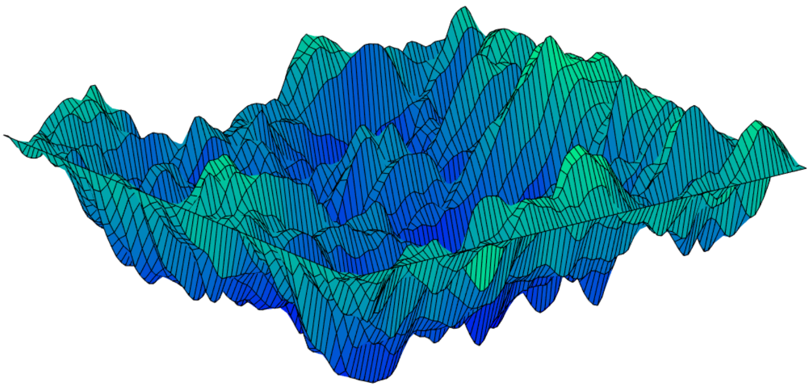
Winter School on

Numerics for Stochastic Partial Differential Equations and their Applications

December 5-9, 2016



as part of the
Radon Special Semester 2016 on

Computational Methods in Science and Engineering

ÖAW ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN

RICAM JOHANN·RADON·INSTITUTE FOR COMPUTATIONAL AND APPLIED MATHEMATICS

Partial Differential Equations are used to model real world systems. However for a system subjected to perturbation too complex to be described by deterministic perturbations, Stochastic Partial Differential Equations have proved to be most useful. Environmental loadings such as wind, storms, and earthquake are non-reproducible phenomena, which can be described successfully by stochastic processes.
Another example is provided by the Stochastic Navier-Stokes equations which are used in particular to model the airflow around a wing perturbed by the random state of the atmosphere and weather. Developments in such turbulence models lead to questions about drag reduction and lift enhancement in aircraft, noise control and combustion control. The spread of epidemics in some regions and the spatial spread of infectious diseases can be realistically modelled and mathematically described as a travelling front propagation of a stochastic nonlinear parabolic KPP equation. Investigating realistic epidemic models leads to understanding the development of illnesses like SARS, Ebola and bird flu, and in turn results in new strategies in combating such major diseases. SPDEs are also used in physical sciences (e.g. in turbulence of plasma, physics of growth phenomena such as molecular beam epitaxy and fluid flow in porous media with applications to the production of semiconductors and oil industry) and biology (e.g. bacteria growth and DNA structure). Models related to the so called passive scalar equations have potential applications to the understanding of waste (e.g. nuclear) convection under the earths surface.

Workshop Organizers

Erika Hausenblas, Montanuniversität Leoben, Austria
Zdzislaw Brzezniak, University of York, UK
Anne de Bouard, CNRS and Ecole Polytechnique, France

Welcome

to Linz and thank you very much for participating in the sixth *RICAM Special Semester on Computational Methods in Science and Engineering*, hosted by the Johann Radon Insitute for Computational and Applied Mathematics (RICAM) from October 3 to December 16, 2016.

We sincerely hope that you enjoy your stay in Linz!

Local Organizing Committee

Evelyn Buckwar, Johannes Kepler Universität, Austria
Pani W. Fernando, Montanuniversität Leoben, Austria
Tsiry Randrianasolo, Montanuniversität Leoben, Austria

Contents

Information

Workshop Information

Registration. The workshop registration will be on December 12th, 2011 from 8:00 - 8:50 am next to the seminar room SP2 416 on the 4th floor of the Science Park Building 2 (see floor plan). Participants that arrive later in the week can register at the special semester office SP2 456.

Registration Fee. Non-invited participants are kindly asked to pay the registration fee in cash upon registration.

Campus plan and overview map as well as a floor plan of the 4th floor of the workshop venue (Science Park Building 2) are located on the next pages.

Seminar room. The workshop will take place in seminar room SP2 416 on the 4th floor of the Science Park Building 2 (see floor plan).

Program. A time schedule for the workshop is located on the backside of this booklet.

Coffee breaks. The coffee breaks will be in the corridor of the 4th floor of the Science Park Building 2.

Internet access. There will be an extra information sheet regarding internet access available at registration.

Social Events

Welcome Reception & Poster Session. Monday, December 12th, 2011, 5:15 pm, on the 4th floor of the Science Park Building 2.

Conference Dinner. Tuesday, December 13th, 2011, 7:00 pm, at the restaurant "Kepler's", situated in the Mensa building

Drinks & 2nd Poster Session. Thursday, December 15th, 2011, 5:15 pm, on the 4th floor of the Science Park Building 2.

Restaurants and Cafes

- Mensa Markt (lunch time only) - Main canteen of the University (see campus plan)
- KHG Mensa (lunch time only) - Smaller canteen - good traditional food (see overview map: "KHG Linz")
- Pizzeria "Bella Casa" - Italian and Greek restaurant (located next to the tram stop)
- Chinese restaurant "Jadegarten" - (located close by the tram stop, adjacent to "Bella Casa")
- Asia restaurant "A2" - (located behind the Science Park on Altenbergerstrasse)
- "Chat" cafe - coffee, drinks and sandwiches (located in the "Hörsaaltrakt" - see overview map)
- Cafe "Sassi" - coffee, drinks and small snacks (located in the uilding "Johannes Kepler Universität" - see overview map)
- Bakery "Kandur" - bakery and small cafe (located opposite the tram stop)

General Information

Accommodation. The arranged accomodation for invited participants is the "Sommerhaus" hotel. You can find its location in the overview map on page 4.

Special Semester Office: Room SP2 456. The special semester administrator is Susanne Dujardin.

Audiovisual & Computer Support. Room SP2 458, Wolfgang Forsthuber or Florian Tischler.

Orientation/ Local Transport. From the railway station you have to take tram number 1 or 2 in direction "Universität". It takes about 25 minutes to reach the desired end stop "Universität".

In order to get to the city center of Linz ("Hauptplatz") and back you have to take again tram number 1 or 2 (about 20 minutes). For more information see `www.ricam.oeaw.ac.at/location/`.

Taxi Numbers.

+43 732 6969	Oberösterreichische Taxigenossenschaft
+43 732 2244	2244 Linzer Taxi
+43 732 781463	Enzendorfer Taxi & Transport
+43 732 2214	Linzer Taxi
+43 732 660217	LINTAX TaxibetriebsgesmbH

Further important phone numbers.

+43 (0)732 2468 5222	RICAM & Special Semester Office (Susanne Dujardin)
+43 (0)732 2468 5250/5255	RICAM IT Support (Florian Tischler/ Wolfgang Forsthuber)
+43 (0)732 2457-0	Reception of Hotel Sommerhaus
133	General emergency number for the police
144	General emergency number for the ambulance

More information about RICAM can be found at `www.ricam.oeaw.ac.at`. See also the Special Semester webpage `www.ricam.oeaw.ac.at/specsem/specsem2011/` for additional information.

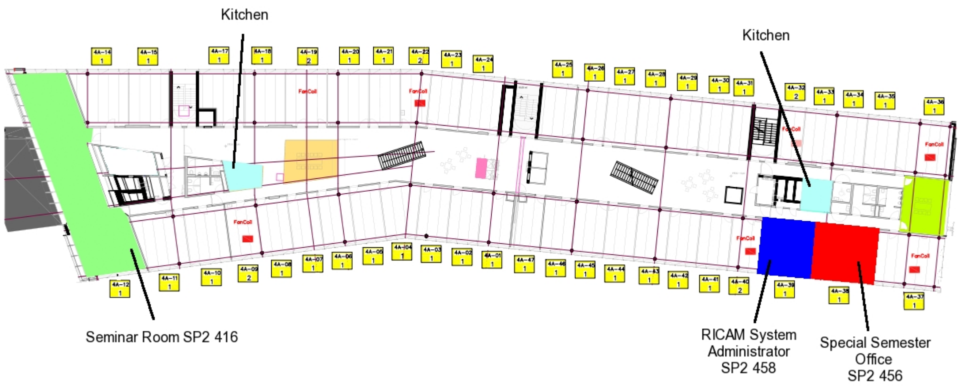


Figure 1: 4th floor of Science Park Building 2.

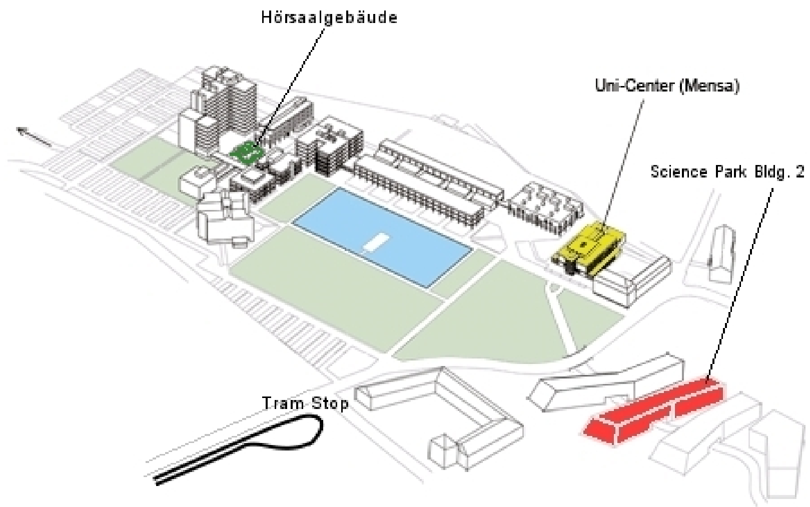


Figure 2: Campus plan

Figure 3: Overview map

Program

Monday, December 5th

08:00 - 08:50	Registration
08:50 - 09:00	Opening
09:00 - 09:50	Gabriel Lord (Heriot-Watt University) "*Numerical analysis for SDEs and SPDEs*"
09:50 - 10:00	Break
10:00 - 10:50	Gabriel Lord (Heriot-Watt University) "*Numerical analysis for SDEs and SPDEs*"
10:50 - 11:15	Coffee
11:15 - 12:05	Mireille Bossy (INRIA) "*Stochastic numerical methods for turbulence*"
12:05 - 14:00	Lunch Break
14:00 - 14:50	Gabriel Lord (Heriot-Watt University) "*Numerical analysis for SDEs and SPDEs*"
14:50 - 15:00	Break
15:00 - 15:50	Gabriel Lord (Heriot-Watt University) "*Numerical analysis for SDEs and SPDEs*"
15:50 - 16:15	Coffee
16:15 - 16:40	Tomasz Kosmala (King's college London) "*Variational Solutions to SPDEs Driven by Cylindrical Lévy Noise*"
16:40 - 16:50	Break
16:50 - 17:15	Ananta Kumar Majee (University of Tübingen) "*Rate of convergence of a semi-discrete finite volume scheme for stochastic balance laws driven by Lévy noise*"

Tuesday, December 6th

09:00 - 09:50	Stig Larsson (Chalmers University) "*Numerical methods for SPDEs*"
09:50 - 10:00	Break
10:00 - 10:50	Stig Larsson (Chalmers University) "*Numerical methods for SPDEs*"
10:50 - 11:15	Coffee
11:15 - 12:05	Mireille Bossy (INRIA) "*Stochastic numerical methods for turbulence*"
12:05 - 14:00	Lunch Break
14:00 - 14:50	Stig Larsson (Chalmers University) "*Numerical methods for SPDEs*"
14:50 - 15:00	Break
15:00 - 15:50	Stig Larsson (Chalmers University) "*Numerical methods for SPDEs*"
15:50 - 16:50	**Coffee & Poster Session**
16:50 - 17:15	Gaurav Dhariwal (University of York) "*Navier-Stokes equations with constrained L^2 energy of the solution*"

Wednesday, December 7th

09:00 - 09:50	Mireille Bossy (INRIA) "*Stochastic numerical methods for turbulence*"
09:50 - 10:00	Break
10:00 - 10:50	Mireille Bossy (INRIA) "*Stochastic numerical methods for turbulence*"
10:50 - 11:15	Coffee
11:15 - 12:05	Jacques Printems (Université Paris-Est Créteil) "*Numerics of dispersive Equations*"
12:05 - 14:00	Lunch Break
14:00 - 14:50	Andreas Prohl (Universität Tübingen) "*Stochastic Ferromagnetism*"
14:50 - 15:00	Break
15:00 - 15:50	Andreas Prohl (Universität Tübingen) "*Stochastic Ferromagnetism*"
15:50 - 16:15	Coffee
16:15 - 16:40	Andreas Thalhammer (Johannes Kepler University Linz) "*Mean-square stability analysis of SPDE approximations: Part 1*"
16:40 - 16:50	Break
16:50 - 17:15	Andreas Petersson (Chalmers University of Technology) "*Mean-square stability analysis of SPDE approximations: Part 2*"

Thursday, December 8th

09:00 - 09:50	Tony Lelievre (Ecole des Ponts ParisTech) "*SDEs in large dimension and numerical methodes*"
09:50 - 10:00	Break
10:00 - 10:50	Tony Lelievre (Ecole des Ponts ParisTech) "*SDEs in large dimension and numerical methodes*"
10:50 - 11:15	Coffee
11:15 - 12:05	Jacques Printems (Université Paris-Est Créteil) "*Numerics of dispersive Equations*"
12:05 - 14:00	Lunch Break
14:00 - 14:50	Andreas Prohl (Universität Tübingen) "*Landau-Lipschitz Equation: Analysis and Numerics*"
14:50 - 15:00	Break
15:00 - 15:50	Andreas Prohl (Universität Tübingen) "*Stochastic Landau-Lipschitz Equation: Analysis and Numerics*"
14:50 - 16:15	Coffee
16:15 - 16:40	Lassaad Michiri (University of Sfax) "*Practical stability for a class of stochastic partial differential equations*"
16:40 - 16:50	Break
16:50 - 17:15	Neelima (University of Edinburgh) "*Higher order moment estimates for SPDEs and a generalization of existence of solutions to SPDEs under local monotonicity*"

Friday, December 9th

09:00 - 09:50	Tony Lelievre (Ecole des Ponts ParisTech) “*SDEs in large dimension and numerical method II*”
09:50 - 10:00	Break
10:00 - 10:50	Tony Lelievre (Ecole des Ponts ParisTech) “*SDEs in large dimension and numerical method III*”
10:50 - 11:15	Coffee
11:15 - 12:05	Jacques Printems (Université Paris-Est Créteil) “*Numerics of dispersive Equations*”
12:05 - 12:15	Break
12:15 - 13:05	Jacques Printems (Université Paris-Est Créteil) “*Numerics of dispersive Equations*”
13:05	Closing

Abstracts for lectures

"*Stochastic Lagrangian Method*"
Mireille Bossy INRIA, France

Abstract

This course is devoted to Stochastic Lagrangian Method (SLM) in the framework of turbulence modeling.

This method, also none as the so-called Probability Distribution Function (PDF) method or fluid-particle method, is both a modeling and numerical tool introduced by physicists and engineers to simulate turbulence problems for complex flow. Adopting the statistical viewpoint of turbulence modeling, the random field solution of the Navier Stokes equation is replaced by a deterministic PDE, plus a closure law or equation on the momenta of the flow.

Most popular numerical methods for turbulence flows are based on Reynolds averaged Navier-Stokes (RANS) turbulence models and large eddy simulation (LES) approaches. The PDF method constitutes an interesting alternative, mostly developed for particle-laden flows.

In this course, we adopt a fully Stochastic Differential Equation (SDE) viewpoint to introduce the SLM approach, as a particular class of stochastic kinetic SDEs, describing the dynamic of a particle's position (X_t) and velocity (V_t) (and other attached physical quantities as temperature, concentration, ...)

The particularity of SLM resides in the fact that the dependency in the space variable x of the coefficients are expressed as a conditional expectation with respect to the event $\{X_t = x\}$. This singular McKean non linearity concerns both the drift and diffusion coefficients.

This course will be divided in four parts

1 Stochastic particle methods for McKean SDEs. As a soft introduction to PDF method, we will begin with a short review of particle methods for non linear McKean SDEs in connection with fluid mechanics.

2 Lagrangian viewpoint in turbulence modeling. We will pursue introducing the SLM approach, with an example of fully stochastic-particle solver applied to turbulent simulations in the atmospheric boundary layer.

3 Well posedness of SLM. Then we will review some aspects of well-posedness for SLM, that not only concerns the singular interacting kernel imposed by the conditional expectation form of the SDE coefficients, but also mass constraint, boundary condition and wall law component.

4 Numerical analysis for SLM type problem. Finally we will discuss the a priory error estimate problem, from time and space approximation of SLM type models.

"*Numerical methods for SPDE: strong and weak convergence analysis*"
Stig Larsson Department of Mathematical Sciences, Chalmers University of Technology and University of Gothenburg

Abstract

Picking up from the lectures of Gabriel Lord, I will present a survey of methods for proving strong convergence and weak convergence of numerical methods for the stochastic heat and wave equations. Strong convergence refers to convergence with respect to a norm, for example, mean square convergence. Proofs typically involve representation of the error using the semigroup theory or energy estimates and using the Ito isometry or the Burkhold–Davies–Gundy inequality. Weak convergence involves the error in some functional of the solution. Proofs may involve representation of the weak error in terms of the Kolmogorov equation and may use integration by parts from the Malliavin calculus.

"*SDEs in large dimension and numerical methods*"
Tony Lelievre Ecole des Ponts ParisTech

Abstract

The objective of these lectures is to introduce some numerical methods which are used to sample probability distributions and stochastic processes in large dimensions. These algorithms play a crucial role in various fields of applications (material science, chemistry, biology) where the matter is simulated at the atomistic level, using molecular dynamics. At the molecular level, the typical timescale is very small compared to the macroscopic timescale of interest. The practical counterpart of this timescale discrepancy is metastability, which refers to the fact that the stochastic processes of interest remain trapped for very long times in some metastable regions, before hopping to another metastable region. This is related to the fact that the equilibrium distribution of these processes (the Boltzmann-Gibbs distribution) is multimodal. Metastability makes the convergence of the stochastic process to equilibrium very slow, and transitions between metastable states are rare events. This is why dedicated algorithms have to be used to sample efficiently these objects. In order to improve and analyze the efficiency of the algorithms, it is thus important to give a precise mathematical description of metastability. In the first part of the lecture, we will describe sampling methods for multimodal distribution, and in particular adaptive biasing which can be analyzed using entropy techniques and logarithmic Sobolev inequalities. In the second part of the lecture, we will discuss the sampling of metastable trajectories, and their link with jump Markov processes. The central mathematical tool will be the quasi stationary distribution.

"*An Introduction to Numerical S(P)DEs*"
Gabriel Lord Heriot-Watt University, UK

Abstract

The aim is to introduce stochastic PDEs, their numerical approximation annd examine strong convergence. We will start by recalling briefly the PDEs/SDEs and their numerical approximation before we introduce SPDEs.

We will introduce a $Q-$Wiener process W, characterize it through and infinite sum and examine how to construct noise with different spatial regularity. We briefly discuss a cylindrical Winer process.

We introduce the infinite dimensional Ito stochastic integrals to final examine semilinear SPDEs. As an example we consider the stochastic heat equation in 1 and 2 dimensions to show that need to be careful about the notion of a solution.

We discuss in space discretization of the SPDE by finite differences, spectral Galerkin and Finite element method. In time we consider a semi-implict Euler Maruyama method along with an exponential based method. We sketch the main ideas to prove strong convergence.

"*Polynomial chaos expansion based numerical methods for nonlinear SPDEs. Study of a specific case*"
Jacques Printems Laboratoire d'Analyse et de Mathématiques Appliquées CNRS UMR 8050, Université Paris–Est, 61, avenue du Général de Gaulle, 94 010 Créteil, France

Abstract

This lectures will be devoted to the introduction of numerical discretization of nonlinear SPDEs using polynomial chaos expansion (PCE). We will try to introduce PCE methods through a unified framework by the mean of the Malliavin calculus. Then we will study more specifically the case of some stochastic nonlinear dispersive equations.

The plan of the lectures is detailed below:

1. Examples of equivalent representation of square integrable functionals of the Brownian motion.
   (a) Finite and infinite dimensional Brownian motion.
   (b) Stochastic Itô integral.
   (c) Iterated Wiener integrals.
   (d) Polynomial chaos expansion.
2. Bridges between these representation using Malliavin calculus
   (a) Malliavin derivative and first properties.
   (b) Higher order Malliavin derivative. Leibniz's formula. Strook's formula.
   (c) Chaos coefficients and Fourier transforms of Malliavin derivatives. Numerical consequences (Plancherel, application to quadratic non-linearities).
3. Numerical application to the stochastic Korteweg–de Vries equations.
   (a) Introduction to the stochastic KdV equations.

(b) Derivation of numerical PCE schemes using the Malliavin derivative.
(c) Numerical study of a particular scheme. Limits and solutions.

"*THE FORWARD-BACKWARD STOCHASTIC HEAT EQUATION: NUMERICAL ANALYSIS AND SIMULATION*"

Andreas Prohl Universität Tübingen

Abstract

I discuss the discretization of the the backward stochastic heat equation, and the forward-backward stochastic heat equation from stochastic optimal control. A full discretization based on finite elements, the implicit Euler method, and a least squares Monte-Carlo method, in combination with the new stochastic gradient method are then proposed, and simulation results are reported. - This is joint work with T. Dunst (U Tuebingen).

Abstracts for talks

"*Navier-Stokes equations with constrained L^2 energy of the solution*"
Gaurav Dhariwal University of York, UK

Abstract

We study deterministic and stochastic Navier-Stokes equations with a constraint on L^2 energy of the solution. We prove the existence and uniqueness of local strong solutions and the existence of a global solutions for the constrained 2D Navier-Stokes equations on the torus and on the whole Euclidean space. This is based on joint works with Zdzisław Bŕezniak (York) and Mauro Mariani (Roma I).

"*Variational Solutions to SPDEs Driven by Cylindrical Lévy Noise*"
Tomasz Kosmala Department of Mathematics, Kings College, London WC2R 2LS, United Kingdom

Abstract

In this talk we prove the existence of solution to an infinite dimensional evolution equation driven by a cylindrical Lévy process. For many decades cylindrical Wiener process has been used to model random perturbations of partial differential equations. Recently, the framework has been extended to cylindrical Lévy processes. The integral with respect to these generalised processes has been defined, which has made it possible to consider stochastic partial differential equations.

It is assumed that the coefficients in the equation are monotone and coercive and that the cylindrical Lévy process is square-integrable. The existence of a variational solution is proved in the Gelfand setting. The solution is constructed as a limit of the Galerkin approximation by projecting the equation onto n-dimensional subspaces, which enables us to use results from finite dimension. Consequently, this approximation can also be considered as a numerical scheme based on finite-dimensional driving noise. Our results cover a wide range of examples such as the heat equation and the porous medium equation.

"*Practical stability for a class of stochastic partial differential equations*"
Lassaad Mchiri University of Sfax, Faculty of Sciences of Sfax, Department of Mathematics, Tunisia

Abstract

In this talk we will show some sufficient conditions ensuring almost sure practical asymptotic stability with a non-exponential decay rate for solutions to stochastic evolution equations based on Lyapunov techniques.

"*Rate of convergence of a semi-discrete finite volume scheme for stochastic balance laws driven by Lévy noise*"
Ananta Kumar Majee Mathematisches Institut Universitt Tbingen Auf der Morgenstelle 10 D-72076 Tbingen Germany

Abstract

In this talk, we analyze a semi-discrete finite volume scheme for a stochastic balance laws driven by multiplicative Lévy noise. Using BV estimates of approximate solutions, generated by finite volume scheme, we show that approximate solutions converges to the unique BV entropy solution of the underlying problem. Moreover, we show that expected value of the L^1-difference between approximate solution and the unique entropy solution converges at rate $\mathcal{O}(\sqrt{\Delta x})$, where Δx being a spatial mesh size. This is a joint work with Ujjwal Koley and Guy Vallet.

"*Higher order moment estimates for SPDEs and a generalization of existence of solutions to SPDEs under local monotonicity*"
Neelima Neelima University of Edinburgh, UK

Abstract

We establish higher order moment estimates for solutions to nonlinear SPDEs by identifying the appropriate coercivity assumption. These are then used to prove existence of solutions to nonlinear SPDEs under local monotonicity conditions. Results in this direction by Röckner and Liu are generalized to allow derivatives in the operator acting on the solution under the stochastic integral. (jointly with D. Šiška).

"*Mean-square stability analysis of SPDE approximations: Part 1*"

Andreas Thalhammer Johannes Kepler University Linz, Altenberger Strae 69, A-4040 Linz

Abstract

In the first part, we examine the asymptotic mean-square stability properties of the zero solution of SPDE approximations. For this we consider fully discrete one-step approximation schemes applied to linear SPDEs with multiplicative noise driven by square-integrable martingales. Since the (standard) finite-dimensional approach to qualitatively analyse the stability properties of numerical approximations of SDEs is not suitable for fine spatial refinement levels due to the high computational cost, we develop tools that allow us to investigate the mean-square stability properties of the zero solution of the fully discrete scheme on an operator-valued level.

This is joint work with Annika Lang and Andreas Petersson.

"*Mean-square stability analysis of SPDE approximations: Part 2*"

Andreas Petersson Mathematical Sciences, Chalmers University of Technology, Chalmers Tvärgata 3, SE-412 96 Göteborg Lévy process

Abstract

In the next part, we assume that the driving noise is a Lévy process and apply the tools we have developed to Galerkin-type methods in space coupled with a number of one-step methods, namely the backward Euler, Crank-Nicolson, and the forward Euler methods as well as a Milstein method. This results in a series of sufficient conditions for the asymptotic mean-square stability of the zero solution of the SPDE approximations. We compare these to one another and derive sufficient conditions for the simultaneous stability of the zero solutions of the SPDE and its approximation when assuming that the driving noise is a Wiener process.

This is joint work with Annika Lang and Andreas Thalhammer.

Abstracts for posters

"*Weak Numeric to SDDE: The Error Analysis*"

Bahareh Akhtari Institut of Advanced Studies in Basic Sciences, Iran

Abstract

It's clear, stochastic delay differential equations (SDDEs) have a deeper insight through real phenomena because they impose the history of system to the models emphasising on dependence of its evolution on the past. In fact, this type of stochastic differential equations retaining the memory, which arising in a wide range of arenas including population dynamics, stochastic control, neuroscience, financial Mathematics and also engineering sciences, are more accurate models rather than stochastic differential equations without memory. There is no doubt that nominating efficient numerical schemes to approximate the exact solution of such equations or functional of that is of great significance in applied mathematics. In line with, a lot of various papers written that presenting numerical schemes in the category of strong convergence sense. however, some works have been made in the weak sense but not so much while in some application areas like financial mathematics, there exist some problems such as option pricing and risk management demanding the latter sense of convergence namely **Weak**. Our purpose in this poster is to introduce a new continous Euler-Maruyama scheme for the SDDEs with discrete delay on a non-equidistant partition, that is without any restriction on stepsize unlike the majority of previous works. This scheme is not only able to compute the solution at the mesh-grid points but also in throughout interval problem defined on that. In fact, we have a dense output method! In the sequel, another more important tip will be examined is to analysis the global error of the scheme based on separating the error into two parts: former is underlying scheme error and latter is the interpolation error. In the case of latter, the error terms are related to approximate the solution in the past of state. We take into account both two parts of global error and rate of convergence of them in two Theorems.

"*One-Dimensional Advection–Diffusion Equation with Boundary Lévy Noise*"

Lena-Susanne, Boltz Friedrich Schiller University Jena

Abstract

We are looking at solutions to the one-dimensional advection–diffusion equation on the half-line $\mathbb{R}_+$ with noise on the boundary. The noise, being the formal derivative $\dot{L}$ of a Lévy process L, models the random influx of contaminants into an aquifer. Using the semigroup approach we define mild solutions to this SPDE as processes with values in the fractional Sobolev space $H^\theta(\mathbb{R}_+)$ for some negative exponent θ. We then investigate how solutions of the stochastic advection-diffusion equation can be approximated by classical solutions to the random PDE, where L is replaced by its continuous approximation $\dot{L}^n$, and establish convergence in probability of the approximations for Lévy-driven Dirichlet and Neumann boundary condition in the non-standard M_1 Skorokhod topology.

"*Solution for stochastic advection-diffusion equations by using hybrid meshless method* "

Majid Darehmiraki Department of applied mathematics, Ferdowsi university of Mashhad, Mashhad, Iran

Abstract

With respect to meshless methods are powerful numerical tools that have been applied for solving many problems in mathematics and engineering, in this paper a numerical technique is proposed for solving the stochastic advection-diffusion equations. The presented meshless method is based on the linear combination of moving least squares (MLS) and local radial basis functions (LRBF) in the same compact support, this method will change between interpolation and approximation. The stochastic advection-diffusion equations are transformed into elliptic stochastic partial differential equations (SPDEs). Thereafter hybrid meshless method is used for solving it. In here, I will focus on the numerical solution of the stochastic advection-diffusion equations in one, two and three dimension. Illustrative examples are included to represent the validity and accuracy of the hybrid approach. Mean, variance and standard deviation are computed for presented examples.

"*Comparison of the order of convergence of some numerical methods based on Wong-Zakai approximation*"
Minoo Kamrani Department of Mathematics, Faculty of Sciences, Razi University, Kermanshah, Iran

Abstract

In this paper, some numerical methods based on Wong-Zakai approximation for the solution of stochastic differential equations will be introduced. Under the globally lipschitz condition on the drift and diffusion the convergence rate of the methods will be obtained and comparison of these orders with the orders of the methods without Wong-Zakai approximation is considered. The advantages of the proposed methods will be investigated and by some numerical examples the efficiency of the theoretical results of the paper will be illustrated.

"*ECG Inverse problem using the factorization method*"
Ronald MOUSSITOU Montanuniversität Leoben, Peter-Tunner-Straße 25-27, 8700 Leoben

Abstract

Solving an inverse problem consist on finding the causes of a phenomenon from its effects in a given situation. In ECG, it consists on determining the cause of the electrical potential generated on the surface of the torso. We want to connect the electrical activity of the heart from the potential it creates to the potential that has spread on the chest by conduction across the torso. This is a rapidly expanding area of research and has many important clinical applications (examples: help to clinicians in their diagnostic of cardiac arrhythmia, help to surgeons by giving them extra informations before the intervention). The purpose of this work is to present a new approach on solving ECG inverse problem. This approach is based on the embedding invariant: the factorization method of boundary values problems. The numerical applications will be done in the cylindrical case (2D) and spherical case (3D) and we will use anadromic scheme to solve the Riccati equations for the Dirichlet-Neumann and the Neumann-Dirichlet operators.

"*Optimal Relaxed Control of Stochastic Hereditary Evolution Equations with Lévy noise*"
Debopriya Mukherjee Indian institute of science education and research, India

Abstract

I would like to give a poster presentation on my recent work on existence theory of optimal relaxed control problem for a class of stochastic hereditary evolution equations driven by Lévy noise. We formulate the problem in the martingale sense of Stroock and Varadhan to establish existence of optimal controls.The construction of the solution is based on the classical Faedo-Galerkin approximation, the compactness method and the Jakubowski version of the Skorokhod Theorem for nonmetric spaces, and certain compactness properties of the class of Young measures on Suslin metrizable control sets. This is a combined work with Dr. Utpal Manna (Associate Professor, Indian Institute Of Science Education and Research, Thiruvananthapuram, Kerala) .

"*Time-discretization of stochastic Navier–Stokes equations by quasi-compressible methods*"
Tsiry Randrianasolo Montanuniversität Leoben, Austria

Abstract

A time-discretization of the stochastic incompressible Navier–Stokes problem by penalty method is analyzed. To treat the noise and the nonlinear term independently, we use the classical decomposition of the solution $\boldsymbol{u} = \boldsymbol{z} + \boldsymbol{v}$ of the problem where $\boldsymbol{z}$ solves an auxiliary stochastic Stokes equation and $\boldsymbol{v}$ solves a deterministic Navier–Stokes equations depending on the random coefficient $\boldsymbol{z}$. Both sub problems are still approximated with a numerical scheme based on penalty method. Error estimates for both of them are derived, combined, and eventually arrive at a convergence in probability with order $0 < \mathrm{r} < 1/2$ of the initial numerical scheme towards the initial problem on the variables velocity and pressure.

"*A Stochastic Competition Model with Multiplicative Noise*"
Karolina Weber TU Vienna, Wiedner Hauptstr. 8, 1040 Wien, room DA 03 E04

Abstract

We consider stochastic reaction-diffusion equations with a multiplicative noise term and analyse the influence of the Brownian Motion on the solution. Therefore, we use a variational approach to show the existence of solutions for a competition model for two species. Moreover, numerical simulations will be presented for the stochastic model and compared with the deterministic case.

List of Participants

Abouelella	Dina	Cairo University
Adeyemi	Oluwaseun Mathew	University of Ado-Ekiti, Nigeria
Akhtari	Bahareh	Institut of Advanced Studies in Basic Sciences Iran
Anjam	Immanuel	University of Duisburg-Essen
Aydogan	Burcu	Middle East Technical University
Bilitewski	Sonja	University of Duisburg-Essen
Biswas	Imran Habib	Tata Institute of Fundamental Research
Boltz	Lena-Susanne	Friedrich Schiller University Jena
Bonkhoff	Sarah-Lena	TU Graz
Bossy	Mireille	INRIA
Darehmiraki	Majid	Ferdowsi university of Mashhad, Iran
de Bouard	Anne	CNRS and Ecole Polytechnique
Dhariwal	Gaurav	University of York, UK
Fahim	Kistosil	Institut Teknologi Sepuleh Nopember
Fajar	Rifaldy	Yogyakarta State University
Gangl	Peter	JKU Linz
Georgiev	Ivan	RICAM
Goudenege	Ludovic	CNRS
Guglielmi	Roberto	RICAM
Hammami	Mohamed Ali	University of Sfax, Tunisia
Hausenblas	Erika	Montanuniversität Leoben
Jodlbauer	Daniel	JKU Linz
Kalise	Dante	Ricam
Kamrani	Minoo	Razi University Iran
Khaksar Ghalati	Maryam	Coimbra University
Kiyanpour	Mojtaba	Sharif University of Technology, Iran
Kok	Tayfun	Univresity of York, UK
Kosmala	Tomasz	King's college London, UK
Kumar	Chaman	University of Edinburgh, UK
Kumar Majee	Ananta	University of Tübingen, UK
Larsson	Stig	Chalmers University
Lelievre	Tony	Ecole des Ponts ParisTech
Leobacher	Gunther	JKU Linz
Li	Liang	Academy of Mathematicas and systems Science, China
Longoria	Genaro	TSSG Ireland
Lord	Gabriel	Heriot-Watt University
Matculevich	Svetlana	RICAM
Mchiri	Lassaad	University of Sfax, Tunisia
Moussitou	Ronald Reagan	Montanuniversität Leoben
Mukherjee	Debopriya	Indian institute of science education and research, India
Neelima	Neelima	University of University of Edinburgh, UK
Nesenenko	Sergiy	TU Berlin
Osterbrink	Frank	
Pani W.	Fernando	Montanuniversität Leoben
Pauly	Dirk	University Duisburg-Essen
Pepin	Bob	University of Luxembourg
Petersson	Andreas	Chalmers University of Technology, Sweden
Poncet	Romain	Ecole Polytechnique, CMAP
Printems	Jacques	Université Paris-Est Créteil
Randrianasolo	Tsiry Avisoa	Montanuniversität Leoben
Ranetbauer	Helene	RICAM
Razafimandimby	Paul	University of Pretoria
Schomburg	Michael	
Sebastian	Daniel	University of Duisburg-Essen
Shah	Maulik	Netherlands
Soos	Anna	Babes Bolyai University
Stiftner	Bernard	TU Wien

Szölgyenyi	Michaela	Vienna University of Economics and Business
Thalhammer	Andreas	JKU Linz
Tseng	Michael	École Polytechnique Fédérale de Lausanne
Utpal	Manna	Trivandrum
Vieth	Christian	University of Bielefeld
Wattson	Rodolfo	Costa Rica
Weber	Karolina	Vienna University of Technology, Austria
Wolfmayr	Monika	RICAM
Wrzosek	Monika	University of Gdańsk, Poland

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00-8:50	Registration				
8:50-9:00	Opening				
9:00-9:50	Gabriel Lord *"Numerical analysis for SDEs and SPDEs"*	Stig Larsson *"Numerical methods for SPDEs"*	Mireille Bossy *"Stochastic numerical methods for turbulence"*	Tony Lelievre *"SDEs in large dimension and numerical methodes"*	Tony Lelievre *"SDEs in large dimension and numerical methodes"*
	Break	*Break*	*Break*	*Break*	*Break*
10:00-10:50	Gabriel Lord *"Numerical analysis for SDEs and SPDEs"*	Stig Larsson *"Numerical methods fors SPDEs"*	Mireille Bossy *"Stochastic numerical methods for turbulence"*	Tony Lelievre *"SDEs in large dimension and numerical methodes"*	Tony Lelievre *"SDEs in large dimension and numerical methodes"*
	Coffee	*Coffee*	*Coffee*	*Coffee*	*Coffee*
11:15-12:05	Mireille Bossy *"Stochastic numerical methods for turbulence"*	Mireille Bossy *"Stochastic numerical methods for turbulence"*	Jacques Printems *"Numerics of dispersive Equations"*	Jacques Printems *"Numerics of dispersive Equations"*	Jacques Printems *"Numerics of dispersive Equations"*
					Break
12:15-13:05	*Lunch* *Break*	*Lunch* *Break*	*Lunch* *Break*	*Lunch* *Break*	Jacques Printems *"Numerics of dispersive Equations"*
14:00-14:50	Gabriel Lord *"Numerical analysis for SDEs and SPDEs"*	Stig Larsson *"Numerical methods for SPDEs"*	Andreas Prohl *"Stochastic Ferromagnetism"*	Andreas Prohl *"Stochastic Ferromagnetism"*	
	Break	*Break*	*Break*	*Break*	
15:00-15:50	Gabriel Lord *"Numerical analysis for SDEs and SPDEs"*	Stig Larsson *"Numerical methods for SPDEs"*	Andreas Prohl *"Stochastic Ferromagnetism"*	Andreas Prohl *"Stochastic Ferromagnetism"*	
	Coffee	*Coffee &* *Poster Session*	*Coffee*	*Coffee*	
16:15-16:40	Tomasz Kosmala *"Talk 1"*		Andreas Thalhammer *"Talk 5"*	Lassaad Michiri *"Talk 7"*	
	Break		*Break*	*Break*	
16:50-17:15	Ananta Kumar Majee *"Talk 2"*	Gaurav Dhariwal *"Talk 3"*	Andreas Petersson *"Talk 6"*	Neelima Neelima *"Talk 8"*	
17:25-17:50					

Each "Talk" is **20** minutes long. After the end of each "Talk", there are **5** minutes for discussion.