DETERMINISTIC AND STOCHASTIC PROCESSES

IAŞI, 25-28 February 2026

Titles and Abstracts

- **Sebastian ANIŢA:** *Regional Control of Reaction-Diffusion Models in Mathematical Biology*

  ABSTRACT: We discuss some regional control problems for reaction-diffusion models in mathematical biology. The models describe the dynamics of interacting populations and contain local or nonlocal reaction and diffusion terms. A special attention is given to the necessary and sufficient conditions for stabilizability and to the structure of a stabilizing feedback control.

- **Ştefana ANIŢA:** *A Mean Field Game system and a related deterministic optimal control problem*

  ABSTRACT: This paper concerns a Mean Field Game (MFG) system related to a Nash type equilibrium for dynamical games associated to large populations. One shows that the MFG system may be viewed as the Euler–Lagrange system for an optimal control problem related to a Fokker–Planck equation with control in the drift. One derives the existence of a weak solution to the MFG system and under more restrictive assumptions one proves some uniqueness results

- **Marius BECEANU:** *Dispersive equations with time dependent stochastic potential*

  ABSTRACT: We address in this talk the semilinear Schrödinger equation with time dependent stochastic potential. Possible generalizations and future directions of study will be discussed if time is available.

- **Cristian S. CALUDE:** *N-Dimensional Located Kochen-Specker Theorem and Quantum Random Generation*

  ABSTRACT: **TBA**

- **Ovidiu CÂRJĂ** *A Petrov-type condition for semiliniar evolutions*

  ABSTRACT: In 1970, N. N. Petrov, gave a necessary and sufficient condition for the Lipschitz continuity of the minimum time function associated to a finite dimensional control system. We investigate here the infinite dimensional semiliniar control system $y' = Ay + f(y) + Bu$ where A generates a linear semigroup in a Banach space X, the function f is Lipschitz and B is bounded from a Banach space U to X. We show that a necessary and sufficient condition for the Lipschitz property of the minimum time function is the surjectivity of B. We discuss further the case where instead of $f(x) + Bu$ we

have an upper semicontinuous multifunction with nonempty, weakly compact and convex values.

- **Adina CIOMAGA:** *Nonlocal Hamilton–Jacobi Equations*

  ABSTRACT: Hamilton–Jacobi equations with nonlocal integro-differential terms naturally arise in optimal control, front propagation, and stochastic processes with jumps. When the control is unbounded, such equations typically take the form $u - I[u](x) + b(x)|Du|^m = f(x)$, $x \in \mathbf{R}^d$, where $I[u]$ is a nonlocal operator associated with a Lévy measure, encoding long-range interactions or jump dynamics, and $H(x,p) = b(x)|p|^m$ is the Hamiltonian. In the first part of the talk, I will discuss the analytical framework for viscosity solutions in the presence of nonlocal operators, focusing on well-posedness, comparison principles, and stability under natural structural assumptions on the Hamiltonian H and the operator I. In the second part, I will address regularity issues for Hamilton–Jacobi equations with integro-differential terms. This is a delicate problem due to the interplay between the first-order nonlinear Hamiltonian and the nonlocal operator. Unlike the purely local case, where coercivity or convexity of H may yield Lipschitz continuity, the nonlocal term introduces long-range interactions that can either enhance or obstruct regularization. In many situations, however, the nonlocal operator provides a compensating effect that prevents singularity formation and leads to improved regularity. Determining optimal regularity remains largely open and strongly depends on fine properties of the jump measure and its interaction with the nonlinear Hamiltonian.

- **Ioana CIOTIR** *Stochastic porous media equation with Robin boundary conditions and gravity-driven infiltration*

  ABSTRACT: We aim at studying a novel mathematical model associated to a physical phenomenon of infiltration in an homogeneous porous medium.
  The particularities of our system are connected to the presence of a gravitational acceleration term proportional to the level of saturation, and of a Brownian multiplicative perturbation. Furthermore, the boundary conditions intervene in a Robin manner with the distinction of the behavior along the inflow and outflow respectively.
  We provide qualitative results of well-posedness, the investigation being conducted through a functional approach.

  Joint work with Dan Goreac from Laval University, Canada and Juan LI from Shandong University, China and Antoine Tonnoir from INSA Rouen, France

- **Iulian CÎMPEAN:** *Regularization of the superposition principle: Potential theory meets Fokker-Planck equations*

  ABSTRACT: For a (probability measure valued) solution to a (possibly nonlinear) Fokker-Planck equation (FPE) the powerful superposition principle renders a probability measure on path space with one dimensional time marginals equal to this solution, and additionally solving the martingale problem for the (possibly nonlinear) Kolmogorov operator given by the FPE. The superposition principle thus reveals that such parabolic PDEs have a probabilistic counterpart. The aim of this talk is to go a substantial further step and, by exploiting the superposition principle, construct a full fledged Markov process, i.e. a family of path space measures for a large set of space time starting points connected by the Markov property, associated to the (linearized) FPE in the above way. In fact, under very general (merely measurability) conditions on the coefficients of the FPE this is achieved in this work in such a way that the resulting process is a right process, which is a particularly useful class of Markov processes, enjoying among other regularity properties the strong Markov property, which is fundamental for the analysis of the underlying FPE as a (nonlinear) parabolic PDE by probabilistic tools. The validity of the strong Markov property in the context of the superposition principle was an open problem even in the linear case. In this work we solve this also in the nonlinear case, i.e. for path laws of solutions to McKean-Vlasov SDEs with Nemytskii type coefficients. A main application here is the FPE given by the generalized porous media equation and its corresponding McKean-Vlasov SDE.

  Joint work with L. Beznea and M. Röckner.

- **Franco FLANDOLI:** *SPDEs for turbulent transport*

  ABSTRACT: Modern fusion plasma devices called Tokamak aim to work in the so-called H-mode regime (High confinement), opposite to the L-mode one (Low confinement). Both of them are turbulent fluid dynamic regimes, for a plasma subject to a very strong magnetic field. After a brief introduction to the topic, the talk will focus on the turbulent heat transport, showing how SPDEs suitably model the problem and allow one to compute the energy confinement time, the quantity of major interest. SPDEs may be crucial also for the understanding of the L-H transition and for the development of anomalous heat transport models; some ideas in this direction will be also mentioned. The research has been performed in the framework of the ERC AdG project NoisyFluid, no. 101053472.

- **Valeriu GUŢU:** *How many contractions are needed to build an IFS with a given attractor?*

  ABSTRACT: The question, whether a compact set can or cannot be represented as the attractor of in Iterated Function System (IFS), was studied by many authors. If for a compact set the previous question has a positive answer, then which is the minimal possible number (or some its estimation) of the components of such an IFS? This question is related to many other topological questions, such as Borsuk's and Hadwiger's Conjectures, the covering a piece by its smaller copies.

- **Mimmo IANNELLI:** *UNDERSTANDING AND CONTROLLING PANDEMIC DISEASES. The paradigmatic case of COVID 19*

  ABSTRACT: The COVID-19 pandemic experience has highlighted the complex shape of threatening epidemic outbreaks that will represent the main challenge for future preparedness activities against new diseases. In this talk, I will summarize published and progress work on complex epidemics relying on a number of variants of the classical Kermack and McKendrick epidemic model with age of infection (1927), which still represents the basis of any attempt to understand infectious diseases spread and their control/mitigation interventions. The model provides an adequate reproduction of the overall story of the COVID-19 pandemic until the spread of omicron variant by using a minimal parametrization. Moreover, an optimal control variant of the model is used to seek optimal combinations of social distancing and vaccination.

  References

  - A. D'Onofrio, M. Iannelli and P. Manfredi "Dynamics of partially mitigated multi-phasic epidemics at low susceptible depletion. Phases of COVID-19 control in Italy as case study" Mathematical Biosciences (MB) 340, 108671 (2021)

  - A. D'Onofrio, M. Iannelli, P. Manfredi and G. Marinoschi "Optimal Epidemic control by social distancing and vaccination of an Infection structured by Time Since Infection: the COVID-19 case study", SIAM J. of Applied Math. (SIAP) 84 (3), 199 – 224, (2023)

  - A. D'Onofrio, M. Iannelli, P. Manfredi and G. Marinoschi "Multiple pandemic waves vs multi-period/multi-phasic epidemics: global shape of the COVID-19 pandemic", J. of Theoretical Biology (JTB) 593, 111881 (2024)

  - A. D'Onofrio, M. Iannelli, P. Manfredi and G. Marinoschi "Optimal control of diseases by social distancing and vaccination: numerical application to COVID-19 and to other multi-phase epidemics", Math. Biosciences and Engineering (MBE) 21 (7), 6493–6520 (2024)

- V. Barbu, M. Iannelli and G. Marinoschi "Optimal control of epidemics by alternating vaccination strategies" Nonlinear Differ. Equ. Appl. (NoDEA) 32, 87 (2025)

- **Sorin ISTRAIL:** *Constructing Universal Traversal Sequences: How to take a random walk deterministically*
  ABSTRACT: **TBA**

- **Petru MIRONESCU:** *Topological invariants and approximability in low regularity Sobolev spaces to manifolds*
  ABSTRACT: We present a number of objects that 'hear' the homotopy properties or the singularities of Sobolev maps to manifolds. A simple starting point is the following: when M is a metric measure space and N is a smooth compact manifold, we may naturally associate with a vanishing mean oscillation (VMO) map $f : M \to N$ a homotopy class, which is a 'robust' object. Another example is $\int_M f * *\omega$, if $f \in \mathrm{VMO}(M; N)$, M is k-dimensional, Lipschitz, and compact, and ω is a closed k-form on N. This is again a robust (homotopy invariant) object. In higher dimensions, say $M = \mathbb{R}^d$, with $d > k$, one may define the current $d(f^*\omega)$, when f is in one of the 'critical' Sobolev spaces $W^{s,p}(\mathbb{R}^d; N)$ with $sp = k$. This is straightforward when $s \geq 1$, but more delicate when $0 < s < 1$. We explain the existence of this current, and its robust character. When N has a simple topology (e.g., when it is $(k-1)$-connected), the above currents detect all the topological the obstructions to the approximation with smooth maps with values into N. These results generalize previous works of Bethuel, Bourgain, Bousquet, Brezis, Coron, Demengel, Hélein, Giaquinta, Mucci, and the author. Joint work with Antoine Detaille (ETH Zurich) and Kai Xiao (Université Claude Bernard Lyon 1).

- **Ionuţ MUNTEANU:** *Stabilization of fractional PDEs*
  ABSTRACT: The talk is devoted to the problem of boundary stabilization for time-space fractional diffusion equation, in a multi-dimensional domain. The method employs the Riesz basis approach and proportional control design. The stability of the closed-loop system is proved via fractional Lyapunov technique.

- **Andrei PERJAN** *The convergence estimates of solutions to the hyperbolic relaxation of the non viscous Cahn-Hilliard equation*
  ABSTRACT: Let $\Omega \subset \mathbb{R}^n$ $(n = 1, 2, 3)$ be a bounded domain with smooth boundary $\partial\Omega$, $T > 0$ and $Q_T = \Omega \times (0, T)$. We will study the behaviour of the solutions of the initial boundary problem

$$\begin{cases} \varepsilon\, \partial_{tt}^2 u_\varepsilon + \partial_t u_\varepsilon - \Delta\big(-\Delta u_\varepsilon + a\, u_\varepsilon + B(u_\varepsilon)\big) = f_\varepsilon(x,t), \quad (x,t) \in Q_T, \\ u_\varepsilon\big|_{t=0} = u_{0\varepsilon}(x), \quad \partial_t\, u_\varepsilon\big|_{t-0} = u_{1\varepsilon}(x), \quad x \in \Omega, \\ u_\varepsilon\big|_{x\in\partial\Omega} = \Delta\, u_\varepsilon\big|_{x\in\partial\Omega} = 0, \quad t \in (0,T), \end{cases} \tag{P_ε}$$

as $\varepsilon \to 0$, where $\Delta : H^2(\Omega) \bigcap H_0^1(\Omega) \mapsto L^2(\Omega)$, $a \in \mathbb{R}$ and $B(u) = |u|^p u$. The problem (P_ε) is the hyperbolic relaxation for the corresponding initial boundary problem for the non viscous Cahn-Hilliard equation

$$\begin{cases} \partial_t v - \Delta\big(-\Delta v + a\, v + B(v)\big) = f(x,t), \quad (x,t) \in Q_T, \\ v\big|_{t=0} = v_0(x), \quad x \in \Omega, \\ v\big|_{x\in\partial\Omega} = \Delta\, u\big|_{x\in\partial\Omega} = 0, \quad t \in (0,T). \end{cases} \qquad (P_0).$$

The model (P_0) is governed by the celebrated Cahn-Hillard equation, which was proposed to describe phase separation phenomena in binary systems (phase separation process between healthy and tumour, the phase separation of a binary mixture and other phenomena) [J.W. Cahn and J.E. Hilliand, 1958]. The operator B is the derivative of a non-convex potential $\mathcal{B}$.

The mathematical literature devoted to (P_0) focuses on the fundamental properties of solutions in terms of regularity, qualitative behavior, and asymptotics. In recent years, research has shifted to other versions of (P_0) related to specific physical situations. Among these is the so-called hyperbolic relaxation of the equation, proposed by P. Galenko and V. Lebedev in 2008 and described by the (P_ε) model.

Under some smoothness conditions on the functions $u_{0\varepsilon}$, $u_{1\varepsilon}$, f_ε, v_0, f, if

$$||u_{0\,\varepsilon} - u_0||_{H_0^1(\Omega)} \to 0,\ ||u_{1\,\varepsilon} - u_1||_{L^2(\Omega)} \to 0,\ ||f_\varepsilon - f||_{W^{1,2}(0,T;L^2(\Omega))} \to 0,$$

using the relationship between the solutions of systems (P_ε) and (P_0), as well as a priori estimates of the solutions to the system (P_ε), we prove that

$$u_\varepsilon \to v \quad \text{in} \quad C([0,T]; L^2(\Omega)) \cap L^\infty(0,T; H_0^1(\Omega)), \quad \text{as} \quad \varepsilon \to 0.$$

This means that the perturbations of the system (P_0) by the system (P_ε) are regular in the indicated norms.

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- **Michael RÖCKNER:** *NONLINEAR MARKOV PROCESSES IN THE SENSE OF MCKEAN*

  ABSTRACT: In the talk we shall discuss nonlinear Markov processes in the sense of McKean's seminal work in PNAS 1966. In particular, we shall present a general new technique how to show that a family of probability measures on cadlag paths, given by the path laws of solutions to a McKean-Vlasov type SDE, form anonlinear Markov process. The SDE's coefficients are only assumed to be measurable in their measure variable, so that they may depend on derivatives of any order of the solutions' time-marginal densities.

In particular, the p-Brownian motion associated to the parabolic p-Laplace equation turns out to be a nonlinear Markov process in the sense of McKean. Further examples are related to the generalized (fractional) porous media equation, the Burgers and the 2D vorticity Navier-Stokes equation.

Joint work with: Marco Rehmeier

References on which the talk is based:

[1] Rehmeier/R.: arXiv: 2212.12424v2, to appear in J. Theor. Probab.

[2] Barbu/Rehmeier/R.: arXiv: 2409.18744v2, to appear in AOP

[3] Barbu/R.: Springer LN 2024

[4] Barbu/R./Deng Zhang: arXiv: 2309.13910, to appear in JEMS

[5] Barbu/R.: PTRF 2024

[6] Barbu/R.: JFA 2023 and JFA 2021

[7] Barbu/R.: IUMJ 2023

[8] Barbu/R.: AOP 2020 and SIAM 2018

[9] R./Longjie Xie/Xicheng Zhang: PTRF 2020

- **Franceso RUSSO:** *Exponential twist of probability measures: drift correction in term of a generalized gradient*

  ABSTRACT: This talk will concern the exponential twist, i.e. a path-integral exponential change of measure, of a Markovian reference probability measure P. This type of transformation naturally appears in variational representation formulae originating from the theory of large deviations and can be interpreted in some cases, as the solution of a specific stochastic control problem. Under a very general Markovian assumption on P, we fully characterize the exponential twist probability measure as the solution of a martingale problem and prove that it inherits the Markov property of the reference measure. The "generator" of the martingale problem shows a drift depending on a generalized gradient of some suitable value function v. Applications of this work refer to an entropy minimization algorithm, see e.g. [2] and [1]. This work is based on a collaboration with Th. Bourdais (ENSTA and Mazars), and N. Oudjane (EDF). It is the object of [3].

  References

  [1] T. Bourdais, N. Oudjane, and F. Russo. An entropy penalized approach for stochastic control problem. To appear: SIAM Journal on Control and Optimization (SICON), 2025. [[2] T. Bourdais, N. Oudjane, and F. Russo. An entropy penalized approach for stochastic control problem. Complete Version. Preprint HAL-04193113 v2, 2025.

  [3] T. Bourdais, N. Oudjane, and F. Russo. Exponential twist of probability measures: drift correction in term of a generalized gradient. Complete Version. Preprint HAL-04644249. v2, 2025

- **Andrea SGARRO:** *Infomation measures: uncertainty, ignorance and contradiction.*
  ABSTRACT: **TBA**
- **Gabriel TURINICI:** *Physics Informed neural networks for stiff transient dynamics*
  ABSTRACT: Physics Informed Neural Networks have been successfully used for the numerical simulation of transient physical phenomena modeled by ODEs & PDEs. But specific challenges arise when the dynamics is stiff or multi-scale. We will present several approaches that allow to propose optimal time sampling of the discretization points and on the other hand we will investigate what adaptations are required when systems of PDEs are considered.
- **Ionel URDEA MARCUS:** *Deterministic and stochastic processes in measurement practice.*
  ABSTRACT: **TBA**
- **Adrian ZĂLINESCU:** *Mild Solutions for Path-Dependent Parabolic PDEs via Time-Delayed BSDEs*
  ABSTRACT: This talk unifies recent advances on time-delayed BSDEs and their nonlinear Feynman–Kac representations for path-dependent (integro-differential) PDEs. We first show how delayed generators yield viscosity and mild solutions of pathdependent Kolmogorov equations and how state-space lifting restores Markovianity. We then extend the framework to L´evy jumps, obtaining a representation for path-dependent PIDEs and stability/regularity results under smalldelay (or small Lipschitz) conditions. Next, we introduce generalized BSDEs with Stieltjes terms to capture Neumann boundary conditions via reflected SDEs and prove existence–uniqueness together with continuity under uniform perturbations of the increasing process. Applications include large-investor models, delay-sensitive risk measures, and insurance valuation with memory and boundary effects. Throughout, we emphasize fixed-point constructions, semigroup methods, and generalized directional gradients linking stochastic dynamics to PDE/PIDE solutions.