

**REPORT on**  
NASPDE09 : NUMERICAL ANALYSIS OF STOCHASTIC PDES 2009  
Organisers : Dr G J Lord (Principal Organiser) & Dr E Buckwar

1. We held the meeting in May 2009. This was a change from the proposed date of September 2009 as this avoided an accumulation of related meetings in August and September, e.g., SPDE09: Workshop on Stochastic Partial Differential Equations: Modelling, Analysis, and Approximation in Darmstadt, Germany, and the opening workshop of the 2009-10 Program on Stochastic Dynamics at SAMSI in North Carolina, USA. Further, there will be a Minisymposium session on 'Stochastic Differential Equations' at the Conference NUMDIFF-12 in Halle, Germany, in September.

2. The numerical solution of stochastic PDEs (SPDEs) is a very active area of research and is of both theoretical and practical interest. Quoting from the feedback summary of the participants: *The key future research direction in my field is exactly Numerics for SPDEs. and In connection with the solution of differential equations with random data I see the key future research directions in more effective and accurate methods under simpler and more realistic assumptions on the data. Furthermore the modeling problem seems to me to become more important.*

The topics of the talks thus covered a range of aspects of numerical analysis and applications of SPDEs. In particular there were talks treating different types of SPDEs, e.g., Allen-Cahn equation with additive noise, the stochastic wave equation and the stochastic Landau-Lifschitz equation, as well as random PDEs; different numerical schemes and convergence notions, e.g., exponential integrators, Itô-Taylor expansions or splitting schemes for Monte-Carlo methods or pathwise approximation; different types of application area, e.g., groundwater or multiphase flow, ferromagnetism and stochastic diffusive interfaces. The participants commented very favourably on the breadth of topics. The meeting was attended by 30 participants, established researchers from various backgrounds, as well as PhD students. The goals of the meeting were met and, quoting from the feedback form again: *By my opinion the academic value was very high, the researchers gave impressive talks about their very recent work.*

3. This two-day workshop was the third of a series of NASPDE meetings, the previous ones were held in 2007 in Manchester and in 2008 in Zürich. The focus of these meetings is on research concerning the development and analysis of numerical schemes and applications of stochastic partial differential equations. The meeting was attended by 30 participants, established researchers with different backgrounds as well as PhD students. It is planned to have the fourth meeting in 2010 at the TU Bergakademie Freiberg in Germany, organised by Hans-Jörg Starkloff and Oliver Ernst.

**Monday 11 May**

**Tony Shardlow** (University of Manchester) opened the workshop with a talk on pathwise error bounds for exponential integrator schemes to approximate a reaction diffusion equation with additive space-time forcing. **Omar Lakkis** (University of Sussex) addressed the numerical discretisation of the AllenCahn problem with an additive time-space white noise as a forcing term in one-dimensional space. Simulation results, based on a two-stage approximation process involving the regularisation of the white noise and an application of a finite element scheme, are related to theoretical results from the probabilistic analysis of

scaling limits with respect to a small interface thickness parameter and the noise intensity. **Istvan Gyöngy** (University of Edinburgh) presented accelerated finite difference schemes and an outline of the convergence theory for stochastic PDEs of parabolic type. The main idea is to use Richardson's method and the results are applied to numerical solutions of nonlinear filtering problems. Then, **Patrick Jenny** (ETH Zürich) discussed the stochastic modelling by a stochastic particle method (SPM) of non-equilibrium multi-phase flow linking the physics and dynamics at the pore scales to the macroscopic equations, which deal with average values. **Rob Scheichl** (University of Bath) spoke about a way to model the data uncertainty in a problem of safety assessment of radioactive waste disposal underground through stochastic modelling of the rock permeabilities leading to a random PDE for the groundwater flow. He presented computational challenges arising in the numerical solution of these kinds of random PDEs involving an approach using Monte Carlo type simulation and robust multi-level iterative techniques with energy minimising coarse spaces. **Wolfgang Nowak** (Institut für Wasserbau, University of Stuttgart) highlighted further challenges requiring advancement of stochastic modeling and numerical analysis tools for application problems, in particular problems from stochastic hydrogeology. Among these challenges are stochastic inverse modeling and Bayesian updating, optimal design of experiments and extreme value statistics. The final talk for this day was given by **Erika Hausenblas** (University of Salzburg) and focussed on the numerical approximation and weak convergence analysis of the leap frog method for the stochastic wave equation.

The poster session and reception after this last talk was well attended and later, the participants enjoyed the dinner at The Magnum Restaurant.

**Tuesday 12 May** The second day began with a talk by **Rachel Kuske** (University of British Columbia) concerned with the dynamical behaviour of another class of stochastic infinite dimensional dynamical systems, i.e., stochastic delay differential systems. Starting with a canonical model of machine tool dynamics, she discussed the effects of different noise sources in systems with delayed feedback, so that transients can dominate the long range behaviour. **Arnulf Jentzen** (Johann-Wolfgang-Goethe University, Frankfurt) presented Taylor expansions of the solution of a stochastic partial differential equation (SPDE) of evolutionary type derived via the semigroup approach and an appropriate recursion technique. Then **Nikolai Krylov** (University of Minnesota) spoke about results concerning the Itô and Itô-Wentzell formulas for distribution-valued processes and some related results on the stochastic Fubini theorem. The final talk of the workshop was given by **Zdzisław Brzezniak** (University of York). He discussed stochastic parabolic Landau-Lifschitz arising in problems of ferromagnetism, in particular existence and uniqueness of solutions and the Large Deviations principle.

Feedback from the participants was very positive about highlights and interaction amongst participants:

*Excellent organisation, covering all fields from fundamental theory to practical (engineering) applications.*

*I think that this workshop was very nice, with people of high scientific level. It was not a big conference, so we can talk a lot, with a good exchange of ideas.*

*Being an engineer that applied stochastic methods, I've had only little contacts to the international mathematical community on SPDEs. It was a great opportunity to meet and discuss with many of them at a time!*

*Some talks were very interesting as delivering background knowledge about related research areas, but also new ideas for my own scientific work were given.*

The administration and venue were commented on very positively as well:

*The workshop was very well organised, I found a fine and productive atmosphere at the ICMS in Edinburgh.*

### **Budget**

The total budget applied for was at £10,360, the budget has been managed by the ICMS.