Schedule and additional information for the Workshop

Advances in Nonlinear PDEs: Analysis, Numerics, Stochastics, Applications

02-03 June 2014, TU Wien & Uni Wien

The workshop is the kick-off meeting of the new *Vienna Center for Partial Differential Equations (Vienna PDE)*. This center is an initiative to bundle the excellence in PDE research in Vienna, to strengthen the Viennese PDE activities, and to provide a contact point for interdisciplinary projects involving PDEs in applications. The new doctoral school *Dissipation and Dispersion in nonlinear PDEs* is one of the cornerstones of the center.

The event shall provide an overview of recent progress in the mathematics of PDEs, in particular their interplay between analysis, numerical approximations, stochastic methods, and applications. The aim is to identify emerging research directions.

1 Schedule

Registration starts on 02 June 2014, 08:30–9:30h.

Location: Böcklsaal, first floor, TU Wien (see the maps at the end of the booklet).

Time	**Monday 02/06**	**Tuesday 03/06**
09:00–09:30	*Presentation**	
09:30–10:15	A. Mielke (Analysis)	G. Toscani (Stochastics)
10:20–10:50	*Coffee break*	*Coffee break*
10:50–11:35	Y. Maday (Numerics)	R. Klein (Applications)
11:40–12:25	I. Perugia (Numerics)	P. Maini (Applications)
12:30–14:30	*Lunch break*	*Lunch break*
14:30–15:15	M.-G. Mora (Applications)	E. Zuazua (Numerics)
15:20–15:50	*Coffee break*	*Coffee break*
15:50–16:35	E. Carlen (Stochastics)	L. Saint-Raymond (Analysis)
16:40–17:25	D. Bakry (Stochastics)	A. Constantin (Analysis)
19:00-22:00	*Workshop dinner*	

**Presentation of the Vienna Center for Partial Differential Equations:*

S. Seidler (Rector of TU Wien)

H. Engl (Rector of Uni Wien)

A. Jüngel (Speaker of Vienna PDE)

2 Keynote Lectures

Dominique Bakry (University Paul Sabatier, Toulouse, France)
Some examples of diffusion processes where spectral computations are explicit

Spectral decomposition is a powerful tool to analyse heat kernels. However, it is a rarely explicit. I shall propose families of examples, arising from Lie groups or orthogonal polynomials, where those computations may be effective. They may serve as models for testing various properties concerning convergence to equilibrium or other properties.

Eric Carlen (Rutgers University, New Jersey, USA)
Stochastic evolution and Gibbs measures for the focusing 1D non-linear Schrödinger equation

The 1D focusing non-linear Schrödinger equation has well-defined canonical and grand-canonical Gibbs measures. We study infinite diemension diffusion processes with a current velocity that comes from the Hamiltonian flow, and osmotic velocity generated by the invatiant measure and study the rate of relaxation to equilibrium for these flows. We also study analyticity properties of the partition functions. This is joint work with Joel Lebowitz and Jürg Fröhlich.

Adrian Constantin (King's College London, University of Vienna)
Particle trajectories beneath irrotational travelling water waves

The description of the particle paths within water over a flat bed, as a regular wave pattern propagates on the water's free surface, is a basic problem in hydrodynamics, more than 200 years old. We will describe some recent mathematical results that enable an in-depth qualitative study of this problem, offering new and surprising insights.

Rupert Klein (Freie Universität Berlin, Germany)
Internal wave dynamics in the atmosphere

Internal gravity waves in the atmosphere contribute to a broad spectrum of processes that are of importance for short time weather as well as climate evolution. Covering a huge range of length and time scales, they pose a number of challenges to mathematical analysis and numerical simulation.

In this presentation I will highlight how motions in the troposphere can be understood as a three-scale asymptotic problem involving advection, internal waves, and sound waves. Sound waves have negligible amplitudes in general as far as weather phenomena are concerned, so a valid question concerns reduced dynamical models that approximate the full compressible dynamics well, but do not support sound waves by design. Some semi-

heuristically motivated soundproof flow models are being used frequently in meteorology, in particular the so-called ”anelastic” and ”pseudo-incompressible” models. I will discuss how a detailed understanding of the intricate dispersion properties of internal and sound modes is a prerequisite for rigorously proving or disproving the validity of these existing models, and will report on current progress in this direction.

Yvon Maday (Université Pierre et Marie Curie, Paris, France)
Numerical analysis of some problems in electronic structures calculation

The field of computational chemistry is booming. While so far, very few collaborations exist between quantum chemists and mathematicians (in any case much less in this area than in the context of computational fluid mechanics or structures), things are changing rapidly and the interactions between the two communities grow significantly, each community understanding what the other can provide. The purpose of this talk is to present mathematical models and some work on the a priori and a posteriori analysis for discretization of ab initio models like Hartree-Fock or Kohn-Sham. Recent results on a posteriori analysis identify the contributions to the error of the various ingredients involved in the approximation of a solution: (i) approximation of the model (Schrödinger versus Hartree-Fock or density functional); (ii) due to approximation of the space and the discretization method - variational or not (with the inclusion of many nonlinearities); (iii) of the algorithm for solving the discrete system (always recursive and converging but where the limit is never reached in practice), to discern areas for improvement to increase the accuracy of calculations.

Work done in collaboration with E. Cancès, R. Chakir, G. Dusson, L. He, B. Stamm, M. Vohralik.

Philip Maini (University of Oxford, UK)
Modelling collective cell migration in biology

There are many examples of collective cell migration in biology: cells can move in a coordinated manner as sheets of tissue; they can move as individuals responding to chemical cues; they can move in high density waves. In this talk we will consider examples of each of these, with applications in early development and in cancer. We will consider three different mathematical modelling frameworks, each chosen appropriately for the particular example. We will show that all of these models, in their simplest form, reduce to the common coarse-grained framework of a reaction-diffusion system, where the nonlinear diffusion coefficient at the coarse-grained level incorporates the modelling assumptions at the microscopic level.

Alexander Mielke (WIAS Berlin, Germany) Gradient structures and dissipation distances for reaction-diffusion systems

We discuss reaction-diffusion systems with reactions satisfying mass-action kinetics and the

detailed-balance condition. They allow for a gradient structure where the dissipation potential is the sum of a Wasserstein part for diffusion and a reaction part. We also show that in a simple case the induced dissipation distance, called Hellinger-Kantorovich distance, can be characterized explicitly.

Maria Giovana Mora (University of Pavia, Italy)
Quasistatic evolution problems in plasticity

Elastoplastic processes play an important role in many engineering applications. In this talk I will focus on the quasistatic evolution problem for elastoplastic materials in the framework of the variational theory for rate-independent processes. In this approach elastoplastic evolution is seen as a time-parameterized set of minimization problems for the sum of the elastic energy and of a dissipated energy. I will review some recent results based on this approach and discuss some open questions.

Ilaria Perugia (University of Vienna, Austria)
Discontinuous Galerkin methods and what they can do for you

Finite elements are a powerful, flexible, and robust class of methods for the numerical approximation of solutions to partial differential equations. In their standard version, they are based on piecewise polynomial functions on a partition of the domain of interest. Continuity requirements are possibly dictated by the regularity of the exact solutions. Over the last years, new methods which break the constraints of the classic finite element paradigm have been developed. In this talk, we will focus on the case of discontinuous Galerkin methods. Being based on completely discontinuous approximating spaces, they allow flexibility in the mesh design, and provide a general setting where stabilization mechanisms can be naturally incorporated and some properties of the continuous problem (e.g., mass conservation, positivity of solutions) can be preserved in the numerical solution. In addition to that, they can easily accommodate non polynomial basis functions. This facilitate the use of operator-adapted approximating spaces in order to improve the accuracy vs. computational cost with respect to standard polynomial-based finite element methods. Applications of these strategies will be discussed.

Laure Saint-Raymond (ENS Paris, France)
Dynamics of hard spheres gases

According to the observation scale, the dynamics of a gas can be described by different models, for instance as a system of particles at the atomistic level, or by fluid models at thermodynamic equilibrium. We will study the transition between these different regimes, using the Boltzmann equation as an intermediate level of description.

Giuseppe Toscani (University of Pavia, Italy)
Entropies and nonlinear diffusion equations

In recent years, entropies (Lyapunov functionals) have proven to be a very useful tool for the study of the asymptotic behavior of nonlinear diffusion equations. This feature is mainly due to their monotonicity properties when evaluated on the solution of these equations. However, the connections between nonlinear diffusion equations and entropies are more deep. Not only entropies can be used to obtain results on the large-time behavior of the solution to nonlinear diffusions, but, on the reverse, nonlinear diffusions allow to obtain a number of results for entropies, in the form of inequalities in sharp form. In this lecture, we focus our attention on Renyi entropies, which are mainly popular in the framework of information theory. In particular, we outline the relationships between Renyi entropies and the nonlinear diffusion equations, by showing in details the most important consequences. These results have been partially obtained in collaboration with Jose Antonio Carrillo (Imperial College, London), and Giuseppe Savare (University of Pavia).

Enrique Zuazua (BCAM, Bilbao, Spain)
Flow control in the presence of shocks

In this talk we present some joint work in collaboration with C. Castro (UPM, Madrid), R. Lecaros (CMM- Chile) and F. Palacios (Stanford) on flow control. We address a classical optimal control problem of inverse design, aiming to identify the initial source leading to a desired final configuration.

First, in the one-dimensional case, we explain why classical strategies, based on l inearization methods, fail, because of the lack of regularity of solutions. We then introduce an alternating descent method that exploits the generalized gradients that take into account the sensitivity of the smooth arcs of the solutions but also of shock locations. We compare the performance of the method with classical purely discrete strategies through various numerical experiments. We also address the multi-dimensional case and point towards perspectives of future development.

3 Poster

Winfried Auzinger (TU Wien), Thomas Kassebacher (Innsbruck), Othmar Koch (TU Wien), Mechthild Thalhammer (Innsbruck, Austria):
Parameter dependent convergence of exponential operator splitting methods for cubic Schrödinger equations in the semiclassical regime

Lukas Einkemmer, Alexander Ostermann (Innsbruck, Austria):
Analysis of a discontinuous Galerkin/Strang splitting scheme for Vlasov equations

Marko Erceg (Zagreb, Croatia):
Localisation principle for 1-scale H-measures

Bandhisattambige Pani Fernando, Erika Hausenblas (Leoben, Austria)
Nonlinear filtering with pure jump noise and a financial application

Marin Mašur (Zagreb, Croatia):
Recent results on H-distributions

Paul Razafimandimby, Erika Hausenblas (Leoben, Austria):
Stochastic nonparabolic dissipative systems modeling the flow of liquid crystals

Leila Taghizadeh (TU Wien), Chris Budd (Bath, UK), Othmar Koch (TU Wien), and Ewa Weinmüller (TU Wien):
Time and space adaptive numerical integration of nonlinear evolution equations

4 Practical Information

From the airport to the Hotel Johann Strauss

There are three ways to go by public transport from the airport to the hotel:

- *(Preferred way)* Take the local train (Schnellbahn, two zones, 4,20 Euro one way, every 30 min., travel time: 24 min.), leave the train at Wien Mitte (Landstraße), and take the subway U4 in the direction of Hütteldorf (included in ticket price), exit two stops later at Karlsplatz, take the subway U1 in the direction of Reumannplatz and leave one stop later at Taubstummengasse. Walk the Favoritenstraße until Favoritenstraße 12 where your hotel is located.
- Take the City Airport Train (17 Euro return ticket, every 30 min., travel time: 16 min.), leave the train at Wien Mitte (Landstraße), and take the subway U4 in the direction of Hütteldorf (ticket: Einzelfahrschein, 2,10 Euro), exit two stops later at Karlsplatz, take the subway U1 in the direction of Reumannplatz and leave one stop later at Taubstummengasse. Walk the Favoritenstraße until Favoritenstraße 12 where your hotel is located.
- Take the bus (Vienna Airport Line, about 13 Euro return ticket, every 30 min., travel time: 20 min.), leave at Schwedenplatz, take the subway U1 in the direction of Reumannplatz and leave 3 stops later at Taubstummengasse. Walk the Favoritenstr. until Favoritenstr. 12 where your hotel is located.

Hotel

Hotel Johann Strauss
Address: Favoritenstraße 51, 1040 Wien
Tel.: +43/1/505 76 24
Fax: +43/1/505 76 28
e-mail: js@kremslehnerhotels.at
http://www.kremslehnerhotels.at/de/hotel-johann-strauss-wien

Lecture room

Böcklsaal, first floor, TU Wien main building, Karlsplatz 13, 1040 Wien (see location plans below).

Internet connection

You will be able to use wireless internet connections at TU Wien. The networks *tunet* and *eduroam* are available.

To use *tunet*, please use an open authentification, deactivate data encryption, and automatic IP address and DNS server. You can login by opening any homepage; you will be directed to the page *Captive Portal* at which you can login using your personal user name and password written on the separate leaflet.

To use *eduroam*, you need to have an account set up at your home institution. Then you can simply login using the same credentials (username and password) that you would use at your home institution.

Food

Sandwiches and fingerfood will be provided for lunch close to the lecture room. At 7:00 pm, 02 June, there will be a workshop dinner at Kleiner Festsaal, Uni Wien, Universitätsring 1, 1010 Wien. The lunches and workshop dinner are complimentary.

For other or additional food options, see below.

Three cafeterias (Mensa Markt, Marktcafé and Cafe Schrödinger) are located in the Freihaus building close to the TU main building where the workshop is held.

On the first floor in the yellow aisle you find the Mensa Markt and the Marktcafé. The latter is open from 9.00 to 16.00. Breakfast, cold and warm beverages, pastry and snacks are served. The Mensa Markt is open from 11.00 to 14.30. You also may choose a menu. A non-alcoholic beverage is included in the menu. Or you can have a choice of soups, vegetables, grilled meat, a salad buffet, and a pastry buffet. Café Schrödinger: Opening hours from 8.00 to 19.00. You find it on the ground floor in the green aisle of the Freihaus.

In the vicinity of the Vienna University of Technology, there are quite a few bistros and small restaurants ranging from the typical Viennese to the exotic. Most of them are situated on the Naschmarkt, a few minutes walk to the west of the Freihaus building down Faulmanngasse.

- Gastwirtschaft am Rilkeplatz: Rilkeplatz 9, simple dishes
- Yamo-Yamo: Favoritenstrasse 2, Japanese type and Thai food (vegetarian options)
- Kebabhaus: Faulmanngasse 1, a variety of Turkish food.
- Chang Asian Duck: Rienößlgasse 1, gourmet Chinese food (vegetarian options)
- There are many restaurants around Schleifmühlgasse and Naschmarkt.

A list with restaurants in the vicinity of the TU Wien can be found at
http://www.fam.tuwien.ac.at/contact/restaurants.pdf.