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em Matemática Pura, Aplicada e Estatística

Curitiba, December 12-14, 2018

Session: Tópicos Atuais de Análise Global e Equações
Diferenciais Parciais

Organized by Edgard Pimentel (PUC-Rio)
and Luiz Hartmann (Universidade Federal de São Carlos)

Schedule

Wednesday, December 12

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|---------------|--|
| 9:00 - 9:30 | Opening |
| 9:30 - 10:30 | Plenary talk 1 |
| 10:30 - 11:00 | Coffee break |
| 11:00 - 11:30 | Pricila da Silva Barbosa (UTFPR-Londrina)
<i>Continuity of attractors for a family of semi linear parabolic problems in Lipschitz domains</i> |
| 11:30 - 12:00 | Abiel Costa Macedo (UFG)
<i>A sharp Adams type inequality for weighted Sobolev spaces</i> |
| 12:00 - 13:30 | Lunch |
| 13:30 - 14:30 | Plenary talk 2 |
| 14:40 - 15:10 | Aldo Pereira (UnB)
<i>A differnet approach for approximate controllability</i> |
| 15:10 - 15:40 | Sandra Imaculada Moreira (UEMA)
<i>The first eigenvalue for a quasilinear Schrödinger operator and its</i> |
| 15:40 - 16:10 | Rafael Lima Oliveira (UFPR)
<i>Taxas ótimas para ondas acopladas com retardo</i> |
| 16:10 - 16:40 | MARIANE PIGOSSI (IME-USP)
<i>Localização dinâmica para operadores de Schrödinger discretos</i> |
| 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 Giovana Siracusa Gouveia (UFS)
Existence results for fractional integro-differential inclusions with state-dependent delay
- 11:00 - 11:30 Mirelson Martins Freitas (UFPA)
FSqueezing and finite dimensionality of cocycle attractors for 2D stochastic Navier-Stokes equation with non-autonomous forcing
- 11:30 - 12:00 CLEBER de MEDEIRA (UFPR)
A class of globally non-solvable involutive systems on the torus
- 12:00 - 13:30 Lunch
- 13:30 - 14:30 Plenary talk 4
- 14:40 - 15:10 João Vitor da Silva (Universidad de Buenos Aires)
Geometric $C^{1+\alpha}$ regularity estimates for nonlinear evolution models
- 15:10 - 15:40 María Rosario Astudillo Rojas (UFPR)
Stability for Timoshenko systems with memory possessing a fractional damping term
- 15:40 - 16:10 Ederson Braga (UFC)
Regularidade ótima para o envelope convexo e funções semiconvexas relacionados a supersoluções de EDP's totalmente não lineares
- 16:10 - 16:40 Damião Júnio Gonçalves Araújo (UFPB)
Sharp Regularity for the Inhomogenous Porous Medium Equation
- 16:40 - 17:10 Coffee break
- 17:10 - 17:40 Giane Casari Rampasso (Unicamp)
Regularity theory for roughly degenerate diffusions
- 17:40 - 18:10 Fernando de Avila Silva (UFPR)
A class of globally hypoelliptic operators on manifolds
- 20:00 - 0:00 Social dinner

Friday, December 14

- 9:00 - 10:00 Plenary talk 5
10:00 - 10:30 Coffee break
10:30 - 11:00 Anne Bronzi (Unicamp)
On the Euler equations with helical symmetry
11:00 - 11:30 Janielly Araújo (UFC)
*Regularidade Sharp Para Soluções da Equação Parabólica Dupla-
mente Não Linear*
11:30 - 12:00 Edison Fausto Cuba Huamani (PUC-Rio)
*The Radiative Transfer Equation in the Forward-Peaked Regime on
the Half-Space*
12:00 - 13:30 Lunch
13:30 - 14:30 Plenary talk 6
14:40 - 15:10 Pedro Zuhlke (UnB)
Homotopical rigidity of hypersurfaces of space forms
15:10 - 15:40 Ezequiel Barbosa (UFMG)
TBA
15:40 - 16:10 Ricardo de Lima Ribeiro (UTFPR-Londrina)
Mean-field games with logistic effects
16:10 - 16:40 Bruno Caldeira Carlotti (UFSCAR)
Intrinsic geometric flows in singular spaces
16:40 - 17:10 Coffee break
17:10 - 18:40 Assembly

Abstracts

1. *Speaker:* **Pricila da Silva Barbosa***Affiliation:* UTFPR - Londrina*Title:* ***Continuity of attractors for a family of semi linear parabolic problems in Lipschitz domains***

The study of existence and continuity of attractors for parabolic problems in relation to the perturbation of the domain is a subject much approached in the literature. In general, works that deals with perturbations of domain has as assumptions that the domain is smooth. In this talk we consider a family of semi-linear parabolic problems with non-linear Neumann boundary conditions, defined in Lipschitz domains. These domains are obtained considering a family of perturbations of the square that depend on a parameter ϵ and converge to the identity in the C^1 -norm. Using tecniques of perturbations of the boundary and under appropriates assumptions on the problem addressed, we will prove that the associated semigroup has aglobal attractor and the family of attractors obtained is continuous at $\epsilon = 0$.

2. *Speaker:* **Abiel Costa Macedo***Affiliation:* UFG*Title:* ***A sharp Adams type inequality for weighted Sobolev spaces***

In a classical work (Ann. Math. 128, (1988) 385–398), D. R. Adams proved a sharp Trudinger-Moser inequality for higher order derivatives. We derive a sharp Adams-type inequality and Sobolev-type inequalities associated with a class of weighted Sobolev spaces which is related to a Hardy-type inequality.

3. *Speaker:* **Aldo Pereira***Affiliation:* Universidade de Brasília*Title:* ***A differnet approach for approximate controllability***

This talk treats about the approximate controllability of fractional differential systems of Sobolev type in Banach spaces. In contrast to the usual development, follows in part the main idea of some very recent articles - namely, to suppose certain properties on the resolvent operators to obtain approximate controllability. First, we characterize the properties on the norm continuity and compactness of some resolvent operators (also called solution operators). And then, via the obtained properties on resolvent operators and fixed point techniques, we give some approximate controllability results for Sobolev type fractional differential systems in the Caputo and Riemann-Liouville fractional derivatives, with order $1 < \alpha < 2$. As applications, we mention some examples of abstract and partial differential equations.

4. *Speaker:* **Sandra Imaculada Moreira**

Affiliation: UEMA

Title: ***The first eigenvalue for a quasilinear Schrödinger operator and its application***

In this work we establish the existence of standing wave solutions for quasilinear Schrödinger equations involving subcritical growth. By using a change of variables, the quasilinear equation is reduced to semilinear one, which associated functional is well defined in the usual Sobolev space. And we studied the "first" eigenvalue type of a nonhomogeneous operator, which is greater than the first eigenvalue of the usual laplacian operator. As an application we treat a quasilinear resonance problem involving a subcritical growth perturbation.

5. *Speaker:* **Rafael Lima Oliveira**

Affiliation: Universidade Federal do Paraná

Title: ***Taxas ótimas para ondas acopladas com retardo***

Problemas envolvendo retardo de tempo aparecem frequentemente em muitas áreas da ciência como engenharia, biologia e medicina. Em geral, o interesse é estudar o que esse tipo de efeito causa num modelo. Neste sentido, propomos um sistema de equações de ondas acopladas com retardo, problema que foi motivado por alguns trabalhos existentes na literatura. Para o modelo, inicialmente fizemos o estudo de existência e unicidade de solução. Os resultados foram obtidos via teoria de semigrupos. Sobre o comportamento assintótico, mostramos que decaem quando $t \rightarrow +\infty$ com taxas polinomiais que mudam de acordo com a diferença entre as velocidades de propagação das ondas. Finalmente, mostramos que as taxas obtidas são ótimas. Esses resultados foram estabelecidos usando o teorema de Borichev e Tomilov, importante resultado da teoria de semigrupos.

6. *Speaker:* **MARIANE PIGOSSI**

Affiliation: IME-USP

Title: ***Localização dinâmica para operadores de Schrödinger discretos***

Demonstramos que o operador de Schrödinger discreto unidimensional com campo elétrico tem espectro discreto e localização dinâmica, sob certas condições na perturbação. A demonstração da localização dinâmica é baseada em um procedimento iterativo devido a Kolmogorov, Arnold e Moser (técnica KAM).

7. *Speaker:* **Giovana Siracusa Gouveia**

Affiliation: Universidade Federal de Sergipe

Title: ***Existence results for fractional integro-differential inclusions with state-dependent delay***

In this work we are concerned with a class of abstract fractional integro-differential inclusions with state-dependent and infinite delay. Our approach is based on the existence of a resolvent operator

for the homogeneous equation. We establish the existence of mild solutions using both contractive and condensing maps. Finally, an application to the theory of diffusion problems in materials with memory is given.

8. *Speaker:* **Mirelson Martins Freitas**

Affiliation: UFPA

Title: ***Squeezing and finite dimensionality of cocycle attractors for 2D stochastic Navier-Stokes equation with non-autonomous forcing***

In this paper, we study the squeezing property and finite dimensionality of cocycle attractors for non-autonomous random dynamical systems (NRDS). We show that the generalized random cocycle squeezing property (RCSP) is a sufficient condition to prove a determining modes result and the finite dimensionality of invariant non-autonomous random sets, where the upper bound of the dimension is uniform for all components of the invariant set. We also prove that the RCSP can imply the pullback flattening property in uniformly convex Banach space so that could also contribute to establish the asymptotic compactness of the system. The cocycle attractor for 2D Navier-Stokes equation with additive white noise and translation bounded non-autonomous forcing is studied as an application

9. *Speaker:* **CLEBER de MEDEIRA**

Affiliation: UFPR

Title: ***A class of globally non-solvable involutive systems on the torus***

We consider an involutive system associated with a smooth and closed 1-form defined on the n -dimensional torus. We show the non-global solvability of the system by assuming a certain geometric condition on the global primitive of the imaginary part of this 1-form. We use this result to characterize completely the global solvability of certain partially coupled systems.

10. *Speaker:* **João Vitor da Silva**

Affiliation: Universidad de Buenos Aires

Title: ***Geometric $C^{1+\alpha}$ regularity estimates for nonlinear evolution models***

In this lecture we establish geometric $C^{1+\alpha}$ regularity estimates for bounded solutions of a number of nonlinear evolution models in divergence form. The main insights to obtain such estimates are based on geometric tangential methods, and make use of systematic oscillation mechanisms combined with intrinsic scaling techniques.

11. *Speaker:* **María Rosario Astudillo Rojas**

Affiliation: UFPR

Title: ***Stability for Timoshenko systems with memory possessing a fractional damping***

term

We study the asymptotic behavior of Timoshenko systems with memory possessing a fractional damping term depending on a parameter $\theta \in [0, 1]$ and acting only on one equation of the system. We provide an explicit characterization of the decay rate. To be precise, we show that for $\theta \in [0, 1)$, the decay rate of the solutions is polynomial with rates that depend on the value of the difference of the propagation speeds. We also prove that these polynomial decay rates are optimal. Moreover, when $\theta = 1$, we obtain the exponential decay of the solutions.

12. *Speaker: Ederson Braga*

Affiliation: UFC

Title: Regularidade ótima para o envelope convexo e funções semiconvexas relacionados a supersoluções de EDP's totalmente não lineares

Neste artigo provamos regularidade ótima para o envelope convexo de supersoluções de EDP's totalmente não lineares com coeficientes ilimitados. Precisamente, trabalhamos com o termo não homogêneo da EDP em L^q com $q \geq n$, onde n é a dimensão do espaço Euclidiano onde estamos trabalhando. Nossos resultados estendem os já dantes obtidos por L. Caffarelli, quando provou regularidade $C_{loc}^{1,1}$ para o envelope convexo de supersoluções de EDP's totalmente não lineares com termo não homogêneo limitado. Além deste Teorema, nós providenciamos resultados de regularidade pra funções ω -semiconvexas que são supersoluções para o mesmo tipo de operador. Este resultado estende os resultados de estimativa a priori de L. Caffarelli, J. J. Kohn, L. Nirenberg and J. Spruck que mostraram que se ω tem comportamento Hölder contínuo, então o gradiente de supersoluções clássicas de uma EDP linear de segunda ordem com termo não homogêneo limitado que são ω -semiconvexas tem módulo de continuidade logarítmico. Estes resultados form obtidos em parceria com Alessio Figalli (ETH Zürich) e Diego Moreira (UFC – CE).

13. *Speaker: Damião Júnio Gonçalves Araújo*

Affiliation: Universidade Federal da Paraíba

Title: Sharp Regularity for the Inhomogenous Porous Medium Equation

In this talk we shall consider the inhomogeneous porous medium equation

$$\partial u_t - \Delta u^m = f \in L^{q,r} \quad m > 1.$$

Here we show that weak solutions are Hölder continuous, with the following sharp exponent

$$\min \left\{ \frac{\alpha_0^-}{m}, \frac{[(2q - n)r - 2q]}{q[mr - (m - 1)]} \right\},$$

where α_0 denotes the optimal Hölder exponent for solutions of the Homogeneous equation. The method relies on an approximation lemma and geometric iteration with the appropriate intrinsic scaling. This talk is based on joint work with J. Miguel Urbano and A.F. Maia - University of Coimbra - Portugal.

14. *Speaker:* **Giane Casari Rampasso**

Affiliation: UNICAMP

Title: ***Regularity theory for roughly degenerate diffusions***

The purpose of this work is to study the regularity theory of a degenerate diffusion equation in the divergence form

$$\operatorname{div}(|Du|^{\theta(x)-2}Du) = f(x) \text{ in } B_1 \quad (1)$$

for a variable exponent given by a function $\theta : B_1 \rightarrow \mathbb{R}$ merely measurable and bounded and $f : B_1 \rightarrow \mathbb{R}$ is in a suitable Lebesgue space with variable exponent. We resort to variational techniques to prove the solvability of this problem in $W^{1,\theta(\cdot)}(B_1)$. Our methods also produce regularity of the solutions in $C^{0,\alpha}(B_1)$ with appropriate estimates. Under more regular exponents θ , we establish gains of regularity for the solutions. This is done through geometric and approximation methods. In particular, we prove that solutions are asymptotically of class $C^{1,1}(B_1)$. This is a joint-work with E. Pimentel (PUC-Rio) and M. Santos (PUC-Rio).

15. *Speaker:* **Fernando de Avila Silva**

Affiliation: UFPR

Title: ***A class of globally hypoelliptic operators on manifolds***

In this work we present recent results on the investigation of the Global Hypoellipticity of operators in the class

$$L = D_t + C(t, D_x), (t, x) \in \mathbb{T} \times M,$$

and its corresponded perturbations

$$L_\epsilon = D_t + C_\epsilon(t, D_x), (t, x) \in \mathbb{T} \times M,$$

where $\mathbb{T} = \mathbb{R}/2\pi\mathbb{Z}$ stands for the flat torus, M is a closed smooth manifold and $C(t, D_x)$ is an operator on M smoothly depending on the periodic variable t . We propose a novel approach, as far as we know, based on generalizations for parameter depending operators which were inspired by the works of J. Hounie (Trans AMS, 1979), S. Greenfield and N. Wallach (Trans AMS, 1973) and the recent generalization of the notion of invariance for elliptic pseudo-differential operators on compact manifolds given by J. Delgado and M. Ruzhansky (C.R. Math. Acad. Sci.,2014). In our approach we assume that $C(t, D_x)$ belongs to the commutator of an elliptic operator E , that is, $[C(t, D_x), E] = 0$. In particular, we study the global hypoellipticity of the operators L and L_ϵ by analyzing the behavior of the sequence of eigenvalues of the restrictions

$$C_j(t) \doteq C(t, D_x)\Big|_{E_j} \text{ and } C_{j,\epsilon}(t) \doteq C_\epsilon(t, D_x)\Big|_{E_j}, j \in \mathbb{N},$$

where E_j denotes the eigenspaces of the elliptic operator E .

16. *Speaker:* **Anne Bronzi**

Affiliation: IMECC-UNICAMP

Title: On the Euler equations with helical symmetry

In this talk we will survey some results regarding the global existence of weak solutions of the Euler equations with helical symmetry.

17. *Speaker: Janielly Araújo*

Affiliation: UFC

Title: Regularidade Sharp Para Soluções da Equação Parabólica Duplamente Não Linear

O principal objetivo desse artigo é obter estimativas de regularidade sharp para soluções localmente limitadas da equação duplamente não linear degenerada

$$u_t - \operatorname{div}(mu^{m-1}|\nabla u|^{p-2}\nabla u) = f,$$

onde $m > 1$, $p > 2$ e $f \in L^{q,r}$. Mais precisamente, mostramos que soluções são localmente de classe $C^{0,\beta}$, onde β depende explicitamente somente do expoente Hölder ótimo para soluções do caso homogêneo, da integrabilidade de f , das constantes p , m e da dimensão espacial n .

18. *Speaker: Edison Fausto Cuba Huamani*

Affiliation: PUC-Rio

Title: The Radiative Transfer Equation in the Forward-Peaked Regime on the Half-Space

In this work we study the radiative transfer equation in the forward-peaked regime on the Half-Space. More precisely, it is shown that the equation is well-posed by proving instantaneous regularization of weak solutions for arbitrary initial datum in L^2 . Classical techniques for hypo-elliptic operators, such as averaging lemma, are used in the argument. The (RTE) in the half-space reduces to

$$\begin{cases} \partial_t u + \theta \cdot \nabla_x u = \mathcal{I}(u), & \text{in } (0, T) \times \mathbb{R}_+^d \times \mathbb{S}^{d-1}, \\ u = u_0, \text{ on } \{t = 0\} \times \mathbb{R}_+^d \times \mathbb{S}^{d-1}, \\ u = g, \text{ on } (0, T) \times \partial\mathbb{R}_+^d \times \mathbb{S}^{d-1} \text{ and } -v \cdot n(x) > 0. \end{cases} \quad (2)$$

where T is any arbitrary time, $0 \leq u_0 \in L^1(\mathbb{R}_+^d \times \mathbb{S}^{d-1})$ and $0 \leq g \in L^2(\Sigma_-^T)$.

Theorem 1 (R.Alonso and E.Cuba). *For any dimension $d \geq 3$ fixed and assume that $u \in \mathcal{C}([t_0, t_1]; L^2(\mathbb{R}_+^d \times \mathbb{S}^{d-1}))$ solves the RTE on the half-space (2) for $t \in (t_0, t_1)$ and $g \in L^2([t_0, t_1] \times \Gamma_-)$. Then for any $s \in (0, 1)$, there exists a constant $C \in C(d, s)$ independent of time such that*

$$\begin{aligned} \|(-\Delta_x)^{s_0/2} u\|_{L^2((t_0, t_1) \times \mathbb{R}_+^d \times \mathbb{S}^{d-1})} &\leq C \left(\|u(t_0)\|_{L^2(\mathbb{R}_+^d \times \mathbb{S}^{d-1})} + \|u\|_{L^2([t_0, t_1] \times \mathbb{R}_+^d \times \mathbb{S}^{d-1})} \right. \\ &\quad \left. + \|(-\Delta_v)^{s/2} w_{\mathcal{J}}\|_{L^2([t_0, t_1] \times \mathbb{R}_+^d \times \mathbb{S}^{d-1})} + \|g\|_{L^2([t_0, t_1] \times \Gamma_-)} \right), \quad s_0 = \frac{s/4}{2s+1}. \end{aligned} \quad (3)$$

Together with other related results, this work in progress is part of my doctoral thesis.

19. *Speaker:* **Pedro Paiva Zühlke d'Oliveira**

Affiliation: UnB

Title: ***Homotopical rigidity of hypersurfaces of space forms***

Several known theorems assert that under suitable conditions on the extrinsic curvature of a closed hypersurface, its domain must be diffeomorphic to a sphere. Briefly, such hypersurfaces are topologically rigid. We shall present results concerning hypersurfaces of space forms which guarantee that under the same conditions, they are also homotopically rigid (in a sense to be made precise during the lecture).

20. *Speaker:* **Ezequiel Barbosa**

Affiliation: UFMG

Title: ***TBA***

TBA

21. *Speaker:* **Ricardo de Lima Ribeiro**

Affiliation: UTFPR – Londrina

Title: ***Mean-field games with logistic effects***

We consider stationary mean-field games with logistic effects in dimension one. These mean-field games are written as a coupled system of Hamilton-Jacobi and a non-linear (stationary) Fokker-Plank equation.

$$\begin{cases} \frac{v_x^2}{2} + V(x) = \bar{H} + g(m) - m^\alpha v + v_{xx} \\ -(mv_x)_x = (1 - m^\alpha)m + m_{xx} + \delta. \end{cases}$$

Unlike in the standard mean-field games, the Fokker-Plank equation is not the adjoint of the linearization of the Hamilton-Jacobi equation because agents have a non-linear death rate in addition to birth and seeding effects which are natural in population dynamics. This model illustrates various techniques to obtain regularity for this class of equations. This is joint work with Diogo Gomes.

22. *Speaker:* **Bruno Caldeira**

Affiliation: UFSCar

Title: ***Intrinsic geometric flows in singular spaces***

In recent years, geometric flows have evolved into a central aspect of mathematical research in

geometric analysis. Such concept of geometric flow is mainly based on Hamilton's inspired work on three-manifolds with positive curvature defined a new groundbreaking tool: the Ricci flow. Given a Riemannian manifold M with a metric g_0 , a geometric flow is a PDE that evolves the metric tensor:

$$\begin{cases} \frac{\partial}{\partial t}g(t) &= -T_{g(t)} \\ g(0) &= g_0 \end{cases}$$

with $\{g(t)\}$ a collection of Riemannian metrics over M and T is a geometric tensor depending on the metric, eg. the Ricci curvature tensor or the scalar curvature tensor. In this work, we present the main ingredients of two geometric flows: the Ricci flow and the Yamabe flow, and discuss the recent developments on this concept, regarding question about existence, uniqueness and stability of such flows in spaces with singularities.