

# Deterministic and Stochastic Evolution Equations

---

October 26-28, 2026

**Aula Dini, Palazzo del Castelletto**

Scuola Normale Superiore, Pisa, Italy

## BOOK OF ABSTRACTS

ORGANIZING COMMITTEE

**Franco Flandoli**  
**Andrea Di Primio**

<https://indico.sns.it/e/dsee2026>

# Program

| Time        | Monday<br>October 26 | Tuesday<br>October 27 | Wednesday<br>October 28 |
|-------------|----------------------|-----------------------|-------------------------|
| 08:30–09:00 | Registration         |                       |                         |
| 09:00–09:45 | V. Barbu             | M. Gubinelli          |                         |
| 09:45–10:30 | G. Metafuno          | E. Priola             | A. Debussche            |
| 10:30–11:00 | Coffee break         | Coffee break          | Coffee break            |
| 11:00–11:45 | G. Marinoschi        | B. Gess               | M. Zanella              |
| 11:45–12:30 | M. Iannelli          | D. A. Bignamini       | L. Scarpa               |
| 12:30–14:00 | Lunch break          | Lunch break           | Lunch break             |
| 14:00–14:45 | P. Cannarsa          | M. Fuhrman            |                         |
| 14:45–15:30 | C. Lefter            | F. Masiero            |                         |
| 15:30–16:00 | Coffee break         | Coffee break          |                         |
| 16:00–16:45 | I. Cimpean           | F. Confortola         |                         |
| 16:45–17:30 | S. Bonaccorsi        | C. Orrieri            |                         |

# Abstracts

MON 26 OCT

09:00–09:45

## The Fokker–Planck flows: regularity and the convergence to equilibrium

**Viorel Barbu**

*Octav Meyer Institute of Mathematics of the Romanian Academy*

---

For the initial data in the Wasserstein space  $W_2$  and with finite Gibbs–Boltzmann entropy, the solution to the nonlinear Fokker–Planck equation is time absolutely continuous in the Wasserstein metric. Moreover, for initial data with exponential decay, the solution is convergent in  $L^1(\mathbb{R}^d)$  for  $t$  convergent to  $+\infty$  to a stationary solution of this equation.

---

TUE 27 OCT

11:45–12:30

## Integration by parts and DLR equations for SPDEs on the whole line

**Davide Augusto Bignamini**

*Università degli Studi dell’Insubria*

---

We study a stochastic reactiondiffusion equation on the whole real line, driven by spacetime white noise, with a possibly nonlocal diffusion operator and a superquadratic potential. Unlike the case of bounded intervals, on the whole line the invariant measures cannot be described by an explicit density with respect to a Gaussian measure. We formulate the equation in suitable weighted spaces and show that invariant and infinitesimally invariant measures coincide, and that reversible measures coincide with the solutions of an integration-by-parts formula. Finally, we prove that the reversible measures are precisely the Gibbs measures with finite moments defined via the DobrushinLanfordRuelle equations. In particular, we connect the Da PratoZabczyk approach to invariant measures of SPDEs with the statistical mechanics approach of Osada and Spohn, within a framework covering both uniqueness and non-uniqueness regimes. Joint work with F. C. De Vecchi, C. Orrieri and C. Villanueva Mariz.

---

## A stochastic diffusion problem with obstacle on a star graph

**Stefano Bonaccorsi**

*Università di Trento*

MON 26 OCT

16:45–17:30

This talk is based on an ongoing project with Z. Brzezniak, where we study a stochastic diffusion-transport problem on a finite star graph with a nonlinear dynamic condition at the junction and a reflecting obstacle acting on the junction variable. A natural physical interpretation is the evolution of a concentration in a network of thin channels connected to a small central reservoir. Along the channels, the concentration diffuses and is transported by a nonlinear flux. At the junction, the reservoir exchanges mass with all channels, is subject to random fluctuations, and is constrained to remain nonnegative.

Problems with dynamic conditions on selected vertices are naturally formulated on a product space containing both the edge variables and the nodal variables, with the coupling imposed through trace conditions. The main difficulty of our model is introduced by the reflection acting on the dynamic variable at the junction. This variable is subject to both a stochastic forcing and a reflecting constraint, but its evolution is not autonomous: it is coupled to the diffusion-transport dynamics on the edges through the boundary fluxes at the common vertex. Thus, although the constraint itself is deceptively simple, since it only requires the scalar junction variable to remain nonnegative, the resulting obstacle problem couples a finite-dimensional reflected component with an infinite-dimensional evolution equation on the network. In particular, it cannot be reduced to the standard one-dimensional problem of reflection on the half-line  $[0, \infty)$ .

## Inverse problems for degeneracy parameters in evolution equations

**Piermarco Cannarsa**

*Università degli Studi di Roma Tor Vergata*

MON 26 OCT

14:00–14:45

Degenerate evolution equations arise when the diffusion or propagation mechanism vanishes on part of the spatial domain. A natural inverse problem is then to determine the location and the strength of the degeneracy from suitable observations of the solution.

In this talk I will discuss a class of inverse problems for strongly degenerate evolution equations, starting from one-dimensional parabolic models in which the diffusion coefficient vanishes at an unknown interior point. Boundary measurements can be used to recover the location of the degeneracy and, under suitable assumptions, to

obtain uniqueness and stability results. The analysis also leads to the simultaneous identification of other parameters, including the degeneracy exponent and, in some cases, the initial datum. Spectral methods play a central role and also provide a basis for effective numerical reconstruction.

I will then describe some recent developments concerning multidimensional parabolic equations and degenerate wave equations. These extensions illustrate how the reconstruction problem changes when explicit spectral representations are no longer available or when finite propagation introduces a critical observation time.

MON 26 OCT

16:00–16:45

## Right Markov processes for McKeanVlasov SDEs and the branching particle systems they drive

**Iulian Cîmpean**

*University of Bucharest and Romanian Academy*

The superposition principle turns a solution of a (possibly nonlinear) FokkerPlanck equation into a probability measure on path space that solves the associated martingale problem. It does not, in general, produce a Markov process, and the strong Markov property for such path laws has remained open in general even in the linear case. In the first part of the talk we show how potential theory closes this gap. Under merely measurable conditions on the coefficients, we construct a right (hence strong Markov) process on a large set of space-time starting points whose one-dimensional marginals reproduce the given solution. For McKeanVlasov SDEs with Nemytskii-type coefficients, such as those behind generalized porous media equations, this gives the strong Markov property for the corresponding nonlinear Markov process.

In the second part we use these processes as the motion of a branching particle system. Picture a large population of interacting healthy particles, described in the mean-field limit by a McKeanVlasov SDE, and a small population of infected particles that move like the healthy ones and branch at rates depending on time, position and the distribution of the whole population. We construct the infected population as a right branching process on the space of finite configurations. The approach is analytic: the branching semigroup is a jump perturbation of the diagonal process, realized through inverse subordination. This avoids the regularity conditions on the base process required by earlier constructions, and it identifies the fine and natural topologies of the resulting process. Joint work with Lucian Beznea and Michael Röckner.

## Markovian lifting and optimal control for stochastic Volterra equations driven by pure jump Lévy processes

**Fulvia Confortola**

*Politecnico di Milano*

TUE 27 OCT

16:00–16:45

---

We deal with stochastic optimal control problems for integral stochastic Volterra equations in a finite-dimensional setting. The noise term is driven by a pure jump Lévy process and the control acts on the intensity of the jumps. We use the machinery of Laplace transform to lift the original control problem in a suitable infinite dimensional space large enough to contain all the information about the history of the process and we solve it by using the approach based on forward-backward stochastic differential equations. Under this approach, we prove the existence of the optimal control for the original problem. The talk is based on a joint work with Stefano Bonaccorsi.

---

## Fluctuation dynamics in randomly advected Navier-Stokes equations below critical scaling

**Arnaud Debussche**

*École Normale Supérieure de Rennes*

WED 28 OCT

09:45–10:30

---

We study randomly advected incompressible Navier-Stokes equations, where the advecting field is a mean-zero, divergence-free, space-time stationary velocity field with smooth order-one correlations. We introduce a two-parameter family of models in which the advection is accelerated on a fast temporal scale  $\epsilon^2$  and has spatial correlation length  $\delta$ ; the critical regime  $\epsilon = \delta$  corresponds to the natural parabolic scaling of the Navier-Stokes equation. In the full subcritical regime  $\epsilon = o(\delta)$  we prove a law of large numbers in dimensions  $d = 2, 3$ : the solutions converge to a deterministic Navier-Stokes system with an enhanced diffusion coefficient given by a Green-Kubo formula. In two space dimensions, under the slightly stronger assumption  $\epsilon = o(\delta^{\iota+1})$  for some  $\iota > 0$ , we identify the leading-order fluctuations: after subtracting deterministic macroscopic corrections satisfying a nonlinear system of Navier-Stokes type, the rescaled fluctuations converge to a Gaussian field solving a linearized Navier-Stokes equation driven by multiplicative space-time white noise.

---

TUE 27 OCT

14:00–14:45

## Some results on partially observed optimal control of McKean-Vlasov systems

**Marco Fuhrman**

*Università degli Studi di Milano*

---

We study optimal control problems for a class of dynamical systems of McKean-Vlasov type exhibiting mean-field effects, namely where the coefficients also depend on the joint distribution of the state and control. The controlled system is subject to regime switching driven by a hidden Markov chain, so that the problems under consideration are partially observed. The main contribution of this paper is to show how the distribution dependence can be handled within a change-of-probability framework, leading to a well-posed separated control problem. We derive a controlled Zakai equation with a specific structure for the unnormalized filter, and show that the corresponding value function satisfies a dynamic programming principle. This yields a Bellman equation posed on a convex subset of a Wasserstein space, characterizing the optimal control problem under partial observation. The paper is available as [arXiv:2601.09311v1](https://arxiv.org/abs/2601.09311v1). It is joint work with Huy  n Pham and Silvia Rud  .

---

TUE 27 OCT

11:00–11:45

## Stabilization by transport noise for aggregation-diffusion equations

**Benjamin Gess**

*Technische Universit  t Berlin & Max Planck Institute for Mathematics in the Sciences*

---

We consider stochastic McKean-Vlasov equations whose deterministic dynamics can exhibit phase transitions and nonuniform equilibria. We establish that under suitable assumptions, sufficiently strong divergence-free transport noise makes the Dirac mass at the homogeneous density the unique invariant probability measure. The proof combines enhanced dissipation, local Eulerian stability through a negative top Lyapunov exponent, and global accessibility through mixing and a support theorem. Joint work with Rishabh S. Gvalani and Adrian Martini.

---

## Stochastic observables

**Massimiliano Gubinelli**

*University of Oxford*

TUE 27 OCT

09:00–09:45

[Abstract TBA].

## A size structured Volterra predator-prey system: a model for the centennial

**Mimmo Iannelli**

*Università di Trento*

MON 26 OCT

11:45–12:30

In 1926 Vito Volterra proposed his prey-predator model within his “Teoria Matematica della Lotta per la Vita” and gave an explanation to some biological oscillations observed in several natural contexts. Since then, several extensions of Volterra model have been considered, in the context of O.D.E. modeling, to explain the rich behavior of ecological prey-predator system. *These models have been used widely and form the basis of most, if not all, of our current theory on population and community processes. And yet, these models completely ignore one of the most important processes in an individual’s life history: development* (A. M. de Roos and L. Persson, Population and Community Ecology of Ontogenetic Development, 2013). Development mechanisms regard how individual internal variables change in time, influencing vital parameters such as fertility and mortality and tuning the interaction of different populations. In particular, in the case of a prey-predator system, the size of an individual is crucial, because apart from its influence on fertility and mortality, it determines the predator ability to catch the prey, and the prey contribution to predator growth. The model we consider corresponds to Volterra model and is fully size-structured. We are interested in steady states, in their stability and in the existence of periodic solutions. The complexity of the model allows only partial analytical results, but we adopt a pseudo-spectral method to perform a thorough numerical exploration.

MON 26 OCT

14:45–15:30

## Control and inverse source problems for reaction-diffusion systems in annular domains

**Cătălin-George Lefter**

*“Al. I. Cuza” University & Octav Mayer Institute of Mathematics of the Romanian Academy*

---

We consider systems of reaction-diffusion equations coupled in zero order terms, with general homogeneous boundary conditions, in domains with a particular geometry (annular type domains). We establish specific Carleman estimates with boundary observations relying on the possibility of choosing special auxiliary functions, due to the geometry of the domain. These observability estimates are useful in approaching controllability and stabilization problems associated to such systems, as well as for source stability estimates. We establish stability estimates in  $L^2$  norm for the source in terms of the solution and/or its normal derivative on a connected component of the boundary. Another important ingredient here is represented by the positivity improving properties for the flow associated to parabolic systems. By carefully analyzing the Carleman estimates with internal observations, we also obtain a unique continuation result at initial type for systems of parabolic equations.

---

MON 26 OCT

11:00–11:45

## Identification of vital parameters in a stochastic age-structured population model

**Gabriela Marinoschi**

*Institute of Mathematical Statistics and Applied Mathematics of the Romanian Academy*

---

We present an inverse problem related to the dynamics of an age-structured population in which the evolution of individuals is also influenced by some random events. The model consists in a stochastic equation describing the time and age evolution of a population, governed by vital factors and influenced by a linear multiplicative noise perturbation, possibly related to emigration, immigration, environmental particularities, climate influence, epidemics, catastrophes, food availability at a given time and fortuitous mortality. A minimization problem is associated to this system, with the goal of identifying the mortality rate and the coefficient in the stochastic term, analogous to the volatility, by knowing the total population at certain times. A rescaling formula transforms the state system in a deterministic differential one with random coefficients. After proving existence and uniqueness results for this state system and the existence of a least one solution to the minimization problem, the inverse problem is solved by following an optimal control technique, proving the necessary conditions of optimality, that is the expressions of the two parameters which ensure the achievement of the objective.

## On smoothing properties for McKean–Vlasov SDEs in Hilbert spaces

**Federica Masiero**

*Università degli Studi di Milano-Bicocca*

TUE 27 OCT

14:45–15:30

We study a class of McKean-Vlasov SDEs in a Hilbert space  $H$  and prove that the associated transition semigroup (which is defined on a Wasserstein space  $\mathcal{P}_p(H)$  for some  $p \geq 1$ ) possesses a smoothing property, i.e., it transforms continuous functions admitting the linear functional derivative  $\frac{\delta}{\delta m}$  into functions admitting the measure derivative  $D_m$ . This generalizes in various ways previous results obtained in the finite-dimensional setting by Chaudru de Raynal and Frikha (*Well-posedness for some non-linear SDEs and related PDE on the Wasserstein space*, J. Math. Pures Appl., 2022). We then discuss the applications of such results. The talk is based on a joint work (in progress) with A. Calvia and F. Gozzi.

## Spectrum of Ornstein–Uhlenbeck operators

**Giorgio Metafuno**

*Università del Salento*

MON 26 OCT

09:45–10:30

We describe the spectrum of degenerate hypoelliptic Ornstein-Uhlenbeck operators in  $L^p(\mathbb{R}^N)$  with respect to the Lebesgue measure. It turns out that the spectrum is the sum of the spectra of the diffusion term and of the drift term. Our result gives a complete picture of the spectral properties of Ornstein–Uhlenbeck operators in  $L^p$  spaces.

TUE 27 OCT

16:45–17:30

## Pathwise uniqueness for a class of SPDEs

**Carlo Orrieri**

*Università di Pavia*

---

In the talk we address pathwise uniqueness for stochastic PDEs with drift in differential form. The result is firstly presented in the general framework of stochastic evolution equations on separable Hilbert spaces and subsequently applied to several classes of examples. The talk is based on a joint work with D. Addona, D. Bignamini and L. Scarpa.

---

TUE 27 OCT

09:45–10:30

## Exponential integrability of the solution to the stochastic Burgers equation driven by white noise

**Enrico Priola**

*Università di Pavia*

---

We study stochastic Burgers equation driven by a rough noise  $(-\Delta)^\gamma dW_t$ , where  $\Delta$  is the Laplacian in one dimension with Dirichlet boundary conditions, and  $\gamma \in [0, 1/4)$ . We prove exponential estimates for the solution  $X_t^x$ , starting from  $x \in L^2(0, 1)$ , by showing that there exists some constant  $\lambda > 0$  for which

$$\mathbb{E} \left[ \exp \left( \lambda \sup_{t \in [0, T]} \|X_t^x\|_{L^2(0, 1)}^2 \right) \right] < \infty. \quad (\star)$$

This estimate was known only in the case of trace class noise when  $-1/2 < \gamma < -1/4$  since in that case one can use the Itô formula. To prove the result we combine the Boué-Dupuis method with an argument used in [Da Prato-Debussche, Potential Anal. 2007]. Estimate  $(\star)$  has interesting applications. We also deduce a new Lipschitz regularizing effect for the corresponding Markov semigroup. This is a joint work with Francesco C. De Vecchi and Josef Janák.

---

## Strong Feller property and irreducibility for stochastic PDEs with degenerate multiplicative noise

WED 28 OCT

11:45–12:30

**Luca Scarpa**

*Politecnico di Milano*

---

We establish strong Feller property and irreducibility for the transition semigroup associated to a class of nonlinear stochastic partial differential equations with multiplicative degenerate noise. As a byproduct, we prove uniqueness of the invariant measure under very mild assumptions. The drift of the equation diverges exactly where the noise coefficient vanishes, resulting in a competition between the dissipative effects and the degeneracy of the noise. The main idea is to introduce a mathematical method to measure the accumulation of the solution towards the potential barriers, allowing to give rigorous meaning to the inverse of the noise operator even in the degenerate case. If the singularity of the drift and the degeneracy of the noise are suitably balanced, the dynamics are shown to stabilise for large times. From the mathematical point of view, the results provide a first generalisation of the classical work by Peszat & Zabczyk to the case of degenerate multiplicative diffusions. From the application perspective, the models cover interesting scenarios in physics, in the context of evolution of relative concentrations of mixtures, under the influence of thermodynamically-relevant potentials of Flory–Huggins type. The work presented in the talk is based on a joint collaboration with Margherita Zanella (Politecnico di Milano, Italy).

---

## Existence, uniqueness and asymptotic stability of invariant measures for the stochastic Allen–Cahn–Navier–Stokes system with singular potential

WED 28 OCT

11:00–11:45

**Margherita Zanella**

*Politecnico di Milano*

---

We investigate the long time behavior of a stochastic Allen–Cahn–Navier–Stokes system modeling the dynamics of binary mixtures of immiscible fluids. The model features the thermodynamically relevant Flory–Huggins logarithmic potential and incorporates two stochastic forcing terms: one driving the velocity field in the Navier–Stokes equation and the other acting on the phase variable in the Allen–Cahn equation. First, we establish the existence of ergodic invariant measures. Furthermore, we prove that the stochastic flow admits a unique, asymptotically stable invariant measure, provided that the noise driving the Navier–Stokes equation is non-degenerate along

sufficiently many low modes and the Allen-Cahn equation exhibits strong dissipativity. The talk is based on a joint work with A. Di Primio and L. Scarpa.

---