



III Congresso Brasileiro de Jovens Pesquisadores  
em Matemática Pura, Aplicada e Estatística

Curitiba, December 12-14, 2018

Session: Recent Trends in Nonlinear PDEs

Organized by Damião J. Araújo (Universidade Federal da Paraíba)  
Edgard Pimentel (PUC-RIO)  
and Maurício Santos (Universidade Federal do Pernambuco)

Schedule

**Wednesday, December 12**

- |               |                                                                                                                                                           |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9:00 - 9:30   | Opening                                                                                                                                                   |
| 9:30 - 10:30  | Plenary talk 1                                                                                                                                            |
| 10:30 - 11:00 | Coffee break                                                                                                                                              |
| 10:30 - 11:00 | Disson Soares dos Prazeres (UFS)<br><i>Interior Regularity Results for Zero-TH Order Operators Approaching the Fractional Laplacian</i>                   |
| 11:00 - 11:30 | Rafayel Teymurazyan (Univ. Coimbra)<br><i>Optimal design problems with fractional diffusion</i>                                                           |
| 11:30 - 12:00 | José Francisco Alves de Oliveira (UFPI)<br><i>Problema Extremal para uma desigualdade de Trudinger-Moser incluindo o operador <math>k</math>-Hessiano</i> |
| 12:00 - 13:30 | Lunch                                                                                                                                                     |
| 13:30 - 14:30 | Plenary talk 2                                                                                                                                            |

- 14:40 - 15:10 Fabiana Travessini De Cezaro (UFRGS)  
*Estudo sobre o sistema de Marguere-Vlasov com efeitos térmicos dados pela relação de Cattaneo*
- 15:10 - 15:40 Gaetano Siciliano (USP)  
*On Schrödinger equation in electromagnetic theories*
- 15:40 - 16:10 Matheus Correia dos Santos (UFRGS)  
*Displacement convexity for the entropy in semidiscrete nonlinear Fokker-Planck equations*
- 16:10 - 16:40 Diego Marcon Farias (UFRGS)  
*Um problema de otimização com restrições para o Laplaciano fracionário*
- 16:40 - 17:10 Coffee break
- 17:10 - 18:40 Round Table

**Thursday, December 13**

- 9:00 - 10:00 Plenary talk 3
- 10:00 - 10:30 Coffee break
- 10:30 - 11:00 Felipe W. Chaves Silva (UFPB)  
*Spectral Inequalities for the Stokes Operator and Applications*
- 11:00 - 11:30 Nicolás Carreño (UTFSM)  
*Control of parabolic systems and some applications to the control of fluids*
- 11:30 - 12:00 Adriano De Cezaro (UFRGS)  
*Parameter identification problems in PDE's and the multi-physics tomography problem*
- 12:00 - 13:30 Lunch
- 13:30 - 14:30 Plenary talk 4
- 14:40 - 15:10 Patrícia Lisandra Guidolin (UFRGS)  
*Global Solvability results for parabolic equations with  $p$ -Laplacian type diffusion*
- 15:10 - 15:40 Vanderley Alves Ferreira Junior (ITA)  
*New developments in a nonlocal model for a partially hinged plate*
- 15:40 - 16:10 Kaye Oliveira da Silva (UFG)  
*On the extremal parameters of a subcritical Kirchhoff type equation and its applications*
- 16:40 - 17:10 Coffee break
- 20:00 - 0:00 Social dinner

**Friday, December 14**

9:00 - 10:00 Plenary talk 5  
10:00 - 10:30 Coffee break  
12:00 - 13:30 Lunch  
13:30 - 14:30 Plenary talk 6  
16:40 - 17:10 Coffee break  
17:10 - 18:40 Assembly

## Abstracts

1. *Speaker: Disson Soares dos Prazeres**Affiliation:* Universidade Federal de Sergipe-UFS*Title: Interior Regularity Results for Zero-TH Order Operators Approaching the Fractional Laplacian*

In this lecture we going to talk about interior regularity results for the solution  $u_\epsilon \in C(\bar{\Omega})$  of the Dirichlet problem

$$\begin{cases} -\mathcal{I}_\epsilon(u) = f_\epsilon & \text{in } \Omega \\ u = 0 & \text{in } \Omega^c. \end{cases} \quad (1)$$

where  $-\mathcal{I}_\epsilon$  is an approximation of the well-known fractional Laplacian of order  $\sigma$ , as  $\epsilon$  tends to zero. The purpose of this talk is to understand how the interior regularity of  $u_\epsilon$  evolves as  $\epsilon$  approaches zero. We going to present recent results which provide that  $u_\epsilon$  has a modulus of continuity which depends on the modulus of  $f_\epsilon$ , which becomes the expected Hölder profile for fractional problems, as  $\epsilon \rightarrow 0$ . This analysis includes the case when  $f_\epsilon$  deteriorates its modulus of continuity as  $\epsilon \rightarrow 0$ . Joint work with P. Felmer (CMM-UC) and E. Topp (USACH).

2. *Speaker: Rafayel Teymurazyan**Affiliation:* Universidade de Coimbra*Title: Optimal design problems with fractional diffusion*

We study optimization problems ruled by fractional diffusion operators with volume constraints. By means of penalization techniques, we prove existence of solutions. We also show that every solution is locally of class  $C^{0,\alpha}$  (optimal regularity), and that the free boundary is a  $C^{1,\gamma}$  surface, up to an  $H^{n-1}$  - negligible set.

3. *Speaker: José Francisco Alves de Oliveira**Affiliation:* Universidade Federal do Piauí*Title: Problema Extremal para uma desigualdade de Trudinger-Moser incluindo o operador k-Hessiano*

Iremos apresentar uma prova da existência de função extremal para a desigualdade do tipo Trudinger-Moser para o k-Hessiano provada por G.-T, Tian, X. -J. Wang (J. Funct. Anal. (2010)). Obtivemos um resultado análogo ao famoso resultado de L. Carleson, S. Y. A. Chang (J. Moser, Bull. Sci. Math. 1986)) que assegura a existência de funções extremas para a desigualdade de Trudinger-Moser clássica suportada em bolas do espaço euclidiano.

4. *Speaker: Fabiana Travessini De Cezaro**Affiliation:* Universidade Federal do Rio Grande

*Title: Estudo sobre o sistema de Marguere-Vlasov com efeitos térmicos dados pela relação de Cattaneo*

Neste trabalho, estudamos o sistema de equações diferenciais Marguerre-Vlasov, acoplado com efeitos térmicos dados pela Lei de Cattaneo e com condições de fronteira de Dirichlet, o qual modela as deformações de cascas rasas. Estabelecemos a existência e unicidade de soluções regulares e fracas e o decaimento exponencial da energia associada ao sistema.

5. *Speaker: Gaetano Siciliano*

*Affiliation: IME-USP*

*Title: On Schrödinger equation in electromagnetic theories*

We consider the coupling of the Schrödinger equation with the equations of some of the most important electromagnetic theories. This coupling gives rise to nonlinear system of PDEs that we study by showing existence and eventually nonexistence of solutions.

6. *Speaker: Matheus Correia dos Santos*

*Affiliation: UFRGS*

*Title: Displacement convexity for the entropy in semidiscrete nonlinear Fokker-Planck equations*

In this talk, we show that a nonstandard entropy is  $\lambda$ -convex along the solutions to a finite-difference approximation of a nonlinear Fokker-Planck equation. This convexity is obtained using a gradient flow approach with respect to a nonlocal transportation metric in finite state spaces. The constant  $\lambda$  is computed explicitly in terms of a priori estimates of the solution. The key idea is to employ a new mean function, which defines the Onsager operator in the gradient flow formulation.

7. *Speaker: Diego Marcon Farias*

*Affiliation: UFRGS*

*Title: Um problema de otimização com restrições para o Laplaciano fracionário*

Consideramos um problema de otimização para o Laplaciano fracionário com restrição de volume e com um obstáculo inferior para a temperatura. Provamos a existência e a regularidade ótima das soluções. Além disso, neste problema, surgem naturalmente duas fronteiras livres. Assim, derivamos não apenas propriedades geométricas das soluções, mas também das correspondentes fronteiras livres externa e interna. Este trabalho é em conjunto com V. Nersesyan e R. Teymurazyan.

8. *Speaker: Felipe W. Chaves Silva*

*Affiliation: UFPB*

*Title: Spectral Inequalities for the Stokes Operator and Applications*

In this talk, we show a spectral inequality for the low frequencies of the Stokes Operator. We use this result to obtain the optimal cost, with respect to time, to steer solutions of the Stokes system to zero.

9. *Speaker: Nicolás Carreño*

*Affiliation: Universidad Técnica Federico Santa María*

*Title: Control of parabolic systems and some applications to the control of fluids*

This talk is meant to be a brief overview of the control of linear parabolic equations and systems, using the heat equation as an example. As we will see, the control problem is equivalent to an observability inequality for the adjoint equation. We will present a strategy based on Carleman estimates to prove observability for equations and systems. Then, we will see how these ideas are applied to obtain controllability results for some models from fluid mechanics: the Navier-Stokes and Boussinesq systems. In particular, we are interested in controlling these systems when one or more components of the control are missing.

10. *Speaker: Adriano De Cezaro*

*Affiliation: Universidade Federal do Rio Grande*

*Title: Parameter identification problems in PDE's and the multi-physics tomography problem*

Quantitative Photoacoustic tomography (QPAT) is an emerging medical imaging modality that offers the possibility of combining the high resolution of acoustic waves and large contrast of optical waves by quantifying the molecular concentration in biological tissue. In this talk, we will motivate this medical imaging modality and present the PDE's equation for modelling the problem. Based on properties of the PDE, we prove properties of the forward operator (that associate optical parameters from measurements of a reconstructed Photoacoustic image). This is often referred as the optical inverse problem, that turns out to be non-linear and ill-posed. Such properties of the forward operator provide sufficient conditions to show regularized properties of approximated solutions obtained by Tikhonov-type approaches. The proposed Tikhonov-type approaches analyzed in this contribution are concerned with physical and numerical issues as well as with *a priori* information on the smoothness of the optical coefficients.

11. *Speaker: Patrícia Lisandra Guidolin*

*Affiliation: UFRGS*

*Title: Global Solvability results for parabolic equations with  $p$ -Laplacian type diffusion*

Neste trabalho são dadas condições para garantir a existência global da solução fraca limitada para

o problema de Cauchy, cuja equação é  $u_t + \operatorname{div}f(x, t, u) + \operatorname{div}g(t, u) = \mu(t)\operatorname{div}(|\nabla u|^{p-2}\nabla u)$ , com condição inicial  $u_0 \in L^1(\mathbb{R}^n) \cap L^\infty(\mathbb{R}^n)$ . A dependência explícita da variável  $x$  no termo  $f(x, t, u)$  faz com que a existência de blow-up em tempo finito seja difícil de prever, tornando a análise do problema mais interessante.

12. *Speaker:* **Vanderley Alves Ferreira Junior**

*Affiliation:* ITA

*Title:* ***New developments in a nonlocal model for a partially hinged plate***

We discuss existence, uniqueness and long time behavior of solutions to a initial boundary value problem for a nonlocal fourth order equation related to oscillations in large structures.

13. *Speaker:* **Kaye Oliveira da Silva**

*Affiliation:* Universidade Federal de Goiás

*Title:* ***On the extremal parameters of a subcritical Kirchhoff type equation and its applications***

We study a superlinear and subcritical Kirchhoff type equation which is variational and depends upon a real parameter  $\lambda$ . The nonlocal term forces some of the fiber maps associated with the energy functional to have two critical points. This suggest multiplicity of solutions and indeed we show the existence of a local minimum and a mountain pass type solution. We characterize the first parameter  $\lambda_0^*$  for which the local minimum has non-negative energy. Moreover we characterize the extremal parameter  $\lambda^*$  for which if  $\lambda > \lambda^*$ , then the only solution to the Kirchhoff equation is the zero function. In fact,  $\lambda^*$  can be characterized in terms of the best constant of Sobolev embeddings. We also study the asymptotic behavior of the solutions when  $\lambda \downarrow 0$ .