Programme of the WIAS-workshop

From particle systems to differential equations

Berlin, February 21–23, 2012

	Tuesday, Feb. 21	**Wednesday, Feb. 22**	**Thursday, Feb. 23**
09:00–10:30	M. Pulvirenti	S. Olla	M. Pulvirenti
	c o f f e e		
11:00–12:30	S. Olla	M. Pulvirenti	S. Olla
	l u n c h		
14:00–15:00	M. Herrmann	W. de Roeck	
15:00–15:45	A. Mielke	W. Wagner	
	c o f f e e		
16:30–17:30	M. Renger	R. Patterson	
17:30–18:30	**wine & cheese**	C. Landim	

Minicourses:

Stefano Olla (CEREMADE, Paris)

From microscopic dynamics to thermodynamics: a “classical“ approach through hydrodynamic limits

Abstract: Thermodynamic transformations (isothermal, adiabatic, etc) are obtained as the evolution in a large space-time scale of the corresponding conserved quantities. I will examine this point of view in a one dimensional system controlled by temperature and tension. In this model some scaling limit can be proven rigorously through the theory of hydrodynamic limits.

- A crash course on Thermodynamics and Statistical mechanics.
- Carnot Cycles: adiabatic and isothermal transformations through hydrodynamic limits.
- Heat diffusion

Mario Pulvirenti (Università di Roma “La Sapienza“)

From Hamiltonian particle systems to kinetic equations

Abstract: In these lectures I shall try to explain the various scaling limits by means of which the most relevant kinetic equations, like the Boltzmann or the Landau equations, are expected to be derived starting from a large Hamiltonian particle system. We discuss the few rigorous results available until now and many challenging open problems.

Talks:

Michael Herrmann (Universität des Saarlandes)

Effective dynamics of many-particle systems with dynamical constraint

Abstract: Recently, the thermodynamics group at WIAS proposed a class of Fokker–Plack equations to model the hysteric behaviour of many-particle storage systems. These equations involve two small parameters and are non-autonomous and nonlocal due to a time-dependent constraint. In this talk we consider different small-parameter regimes and derive, by means of formal asymptotic analysis, reduced models for the limit dynamics. In particular, in the “fast reaction regime“ we modify Kramers' formula for large deviations to obtain a rate-independent limit equation. There is also a “slow reaction regime“, in which the limit dynamics is governed by a singular two-particles model.
(Joint work with Barbara Niethammer and Juan Velazquez.)

Alexander Mielke (WIAS Berlin)

Gradient structures and discrete Markov chain models for reaction-diffusion systems

Abstract: We consider reaction-diffusion systems that have the form of gradient flows with respect to a relative entropy. Similarly, we discuss reversible Markov chains as gradient flows with respect to the relative entropy. Our aim is to highlight certain connections between the two classes and to address open questions:

(i) How do nonlinear reaction-diffusion systems arise as limits of discrete Markow chain models? For the pure reaction kinetics the limit of the chemical master equations is well known, but how can this be combined with spatial structures?

(ii) Can the limit be done on the level of gradient systems using suitable energy-dissipation formulations (involving optimal transport)?

Michiel Renger (Eindhoven University of Technology)

From particle systems to differential equations. A particle systems method to derive Wasserstein gradient flow structures

Abstract:
The statistical mechanics programme has provided us with a deep understanding of the connection between stochastic particle systems at the microscopic level and thermodynamics on the macroscopic level. The discovery that diffusion is a Wasserstein gradient flow of entropy can potentially extend this knowledge to the non-equilibrium case. In the first part of my talk, I will discuss some recent results that connect this Wasserstein gradient flow formulation to a system of independent Brownian particles. In the second part, I will discuss how this connection can be used as a general method for deriving natural gradient flow structures for more complex diffusion processses. More specifically, I will discuss the case of diffusion in a force field, diffusion with internal decay and diffusion with decay at a boundary.

Wojciech de Roeck (Universität Heidelberg)

From Hamiltonian dynamics to stochastic dynamics

Abstract: My aim is to present a (non-exhaustive) overview of some classical problems and results in mathematical physics; namely how and when do dissipative evolution equations emerge from the underlying, time-reversible, Hamiltonian dynamics. A typical example is: particles in contact with a wave field (or free quantum field). Depending on the precise model, this can lead to a discrete jump process, transport equations like the Boltzmann equation, diffusion, friction, Cerenkov radiation, localization. I will most likely center on this example and I will try to stress basic concepts, rather than technical details.

Wolfgang Wagner (WIAS Berlin)

Coagulation equations and particle systems

Abstract: A coagulation equation describes the time evolution of the average size distribution of particles that merge during collisions. These equations have a wide range of applications, e.g., in polymer physics, combustion theory (soot formation), and meteorology (aerosol transport).
The talk is concerned with connections between stochastic coagulation models and corresponding deterministic equations. In particular, a phase transition due to the formation of big particles (gelation) is discussed. This phenomenon is related to a non-conservation property (mass loss) in the kinetic equation and to the explosion property (accumulation of infinitely many jumps on a finite time interval) in a certain stochastic coagulation model.

Robert Patterson (WIAS Berlin)

Convergence of simulable processes for coagulation with transport

Abstract: Systems of particles that appear and are transported in a laminar flow while undergoing coagulation as a result of random collisions will be introduced in a form suitable for computer simulation. The systems are all defined on a bounded interval and particles routinely leave the system as a result of the flow, which takes the problem outside the domain of existing results. Existing theory does however enable the construction of martingales from the generators of the particle processes. These martingales provide the starting point for proving relative compactness and for characterising the limit points as weak solutions to a reaction–advection equation with a Smoluchowski source term. This justifies the simulation of the particle systems as a numerical method for solving the non-linear Smoluchowski reaction–advection problem.

Claudio Landim (IMPA, Rio de Janeiro)

A thermodynamical theory for nonequilibrium systems

Abstract: We present “physical theory“ for a certain class of thermodynamic systems out of equilibrium, which is founded on and supported by the analysis of a large family of stochastic microscopic models.
We first describe nonequilibrium stationary states (NSS) under the action of weak external fields. We examine then the situation in which a stationary states is driven to another stationary state by varying the external parameters on the macroscopic time scale.

All those interested are welcome!

Wolfgang Dreyer Alexander Mielke Wolfgang König