequency range, J. Acoust. Soc. Amer., 28, No. 2, 179–191 (1956).
3. Lorenzi A., Priimenko V. I., Direct problems for poroelastic waves with fractional derivatives, SIAM J. MATH. ANAL., 46, No. 3, 1874–1892 (2014).
4. Priimenko V. I., Vishnevskii M. P., An identification problem related to the Biot system, J. Inverse Ill-Posed Probl., 23, No. 3, 219–230 (2015).
5. Vishnevskii M., Priimenko V., On the solvability of some dynamic poroelastic problems, Siberian Mathematical Journal, 60, No. 3, 429–449 (2019).

Dirichlet Problem for Degenerate Fractional Parabolic Hyperbolic Equations

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We are concerned in this paper with the degenerate fractional diffusion advection equations posed in bounded domains. Due to a suitable formulation, we show the existence of weak entropy solutions for measurable and bounded initial and Dirichlet boundary data. Moreover, we prove a L1−type contraction property for weak entropy solutions obtained via parabolic perturbation. This is a weak selection principle which means that the weak entropy solutions are stable in this class.

Cálculo Funcional de Itô: teoria, aplicações e métodos numéricos

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O cálculo funcional de Itô é uma generalização do cálculo estocástico de Itô que nos permite examinar modelos com dependência na história dos estados observados. Nesta palestra, eu vou introduzir esse cálculo funcional e mostrar seus desdobramentos em diversas áreas. Como aplicação principal, mostrarei como essa teoria nos permite considerar problemas de Controle Ótimo cuja dinâmica pode depender do caminho do controle. Além disso, vamos apresentar um novo método numérico baseado em Deep Learning para solução das equações funcionais que nascem dessa teoria.

Sessao de poster

Workshop on control theory and partial differential equations

Null-controllability property for the Kawahara equation.

Miguel D. Soto Vieira
Universidade Federal do Rio de Janeiro, UFRJ, Rio de Janeiro, RJ, Brazil .

Lack of exact controllability of a higher-order bbm-system

Oscar Alfredo Sierra Fonseca
Universidade Federal do Rio de Janeiro (UFRJ)

Numerical Analysis of a Wave Equation Multi-Objective Controllability Problem in a Non-cylindrical Domain

Pedro Paulo Alves Oliveira
Universidade Federal do Piauí

A equação de black-sholes, análise, discretização e implementação computacional

Cristian Amador Loli Prudencio
Universidade Federal Fluminense (Brasil), Universidad Nacional Mayor de San Marcos (Perú)

Insensitizing controls with one vanishing component for the Ladyzhenskaya-Smagorinsky

João Carlos Fernandes Barreira
Universidade Federal Fluminense