2019 CHAPTER

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ON DIFFERENTIAL EQUATIONS

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SESSIONS:

- Boundary Perturbations of Domains for PDEs and Applications
- Computational Dynamics in the Context of Data
- Dispersive Equations
- Elliptic Equations
- Evolution Equations and Applications
- Fluid Dynamics
- Linear Equations
- Nonlinear Dynamical Systems
- Ordinary/Functional Differential Equations
- Poster Session

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Unbounded Sturm attractors for quasilinear equations

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We plan to construct explicitely the global attractors of quasilinear parabolic equations in one dimensional domain when solutions can grow-up, and hence there is a global attractor which is unbounded. In particular, we construct heteroclinic connections between bounded and/or unbounded hyperbolic equilibria.

Non-dissipative system as limit of a dissipative one

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Let $\Omega \subset \mathbb{R}^n$ be a bounded smooth domain in $\mathbb{R}^n$. Given $u_0 \in L^2(\Omega)$, $g \in L^\infty(\Omega)$ and $\lambda \in \mathbb{R}$, consider the family of problems parametrised by $p \searrow 2$,

$$\begin{cases} \dfrac{\partial u}{\partial t} - \Delta_p u &= \lambda u + g, & \text{on} \quad (0,\infty) \times \Omega, \\ u &= 0, & \text{in} \quad (0,\infty) \times \partial\Omega, \\ u(0,\cdot) &= u_0, & \text{on} \quad \Omega, \end{cases}$$

where $\Delta_p u := \operatorname{div}\Big(|\nabla \mathrm{u}|^{\mathrm{p}-2}\nabla \mathrm{u}\Big)$ denotes the p-Laplacian operator.

Our aim in this work is to describe the asymptotic behavior of this family of problems comparing compact attractors in the dissipative case $p > 2$, with non-compact attractors in the non-dissipative limiting case $p = 2$ with respect to the Hausdorff semi-distance between then.

Trajectory and global attractors for generalized processes

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In this work the theory of generalized processes is used to describe the dynamics of a nonautonomous multivalued problem and, through this approach, some conditions for the existence of trajectory attractors are proved. By projecting the trajectory attractor on the phase space, the uniform attractor for the multivalued process associated to the problem is obtained and some conditions to guarantee the invariance of the uniform attractor are given. Furthermore, the existence of the uniform attractor for a class of p-Laplacian non-autonomous problems with dynamical boundary conditions is established.

Singularly perturbed non-local diffusion systems applied to disease models

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We study a model, suitable for modeling vector-borne diseases, where we assume that the human hostsâï¿ï¿ï¿¡ï¿ï¿ï¿¡ epidemiology acts on a much slower time scales than the one of the mosquitoes transmitting as a vector from human to human, due to their vastly different life cycles. This particular model also includes the spatial movement of both vectors and humans getting a couple system of non-local and local spatial dynamics. (Joined work with M. Pereira)

The model proposed takes the form, where i and j will model the density of infected human and vector population.

$$\begin{cases} \dfrac{\partial i}{\partial t} = \alpha_h(1-i)j - \beta_h i + d_1 K_J\, i, \\ \\ \dfrac{\partial j}{\partial t} = \dfrac{\alpha_v}{\varepsilon}(1-j)i - \dfrac{\beta_v}{\varepsilon} j + d_2 \Delta j, \end{cases} \quad x \in \Omega,\ t > 0. \tag{13}$$

We work in a regular bounded domain $\Omega \subset \mathbb{R}^N$ with exterior unit normal N. Also, we take the homogeneous Neumann boundary condition to the function j

$$\frac{\partial j}{\partial N} = 0, \quad x \in \partial\Omega. \tag{14}$$

The constants α_h, α_v, β_h, β_v, d_1 and d_2 are positive, Δ denotes the Laplacian differential operator and K_J is the following nonlocal operator

$$K_J\, i(x) = \int_\Omega J(x-y)(i(y) - i(x))dy, \quad x \in \Omega.$$

We assume that the kernel J satisfies the hypotheses

$$(\mathbf{H_J}) \qquad \begin{array}{c} J \in \mathcal{C}(\mathbb{R}^N, \mathbb{R}) \text{ is non-negative with } J(0) > 0,\ J(-x) = J(x) \text{ for every } x \in \mathbb{R}^N, \text{ and} \\ \displaystyle\int_{\mathbb{R}^N} J(x)\, dx = 1. \end{array}$$

Under these conditions, the K_J is known as a nonlocal operator with non-singular kernel and Neumann condition.

Dynamics of coupled systems: reductions and emergence across scales

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We will talk about the dynamics of Heterogeneously Coupled Maps (HCM). Such systems are determined by a network with heterogeneous degrees. Some nodes, called hubs, are very well connected while most nodes interact with few others. The local dynamics on each node is chaotic, coupled with other nodes according to the network structure. Such high-dimensional systems are hard to understand in full, nevertheless we are able to describe the system over exponentially large time scales. In particular, we show that the dynamics of hub nodes can be very well approximated by a low-dimensional system. This allows us to establish the emergence of macroscopic behaviour such as coherence of dynamics among hubs of the same connectivity layer (i.e. with the same number of connections), and chaotic behaviour of the poorly connected nodes. This is a joint work with Matteo Tanzi and Sebastian van Strien.