A model of Voronoi volume fluctuations predicts the random close packing of anisotropic particles

Baule, Adrian
(Queen Mary University of London, School of Mathematical Sciences, London, United Kingdom)

Finding the densest random packing of particles with a non-spherical shape is a long standing mathematical problem. In particular, random packings of anisotropic particles can reach higher packing fractions than spheres, which reach maximally 64% volume fraction. In this talk I present a theory based on a model of Voronoi volume fluctuations, which can predict densest random packings in good agreement with empirical data.

Breaking of central limit theorem in non-equilibrium systems: a few examples

Bertin, Eric
(CNRS, ENS Lyon, Laboratoire de Physique, Lyon, France)

The breaking of the central limit theorem (CLT) and of the law of large numbers (LLN) is well-known to play an important role in aging dynamics. I this talk, I wish to discuss further examples of breaking of CLT and LLN for other types of non-equilibrium systems, namely driven dissipative systems, and models that can be described by a matrix product ansatz like some boundary driven systems.

Moment equations for the stochastic analysis of chemical and biological networks

Biham, Ofer
(The Hebrew University, Racah Institute of Physics, Physics, Jerusalem, Israel)

Complex reaction networks are common in physical, chemical and biological systems. In many cases, the reactive species are confined to a small volume, in which the copy number of each species is low. Relevant examples include biochemical networks in cells and reactions on dust grains in the interstellar medium. In these systems the reaction rates are often dominated by fluctuations and cannot be evaluated by the mean-field approach of rate equations. Stochastic methods such as the direct integration of the master equation or Monte Carlo simulations are needed. However, the number of microscopic states (and the number of equations) increases exponentially with the complexity of the network. This makes the stochastic simulations infeasible for complex networks. We have recently developed a method for the derivation of moment equations for a given stochastic network. The method provides a dramatic reduction in the number of equations and enables efficient stochastic simulations of complex reaction networks. The resulting moment equations form a closed set for the first few moments, with a suitable closure condition. Applications of the moment equations will be shown and their advantages and limitations in comparison with Monte Carlo simulations will be discussed.

Condensation in the totally asymmetric Inclusion process

Cao, Jiarui
(The University of Warwick, Mathematics Institute, Mathematics, Coventry, United Kingdom)

The inclusion process is an interacting particle system where particles perform independent random walks with a diffusion rate d in addition to an 'inclusion' effect. The rates for inclusion jumps are proportional to the product of the occupation numbers on departure and target site. In the limit of vanishing diffusion rate a condensation phenomenon occurs where all particles concentrate on a single site in a typical stationary configuration. We focus on the totally asymmetric one-dimensional case with nearest neighbor jumps. Our aim is to analyze the dynamics of the condensate's emergence in the thermodynamic limit with fixed average particle density. The whole time evolution can be divided into four regimes, nucleation, coarsening, saturation and stationarity. We describe each of them heuristically, with a particular emphasis on the power law behaviour in the coarsening regime.

This is a joint work with Paul Chleboun and Stefan Grosskinsky.

Rate of mutual information between coarse-grained non-Markovian variables

Cardoso Barato, Andre
(Universität Stuttgart, II. Institut für Theoretische Physik, Stuttgart, Germany)

The problem of calculating the rate of mutual information between two coarse-grained variables that together specify a continuous time Markov process is addressed. As a main obstacle, the coarse-grained variables are in general non-Markovian, therefore, an expression for their Shannon entropy rates in terms of the stationary probability distribution is not known. A numerical method to estimate the Shannon entropy rate of continuous time hidden-Markov processes from a single time series is developed. With this method the rate of mutual information can be determined numerically. Moreover, an analytical upper bound on the rate of mutual information is calculated for a class of Markov processes for which the transition rates have a bipartite character. Our general results are illustrated with explicit calculations for four-state networks.

Anomalous dynamics in polymer systems

Carlon, Enrico
(KU Leuven, Theoretical Physics, Physics and Astronomy, Leuven, Belgium)

In this talk I will review some recent results concerning the dynamics of polymers. The models studied range from more abstract lattice polymers to coarse-grained models of DNA in the continuum. The dynamical properties of some conformational transitions as the DNA hairpin formation or the unwinding will be discussed. These systems are characterized by an anomalous scaling of the characteristic times as a function of the polymer length. In some cases this dynamics can be understood using a phenomenological Langevin equation describing the evolution of a 1d reaction coordinate. The connection with experiments will also be highlighted.

Chaos in the HMF model

Chaté, Hugues
(CEA - Saclay, Gif-sur-Yvette, France)

Heat Flux and Entropy Produced by Thermal Fluctuations

Ciliberto, Sergio
(ENSL and CNRS, Laboratoire de Physique, Lyon, France)

We report an experimental and theoretical analysis of the energy exchanged between two conductors kept at different temperature and coupled by the electric thermal noise. Experimentally we determine, as functions of the temperature difference, the heat flux, the out-of-equilibrium variance, and a conservation law for the fluctuating entropy, which we justify theoretically. The system is ruled by the same equations as two Brownian particles kept at different temperatures and coupled by an elastic force. Our results set strong constraints on the energy exchanged between coupled nanosystems held at different temperatures

Universal current fluctuations in non equilibrium systems

Derrida, Bernard
(Laboratoire de Physique Statistique, ENS, Paris, France)

Current fluctuations of the current of one dimensional non equilibrium diffusive systems are well understood. After a short review of these one dimensional results, the talk will try to show that the statistics of fluctuations are exactly the same in higher dimension, for arbitrary geometries.

This result can be understood by a microscopic symmetry in the symmetric exclusion process, and by finding a mapping between the variational problem in finite dimension and in one dimension.

Strategy switches and co-action equilibria in a minority game

Dhar, Deepak
(Tata Institute of Fundamental Research, Tata Institute of Fundamental Research, Department of Theoretical Physics, Mumbai, India)

I will discuss an analytically tractable variation of the minority game in which rational agents use probabilistic strategies. In our model, N agents choose between two alternatives repeatedly, and those who are in the minority get a payoff 1, others zero. The agents optimize the expectation value of their discounted future payoff, the discount parameter being $lambda$. The optimal choice of probabilities of different actions are determined exactly in terms of simple self -consistent equations. The optimal strategy is characterized by N real parameters, which are non-analytic functions of $lambda$. This is an example of a far from equilibrium system whose steady state shows `phase transitions' a even for a finite number of agents. The solution for $N leq 7$ is worked out explicitly.

The overdamped limit for the Brownian motion with multiplicative noise

Durang, Xavier
(Korean Institute for Advanced Study, Seoul, Korea, Republic of)

We revisit the problem of the overdamped limit of the Brownian dynamics with space-dependent friction coefficient and noise in one dimension. By integrating out the momentum variable from the Kramers equation, in the large friction limit, the corresponding Fokker-Planck equation is derived analytically. Our result is fully consistent with the previous finding by Sancho, San Miguel, and Dürr, but the derivation procedure is simple and transparent. We also show that the overdamped limit is equivalent to the mass-zero limit in general. Our results are confirmed by numerical simulations for a few simple examples.

Speed selection in coupled Fisher waves

Evans, Martin
(University of Edinburgh, Insitute for Condensed Matter and Complex Systems, School of Physics, Edinburgh, United Kingdom)

The Fisher equation describes the spread of a
population or the spread of an advantageous gene through a population.
It is well known as a simple nonlinear equation which exhibits travelling wave solutions. A selection mechanism for the speed of these waves has been established some time ago.
We consider two coupled Fisher equations representing two populations
e.g. sub-populations of bacteria which are susceptible
or resistant to antibiotic. We show that a subtle coupling between two
population waves gives rise to a novel velocity selection mechanism.

Microtubule Length Regulation by Molecular Motors

Frey, Erwin
(LMU, Physics, München, Germany)

Microtubules (MTs) are highly dynamic cytoskeletal filaments, which continually assemble and disassemble through the addition and removal of tubulin heterodimers at their ends. These processes are known to be regulated by MT associated proteins acting as polymerases and depolymerases. Recent in-vitro experiments have shown that the plus-end-directed motor kinesin-8 regulates MT depolymerization in a length-dependent way [1]. These observations pointed towards a highly interesting correlation between depolymerization dynamics and molecular traffic along MTs. However, the molecular mechanisms behind these correlations were difficult to determine by in-vitro experiments. To reveal these mechanisms we constructed an individual-based model for the regulation of MT dynamics by end-directed motors which act as depolymerases [2,3]. The model is firmly based on well-established molecular properties of motor proteins from the kinesin-8 family, and fully validated by reproducing the experimental findings by Varga and collaborators. It combines motor traffic along MTs with depolymerisation kinetics mediated by kinesin-8 motors, and gives new conceptual insights in the regulatory mechanisms for MT depolymerization. In particular, we have identified crowding of motors on MTs as a key regulatory mechanism, and quantitatively predicted the depolymerization speed and the end-residence time of depolymerases as a function of their bulk concentration and biochemical rates, all of which are amenable to experimental tests. These results should help to obtain deeper insights in the microscopic mechanisms underlying length-regulation.

[1] V. Varga et al., Cell 138, 1174 (2009)
[2] L. Reese, A. Melbinger, E. Frey, Biophys J 101, 2190 (2011)
[3] A. Melbinger, L. Reese, E. Frey, Phys Rev Lett 108, 258104 (2012)

The fluctuations of order parameters in symmetry breaking phenomena

Gaspard, Pierre
(Université Libre de Bruxelles (U.L.B.), Centre for Nonlinear Phenomena and Complex Systems, Department of Physics, B-1050 Brussels, Belgium)

Symmetry breaking happens for instance in ferromagnetic materials at equilibrium in an external magnetic field. In small systems, the magnetization would mostly fluctuate around the direction of the external field. This phenomenon can be characterized by general relationships between the probabilities of opposite fluctuations for the magnetization.

Out of equilibrium, similar relationships are known as fluctuation relations. Such a relation has been obtained in particular for the fluctuating currents flowing through small open systems in contact with reservoirs. Here, the time-reversal symmetry is broken by the stationary probability distributions describing nonequilibrium steady states. In this case, the analogue of the order parameters are the currents and the role of the external field is played by the affinities or thermodynamic forces driving the system out of equilibrium and given by the differences of chemical potentials or inverse temperatures between the reservoirs. The fluctuation relation for the currents has fundamental consequences on the thermodynamic and response properties of small open systems. Several applications of these results will be presented.

References:

D. Andrieux and P. Gaspard, Fluctuation theorem for transport in mesoscopic systems, J. Stat. Mech. (2006) P01011.

D. Andrieux and P. Gaspard, A fluctuation theorem for currents and non-linear response coefficients, J. Stat. Mech. (2007) P02006.

D. Andrieux, P. Gaspard, T. Monnai, and S. Tasaki, The fluctuation theorem for currents in open quantum systems, New J. Phys. 11 (2009) 043014.

P. Gaspard, Fluctuation relations for equilibrium states with broken discrete symmetries, J. Stat. Mech. (2012) P08021.

P. Gaspard, Time-reversal symmetry relations for fluctuating currents in nonequilibrium systems, Acta Physica Polonica B 44 (2013) 815.

Fundamental diagrams for non-Markovian TASEPs

Grosskinsky, Stefan
(University of Warwick, Mathematics, Coventry, United Kingdom)

We study non-Markovian versions of the totally asymmetric exclusion process (TASEP), and observe that non-exponential waiting time distributions with reduced variation coefficient lead to 'synchronized' motion of the particles with enhanced currents and correlated steady states. We give heuristic derivations of related fundamental diagrams and exact results in certain limiting cases, which agree well with numerical results.
This is joint work with Diana Khoromskaia and Rosemary Harris.

Nonequilibrium first-order phase transitions in the Kuramoto model in presence of inertia and noise

Gupta, Shamik
(Laboratoire de Physique Théorique et Modèles Statistiques, Université de Paris-Sud, Paris, France)

The Kuramoto model of coupled nonlinear oscillators serves as a prototype to study spontaneous collective synchronization among constituents occurring in many biological and physical systems, e.g., yeast cell suspensions, cardiac pacemaker cell network, flashing fireflies, superconducting Josephson junction arrays, etc. The original model involves overdamped motion of globally coupled oscillators of distributed natural frequencies, while we study the model by including inertial terms and thermal noise in the dynamics. Inertial terms, for example, account for electrical capacitance of Josephson junction arrays, while thermal noise models the inevitable interaction with the environment. For unimodal frequency distributions, we study the dynamics in a reduced parameter space involving dimensionless mass, temperature, and width of the frequency distribution. We show that the dynamics exhibits a nonequilibrium first-order transition from a synchronized phase at low parameter values to an unsynchronized phase at high values. In proper limits, we recover the known continuous phase transitions in the Kuramoto model and in its noisy extension, and an equilibrium continuous transition in a related model of long-range interactions. By interpreting the model as a system of particles interacting through long-range potential and driven out of equilibrium by quenched external forces, we suggest how one may adopt a statistical physics perspective to study the dynamics, different from the existing dynamical systems perspective. Our theoretical predictions are compared with extensive numerical simulations.

Entropy production in systems with continuous degrees of freedom

Hinrichsen, Haye
(University of Würzburg, Institute for Theoretical Physics and Astronomy, Würzburg, Germany)

tba

Emergent motion of condensates in the accelerated exclusion process and other mass-transport models

Hirschberg, Ori
(Weizmann Institute of Science, Physics of Complex Systems, Rehovot, Israel)

Recently, it was shown that spatial correlations may have a drastic effect on the dynamics of real-space condensates in driven mass-transport systems: in models with a spatially correlated steady state, the condensate is quite generically found to drift with a non-vanishing velocity. In the first part of the talk I will discuss the mechanism underlying this condensate drift. I will then focus on the accelerate exclusion process (AEP), a generalization of the TASEP which was recently introduced as a model for cooperative effects in the transport of ribosomes along RNA molecules. Using a mean-field approach suitable for the study of systems with correlations, I will present the phase diagram of the AEP and discuss condensate dynamics in the model.

Boosting work characteristics and overall heat engine performance via accelerated

adiabatic control: quantum and classical

Hänggi, Peter
(Universität Augsburg, Dept. of Physics, Theoretical Physics I, Augsburg, Germany)

The idea of accelerating quantum adiabatic processes with a control field
is extended to classical adiabatic processes under a general framework,
providing an important guide towards designing and understanding accelerated adiabatic processes.
We then study the distribution function of the work done on a small system initially prepared at thermal equilibrium.
It is found that the work fluctuations can be significantly reduced by use of accelerated adiabatic processes.
For example, in the classical case probabilities of having very large or almost zero work values are largely suppressed.

In the quantum case negative work may be totally removed from the otherwise
non-positive-definite work values. We also apply our findings to a micro Otto-cycle-based heat engine.
It is shown that the use of accelerated adiabatic processes, which directly enhance the engine output power, can
at the same time also increase the heat engine efficiency substantially, in both quantum and classical regimes [1].

[1] <http://arxiv.org/find/quant-ph/1/au:+Deng_J/0/1/0/all/0/1>Jiawen Deng, <http://arxiv.org/find/quant-ph/1/au:+Wang_Q/0/1/0/all/0/1>Qing-hai Wang, <http://arxiv.org/find/quant-ph/1/au:+Liu_Z/0/1/0/all/0/1>Zhihao Liu, <http://arxiv.org/find/quant-ph/1/au:+Hanggi_P/0/1/0/all/0/1>Peter Hänggi, <http://arxiv.org/find/quant-ph/1/au:+Gong_J/0/1/0/all/0/1>Jiangbin Gong, <http://arxiv.org/abs/1307.4182>arXiv:1307.4182

Non-differentiable large deviation functionals

Kafri, Yariv
(Technion - Israel Institute of Technology, Physics, Haifa, Israel)

Exact MPA state of the XXZ open quantum chain

Karevski, Dragi
(Université de Lorraine, Institut Jean Lamour, Physics, Vandoeuvre les Nancy, France)

We demonstrate that the exact nonequilibrium steady state of the one-dimensional Heisenberg XXZ spin chain driven by boundary Lindblad operators can be constructed explicitly with a matrix product ansatz for the nonequilibrium density matrix where the matrices satisfy a quadratic algebra. This algebra turns out to be related to the quantum algebra Uq[SU(2)]. Coherent state techniques are introduced for the exact solution of the isotropic Heisenberg chain with and without quantum boundary fields and Lindblad terms that correspond to two different completely polarized boundary states. We show that this boundary twist leads to nonvanishing stationary currents of all spin components. Our results suggest that the matrix product ansatz can be extended to more general quantum systems kept far from equilibrium by Lindblad boundary terms.

Anomalous fluctuation relations

Klages, Rainer
(Queen Mary University of London, School of Mathematical Sciences, London, United Kingdom)

We study Fluctuation Relations (FRs) for Gaussian stochastic systems that are anomalous, in the sense that the diffusive properties strongly deviate from the ones of Brownian motion. For this purpose we use a Langevin approach: We first briefly review the concept of transient work FRs for simple Langevin dynamics generating normal diffusion [1]. We then consider two different types of additive, power law correlated Gaussian noise [2,3]: (1) internal noise with a fluctuation-dissipation relation of the second type (FDR2), and (2) external noise without FDR2. For internal noise we find that FDR2 leads to conventional (normal) forms of transient work FRs. For external noise we obtain various forms of violations of normal FRs, which we call anomalous FRs. We show that our theory is important for understanding experimental results on fluctuations in biological cell migration. Similar results are observed more generally in small glassy systems [1].

[1] R.Klages, A.V.Chechkin, P.Dieterich, Anomalous fluctuation relations, book chapter in: R.Klages, W.Just, C.Jarzynski (Eds.), Nonequilibrium Statistical Physics of Small Systems, Wiley-VCH, Weinheim (2013)
[2] A.V.Chechkin, F.Lenz, R.Klages, J.Stat.Mech. L11001 (2012)
[3] A.V.Chechkin, R.Klages, J.Stat.Mech. L03002 (2009)

Dynamics of Repulsion Processes

Krapivsky, Pavel
(Boston Unversity, Physics, Boston, USA)

I'll describe dynamical behaviors of one-dimensional stochastic lattice gases with repulsive interactions whose span can be arbitrary large. This lattice gas is endowed with a zero-temperature dynamics, so that the hops to the empty sites which would have led to the increase of energy are forbidden. Assuming that the strength of interactions sufficiently quickly decreases with the separation between the particles allows to treat interactions in a lexicographic order. For such repulsion processes with symmetric nearest-neighbor hopping, I'll show how to determine the density-dependent diffusion coefficient and the variance of the displacement of a tagged particle.

Maximum distance traveled by vicious walkers till their survival

Kundu, Anupam
(Laboratoire de Physique Théorique et Modèles Statistiques, University Paris-Sud, Orsay, France)

we study the number of distinct sites $S_N(t)$ and common sites $W_N(t)$ visited by N independent one dimensional
random walkers, all starting at the origin, after t time steps. We show that these two random variables can be
mapped onto extreme value quantities associated
to N independent random walkers. Using this mapping, we compute exactly their probability distributions $P_N^d(S,t)$
and $P_N^d(W,t)$ for any value of N in the limit of large time t, where the random walkers can be described by Brownian motions.
In the large N limit one finds that $S_N/sqrt propto 2 sqrt{log N} + widetilde/(2 sqrt{log N})$ and $W_N/sqrt propto widetilde/N$
where $widetilde$ and $widetilde$ are random variables whose probability density functions (pdfs) are computed exactly and are found to be non trivial. We verify our results through
direct numerical simulations.

The frenetic origin of negative differential response

Maes, Christian
(KU Leuven, Instituut voor Theoretische Fysica, Leuven, Belgium)

We discuss systematic aspects of dynamical activity, the so called frenetic contribution, in the construction of nonequilibrium statistical mechanics, including
- modified fluctuation-response relations;
- statistical forces not derivable from a potential;

- modified Clausius heat theorem.

Number of distinct and common sites visited by N random walkers

Majumdar, Satya
(CNRS, Universite Paris-Sud (Orsay), LPTMS, Universite Paris-Sud (Orsay), Physics, Orsay, France)

Limiting Interfaces and Fluctuations

Mallick, Kirone
(CEA, Institute of Theoretical Physics, DSM, Gif Sur Yvette, France)

A simple mechanism for controlling pattern formation in coupled genetic circuits

Meyer-Ortmanns, Hildegard
(Jacobs University Bremen, School of Engineering and Science, Physics, Bremen, Germany)

We study a system of coupled genetic circuits, each of which shows excitable or oscillatory behavior, depending on the choice of parameters. When we couple these units with or without frustrated bonds, we can turn on oscillatory behavior for a finite duration of time that is controlled by the tuning of a single bifurcation parameter. Depending on the coupling strength, the network topology and the tuning speed, our numerical simulations reveal a rich dynamics out-of-equilibrium with dynamically generated time scales, target waves of self-organized pacemakers and spiral patterns. The conversion between the oscillatory and excitable regimes resembles a nucleation process of one phase into another.

Nonequilibrium phase transition in chiral Ising model

Noh, Jae Dong
(University of Seoul, Physics, Seoul, Korea, Republic of)

We introduce a nonequilibrium chiral dynamic for the Ising model in one-dimensional lattice. The chirality is incorporated into the model by choosing different transition rates for events associated with up kinks (-+) and down kinks (+-). Without chirality, the model reduces to the nonequilibrium kinetic Ising model displaying the absorbing phase transition in the parity conserving or directed Ising universality class. Extensive Monte Carlo simulations show that the model displays an intriguing absorbing phase transition and power-law scalings in the absorbing phase. We report our numerical findings and suggest a reasonable renormalization group picture.

The pros and cons of swimming in a noisy environment

Olla, Piero
(CNR, ISAC, Monserrato (Cagliari), Italy)

Swimming at the microscale is constrained by the scallop theorem:
reversing a stroke sequence, irrespective of how fast each stroke is performed, will bring back the swimmer to its original position.
Another factor limiting the ability of a microswimmer to propel itself in a fluid, is of course Brownian motion. As in many other circumstances, however, thermal effects do not act exclusively as an obstacle. In the present case, they could be exploited to counteract the effects of the scallop theorem. A simple microswimmer design, exploiting such an effect, is going to be described. Standard tecniques from stochastic optimization, can be utilized to minimize the energy consumption by the device.

Entropy production and heat in general stochastic processes with odd-parity

variables

Park, Hyunggyu
(Korea Institute for Advanced Study, Physics, Seoul, Korea, Republic of)

Total entropy production is conventionally separated into system entropy change and heat flowing into a thermal reservoir. In the presence of odd-parity variables under the time reversal, however, we explicitly find an extra entropy-like term whose physical origin is still in mystery. We also show that the separation of the total entropy production into the housekeeping (adiabatic) and its complementary functionals respectively holding the fluctuation theorems is not generic. This is due to the non-transient housekeeping contribution caused by the asymmetry of the steady-state distribution with respect to the odd-parity variables.

Fate of the Kinetic Ising and Potts Models

Redner, Sidney
(Boston University Physics Department, Physics, Boston, USA)

What happens when the Ising model initially at infinite temperature is suddenly cooled to zero temperature and subsequently evolves by single spin-flip dynamics? In two dimensions, the ground state is reached only about 2/3 of the time, and the evolution is characterized by two distinct time scales, the longer of which arises from topological defects. There is also an intriguing and deep connection between domain topologies and continuum percolation. In three dimensions, the ground state is never reached and (i) domains at long times are topologically complex, with average genus growing algebraically with system size; (ii) "blinker" spins always arise that can flip ad infinitum with no energy cost; (iii) the relaxation time grows exponentially with system size. The zero-temperature coarsening of the q-state Potts model is richer still. In two dimensions, macroscopic avalanches may occur at long times that drive apparently frozen systems to the ground state.

Models with interactions that weakly decay with distance

Ruffo, Stefano
(Università di Firenze, Dipartimento di Fisica e Astronomia, Sesto Fiorentino, Italy)

I will present an overview of recent results on models with long-range interactions where the potential or the coupling decay with the distance as a power-law.

Fluctuations and large deviations in some nonequilibrium systems

Sabhapandit, Sanjib
(Raman Research Institute, Theoretical Physics Group, Bangalore, India)

I will start with fluctuation theorems and its connections to large deviations. I will then describe how the large deviation function can be evaluated for the heat flow across a harmonic chain and work done for Brownian particles. Finally, I will show application of the results to recent experiments.

Long-range correlation in the steady state of a locally driven system.

Sadhu, Tridib
(CEA/Saclay, CEA/DSM/IPhT, Institut de Physique Théorique, Gif-sur-Yvette Cedex, France)

In systems far from of Equilibrium, local thermodynamic variables often exhibit long-range spatial correlations. This sometime results in phase transitions and long-range order in one dimensional systems, non-local response to local perturbations and other properties. We study the long-range correlation in a microscopic model where particles on a lattice interact with symmetric simple exclusion. The system is brought out of equilibrium by a localized drive across a single bond in the bulk. We analyze the two point correlation of density fluctuation in the steady state. Using an electrostatic analogy we show that the correlation function C(r,s) on a d-dimensional lattice has a power-law tail 1/(r^2+s^2)^d.

Self-organized escape processes of linear chains in nonlinear potentials

Schimansky-Geier, Lutz
(Humboldt-Universität zu Berlin, Institut für Physik, Berlin, Germany)

An enhancement of localized nonlinear modes in coupled systems gives rise to a novel type of escape process. We study a spatially set-up consisting of a linearly coupled oscillator chain of N mass-points situated in a metastable nonlinear potential. The dynamics exhibits breather solutions as a result of modulational instability of the phonon states. These breathers localize energy by freezing other parts of the chain. Eventually, this localized part of the chain grows in amplitude until it overcomes the critical elongation characterized by the transition state. Doing so, the breathers ignite an escape by pulling the remaining chain over the barrier. Even if the formation of singular breathers is insufficient for an escape, coalescence of moving breathers can result in the required concentration of energy. Compared to a chain system with linear damping and thermal fluctuations the breathers help the chain to overcome the barriers faster in the case of low damping. Additional periodic forcing helps to sustain breather solutions which ignite the escape even in case of stronger damping.

Stochastic thermodynamics and hidden slow degrees of freedom

Seifert, Udo
(Universität Stuttgart, II. Institut f. Theoretische Physik, Physik, Stuttgart, Germany)

Mean-field theory for a realistic model for fish schools

Sire, Clément
(CNRS, Laboratoire de Physique Théorique - IRSAMC, Université Paul Sabatier, Toulouse, France)

We will present a realistic model for fish schools reproducing swarming (fishes move erratically), schooling (fishes have a common average velocity), and milling (a "vortex"-like phase), which has been introduced and validated experimentally by Guy Theraulaz' group at CRCA. We will present analytic results for the one-fish dynamics including the interaction with the tank wall, and the two-fish dynamics. Moreover, we will present a mean-field treatment of the model for a large number of fishes, and its phase diagram. The strong analogy (but also the differences) with the Hamiltonian Mean-Field (HMF) model, a paradigm for long range interacting systems, will be emphasized.

Strong and geometry-dependent universality in growing interfaces

Takeuchi, Kazumasa A.
(The University of Tokyo, Department of Physics, Tokyo, Japan)

I will present recent developments on growing interfaces showing universality beyond the scaling exponents, along an experimental realization found in chaotic regimes of liquid crystal convection. Measuring interface fluctuations of growing domains, we found not only the scaling exponents of the Kardar-Parisi-Zhang (KPZ) universality class, but also particular distribution and correlation functions that were previously derived for solvable models in the KPZ class. Interestingly, these statistical properties have direct yet non-trivial relation to random matrix theory, and depend on the global geometry of the interfaces (whether the interfaces are curved or not). In other words, the KPZ class splits into a few universality subclasses. These results constitute direct evidence of the powerful out-of-equilibrium universality of the KPZ class, ruling such detailed statistical properties as distribution and correlation functions.

References:
K. A. Takeuchi and M. Sano, PRL 104, 230601 (2010); J. Stat. Phys. 147, 853 (2012).

Stochastic thermodynamics

Van den Broeck, Christian
(Hasselt University Campus Diepenbeek, faculty of science, Hasselt, Belgium)

We briefly review stochastic thermodynamics, discuss some applications in small systems with respect to efficiency of thermal and non-thermal machines, and present some recent results on model-calculations for the asymptotic work and fluctuation theorem.