Participant	Title	Abstract
Giuliano Benenti	Increasing thermoelectric efficiency: Dynamical models unveil microscopic mechanisms	Dynamical nonlinear systems provide a new approach to the old problem of increasing the efficiency of thermoelectric machines. In this talk I will discuss stylized classical and quantum models, including the disordered hard-point gas and one-dimensional (interacting) quantum electron systems. The main focus will be on the physical mechanisms, unveiled by these dynamical models, which lead to high thermoelectric efficiency approaching the Carnot limit and to high efficiency at maximum power.
Sergey Bezrukov	Entropic potentials in one-dimensional transport description	In many problems of practical and theoretical interest, motion of Brownian particles is spatially constrained. When diffusion occurs in quasi one-dimensional structures, it is intuitively appealing to introduce an effective one-dimensional description, where the spatial constraints are partially accounted for by entropy potentials. The entropic contribution arises naturally if one considers one-dimensional distribution of non-interacting point particles. In equilibrium, the effect of entropic contribution is not different from that of the other components of the potential of mean force. However, under non-equilibrium conditions corresponding to transport of particles that interact with each other or with an applied external force, the situation can be different. In this talk we analyze, both analytically and by Brownian dynamics simulations, several examples of the effective one-dimensional description. In case of a right truncated cone expanding in the left-to-right direction, we show how the fluxes depend on the geometric parameters of the channel and on the particle concentrations. For non-interacting particles the flux is direction-independent in the sense that inversion of the concentration difference leads to the inversion of the direction of the flux without changing its magnitude. This symmetry is broken for repelling particles: the flux in the left-to-right direction exceeds its right-to-left counterpart.
Jesús Casado-Pascual	Effect of a high-frequency magnetic field on the resonant behavior displayed by a spin-$1/2$ particle under the influence of a rotating magnetic field.	In this paper, we investigate the role of a high-frequency magnetic field in the resonant behavior displayed by a spin-$1/2$ particle under the influence of a rotating magnetic field. We propose two alternative methods for analyzing the system dynamics, namely, the averaging method and the multiple scale method. The analytical results achieved by applying these two methods are compared with those obtained from the numerical solution of the Schr\"odinger equation. This comparison leads to the conclusion that the multiple scale method provides a better understanding of the system dynamics than the averaging method. In particular, the averaging method predicts the complete destruction of the resonant behavior by an appropriate choice of the parameter values of the high-frequency magnetic field. This conclusion is disproved both by the numerical results, and also by the results obtained from the multiple scale method.
Cristiane de Morais Smith	Artificial staggered magnetic field for ultracold atoms in optical lattices	Uniform magnetic fields are ubiquitous in nature, but this is not the case for staggered magnetic fields. In this talk, I will discuss an experimental set-up recently proposed by us [1], which allows for the realization of a "staggered gauge field" in a 2D optical lattice loaded with cold atoms. If the lattice is loaded with bosons, the effective Hamiltonian of the system is a Bose-Hubbard one, with complex and anisotropic hopping coefficients. A very rich phase diagram emerges from the model: besides the usual Mott-insulator and zero-momentum condensate, a new phase with a finite momentum condensate becomes the ground-state at high-rotation [2]. By using the technique of Feshbach resonance, it is possible to realize bosonic molecules and observe a coherent superposition of a vortex-carrying atomic condensate and a conventional zero-momentum molecular condensate [3]. On the other hand, if the lattice is loaded with fermions, the system allows us to emulate graphene under uniaxial pressure [4]. When the system is loaded with a mixture of bosons and two-species fermions, several features of the high-Tc phase diagram can be reproduced. Starting from a DDW phase, with a staggered pi-flux traversing each plaquette, unconventional superconductivity with features of the RVB state is obtained for a certain range of parameters. Even more interestingly, the complexity of the normal phase surrounding the superconducting dome emerges naturally in this system, and the evolution from a non-Fermi liquid to a Fermi-liquid behavior with increasing doping can be naturally understood. The evolution of the Fermi-surface upon doping also shows that CDW and SDW instabilities could easily occur, due to nesting [5]. Finally, I will discuss a completely different set-up, which allows for the realization of an ffective staggered Zeeman fieldfor fermions in a 2D optical lattice [6]. The resulting band structure is quite exotic; fermions in the third band have an unusual rounded picture-frame Fermi surface (essentially two concentric squircles), leading to imperfect nesting. We develop a generalized SO(3,1) SO(3,1) theory describing the spin and charge degrees of freedom simultaneously, and show that the system can develop a coupled spin-charge-density wave order. [1] A. Hemmerich and C. Morais Smith, Phys. Rev. Lett. 99, 113002 (2007). [2] Lih-King Lim, A. Hemmerich, and C. Morais Smith, Phys. Rev. Lett. 100, 130402 (2008). [3] Lih-King Lim, T. Troppenz, and C. Morais Smith, arXiv:1009.1471. [4] Lih-King Lim, A. Hemmerich, and C. Morais Smith, Phys. Rev. A 81, 023404 (2010). [5] Lih-King Lim, A. Lazarides, A. Hemmerich, and C. Morais Smith, EPL 88, 36001 (2009) and Phys. Rev. A 82, 013616 (2010). [6] D. Makogon, I. B. Spielman, and C. Morais Smith, arXiv: 1007.0782.
Thomas Dittrich	Directed transport in a ratchet with internal and chemical freedoms	We consider mechanisms of directed transport in a ratchet model intended to account for the physical essentials of motor molecules but remaining on a level of abstraction that allows for analysis beyond biophysical detail. It comprises, besides the external freedom where transport occurs, a chemical freedom replacing the familiar external driving and an internal freedom representing a functional mode of a motor molecule. The dependence of the current on various parameters is is studied in numerical simulations. As a main conclusion, we point out and provide evidence that the internal freedom could play the role of a buffer between energy input and output of mechanical work, allowing a temporary accumulation and storage of injected energy. In this way, it can contribute to the efficiency of current generation.
Werner Ebeling	Shotnoise models and efficiency of ATP-driven nano-scale machines operating under far-from-equilibrium conditions	We consider ATP-driven nano-scale machines operating under far-from-equilibrium conditions which are able to do machanical work against an external force or momentum on the cost of ATP-energy inflow into a depot. Efficiency is defined as the relation of the the mechanical work to the input of chemical energy. The input of ATP-energy is at first modelled as a continuous flow and then - more realistic - as as shot noise considering the supply as energy quanta arriving at Poisson distributed times. We consider simple models of linear climbing motors, rotating motors and stepper motors. We calculate the efficiency - analytically and numerically - in dependence on the external load and the parameters of the noise. The effienecy shows typically - as demonstrated also in several experiments and other theoretical studies - a maximum for intermediate strength of the external load force or momentum. The dependence on noise parameters, which is more complex is studied for several examples. Coauthors: A. Fisasconaro, E. Gudowska-Nowak, Yu.M. Romanovsky, M. Zabicki. References: Fiasconaro et al. Eur.Phys.J.B 65, 403 (2008) Fiasconaro et al. JSTAT/2009/P01029 Bödeker,H.U. at al.,Eur.Phys.Lett.90, 28005 (2010) Zabicki, M. et al., J. Chem. Phys 7975 (2010)
Sergej Flach	The weak password problem: Chaos, criticality and encrypted p-CAPTCHAs	
Thomas Franosch	Persistent memory for a Brownian walker in a random array of obstacles	
Hans Frauenfelder	Noise is essential for proteins.	Biomolecules must move in order to work. Fluctuations in the hydration shell and the environment are essential for the function. Input from the physics of glasses, supercooled liquids, and polymers is helpful. At the same time, proteins may feed back with new knowledge.
Igor Goychuk	Viscoelasticity, dispersive kinetics and anomalous diffusion	I will discuss anomalous kinetic and diffusion processes within the Generalized Langevin Equation (GLE) description typified by a viscoelastic power-law memory kernel and a fractional Gaussian noise source related by the fluctuation-dissipation relation and featured by an ultraslow power-law relaxation in harmonic potentials. Approximating the power-law memory

kernel by a sum of exponentials obeying a fractal scaling it will be shown that such a profoundly non-Markovian GLE dynamics can be nicely approximated by a multi-dimensional Markovian dynamics of a finite embedding dimension sufficient to describe anomalously slow diffusion in nonlinear force fields on practically any experimentally observed time scale [1]. The proposed Markovian embedding scheme allows also for a simple and insightful physical interpretation. In the case of bistable transitions it leads to the physical picture of fluctuating non-Markovian rates, combining static and dynamical rate disorder and yielding dispersive non-exponential kinetics even if the activation energy barrier can many times exceed the thermal energy. Strikingly enough, in spite of ultraslow intra-well relaxation there are many fast escape events. The corresponding dispersive kinetics has a stretched-exponential tail and the non-Markovian rate theory [2] is shown to describe the most probable logarithm of the residence times [1]. Moreover, it is confirmed to work excellently in the limit of very high barriers, when the rate disorder gradually diminishes and the normal rate description is restored. Furthermore, viscoelastic subdiffusion is shown to be asymptotically not sensitive to the presence of a periodic potential and asymptotically ergodic [1]. However, the transient to this asymptotical regime can be extremally slow which leads to a possibility of non-adiabatically driven subdiffusive ratchets with unusual properties [3].

[1] I. Goychuk, Phys. Rev. E 80, 046125 (2009).
[2] P. Hanggi, P. Talkner, and M. Borkovec, Rev. Mod. Phys. 62, 251 (1990).
[3] I. Goychuk, Chem. Phys. 375, 450 (2010).

Milena Grifoni

Quantum spin-orbit ratchets

We discuss mechanisms to obtain a pure spin-current, i.e., a directed spin current withouth charge current, in dissipative periodic structures with spin-orbit interaction subject to an unbiased time-dependent field.
We also demonstrate that in the presence of electric and magnetic driving the coexistence of quantum dissipation with the spin flip processes induced by spin-orbit interactions can yield a charge current even for inversion symmetric periodic potentials.

Frank Großmann

Semiclassics plus noise: A trajectory approach to dissipation in quantum mechanics

Using the stochastic, wavefunction-based approach to the Feynman-Vernon influence functional developed by Stockburger and Grabert, we investigate two different scenarios:

1) The thermalization of an anharmonic oscillator in a bath with Ohmic spectral density [1]
2) Tunneling of a particle through an Eckart barrier in the presence of a heat bath [2]

In the first case we will use the Herman-Kluk propagator for the propagation of the wavefunction and in the second case the BOMCA approach developed by the Tannor group.

[1] W. Koch, F. Grossmann, J. T. Stockburger and J. Ankerhold, Phys. Rev. Lett. 100, 230402 (2008)

[2] W. Koch, F. Grossmann, and D. J. Tannor, Phys. Rev. Lett. 105 (2010)

Frank Jülicher

The stochastic dance of helical swimmers

Many eucaryotic cells possess motile cilia to propel their swimming motion. We discuss the role of chirality of the ciliar structure for helical swimming motion. Microswimmers driven by chiral beating patterns can be steered reliably in a chemical concentration field using a simple and general mechanism. We discuss the principles underlying reliable steering of helical micro-swimmers towards a target. This mechanism of chemotaxis permits sperm to find the egg by following a chemoattractant gradient secreted by the egg. Signaling noise due to stochastic arrival of chemoattractant molecules leads at low concentrations to fluctuations in the swimming path that can be described by stochastic differential geometry.

Peter Jung

How Nerves get into Shape

Nature has endowed dendritic and axonal trees with a huge variety of shapes and morphologies, reflecting the diversity of their function. Morphology is important as, for example, the speed of an action potential depends on the caliber of the axon. Yet, we are only beginning to understand the mechanisms by which an axon acquires its shape during development.
In this presentation I will give a review on the axonal cytoskeleton and slow axonal transport, i.e. the mechanism by which neurofilaments, the main structural elements of the axon, are transported along the axon. I will give a brief account of the main experimental techniques, their strengths and weaknesses, and how mathematical modeling has become a useful tool to complement experimentation. Our central hypothesis is that neurofilament kinetics and modulation thereof regulates axonal morphology. Mathematical modeling starts at the level of single neurofilaments and their measured kinetics and can predict local neurofilament content and axonal caliber which in turn can be measured. Specifically, I will address the relation between neurofilament kinetics and content in the mouse optic nerve and the effects of myelination on axon caliber.

Sigmund Kohler

Graphene ratchets

The ratchet effect, i.e., the induction of a dc current by an ac force in the absence of any net bias, represents one of the most intriguing phenomena in non-equilibrium transport. In graphene, one expects that the gapless and chiral nature of this material negatively affects ratchet effects, because it hinders the confinement of electrons. Despite this expectation, a ratchet mechanism that is particularly efficient in graphene exists: It is based on the promotion of electrons in evanescent modes to propagating modes, provided that they enter the barrier from one particular side. Electrons entering from the other side, by contrast, fade away before they reach the driving region. The efficiency stems from the fact that within a certain energy range, all evanescent modes contribute. The corresponding mechanism in a two-dimensional electron gas works only with modes that fulfill certain resonance conditions, which leads to a much smaller current.

Jörg Kotthaus

Self-oscillation in nanoelectro- and nanooptomechanical systems

The sensitive interaction of nanomechanical resonators with electrical and optical fields can be utilized to induce nanomechanical self-oscillations without a periodic external driving field. Different routes will be discussed how such self-oscillations can be triggered and sustained out of thermal or mechanical fluctuations.

Baowen Li

Creating heat current from zero thermal bias

Heiner Linke

An approach to an artificial protein motor

I will describe an ongoing, experimental effort to design and construct a synthetic molecular protein motor designed to move along a synthetic DNA track, the Tumbleweed [1]. This motor will move unidirectionally by rectified thermal fluctuations, and it will be powered by temporal changes in chemical potential. The experimental approach will be described, and the focus will be on modeling efforts to identify the optimal motor design. We use a combination of Langevin Dynamics, Molecular Dynamics and Master Equations [2], to estimate the flexibility of motor parts based on molecular structure, and to identify optimal design details including the role of stiffness and non-specific binding to the motor's DNA track. Finally, we study the interplay of relevant time scales for optimal motor performance (speed, processivity, load force tolerance).

1) B. Bromley, N. Kuwada, M. Zuckermann, R. Donadini, L. Samii, G. Blab, G. Gemmen, B. Lopez, P. Curmi, N. R. Forde, D. N. Woolfson, and H. Linke, The Tumbleweed: Towards a synthetic protein motor. HFSP J. 3, 204 (2009).
2) N. Kuwada, G. Blab, and H. Linke, A Master equation approach to modeling an articial protein motor arxiv.org/abs/1004.1114. accepted by J. Chem. Phys. (2010).

Stefan Linz

Modeling global and local avalanching of granular matter

In spite of two decades of intensive research, the theoretical description and understanding of avalanching processes of granular matter and, more specifically, of granular surface flow along heaps and inclines still constitute a major challenge. In this contribution, we generalize a previous approach based on a minimal model for global avalanches [1] in two directions:

First, using an appropriate stochastic extension [2] of the model for global avalanches [1] that incorporates static and dynamic fluctuations,
we present a unifying description for the global surface flow along heap and in rotated drums that reproduces recent thorough experimental findings in surprising detail.

Second, we present and analyze a cellular automaton model for granular surface flow including local avalanches and its corresponding continuum approximation [3]. The modeling approach takes advantage of the global model [1] for granular avalanching and is based on the intuitive idea that such flows arise from successive excitations of small-scale avalanches. Also here, we show that many essential experimental results for global and local avalanching can be recovered.

[1] S.J. Linz, P. Hänggi, Phys. Rev. E 51, 2538-2542 (1995)

[2] D. Sandbrink, S.J. Linz, in preparation

[3] A. Hoffmann, S.J. Linz, Physica D 239, 2025–2038 (2010)

Jerzy Luczka	Interaction-induced negative mobility in a systems of two overdamped Brownian particles	
Jose L. Mateos	Experimental Control of Transport in a Deterministic Optical Ratchet	I will present results of an experiment with a deterministic optical rocking ratchet. A periodic and asymmetric light pattern is created to manipulate a suspension of dielectric microparticles in water. The sample is moved with respect to the pattern with an unbiased time-periodic function that tilts the optical potential in alternating opposite directions. We obtain a current of particles whose direction depends on the particle size and that can be controlled at will in real time.
Volkhard May	Quantum transport in nanohybrid systems	
Manuel Morillo-Buzon	Noise effects on collective variables of finite arrays driven by time-periodic forces	The equilibrium properties of finite chains of coupled noisy bistable units and their response to time periodic forces will be discussed. Different types of couplings will be considered. I will focus on the study of a collective variable and its emerging properties. The possibility of a reduced description of the collective dynamics by a one-dimensional Langevin equation will be explored. For the types of chains considered, both the power spectral amplification and the signal-to-noise ratio of the collective variable are analyzed as the noise strength, the coupling parameter and the number of bistable units in the system are varied. Compared with the effects observed in single unit systems, the collective variable shows a strong enhancement of the stochastic resonance effects.
Roland Netz	DNA dynamics and the measurement problem in protein force spectroscopy	- The local dynamics of DNA is scale dependent and exhibits elastic effects, hydrodynamic interactions and center-of-mass dynamics as one goes from smaller to larger scales. A dynamic mean-field approach is validated by hydrodynamic simulations and quantitatively compare with recent fluorescence-correlation spectroscopy data. Problems in experimental data are discerned. - In modern single-molecule force-spectroscopic studies of RNA or protein unfolding, DNA functions as a stochastic force-transducer. Extracting folding landscapes and transition rates requires a novel dynamic deconvolution approach. The dynamic response functions of DNA needed for this are supplied by theory.
Abraham Nitzan	Unidirectional hopping transport of interacting particles on a finite chain	Coauthors: Mario Einax, Gemma Salomon and Wolfgang Dieterich Particle transport through an open, discrete 1-D channel against a mechanical or chemical bias is analyzed within a master equation approach. The channel, externally driven by time dependent site energies, allows multiple occupation due to the coupling to reservoirs. Performance criteria and optimization of active transport in a two-site channel are discussed as a function of reservoir chemical potentials, the load potential, interparticle interaction strength, driving mode and driving period. Our results, derived from exact rate equations, are used in addition to test a previously developed time-dependent density functional theory, suggesting a wider applicability of that method in investigations of many particle systems far from equilibrium.
Gloria Platero	Topology and phase: Two ways to control the coherent dynamics of electrons	
Eli Pollak	Stochastic theory of atom surface scattering	
Klaus Richter	Quantum universality and its breakdown in ergodic mesoscopic systems	Electric transport properties of complex mesoscopic systems are determined by the presence of few symmetries only, most notably time-reversal symmetry. This character of universality is believed to be independent of the source of scattering in the system, and to exist in both ballistic chaotic quantum dots or diffusive disordered conductors under the sole assumption that scattering generates complete ergodicity. Several recent works have further suggested that spin transport in mesoscopic systems with spin-orbit interaction also displays universal behavior similar to electric transport. The above universality conjecture for charge and spin transport is based on predictions and assumptions from random matrix theory (RMT). In this talk I will consider different cases where RMT universality breaks down even if the underlying dynamics is ergodic. In particular I will show that subtle geometric correlations render the average spin conductance finite, in contrast to its vanishing RMT value. We will see that the direction of the spin porization is governed by the direction of average charge flow. Moreover the size of the spin conductance crucially depends on the number of terminals of the mesoscopic conductor. I will first show how RMT univerality of obervables at mesoscopic scales can be deduced within a semiclassical path integral approach, invoking classical trajectory correlations as a key element. I will then demonstrate how these semiclassical tools are used to go beyond random matrix theory and to explain the above mentioned features in spin transport.
Miguel Rubi	Thermodynamics and stochastic dynamics of transport in confined media	We show how a probabilistic interpretation of non-equilibrium thermodynamics can be used to analyze the stochastic dynamics of entropy driven diffusion processes characterized by the presence of entropic barriers. This approach sets up a systematic method to study the effect of confinement on the transport properties, providing a derivation of a generalized Fick–Jacobs equation for the constrained dynamics of the mesoscopic degrees of freedom. It is shown that confinement originates an entropic bias which gives rise to a geometric rectification of non-equilibrium fluctuations and that entropic effects in transport can be controlled by means of the application of an external force.
Keiji Saito	Additivity principle in high-dimensional harmonic lattices	We consider heat transfer across disordered harmonic lattice, which is connected to two heat baths at different temperatures. Harmonic crystals in three dimensions are known to exhibit different regimes of transport such as ballistic, anomalous and diffusive. We investigate universal current fluctuation in these three regimes. We first derive a formula of cumulant generating function (CGF) of heat transfer, which satisfies Gallavotti-Cohen fluctuation symmetry. Using recursive Green function method, we numerically consider properties of CGF, and discuss so-called additivity principle.
Lutz Schimansky-Geier	Fluctuations in Models of Self-Propelled Particles	The dynamics of particles with fluctuating velocity and orientation in two spatial dimensions is analyzed. The difference between passive (e.g. thermal fluctuations) and active fluctuations which emerge in active systems far from equilibrium as for example living organisms or chemically driven colloids is outlined. Analytical expressions for the speed and velocity distributions for generic models of (active) Brownian particles are derived. The presence of active fluctuations already for simple Stokes friction results in speed and velocity distributions which differ from the classical Maxwell distribution. Active Gaussian fluctuations lead to speed distributions with a many probability concentrated at small or vanishing speeds . Finally it is shown that such a behavior may also occur in non-Gaussian active fluctuations.
Wolfgang Schleich	Focusing without a lens	
Udo Seifert	Stochastic thermodynamics	
Igor Sokolov	Particles in confining potentials under Levy noise: Old and new results	
Michael Thorwart	Competition between relaxation and external driving in the dissipative Landau-Zener problem	Landau Zener transitions in a dissipative environment reveal an interesting nontrivial dynamical competition between relaxation processes and the external sweep. Numerically exact results are presented which can be explained in terms of a simple physical picture. In the limits of large and small sweep velocities and low temperatures, our results coincide with existing analytical predictions for the Landau-Zener transition probability. For small sweep velocities and medium to high temperatures, however, we find nonmonotonic dependencies on the sweep velocity, temperature, coupling strength, and cutoff frequency, which are not captured by perturbative approaches. In addition to the Landau-Zener transition probability, we also address the excitation survival probability and provide as well a qualitative understanding of the involved competition of time scales.

		[1] P. Nalbach and M. Thorwart, Phys. Rev. Lett. 103, 220401 (2009). [2] P. Nalbach and M. Thorwart, Chem. Phys. 375, 234 (2010).
Christian Van den Broeck	The efficiency of small machines	
Thomas Wellens	Efficient and coherent excitation transfer across disordered molecular networks	We show that finite-size, disordered molecular networks can mediate highly efficient, coherent excitation transfer which is robust against ambient dephasing and associated with strong multi-site entanglement. Such optimal, random molecular conformations may explain efficient energy transfer in the photosynthetic FMO complex. We investigate the properties of optimal configurations with respect to different measures of the transport efficiency, and examine under what conditions transport is increased or decreased by adding noise.
Sophia Yaliraki	Multiscale dynamics of biomolecular networks	