Finite-dimensional drivers for infinite dimensional dynamical systems

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Abstract

The design of low-dimensional controllers for infinite-dimensional systems is a problem of great practical interest. In this talk, we intend to tackle the problem by considering a situation where we have a scalar ordinary differential equation (ODE), which is the driver, and a scalar reaction- diffusion equation (PDE). Those equations are coupled through a linear term and the objective is to find conditions ensuring that the solutions of the PDE behave, in some sense, as the solutions of the ODE. The framework built to achieve our results, is developed by studying an abstract ordinary differential equation.

Allen-Cahn Equation and the Higher dimensional catenoid

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Abstract

In this work we present the existence of a family of entire solutions to the Allen-Cahn Equation

$$\Delta u + u(1-u^2) = 0, \quad \text{in } \mathbb{R}^N$$

for $N \geq 4$. We exhibit a strong connection with the Theory of Minimal surfaces and the Liouville equation. We give precise information on the Asymptotic Behavior of the solution and Morse Index of the solutions. This is a joint work with Manuel del Pino from the University of Chile and Jung Cheng Wei from the University of British Columbia.

Fully nonlinear elliptic eigenvalue problems

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Abstract

We investigate the fully nonlinear elliptic problem

$$\begin{cases} -F(D^2u, x) &= g(u) & \text{in } \Omega \\ u &> 0 & \text{in } \Omega \\ u &= 0 & \text{on } \partial\Omega, \end{cases}$$

where Ω is a bounded domain of $\mathbb{R}^n$, F is a real valued function defined on $\mathcal{S} \times \mathbb{R}$, $\mathcal{S}$ is the space of real symmetric matrices, F is uniformly elliptic, and $g(u) = 1$ or $g(u) = \mu^+ u$. The last case for g corresponds to some kind of eigenvalue problem, for which we estimate the L^∞ norm of a solution u by the product of its L^p norm, some power of μ^+ and some constant that depends on the measure of Ω. We study also the plasma problem.

The Cauchy problem for a fifth order KdV equation in weighted Sobolev spaces

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Abstract

In this talk we consider the initial value problem (IVP)

$$\left.\begin{aligned} \partial_t u + \partial_x^5 u + u^k \partial_x u = 0, \qquad & x, t \in \mathbb{R} \\ u(0) = u_0 \qquad & \end{aligned}\right\}, \tag{1}$$

We will study real valued solutions of the IVP (1) in the weighted Sobolev spaces

$$Z_{s,r} := H^s(\mathbb{R}) \cap L^2(\langle x \rangle^{2r} dx),$$

where $\langle x \rangle := (1 + x^2)^{1/2}$, and $s, r \in \mathbb{R}$.
With respect to the IVP (1) with $k = 1$ we establish local well-posedness (LWP) in $Z_{4r,r}$ for $\frac{5}{16} < r < \frac{1}{2}$ and global well-posedness (GWP) in $Z_{4r,r}$, for $r \geq \frac{1}{2}$.
And with respect to the IVP (1) with $k = 2$, we establish LWP and GWP in $Z_{2,1/2}$.

Dynamical systems and their attractors under perturbations

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Abstract

In this lecture we survey our recent results on dynamical systems and their attractors (autonomous or not) under perturbations. We study the continuity of attractors using several different "metrics"; namely, Upper-semicontinuity, Lower-Semicontinuity, Topological structural stability and Phase-diagram commutativity. At each point we emphasize the extensions that were obtained to the non-autonomous setting.

Blow-up Results for Energy-Critical Schrödinger-Debye System

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Abstract

We will present recent results about the formation of singularities for focusing interactions given by the Schrödinger-Debye (SD) equations in the energy-critical space $H^1(\mathbb{R}^4) \times H^1(\mathbb{R}^4)$. This model is seen as a small perturbation of the classical cubic nonlinear Schrödinger equation. We will show the existence of a "large" class of initial data for (SD) in this setting such that the corresponding solutions for the initial value problem blow-up in finite time for small delay parameter and then we scale the solutions to obtain similar results for any positive delay parameter. To show the existence of singular solutions we derive a viriel type identity and we make a careful control of certain nonlinear terms coming from the Debye relaxation.

The Cauchy Problem for a Schrodinger-Benjamin-Ono Equation

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Abstract

This work is concerned with the Cauchy problem for a coupled Schrödinger-Benjamin-Ono system. In the non resonant case, we prove local well-posedness for a large class of initial data. This improves the results obtained by Bekiranov, Ogawa and Ponce (1998). Moreover, our results are shown to be sharp. In particular, we prove C^2-ill- posedness at low-regularity, and also when the difference of regularity between the initial data is large enough. As far as we know, this last ill-posedness result is the first of this kind for a nonlinear dispersive system.

Finally, we also prove that the local well-posedness result obtained by Pecher (2006) in the resonant case is sharp, except for the end-point.

A Two-Phase Free Boundary Problem For Harmonic Measure

Max Engelstein

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Abstract

We study a 2-phase free boundary problem for harmonic measure first considered by Kenig and Toro (Crelle's Journal, 2006) and prove a sharp Hölder regularity result. The central difficulty is that there is no a priori non-degeneracy in the free boundary condition. Thus we must establish non-degeneracy by means of monotonicity formulae.

Non-topological condensates for the self-dual Chern-Simons- Higgs model

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Abstract

For the abelian self-dual Chern-Simons-Higgs model we address existence issues of periodic vortex configurations the so-called condensates– of non-topological type as $k \to 0$, where $k > 0$ is the Chern-Simons parameter. We provide a positive answer to the long- standing problem on the existence of non-topological condensates with magnetic field concentrated at some of the vortex points (as a sum of Dirac measures) as $k \to 0$, a question which is of definite physical interest.

A Numerical Study of the Pull-In Instability in Some Free-Boundary Models for MEMS

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Abstract

We study the following free-boundary problem for a one-dimensional MEMS device:

$$\epsilon^2 \psi_{xx} + \psi_{zz} = 0$$

in the domain $\Omega(u) = \{(x,z) \in (-1,1) \times (-1,\infty) : -1 < z < u(x)\}$, together with boundary conditions $\psi(x,-1) = 0$, $\psi(x,u(x)) = 1$ for $x \in (-1,1)$, $\psi(\pm 1, z) = 1 + z$ for $z \in (-1,0)$, where u is a solution of

$$\gamma\, u_{tt} + u_t - u_{xx} = -\lambda\,[\epsilon^2\,|\psi_x(x,u(x))|^2 + |\psi_z(x,u(x))|^2].$$

We numerically compute the bifurcation curve for the stationary solutions. It has a single turning point, as in the case of vanishing gap size: $\epsilon = 0$. This critical value of λ represents the static pull-in instability. We also compute the dynamical pull-in value, which separates the stable operation regime in which the membrane converges to a steady state, from the touchdown regime, in which the membrane collapses: u achieves the value -1 in finite time.

Our numerical results indicate that the dynamical pull-in value is smaller than the corresponding static value, in the case of the damped wave equation and in the parabolic case corresponding to $\gamma = 0$. This result estabishes that the membrane collapses even if a steady state exists.

Ideally Plastic Composites

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Abstract

We consider fiber reinforced composites where both the matrix and the fibers are ideally plastic materials. We restrict our attention to microstructures and applied stresses that lead to both microscopic and macroscopic antiplane shear deformations. We obtain a bound on the yield set of the composite in terms of the shape of the fibers, their volume fraction, and the yield set of the matrix. We construct examples of composites showing that our bound is essentially optimal.

Pseudodifferential operators with non-regular operator-valued symbols

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Abstract

In this talk, we consider pseudodifferential operators with operator-valued symbols and their mapping properties, without assumptions on the underlying Banach space E. In the continuous case, we show that, under suitable parabolicity assumptions, the $W_p^k(\mathbb{R}^n, E)$-realization of the operator generates an analytic semigroup. Our approach is based on oscillatory integrals and kernel estimates for them. An application to non-autonomous pseudodifferential Cauchy problems gives the existence and uniqueness of a classical solution. In the discrete case, we present some ideas about the generation of analytic semigroups on the periodic sobolev spaces $W_p^k(\mathbb{T}^n, E)$. This talk is based on a work joint with B. Barraza and R. Denk.

Existence and non-existence results on semipositone weighted quasilinear radial problems

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Abstract

We study the problem

$$(1) \quad \begin{cases} \Delta_p u + K(\|x\|) f(u) = 0, & x \in B_1(0) \subset \mathbb{R}^N, \\ u = 0, & \|x\| = 1, \end{cases}$$

in the radial context, under suitable conditions on the nonlinearity of f and regularity conditions on K. First, by using the shooting method and a Pohozaev type identity for the p–Laplacian operator, we show the existence of a couple one-signed radial solutions; one of them is positive and the other one is negative. Then, a non-existence result about positive solutions is presented, whenever the weight is sufficiently large.

Finally, in the case $p = 2$, some comments will be discussed about uniqueness with prescribed nodal regions on a non-homogeneous problem.

Existence and decay of solutions of the 2D QG equations in the presence of an obstacle

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Abstract

We study certain aspects of dissipative partial differential equations governing fluid motion in the presence of an obstacle, in which the dissipative term is given by the Laplacian, or a fractional power of the Laplacian. Our main tools are a generalized version of the Fourier transform due to Ikebe and Ramm, and the localized version of the fractional Laplacian due to Caffarelli and Silvestre, as improved by Stinga and Torrea. We give applications to the problem of existence of weak solutions of the two dimensional dissipative quasi-geostrophic equation and the decay of these solutions in the L^2-norm.

Bubbling solutions for nonlocal elliptic problems

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Abstract

We investigate bubbling solutions for the nonlocal equation

$$A^s_\Omega u = u^p,\ u > 0 \quad \text{in } \Omega,$$

under homogeneous Dirichlet conditions, where Ω is a bounded and smooth domain. The operator A^s_Ω, $s \in (0,1)$, stands for two types of nonlocal operators: the spectral fractional Laplacian and the restricted fractional Laplacian. We construct solutions when the exponent $p = (n+2s)/(n-2s) \pm \varepsilon$ is close to the critical one, concentrating as $\varepsilon \to 0$ near critical points of a reduced function involving the Green and Robin functions of the domain. Furthermore, we provide in both sub and supercritical case a precise asymptotic profile of the blow up of these solutions as $\varepsilon \to 0$. (Joint work with Y. Sire (Marseille) and J. Davila (Santiago)).

Optimal Control in a Free Boundary Fluid-Elasticity Interaction

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Abstract

The problem we consider is controlling turbulence inside fluid flow in the case of a free boundary fluid-elasticity interaction. We prove existence of optimal control acting on the body of the fluid and we derive the necessary optimality conditions.

Mild Solutions to the Time Fractional Navier-Stokes Equations

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Abstract

In this talk the problem of existence and uniqueness of mild solution to the Navier-Stokes equations with time fractional differential operator of order $\alpha \in (0,1)$ is addressed. Several properties about the solution are also discussed; regularity and decay rate in Lebesgue spaces. Moreover, it is shown that the L^p-exponent range, which the solution belongs to, is different from the range for the solution of the classical problem with $\alpha = 1$.

Developing the concept of convex function

Nelson Merentes

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Abstract

In this work will make a historic tour of the concept of convex functions with emphasis on what has been done in the last decade, the concept of functions: convex, midconvex, h-convex, (k,h)-convex, wright-convex, convex set-valued maps, strongly convex, strongly midconvex, strongly wright-convex, strongly (k,h)-convex, strongly h-convex, strongly convex set valued maps and concave functions.

Existence and stability in a wave equation with a strong damping and a strong delay

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Abstract

In this work we consider a wave equation in the presence of a strong damping and a strong delay

$u_{tt}(x,t) - \Delta u(x,t) - \mu_1 \Delta u_t(x,t) - \mu_2 \Delta u_t(x,t-\tau) = 0$

where $\mu_1 > 0$ and μ_2 are constants. In the absence of the delay term ($\mu_2 = 0$), this type of equations has been extensively studied in the literature and many existence, nonexistence and stability results have been established. Introducing a delay term makes the problem different from those considered in the literature since even a weak delay term ($\mu_2 u_t(x,t-\tau)$) may be a source of instability as shown in many other cases. Our goal here is to investigate the effect of the delay and determine necessary and sufficient conditions for obtaining uniform stability.

Optimal dividends for collaborating companies: a free boundary problem

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Abstract

We maximize the sum of the expected discounted dividends of two insurance companies which have an agreement to collaborate. We assume that the uncontrolled reserves follow compound Poisson processes. This is a singular stochastic control problem with jumps in two-dimensions. The associated HJB equation is a non-linear integro-differential equation. We show that the optimal value function is the smallest viscosity solution of this equation. The optimal strategy is described by the boundary between the action and no- action region. If this free boundary is a curve, we propose an iterative approach to find it: in each step, we use calculus of variation techniques to obtain a curve, these curves will converge to the optimal free boundary. Joint work with H. Albrecher (UNIL) and P. Azcue (UTDT).

Collision and blow up for NLS equations

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Abstract

I will discuss a problem of collision of unstable solitary waves of the nonlinear Schroedinger equation. We will describe its dynamics and show how it depends on some particular initial parameters.

On a class of stochastic transport equations for L^2_{loc} vector fields

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Abstract

We study in this article the existence and uniqueness of solutions to a class ofstochastic transport equations with irregular coefficients. Asking only boundedness of the divergence of the coefficients (a classical condition in both the deterministic and stochastic setting), we can lower the integrability regularity required in known results on the coefficients themselves and on the initial condition, and still prove uniqueness of solutions.

Semilinear Biharmonic Problems With A Singular Term

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Abstract

The aim of this work is to study the optimal exponent p to have solvability of problem

$$\begin{cases} \Delta^2 u = \lambda \frac{u}{|x|^4} + u^p + cf \text{ in } \Omega, \\ u > 0 \text{ in } \Omega, \\ u = -\Delta u = 0 \text{ on } \partial\Omega, \end{cases}$$

where $p > 1$, $\lambda > 0, c > 0$, and $\Omega \subset \mathbb{R}^N$, $N > 4$, is a smooth and bounded domain such that $0 \in \Omega$ and f nonnegative function, satisfying some appropriate assumptions.

This is a joint work with Ana Primo.

Regularity theory for mean-field games with logarithmic nonlinearities

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Abstract

In this talk, we report recent developments in the regularity theory of time dependent mean-field games (MFG, for short). Namely, we consider MFG systems in the presence of a logarithmic nonlinearity. This class of problems poses substantial mathematical challenges, since the nonlinearity is unbounded by below. The existence of smooth solutions is established, provided the Hamiltonian satisfies certain growth conditions. This result is proven by carefully combining a-priori estimates for the norms of the nonlinearity in suitable Lebesgue spaces with Lipschitz regularity for the Hamilton-Jacobi equation. The former estimates are produced by exploring concavity properties of the logarithmic function, along with the structure of the Fokker-Planck equation, whereas Lipschitz regularity for the Hamilton-Jacobi is investigated by recurring to the nonlinear adjoint method. This is based on a joint work with D. Gomes (KAUST).

Permutation characterization for noncompact global attractors

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Abstract

We consider a class of nondissipative reaction-diffusion equations with global existence and solutions blowing-up in infinite time. These are known as slowly nondissipative equations. The existence of unbounded solutions requires the introduction of some objects at infinity interpreted as equilibria at infinity. Also, it is well known that there exists a permutation associated with dissipative systems determining many of the main geometric features of the global attractor. Under the nondissipative setting, we still manage to determine the heteroclinic connections on the noncompact global attractor based on the Sturm permutation method, by introducing the concept of k-nondissipativity. This is based on a joint work with C. Rocha.

Existence and stability of traveling waves for Cattaneo- Maxwell systems with bistable reaction

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Abstract

I discuss existence and stability of traveling wave solutions to hyperbolic systems of equations, known as Cattaneo-Maxwell systems. I will show that traveling waves solutions to a Cattaneo-Maxwell system with bistable reaction exist, and that they are orbitally stable. The stability analysis involves Evans function techniques to handle the spectral problem for the perturbations. This is joint work with C. Mascia (Roma 'La Sapienza'), C. Lattanzio (L'Aquila) and C. Simeoni (Nice).

From periodic travelling waves to solitons of a 2D water wave system

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Abstract

We use a variational approach to establish the existence of x-periodic travelling waves and its interrelation with solitons (travelling waves of finite energy) for a 2D water wave system for three-dimensional water wave dynamics in the weakly nonlinear long-wave regime.

As common in many 1D water wave models, we show that a special sequence of the x-periodic 2D travelling wave solutions parametrized by the period k is uniformly bounded in norm and converges to a soliton in R^2 in an appropriate sense, indicating that the shape of x-periodic 2D travelling waves of period k and solitons are almost the same, as the period k is big enough.

Indefinite slightly superlinear problems

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Abstract

We consider a class of semilinear problems which are superlinear and indefinite in sign. In particular, the nonlinearity involved does not satisfy the standard Ambrosetti-Rabinowitz condition. An application to a quasilinear problem with quadratic growth in the gradient is also provided.

Analysis of a Networked Connectivity Model

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Abstract

Most models on epidemics consider the disease restricted to one single community. We give a detailed analysis of a networked connectivity model reflecting the fact that infection patterns are indeed influenced by spatial structure.

Some properties of the strongly connected graph determined by the human and hydrological networks, as well as some properties of stochastic and Metzler matrices associated with the system, help determine precise conditions under which a waterborne disease epidemic can start. This study includes global stability analysis, existence of some bifurcations of the system of $3n$ differential equations, for n nodes or communities, and the description of geographical patterns of disease spread. This work is an extension of previous results on similar models.

On asymptotic equivalence of difference equations in Banach space

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Abstract

We consider the quasilinear system of nonautonomous difference equations in Banach space satisfying the conditions of separation. Our goal is to find a simpler system of difference equations that is conjugated and asymptotic equivalent to the given one. Using this result we obtain sufficient conditions that noninvertible system of difference equations is asymptotic equivalent to the linear one in the case when nonlinear part tends to zero as $n \to +\infty$ sufficiently rapidly.

This work was partially supported by the grant Nr. 345/2012 of the Latvian Council of Science.

Synchronization and Applications

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Abstract

The object of this lecture is to study some applications of Synchronization to nonlinear models, most of them chaotic, in the areas do Engineering, Phisics, Biology, etc. Special emphasis will be given to Communication Systems where chaotic models will be used to codify and to decode signals. Some simulations and some videos will be presented. Also some mathematical methods that are used to prove synchronization will be discussed

Small random perturbations of a PDE with blow-up

Santiago Saglietti

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Abstract

We consider the stochastic PDE $u_t = u_{xx} + u^p + \varepsilon \dot{W}$ with homogenous Dirichlet boundary conditions, where $p > 1$, $\varepsilon > 0$ is a small fixed parameter and $\dot{W}$ stands for space-time white noise. It is well known that the associated deterministic PDE (i.e. $\varepsilon = 0$ in the equation above) admits exactly one asymptotically stable equilibrium and a countable family of unstable equilibria with increasing energy. Furthermore, for certain initial conditions it can be shown that the solution of the deterministic PDE explodes in finite time. We show that, for initial conditions in the domain of attraction of the asymptotically stable equilibrium, the solution X_ε of the SPDE satisfies in the limit as ε tends to zero the description of metastability as proposed by Galves, Olivieri and Vares: the averages of X_ε remain stable and close to the equilibrium up until the explosion time which, when suitably rescaled, converges in distribution to an exponential random variable. Furthermore, for certain initial conditions in the domain of explosion we show the continuity of the explosion time as ε tends to zero.

Exact controllability of 1D Schrdinger–Poisson equation

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Abstract

This talk is concerned with the internal distributed control problem for the 1D Schrödinger equation, $iu_t(x,t) = u_{xx} + \alpha(x)u + m(u)u$ that arises in quantum semiconductor models. Here $m(u)$ is a non local Hartree-type nonlinearity stemming from the coupling with the 1D Poisson equation, and $\alpha(x)$ is a regular function with linear growth at infinity. By means of both the Hilbert Uniqueness Method and the contraction mapping theorem it is shown that for initial and target states belonging to a suitable small neighborhood of the origin, and for controls supported outside of a fixed compact interval, the model equation is controllable. Moreover, it is shown that, for controls with compact support, the exact controllability problem is not possible.

On the first eigenvalue of the p-Laplacian as $p \to +\infty$.

Nicolas Saintier

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Abstract

We study the behaviour as $p \to +\infty$ of the first eigenavalue of the p-Laplacian under various boundary conditions. We find a limit that can be characterized variationally and that has also an interpretation in term of optimal mass transport.

Optimal partitions and refined convergence rates in a homogenization Fučik problem

Ariel Salort

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Abstract

Given a bounded domain Ω in $\mathbb{R}^N$, $N \geq 1$ we study the asymptotic behavior as $\varepsilon \to 0$ of the spectrum of

$$-\Delta_p u_\varepsilon = \alpha_\varepsilon m(\tfrac{x}{\varepsilon})(u_\varepsilon^+)^{p-1} - \beta_\varepsilon n(\tfrac{x}{\varepsilon})(u_\varepsilon^-)^{p-1} \quad \text{in } \Omega \tag{1}$$

with Dirichlet boundary conditions. Here $m(x/\varepsilon)$ and $n(x/\varepsilon)$ are bounded periodic weights. As ε goes to 0 a limit problem is obtained in term of the averages of m and n over a reference cube. We prove an optimal partition characterization of the first nontrivial spectral curve of of (1) and we obtain accurate bounds of the convergence of the first curve of (1).

Long-time behavior of a porous medium equation with fractional pressure

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Abstract

In this talk, we will analyse the asymptotic behaviour of solutions to the one dimensional fractional version of the porous medium equation introduced by Caffarelli and Vázquez and obtained when the pressure is the Riesz potential of the density. Using self-similar variables and the displacement convexity of the Riesz potential in 1D, it is possible to show that the associated entropy satisfy a transport inequality involving also the entropy dissipation and the Euclidean transport distance. An argument by approximation for the equation shows that this functional inequality is enough to deduce the exponential convergence of solutions in self-similar variables to the unique steady state. This is a joint work with J. A. Carrillo, Y. Huang and J. L. Vázquez.

Reconstruction of obstacles and of rigid bodies immersed in a viscous incompressible fluid

Erica Schwindt

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Abstract

We consider the geometrical inverse problem consisting in recovering an unknown obstacle in a viscous incompressible fluid by measurement of the Cauchy force on a part of the exterior boundary. We deal with the case where the fluid equations are the non stationary Stokes system and using the enclosure method, we can recover the convex hull of the obstacle and the distance from a point to the obstacle. With the same method, we can obtain the same result in the case of a linear fluid–structure system composed by a rigid body and a viscous incompressible fluid. We also tackle the corresponding nonlinear systems: the Navier–Stokes system and a fluid–structure system with free boundary. Using complex spherical waves, we obtain some information on the distance from a point to the obstacle.

Bifurcations of Principal Curvature Lines on Hypersurfaces of Euclidean Spaces

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Abstract

We classify the patterns of generic qualitative changes around the umbilic singularities of hypersurfaces evolving in R^n, depending on a real parameter. We focus on the cases $n = 3$ and $n = 4$. Work in collaboration with R. Garcia and D. Lopes.

Numerical analysis of distributed optimal control problems

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Abstract

A continuous optimal control problem (OCP) governed by an elliptic variational inequality was considered in Boukrouche-Tarzia, Comput. Optim. Appl. (2012) where the existence and uniqueness of the optimal control and its associated state system was proved. The goal is to make the numerical analysis of the above OCP, through the finite element method. We prove that there exists a unique discrete optimal control and its associated discrete state system. Finally, we show that the discrete OCP converges to the continuous OCP. The cornerstone of the proof is an inequality between the discrete solution of a convex combination of two data and the convex combination of the discrete solutions of the corresponding two data. It is a joint paper with Mariela C. Olguin (UNR, Argentina).

Asymptotic behavior of solutions for a non-dissipative viscoelastic problem

Nasser-eddine Tatar

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Abstract

In this talk we will present a problem appearing in viscoelastic theory. The exponential decay of solutions for this problem cannot be treated using the existing techniques as the energy of the system is not decreasing from the beginning. One cannot then profit from the dissipativity of the system or even the boundedness of the energy as is the case in the existing papers. We will discuss a way how to overcome this difficulty.

A converse to the Ambrosetti-Prodi theorem

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Abstract

The celebrated Ambrosetti-Prodi theorem, after contributions by Manes, Micheletti, Berger and Podolak, states that for a class of convex nonlinearities f, the operator $F(u) = -\Delta u - f(u)$ acting on functions satisfying Dirichlet boundary conditions is a global fold. In particular, the equation $F(u) = g$ has 0, 1, or two solutions. If f is not convex however, this is not the case: there are functions g with four preimages necessarily. More, F must have a cusp.

Regularity Results and Large Time Behavior for Integro-Differential Equations with Coercive Hamiltonians

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Abstract

We obtain regularity results for elliptic integro-differential equations driven by the stronger effect of coercive gradient terms. This feature allows us to construct suitable strict supersolutions from which we conclude Holder estimates for bounded subsolutions. In many interesting situations, this gives way to a priori estimates for subsolutions. We apply this regularity results to obtain the ergodic asymptotic behavior of the associated evolution problem in the case of superlinear equations. One of the surprising features in our proof is that it avoids the key ingredient which are usually necessary to use the Strong Maximum Principle: linearization based on the Lipschitz regularity of the solution of the ergodic problem. The proof entirely relies on the Hölder regularity.

Regularity results for near field refraction

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Abstract

We prove local $C^{1,\alpha}$ estimates of solutions for the parallel refractor and reflector problems under local assumptions on the target set Σ, and no assumptions are made on the smoothness of the densities.

Adjoint method for a tumor invasion PDE-constrained optimization problem in 2D using Adaptive Finite Element Method

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Abstract

In this talk we present a method for estimating unknown parameter that appear in a two dimensional non-linear reaction-diffusion model of cancer invasion. This model considers that tumor-induced alteration of micro- environmental pH provides a mechanism for cancer invasion. A coupled system reaction-diffusion describing this model is given by three partial differential equations for the 2D non-dimensional spatial distribution and temporal evolution of the density of normal tissue, the neoplastic tissue growth and the excess concentration of H^+ ions. Each of the model parameters has a corresponding biological interpretation, for instance, the growth rate of neoplastic tissue, the diffusion coefficient, the re- absorption rate and the destructive influence of H^+ ions in the healthy tissue.

After solving the direct problem, we propose a model for the estimation of parameters by fitting the numerical solution with real data, obtained via in vitro experiments and fluorescence ratio imaging microscopy. We define an appropriate functional to compare both the real data and the numerical solution using the adjoint method for the minimization of this functional.

We apply a splitting strategy joint with Adaptive Finite Element Method (AFEM) to solve the direct problem and the adjoint problem. The minimization problem (the inverse problem) is solved by using a trust-region-reflective method including the computation of the derivative of the functional.

This work is in collaboration with A. Quiroga, D. Fernandez and G. Torres.

Periodic solutions for a 1D-model with nonlocal velocity via mass transport

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Abstract

We consider the following one-dimensional model

$$u_t + (H(u)u)_x = \nu u_{xx},$$

with the initial condition $u(x,0) = u_0$, $\nu \geq 0$, where H stands for the periodic Hilbert transform

$$H(u)(x) = \frac{1}{2\pi} P.V. \int_{-\pi}^{\pi} \cot(\frac{x-y}{2}) u(y) dy.$$

There is a rich literature showing that solutions can blow up at finite time; for instance, they can form mass-concentration. We develop a global well-posedness theory for periodic measure initial data that allows in particular to analyze how the model evolves from those singularities. Our results are based on periodic mass transport theory and the abstract gradient flow theory in metric spaces developed by Ambrosio et al: *Gradient Flows in Metric Spaces and in the Space of Probability Measures.*

On the Navier-Stokes equations for flows with shear dependent viscosity

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Abstract

We will present some recent results of existence and regularity of solutions to the steady Navier-Stokes equations for flow with shear dependent viscosity in domains with unbounded outlets. We assume that the viscous stress tensor S satisfies a classical power law stress tensor of the form

$$S(x) = 2\nu(\delta + |x|^2)^{\frac{p-2}{2}} x \quad \text{or} \quad S(x) = 2\nu(\delta + |x|)^{p-2} x.$$

This problem is related to the Leray problem, which consists of the Navier-Stokes system for stationary incompressible flows in a domain with unbounded straight outlets, with the velocity field converging to parallel flows (Poiseuille flow) in the ends of the outlets. Our result extend the other ones of O. Ladyzhenskaya, V. Solonnikov,G. Dias and M. Santos.

Weak and strong probabilistic solutions for a class of strongly nonlinear stochastic parabolic problems

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Abstract

We consider higher-order stochastic quasilinear parabolic equations involving unbounded perturbation of zeroth order. The deterministic case was studied by Brezis and Browder (*Proc. Natl. Acad. Sci. USA*, **(**1): 38-40, 1979). We establish the existence of a probabilistic weak solution and a probabilistic strong solution. The main tools used in the paper are a regularization through a truncation procedure which enables us to adapt the work of Krylov and Rozosvkii (*Journal of Soviet Mathematics*, **:** 1233-1277, 1981), combined with analytic and probabilistic compactness results (Prokhorov and Skorokhod Theorems), the theory of pseudomonotone operators, and a Banach space version of Yamada-Watanabe's theorem due to Ondrejat.