DY 24: Poster I

Time: Wednesday 16:00–18:00 Location: Poster D

DY 24.1 Wed 16:00 Poster D

Transition from ballistic to diffusive transport in finite quantum systems — •Jochen Gemmer[1], Robin Steinigeweg[1], and Heinz-Peter Breuer[2] — [1]Universität Osnabrück, Fachbereich Physik, Barbarastr. 7 49069 Osnabrück — [2]Albert-Ludwigs-Universität Freiburg, Physikalisches Institut, Hermann-Herder Str. 3, 79104 Freiburg

Standard tools in transport theory like the Kubo formula or quantum Boltzmann equations face, apart from some conceptual difficulties, the problem of being inapplicable to finite quantum systems. Thus we investigate the dynamics of spatial densities of e.g. energy or particles directly by projection operator techniques similar to those known from the field of open quantum systems. We find that periodic quantum systems may exhibit diffusive transport at intermediate sizes. However, in the limit of small and remarkably also in the limit of large systems, transport tends to be ballistic.

DY 24.2 Wed 16:00 Poster D

Environment-induced transition from diffusive to ballistic transport in a tight-binding model — •Kirsten Wedderhoff and Jochen Gemmer — University of Osnabrueck, Osnabrueck, Germany

We investigate the transport-behavior in a tight-binding model with an additional environment by means of a quantum master equation in Lindblad-form. Starting with the most simple form of two lattice-sites, we try to compare the resulting dynamics with those generated by a discrete diffusion equation. Apparently the environment induces a transition from ballistic to diffusive behavior.

DY 24.3 Wed 16:00 Poster D

Transport properties of finite quantum systems — •Christian Bartsch and Jochen Gemmer — Physics Department, University of Osnabrück, Barbarastr. 7, 49069 Osnabrück, Germany

It has been observed that normal transport behaviour can appear in finite quantum systems for certain quantities. This means, the dynamics of these quantities are statistical, i.e. they are controlled by rate equations, although the time evolution of the complete system is generated by the Schrödinger Equation. The exponential relaxation can be described correctly by the Hilbert Space Average Method (HAM) [1] or the time-convolutionless (TCL) projection operator technique [2]. Both methods also yield some necessary criteria for the occurrence of normal transport concerning rough system parameters like bandwidths and average interaction strengths. Additionally, the structure of the interaction must be taken into account, too. One possibility is to check if the squared interaction matrix is essentially diagonal, which seems to be a crucial feature for statistical decay to occur. A similar approach was proposed by van Hove in [3] for continuous systems. Alternatively, one can evaluate higher orders of the TCL expansion and determine the magnitude of the deviation from the rate equations.

[1] J. Gemmer, M. Michel, G. Mahler, Quantum Thermodynamics, Springer (2004)
[2] H.-P. Breuer, F. Petruccione, The Theory of Open Quantum Systems, Oxford (2002)
[3] L. van Hove, *Physica* **XXI** 517 (1955)

DY 24.4 Wed 16:00 Poster D

Quantum heat transport in harmonic chains — •Christopher Gaul and Helmut Büttner — Universität Bayreuth, Deutschland

We investigate the mechanism of heat conduction in harmonic 1D models — including disorder — with the quantum mechanical Langevin ansatz.

In our quantum mechanical calculations we recover some classical results: The temperature gradient vanishes and heat flux is independent of the length of the chain. In the case of disordered chains normal heat conduction is partially recovered: There is a finite temperature gradient, but the overall heat resistance does not increase linearly with the length of the chain.

Furthermore we observe characteristic quantum mechanical features like freezing of the heat conductivity, entanglement and Bose statistics of the occupation numbers.

DY 24.5 Wed 16:00 Poster D

On the characterization of generalized quantum thermodynamic machines — •Georg Reuther, Markus Henrich, and Günter Mahler — Institut für Theoretische Physik 1, Universität Stuttgart, 70569 Stuttgart

Quantum thermodynamic machines have attracted more and more attention in the past years. It is possible to show that a spin chain with a nearest neighbor Heisenberg interaction which is exposed to a global temperature gradient provided by two heat baths behaves like a heat pump or heat engine if parts of the chain are modulated periodically [1]. We characterize the behavior of different spin chain and spin network configurations with regard to efficiency and other thermodynamic properties.

[1] M. J. Henrich, M. Michel, G. Mahler, cond-mat/0604202

DY 24.6 Wed 16:00 Poster D

Implementation of classical driving on the quantum level — •Heiko Schröder and Günter Mahler — Universität Stuttgart, 1. Institut für Theoretische Physik, Pfaffenwaldring 57, 70550 Stuttgart

The development of Quantum Thermodynamics [1] in the recent years has shown that thermodynamical concepts can be observed in and produced by quite small quantum systems. The existence of and relaxation to a thermal equilibrium has been found to be dependent on the existence of a suitable, but not necessarily big quantum environment. On this background, we have dealt with the question of the implementation of classical control in quantum systems by quantum systems as another important concept of thermodynamics. Here, we present a sufficient condition for a quantum environment in order to operate as a classical driver of another quantum system.

[1] J. Gemmer, M. Michel and G. Mahler: Quantum Thermodynamics, Springer 2004

DY 24.7 Wed 16:00 Poster D

On the derivation of diffusion in randomly coupled modular systems — •Pedro Alejandro Vidal Miranda and Günter Mahler — Universität Stuttgart, 1. Institut für Theoretische Physik Pfaffenwaldring 57 // IV,70550 Stuttgart ,Germany

We analyze the Schrödinger evolution of the Wigner transform of the wave function in a randomly coupled modular system in order to obtain a macroscopic equation for the dynamics of observables such as the energy. For this we average over the randomess in the system and we make use of the long time van Hove limit.

DY 24.8 Wed 16:00 Poster D

Decoherence, entanglement and entropy in non-Markovian quantum Brownian motion — •Christian Hörhammer and Helmut Büttner — Theoretische Physik I, Universität Bayreuth, 95440 Bayreuth

Decoherence is associated with the formation of quantum correlations of an open quantum system with the environment. The fact that the Brownian particle and its environment become entangled may lead to deviations between the thermodynamic entropy of a quantum Brownian oscillator derived from the partition function of the subsystem and the von Neumann entropy of its reduced density matrix. We give an explanation for these findings and point out that these deviations become important in cases where statements about the information capacity of the subsystem are connected to thermodynamic properties.

DY 24.9 Wed 16:00 Poster D

Cyclical Algorithmic Cooling — •Florian Rempp and Günter Mahler — 1. Institut für Theoretische Physik, Universität Stuttgart, Deutschland

Algorithmic cooling is a method to obtain highly polarized spins in a spin system, without cooling down the environment. We introduce a system to perform the cooling algorithm, first presented by Tal Mor et al. in 2002 [1], multiple times on the same set of qbits. we achieve this goal by adding an additional SWAP-gate and a bath contact to the algorithm.

In order to compute the state of the spins after an arbitrary application of the algorithm we introduce a thermalisation super operator to need not to solve the Liouville von Neumann equation for the bath contact for each application step. furthermore we draw a connection to

general thermodynamic machines in order to locate algorithmic cooling in a bigger context.

[1] Tal Mor, P. Oscar Boykin, Vwani Roychowdhury, Farrokh Vatan and Rutger Vrijen, "Algoritmic Cooling and Scalable NMR Quantum Computers", *Proc. Natl. Acad. Sci. USA*, 99:3388-3393, 2002

DY 24.10 Wed 16:00 Poster D

Numerical computations for spin models using weighted graph states — •Simon Anders[1], Hans J. Briegel[1,2], and Wolfgang Dür[1,2] — [1]Institut für Theoretische Physik, Universität Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation (IQOQI) der ÖAW

Recently, a number of novel techniques have been proposed for numerical treatment of spin systems, specifically aiming at the study of ground state properties and time evolution. We have introduced [1] a variational method based on so-called weighted graph states, a class of states with intrinsic long-range entanglement and suitability for arbitrary geometries. Here, we present new results, specifically on the application of our method for bosonic systems such as the Bose-Hubbard model and also compare it with other methods. Further, we have investigated possibilities to form a hybrid technique using the weighted graph states and projected entangled pair states [2] or tensor tree networks [3].

[1] Anders et al., Phys. Rev. Lett. **97** (2006), 107206
[2] Verstraete and Cirac, ArXiv cond-mat/0407066 (2004)
[3] Shi, Duan, Vidal, ArXiv quant-ph/0511070 (2004)

DY 24.11 Wed 16:00 Poster D

Investigations of Ericson fluctuations and time-reversal symmetry in quantum billiards — Stefan Bittner, Barbara Dietz-Pilatus, Thomas Friedrich, Pedro Oria Iriarte, Maksim Miski-Oglu, Achim Richter, and •Florian Schäfer — Institut für Kernphysik, Schloßgartenstraße 9, 64289 Darmstadt

In the presented work, flat microwave resonators were studied experimentally. Those resonators provide a means to simulate corresponding quantum billiards. The theoretical description of those billards is based on the scattering formalism as introduced by Mahaux and Weidenmüller and requires transmission as well as reflection measurements.

We focus here on two special aspects of our investigations. First, the regime of strongly overlapping resonances is studied. Here, the transmitted power through the resonator shows pronounced fluctuations (so called Ericson fluctuations). Their autocorrelation functions are compared to a theory by Verbaarschot, Weidenmüller and Zirnbauer. Second, we investigate the influence of a broken time-reversal symmetry on nearly degenerate resonances and extract the T-violating matrix elements of the effective Hamiltonian describing the quantum billiard.

DY 24.12 Wed 16:00 Poster D

Chaos-assisted tunneling: the effect of Cantori — Mirjam Schmid, Christopher Eltschka, and •Peter Schlagheck — Institut für Theoretische Physik, Universität Regensburg

Dynamical tunneling rates between symmetry-related regular islands in quantum system with a mixed regular-chaotic classical phase space can be semiclassically estimated by means of the effect of prominent nonlinear resonances that manifest within the islands [1]. This approach is implicitly based on the assumption that the classical dynamics of the system is perfectly regular within and fully chaotic outside the islands. To improve on this assumption, we take into account the presence of important partial barriers and Cantori in the chaotic part of the phase space, which may lead to a significant enlargement of the effective island size. Using such partial barriers, and including prominent resonances that are located in between them into the calculation, we obtain a rather good reproduction of the exact quantum tunneling rates in driven one-dimensional model systems.

[1] C. Eltschka and P. Schlagheck, Phys. Rev. Lett. 94, 014101 (2005).

DY 24.13 Wed 16:00 Poster D

Level statistics and bifurcations for a Hamiltonian system — Marta Gutiérrez, •Andreas Koch, Matthias Brack, and Klaus Richter — Institut für Theoretische Physik, Universität Regensburg

We study the effect of bifurcations on the spectral form factor and rigidity of a Hamiltonian quantum system with mixed classical dynamics. The system possesses periodic librational orbits along the axes that undergo an infinite sequence of non-generic pitchfork bifurcations. We show that the signature of these bifurcations is two fold: beside the known effect of an enhanced periodic orbit contribution due to its stronger hbar dependence at the bifurcation, the orbits involved at the bifurcation give a non-diagonal contribution yielding deviations from universality.

DY 24.14 Wed 16:00 Poster D

Mushroom billiards — Stefan Bittner, Barbara Dietz-Pilatus, •Thomas Friedrich, Maksim Miski-Oglu, Pedro Oria-Iriarte, Achim Richter, and Florian Schäfer — Institut für Kernphysik, Schloßgartenstraße 9, 64289 Darmstadt

Mushroom billiards are mixed systems providing a clearly separated phase space. Using a superconducting microwave billiard the spectral properties of quantum mushroom billiards are investigated. Particularly a supershell modulation in the level density and a substructure in the nearest neighbor spacing distribution of levels are found. By decomposing the spectrum in a regular and chaotic part the influence of dynamic tunneling on the eigenfrequencies is reveiled. Wave functions of mushroom billiards have also been determined at room temperature. They are related to the classical dynamics of the billiard. Finally, the decay behavior of classical and quantum mushroom billiards is considered.

DY 24.15 Wed 16:00 Poster D

Dynamical tunneling in a mixed phase space — Arnd Bäcker, Roland Ketzmerick, •Steffen Löck, and Lars Schilling — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

The phase space of mixed systems consists of regular islands being dynamically separated from the chaotic sea. Quantum mechanically these phase space regions are connected by dynamical tunneling. We derive a formula predicting dynamical tunneling rates of regular states to the chaotic sea. Agreement with numerics for kicked systems with resonance-free islands will be presented. In addition this approach is applied to resonance assisted tunneling in systems with one dominating resonance chain.

DY 24.16 Wed 16:00 Poster D

Classical Dynamics of the Time-Dependent Elliptical Billiard — •Florian Lenz[1] and Peter Schmelcher[1,2] — [1]Physikalisches Institut, Universität Heidelberg, 69120 Heidelberg, Germany — [2]Theoretische Chemie, Institut für Physikalische Chemie, Universität Heidelberg, 69120 Heidelberg, Germany

We study classically the dynamics of harmonically driven elliptical billiards with the focus lying on escape rates by performing numerical simulations. In the static ellipse, we find algebraic decay laws due to the integrable dynamics of the system. Besides the energy, the product of the angular momenta (PAM) around the foci is preserved. Depending on the sign of the PAM, particles are confined to either librator or rotator orbits. By varying the hole position, the saturation value (SV) of the decay, caused by librator orbits that are not connected with the hole, can be tuned. We apply harmonic oscillations to the boundary to examine the effect of the driving on this SV. Two universal fundamental processes that are able to destroy this SV via changing librator into rotator orbits (they are scattered across the separatrix) are discussed and a simple qualitative model is established that explains the decay and the amplitude-dependent emission rate of the driven system. The analysis of the time-evolution of velocity distributions suggests that the driven ellipse can be used as a cooling device for particles, provided a suitable preparation of the initial ensemble.

DY 24.17 Wed 16:00 Poster D

Lattice dynamics of polycrystalline Beryllium — •Irmengard Fischer, Alexei Bossak, and Michael Krisch — European Synchrotron Radiation Facility, BP220, F-38043 Grenoble Cedex, France

The phonon dispersion along high-symmetry directions of a single crystal gives access to a large range of physical properties such as electron-phonon coupling, anharmonicity, specific heat, sound velocities and elastic constants. Novel materials and crystals under extreme conditions are, however, often only available as polycrystals, and consequently investigations are limited to orientationally averaged properties such as the phonon density of states (PDOS) and the average sound velocity. To overcome these limitations, we developped a method to extract the single crystal phonon dispersion from inelastic x-ray scattering (IXS) measurements of a polycrystalline material. We chose as

test case Be, because of its well known dispersion and its high IXS efficiency. The spectra were recorded with an energy resolution of 3 meV spanning the 2-80 nm-1 momentum transfer range. The experimental IXS spectra were fitted with a least-square routine using a Born - von Karman model, starting from a known set of force constants. The refined dispersion is in remarkable agreement with inelastic neutron measurements. Furthermore, the reconstructed PDOS is in excellent agreement with calculations, thus allowing the precise determination of macroscopic parameters such as the Debye temperature, the vibrational contribution to the specific heat and the internal energy. This novel application of IXS promises to be a valuable spectroscopic tool in cases where single-crystalline materials are not available.

DY 24.18 Wed 16:00 Poster D

contribution moved to poster session EP — •XXX XXX —

DY 24.19 Wed 16:00 Poster D

Verkehrslenkung mit Hilfe von Onlinesimulationen auf komplexen Autobahnnetwerken — •Florian Mazur, Andreas Pottmeier und Michael Schreckenberg — Universität Duisburg-Essen, Physik von Transport und Verkehr, Lotharstr. 1, D-47057 Duisburg

Ziel eines Verkehrsinformationssystems sollte es sein, möglichst vielen Autofahrern zuverlässige Informationen über den Verkehrszustand auf Autobahnen zu geben. Ein erster Schritt in diese Richtung war die Entwicklung des Verkehrsinformationssystems autobahn.NRW in Nordrhein-Westfalen. Mit Hilfe von Zellularautomatenmodellen wird hier der Verkehr auf dem Autobahnnetzwerk von NRW realitätsnah in Echtzeit simuliert und Informationen über den Verkehrszustand berechnet. Die Datenbasis liefern über 4000 Induktionsschleifen, die online Messdaten über das Verkehrsaufkommen übertragen.

Seit einiger Zeit ist unter der Internetadresse www.autobahn.nrw.de das Ergebnis der Simulation zugänglich und wird von ca. 25.000 Usern täglich genutzt. Um auch während der Fahrt Informationen über Staus geben zu können, wurden in NRW 38 dWiSta-Tafeln (dynamische Wegweiser mit integrierten Stauinformationen) auf den Autobahnen aufgestellt. Über sie können Informationen und Umlenkungsempfehlungen, für die auch die Reisezeiten von autobahn.NRW genutzt werden, an die Verkehrsteilnehmer weitergegeben werden.

Das Poster beschäftigt sich mit dem Simulationsmodell, welches dem Verkehrsinformationssystem autobahn.NRW zugrunde liegt, und erläutert, wie die so gewonnenen Informationen für eine effektive Verkehrslenkung genutzt werden.

DY 24.20 Wed 16:00 Poster D

Networks of chaotic units mutually coupled by their delayed variables — •Johannes Kestler, Markus Mützel, and Wolfgang Kinzel — Theoretische Physik, Universität Würzburg

Identical chaotic systems which are mutually coupled by some of their time-delayed variables can synchronize to a common chaotic trajectory. We investigate this phenomenon for small networks of iterated maps. Analytic calculations of Lyapunov spectra show that high-dimensional chaos is synchronized by delayed couplings. The phase diagrams of complete and sublattice synchronization are calculated analytically for several networks. Time-shifted correlations between different units are calculated numerically. Results are presented for complete, sublattice, achronal and generalized synchronization, de- and re-synchronization after closing the connection and mutual chaos pass filter.

DY 24.21 Wed 16:00 Poster D

Modelling Counterflow Situations of Pedestrian Traffic — •Maike Kaufman, Tobias Kretz, and Michael Schreckenberg — Universität Duisburg-Essen, Physik von Transport und Verkehr, Lotharstr. 1, D-47057 Duisburg

A Cellular Automaton-based model of Pedestrian Dynamics which encorporates intelligent agent behavior in counterflow situations is presented.

The described model is an extention of the F.A.S.T. model of Pedestrian Dynamics. It is discrete in space and time and probabilistic in the pedestrians choice of direction of movement. An agent chooses his next position from the set of accessible cells allowed by his velocity. This choice is made according to a precomputed probability which depends on the agent's neighborhood. In this work a spheric direction-dependant potential surrounds each pedestrian. It is repulsive for agents walking in opposite directions and attractive for agents moving in the same direction, thus ensuring that pedestrians are able to avoid collisions and follow persons in front of them. This modification of the model allows for reproduction of lane formation and higher fluxes at critical densities.

DY 24.22 Wed 16:00 Poster D

Spatio-temporal dynamics of the action potential during atrial fibrillation — •Claudia Hamann, Thomas Hennig, and Philipp Maass — Institut für Physik, Technische Universität Ilmenau, 98684 Ilmenau, Germany

Under normal conditions the contraction of the heart muscles is controlled by the regular propagation of an action potential. Atrial fibrillation (AF) is a common arrhythmia with multiple reentry of the action potential and self-excitation in certain regions of the tissue, which after transduction through the atrio-ventricular node can give rise to different distributions of ventricular beat intervals [1]. On the basis of the model of FitzHugh and Nagumo we simulate the dynamics of the electrical potential in the atrium. The spatio-temporal patterns are analysed with emphasis on the conditions necessary for the occurrence of reentry and self-oscillation phenomena. Characteristic features of the propagation retrieved from the model are compared to statistical properties of the intra-atrial electrocardiogram.

[1] C. Hamann, Th. Hennig, P. Maass, Proceedings of the "Conference of the European Study Group on Cardiovascular Oscillations 2006"(ESGCO 2006), Jena, Germany, 15-17 May 2006, p. 36.

DY 24.23 Wed 16:00 Poster D

Dynamical Behavior and Control of Coupled — Heinz Georg Schuster[1], Michel Le Van Quyen[2], Mario Chavez[2], •Jan Köhler[1], and Jörg Mayer[1] — [1]Institut für Theoretische Physik und Astrophysik, Christian-Albrechts Universität, Olshausenstraße 40, 24098 Kiel, Germany — [2]LENA CNRS UPR640, Hopital de la Salpetriere,Paris, France

We investigate the dynamical behavior of all to all coupled threshold elements with selfinhibition. Coupled threshold elements with selfinhibition display a phase transition to an oscillating state where the elements fire in synchrony with a period T that is of the order of the dead time caused by selfinhibition . This transition is noise activated and therefore displays strong collectively enhanced stochastic resonances. For an exponentially decaying distribution of dead-times the transition to the oscillating state occurs, coming from high noise temperatures, via a Hopf bifurcation and coming from low temperatures, via a saddle node bifurcation. The transitions can be triggered externally by noise and oscillating signals.

DY 24.24 Wed 16:00 Poster D

Current instabilities in resonant tunneling quantum dot structures — •Kathy Lüdge and Eckehard Schöll — Technische Universität Berlin, Hardenbergstraße 36, 10623 Berlin

In this work we investigate the current transport through quantum dots (QDs) embedded in a double barrier structure that is operated in an external circuit with a dc bias voltage Uo and a series resistance R and a parallel capacitance C. We show that the performance of such nonlinear devices is crucially depending on the chosen external circuit parameters, so that they can be used either as switches or as self-sustained current oscillators.

For analyzing the dynamics of the QD system a Master equation approach for sequential tunneling through two parallel, electrostatically coupled quantum dots has been used, followed by a linear stability analysis of the fixed points of the five dimensional system, taking into account also the dynamic degree of freedom of the voltage drop across the QD structure due to Kirchhoff's circuit equation. Interesting effects are found if the nullclines of the external circuit and of the QD system intersect such that three operating points exist. For the usual case of a positive capacitance C we show that oscillatory instabilities caused by a Hopf bifurcation cannot occur. For negative capacitance, which can easily be realized by an active circuit consisting of operation amplifiers, a Hopf bifurcation leading to uniform limit cycle oscillations can be found. At a certain value of C the limit cycle collides with the saddle-point on the low current branch and disappears which represents a global homoclinic bifurcation (or blue-sky catastrophe).

DY 24.25 Wed 16:00 Poster D

Time-delayed feedback control of fixed points with variable phase-dependent coupling — •Thomas Dahms, Philipp Hövel, and Eckehard Schöll — Institut für Theoretische Physik, TU Berlin, Hardenbergstr. 36, D-10623 Berlin

During the last decade time-delayed feedback methods have been successfully used to control unstable periodic orbits as well as unstable steady states. [1] In most of the theoretical analysis, this control method is considered in the realization of diagonal coupling, i.e., the control force applied to the i-th component of the system is a function of exclusively the same component. Although diagonal coupling is suitable for a theoretical investigation, it is often not feasible for an experiment. Therefore we consider the more general case where control is effected by a nondiagonal coupling matrix. Specifically, we investigate the time-delayed feedback scheme for a rotational coupling matrix parametrized by a variable phase. We present an analysis of the domain of control for simple time-delay autosynchronization (TDAS) as well as for multiple time extended feedback (ETDAS). We demonstrate the application to optical systems [2,3] where the optical phase is an additional degree of freedom.

[1] P. Hövel and E. Schöll, Phys. Rev. E **72**, 046203 (2005).
[2] V. Z. Tronciu, H.-J. Wünsche, M. Wolfrum, and M. Radziunas, Phys. Rev. E **73**, 046205 (2006).
[3] S. Schikora, P. Hövel, H.-J. Wünsche, E. Schöll, and F. Henneberger, Phys. Rev. Lett. **97**, 213902 (2006).

DY 24.26 Wed 16:00 Poster D

Experiments on a Ferrofluidic Torsional Pendulum Suspended in an Oscillating Magnetic Field — •Harald Brendel, Reinhard Richter, and Ingo Rehberg — Experimentalphysik 5, Universität Bayreuth, D-95444 Bayreuth

Recently a new type of torsional pendulum was proposed (M.I. Shliomis, M.A. Zaks, Phys. Rev. E, vol.73, 066208 (2006)) which we realize by suspending a DISC SHAPED container in a Helmoltz pair of coils driven by an alternating sinusodial current. In contrast to a spherical pendulum the orientation of the disc is expected to be sensitive to the field direction: It exposes its edge to the stationary oscillating magnetic field and its broad side to the field of high frequency. Increasing the field amplitude the state of rest gives way to oscillations near the equilibrium. Further growth of the driving amplitude is predicted to give rise to rotational motion. We study the scenarios for the case of magnetic fluids of different composition.

DY 24.27 Wed 16:00 Poster D

Reorientation of a scroll ring under an electrical current in a chemical excitable medium — •Chaiya Luengviriya[1,2], Stefan C. Müller[1], and Marcus J. B. Hauser[1] — [1]Otto-von-Guericke-Universtität Magdeburg, Institut für Experimentelle Physik, Abteilung Biophysik, Universitätsplatz 2, 39106 Magdeburg, Germany — [2]Kasetsart University, Department of Physics, Bangkok, 10900, Thailand

Scroll rings are three-dimensional wave structures in excitable media whose filaments form closed loops. Such filaments are subject to wave instabilities which cause the scroll rings to expand or contract intrinsically depending on the excitability of the medium. Even though the length of filament changes due to expansion or contraction, the position and orientation of the scroll ring are approximately stationary - the filament does almost neither drift nor rotate.

We present a study of the dynamics of a scroll ring in a Belosov-Zhabotinsky (BZ) reaction under a constant electrical current. The scroll ring reoriented itself with respect to the direction of the applied electric current. In addition, a linear drift against the direction of the current was observed. These effects were coupled with an intrinsic contraction leading to a self-annihilation of the scroll ring. Numerical calculations show that electrical current and temperature gradients have similar effects on the dynamics of a scroll ring in a BZ reaction. However, temperature gradients cannot cause drifts of scroll rings as in the case of electrical current.

DY 24.28 Wed 16:00 Poster D

Kinematics of excitation waves rotating within an annular channel — Harald Engel, •Hartmut Lentz, and Vladimir Zykov — Technische Universität Berlin

Excitation waves are typical examples for pattern formation processes in reaction-diffusion media of quite different nature. We consider rotating wave patterns in an annular channel of arbitrary inner radius. Varying the inner radius from zero to the outer radius we connect the limiting cases of a two-dimensional disc and a one-dimensional ring.

We study the free-bounday formulation of the waves, which reduces the underlying reaction-diffusion system to the kinematics of the propagating wave fronts. The inner and the outer radii of the channel are considered as the most important control parameters. The refractoriness of the medium is also taken into account. The results of this simplified approach are compared with the direct integration of the excitation medium model.

DY 24.29 Wed 16:00 Poster D

Rigidly rotating wave patterns in excitable media of a circular shape — Grigory Bordyugov, •Vladimir Zykov, and Harald Engel — TU Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

Spiral waves represent a famous example of self-organized spatio-temporal patterns in excitable media. It is well known that rigidly rotating spirals, moving at a constant angular velocity and shape can be induced in a two-dimensional disk. Here, the existence of another type of rigidly rotating patterns is demonstrated which are excitation spots localized near the no-flux boundary of the disk and moving along it. Using the kinematical description of the moving wave fronts and the established continuation engine AUTO we show that spiral waves and boundary spots coexist in a disk of given size below some critical value of the medium excitability. They coincide at this bifurcation point and no rigidly rotating patterns exist above this critical excitability. The results of these simplified approaches are compared with direct integration of the underlying reaction-diffusion models.

DY 24.30 Wed 16:00 Poster D

Stabilization of unstable trajectories of the wave tip in excitable media — •Jan Schlesner, Vladimir Zykov, and Harald Engel — TU Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

In a variety of excitable media, depending on the parameters different regimes of rotation have been observed for spiral waves including rigid rotation, meandering and hypermeandering. A proportional and a time-delayed feedback algorithms are elaborated to stabilize unstable regimes of the tip of spiral waves in a parameter range where these regimes are unstable in the absence of the feedback. As both control methods are non-invasive their application allows us to determine the characteristic parameters of unstable rigid rotation. As representative example of excitable media we use the FHN model in our calculations. In many system there are additional latencies in the control loop that shrink the control domain for successful stabilization. We propose an effective method to overcome its destabilizing influence.

DY 24.31 Wed 16:00 Poster D

Stabilizing chaotic behaviour in a model of ventricular fibrillation — •Zhuchkova Ekaterina[1], Radnayev Boris[2], and Loskutov Alexander[2] — [1]Institut of Theoretical Physics, Technical University Berlin, Germany — [2]Physics Faculty, Moscow State University, Moscow, Russia

It is believed that lethal heart pathology - ventricular fibrillation (VF) is caused by re-entrant activity, which represents multiple rotating spiral waves in 2D and scroll waves in 3D. We have made a comparative analysis of the spatio-temporal complex patterns of activation during VF in the Fenton-Karma model by three methods: counting and tracking phase singularities (PSs) - tips of re-entrant waves, computing invariant characteristics used in the theory of dynamical systems and implementing compression algorithm sensitive to regularity (CASToRe). The processes in excitable media may be more complex than a given set of re-entrant waves. Hence counting singularities is not enough. To find an amount of order in the system (quantify complexity) and determine a possibility to predict the system's dynamics and suppress chaotic behaviour CASToRe is more appropriate.

Choosing quite complex spiral-wave dynamics for stabilizing, in contrast to defibrillation by pulses (single shocks) applied to an entire tissue or a quite large part of it we applied low-amplitude non-feedback periodic excitation of monophasic and biphasic shapes to a point (or a small group of points) of medium. We have found that under some conditions re-entrant waves can be eliminated by a mild stimulation by two-three orders of magnitude less than that used in clinical practice.

DY 24.32 Wed 16:00 Poster D

Hydrodynamic Lyapunov modes and strong stochasticity threshold in Fermi-Pasta-Ulam models — •Hongliu Yang and Günter Radons — Chemnitz University of Technology, Chemnitz, Germany

The strong stochasticity threshold (SST) is characterized by a crossover of the system dynamics from weak to strong chaos with increasing the energy density . Correspondingly, the relaxation time to energy equipartition and the largest Lyapunov exponent exhibit different scaling behavior in the regimes below and beyond the threshold

value. In this paper, we attempt to explore further changes in the energy density dependence of all Lyapunov exponents and of hydrodynamic Lyapunov modes (HLMs). In particular, we find that for the FPU- and FPU- model the scaling of the energy density dependence of all Lyapunov exponents shows similar changes at SST as those of the largest Lyapunov exponent. This supports the point of view that the crossover in the system dynamics at SST reflects a global change in the geometric structure of the phase space. Furthermore, the FPU-model is used as an example to show that HLMs exist in Hamiltonian lattice models with continuous symmetries. Numerical simulations demonstrate that there exist a smooth transition in Lyapunov vectors corresponding to the crossover in Lyapunov exponents at SST. In particular, our numerical results indicate that strong chaos is essential for the appearance of HLMs.

DY 24.33 Wed 16:00 Poster D

Complex behavior of simple maps with fluctuating delay times — •Günter Radons, Hongliu Yang, Jian Wang, and Jianfeng Fu — Chemnitz University of Technology, Chemnitz, Germany

Delay systems used to model retarded actions are relevant in many fields such as optics, mechanical machining, biology or physiology. A frequently encountered situation is that the length of the delay time changes with time. In this study we use a simple map system to investigate the influence of the fluctuating delay time on the system dynamics. For simplicity, the delay time in our system takes only the value of one or two discrete time steps, where the system dynamics reduces to the logistic map and Henon map, respectively. Two cases, periodic or random variation of the delay, have been studied. Rich dynamics including coexisting multiple attractors, strange nonchaotic attractors, and on-off intermittency are observed.

DY 24.34 Wed 16:00 Poster D

Cellular automata under minimally perturbed timing — David Reichelt[1] and •Konstantin Klemm[2] — [1]Wilhelm-Ostwald-Gymnasium, Willi-Bredel-Straße 15, 04279 Leipzig — [2]Bioinformatik, Uni Leipzig, Haertelstr. 16-18, 04107 Leipzig

Elementary cellular automata (ECA) produce a wealth of complex patterns for various rules when cells are updated synchronously. Under a randomized update order for the cells, however, many of the complex patterns are no longer observed [Ingerson and Buvel, Physica D 10, 59 (1984)]. Here we revisit the issue of update modes in ECA. While asynchronous update corresponds to maximally noisy clocking, we here deviate from synchronous update in the mildest manner, by introducing minimal perturbations to timing. Some but not all of the complex patterns that vanish under asynchronous update are recovered when timing perturbations become smaller and smaller.

DY 24.35 Wed 16:00 Poster D

Long-range memory elementary 1D cellular automata: Dynamics and nonextensivity — •Thimo Rohlf[1] and Constantino Tsallis[2] — [1]Santa Fe Institute, 1399 Hyde Park Road, Santa Fe, NM87501, USA — [2]Centro Brasileiro de Pesquisas Fisicas, Xavier Sigaud 150, 22290-180 Rio de Janeiro-RJ, Brazil

We study the dynamics of elementary 1D cellular automata (CA), where the state $\sigma_i(t) \in \{0,1\}$ of a cell i does not only depend on the states in its local neighborhood at time $t-1$, but also on the memory of its own past states $\sigma_i(t-2), \sigma_i(t-3), ..., \sigma_i(t-\tau), ...$ [1]. We assume that the weight of this memory decays proportionally to $\tau^{-\alpha}$, with $\alpha \geq 0$. Since the memory function is summable for $\alpha > 1$ and nonsummable for $0 \leq \alpha \leq 1$, we expect pronounced changes of the dynamical behavior near $\alpha = 1$, particularly for the time evolution of the Hamming distance H of initially close trajectories. We typically expect the asymptotic behavior $H(t) \propto t^{1/(1-q)}$, where q is the entropic index associated with nonextensive statistical mechanics.

In all cases, the function $q(\alpha)$ exhibits a sensitive change at $\alpha \simeq 1$. We focuse on the class II rules 61 and 111. For rule 61, $q = 0$ for $0 \leq \alpha \leq \alpha_c \simeq 1.3$, and $q < 0$ for $\alpha > \alpha_c$, whereas the opposite behavior is found for rule 111. These facts point at a rich dynamics intimately linked to the interplay of local lookup rules and the range of the memory. Finite size scaling studies varying system size N indicate that the range of the power-law regime for $H(t)$ typically diverges $\propto N^z$ with $0 \leq z \leq 1$.

[1] Rohlf, T. and Tsallis, C., preprint: cond-mat/0604459

DY 24.36 Wed 16:00 Poster D

Transport of Brownian Particles in a Velocity Field — •Felix Müller and Lutz Schimansky-Geier — Institut für Physik, Humboldt Universität zu Berlin, Newtonstr. 15, 12489 Berlin

We consider transport in a two dimensional periodic velocity field which is due the addition of two planar waves. The field does not have a underlying potential and possesses extended lines of fixpoints where the deterministic motion stops.

Inclusion of additive noise makes the lines penetrable and an oscillatory motion along tori of the periodic field is excited. We characterize this motion by properties of the distribution density, the stationary mean velocity, the diffusion coefficient and escape times and find regimes where the noise plays a constructive role enhancing the transport of particles compared to the case without noise.

DY 24.37 Wed 16:00 Poster D

Noise- and delay-induced dynamics near a global bifurcation — •Roland Aust, Johanne Hizanidis, and Eckehard Schöll — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstraße 36, 10623 Berlin, Germany

A generic model exhibiting a saddle-node bifurcation on a limit cycle is investigated. The model has served as a prototype example of excitability, strongly related to the existing global bifurcation, and coherence resonance, when a stochastic force is added [1]. We extend the system including time-delayed feedback control according to the Pyragas scheme and study it both in the presence and absence of noise. We find that the delay itself is able to create new, interesting dynamics. A delay-induced homoclinic bifurcation governed by a characteristic period scaling-law is reported. Using DDE-BIFTOOL [2] a bifurcation diagram in the $K - \tau$ plane is given (K being the strength of the control force and τ the time delay). In addition, multistability, including various bifurcations (e. g. saddle-node bifurcation of limit cycles, period-doubling), is found. Finally, we choose our parameters such that no delay-induced bifurcations occur and switch on Gaussian white noise. We compare our results to those of the uncontrolled system, in particular, the coherence resonance curve and features of the oscillations and the related power spectra.

[1] Hu Gang, T. Ditzinger, C.Z. Ning, and H. Haken, Phys. Rev. Lett. **78**, 807 (1993).
[2] K. Engelborghs, T. Luzyanina, and D. Roose, ACM Transactions on Mathematical Software, **28**, 1 (2002).

DY 24.38 Wed 16:00 Poster D

Multiple time-delayed feedback control of noise-induced space-time patterns in a reaction-diffusion system — •Niels Majer, Grischa Stegemann, and Eckehard Schöll — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin

We study the influence of noise upon the nonlinear dynamics of current density patterns in a semiconductor nano-structure, and its control by multiple time delayed feedback methods. The investigated system is a double barrier resonant tunnelling diode described by a nonlinear reaction-diffusion model.

The parameters of the system are fixed at values below a Hopf bifurcation where the only stable state of the deterministic uncontrolled system is a spatially inhomogeneous "filamentary" steady state, and oscillating space-time patterns do not occur. The addition of weak Gaussian white noise to the system gives rise to spatially inhomogeneous oscillations.

We introduce a multiple time-delayed feedback control scheme (ETDAS) with a memory parameter R, and investigate its influence on the regularity of the noise induced dynamics under variation of R. The obtained results are explained using linear stability analysis.

DY 24.39 Wed 16:00 Poster D

Coherence resonance - a mean field approach — Eckehard Schöll, •Valentin Flunkert, and Philipp Hövel — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin

We study the constructive influence of noise upon a nonlinear dynamic system in terms of a self-consistent mean field approach [1]. Two different types of coherence resonance of noise-induced oscillations are found in systems close to, but below, a sub- or supercritical Hopf bifurcation, respectively [2]. They can be explained analytically by a mean-field approximation of the Hopf normal forms, elucidating the different effect of noise upon the power spectrum near sub- and supercritical bifurcations.

[1] J. Pomplun, A. Amann, and E. Schöll, Europhys. Lett. 71, 366 (2005)

[2] O. V. Ushakov, H. J. W**nsche, F. Henneberger, I. A. Khovanov, L. Schimansky-Geier, and M. A. Zaks, Phys. Rev. Lett. 95, 123903 (2005)

DY 24.40 Wed 16:00 Poster D

Stochastic and Deterministic Dynamics in Hysteretic Systems — •Sven Schubert and Günter Radons — Chemnitz University of Technology, D-09107 Chemnitz

Many physical and technical systems such as shape memory alloys, nanowires, or certain friction models are characterized by a non-trivial hysteretic behavior, implying e.g. the appearance of nested sub-loops and a complex dependence on previous input events (hysteretic memory).

We study properties of hysteretic output time series $\{y_n\}$ for stochastic and chaotic input scenarios with similar characteristics using a discrete Preisach-hysteresis transducer. Our results show that stochastic and deterministic trajectories are treated differently by hysteresic systems. The probability distributions $p(y)$ show differing behavior. In addition, return maps (y_{n+1}, y_n), referring to higher order correlations of the signals, show different structures, especially taking into account values belonging to even or odd memory length. Using the sensitivity of the Preisach-hysteresis transducer to properties of the input time series one is able to distinguish deterministic chaos from noise. On the other hand, since hysteresis creates long-term memory we observe a slow decay of the autocorrelation function $C_y(\tau)$ for both types of signals. Spectral properties are changed correspondingly.

DY 24.41 Wed 16:00 Poster D

Validity criteria for the Fick-Jacobs equation — •P.S. Burada[1], G. Schmid[1], P. Hänggi[1], D. Reguera[2], and J.M. Rubí[2] — [1]Institut für Physik, Universität Augsburg, Germany — [2]Department de Física Fonamental, Facultat de Física, Universidad de Barcelona, Spain

We analyze the validity of the *Fick-Jacobs* equation for transport of biased Brownian particles in periodic, quasi-one-dimensional structures [1]. The condition of validity for the critical applied bias up to which the Fick-Jacobs equilibration assumption holds is found to be a quadratic function of the periodicity of the structure, and is numerically verified. The comparison is performed through the average particle current for which an analytic expression within the Fick-Jacobs approach is derived. The validity criteria is established from particle distributions along the main direction of transport and the transversal direction obtained numerically. Finally, we construct a phase diagram for the validity of the equilibration assumption in terms of the periodicity of the structure and the ratio between the work done to the particles and available thermal energy.

[1] D. Reguera, G. Schmid, P.S. Burada, J.M. Rubí, P. Reimann, and P. Hänggi, *Phys. Rev. Lett.* **96**, 130603 (2006).

DY 24.42 Wed 16:00 Poster D

A microscopic view on the Stokes–Einstein relation: anomalous translational and rotational motion of macromolecules in solution — •Alexander Uvarov and Stephan Fritzsche — Institut für Physik, Universität Kassel, D–34132 Kassel, Germany; uvarov@physik.uni-kassel.de.

In this contribution, we re-analyze the translational and rotational diffusion of non-rigid macromolecules in solution, starting from the microscopic view point. If a molecule is immersed into a solvent, its shape and dynamical behaviour will depend not only on the interaction among the individual beads but will be affected also by the solvent particles. Phenomenologically, the dynamical properties of the macromolecules are hereby described in terms of the friction and diffusion coefficients which follow the known Stokes–Einstein relation (SER).

By using a semi–phenomenological expression, derived for the friction of macromolecules [1], we calculate the boundary and diffusion coefficients of the free macromolecule as well as the orientation and relaxation correlation function of the non-rigid macromolecule immobilized on a surface [1, 2]. When compared with modern experiment [3] and dynamical simulations [4], excellent agreement is found even for low temperatures of the system when SER can not be apply.

[1] A. Uvarov and S. Fritzsche, PRE73, 011111 (2006); PRL, submitted (2006). [2] A. Uvarov and S. Fritzsche, JCM 121(13), 6561 (2004); Progr. Colloid and Polymer Science 133, 95 (2006). [3] B. Chen, E. Sigmund and W. Halperin, PRL 96, 145502 (2006). [4] J. Schmidt and J. Skinner, JPC B. 108, 6767 (2004)

DY 24.43 Wed 16:00 Poster D

Persistent and directed random walks with speed and angular fluctuations in two dimensions — Fernando Peruani[1,2] and •Luis Guillermo Morelli[1] — [1]Max Planck for the Physics of Complex Systems, Dresden, Germany — [2]Technische Universitaet Dresden, Dresden, Germany

We study the motion of self-propelled particles with fluctuations in the speed and the direction of motion, in two dimensions. We consider the case in which fluctuations in the speed are not correlated to fluctuations in the direction of motion, and assume that both processes can be described by independent characteristic times. We investigate the dynamics of persistent and directed random walks, and derive exact expressions for the mean displacement and the mean squared displacement for arbitrary speed and angular stationary distributions. We show that both persistent and directed random motion with speed fluctuations exhibit a series of alternating ballistic and diffusive regimes, which arise from the interplay between the different time-scales involved. Our results could be relevant to estimate motility indexes from experiments involving living cells or other self-propelled particles.

DY 24.44 Wed 16:00 Poster D

Dry and wet granular shock waves — •Vasily Zaburdaev and Stephan Herminghaus — MPI for Dynamics and Self-Organization, Bunsenstr. 10, D-37073 Göttingen, Germany

The formation of a shock wave in one-dimensional granular gases is considered, for both the dry and the wet case, and the results are compared with the analytical shock wave solution in a sticky gas. Numerical simulations show that the behavior of the shock wave in both cases tends asymptotically to the sticky limit. In the inelastic gas (dry case) there is a very close correspondence to the sticky gas, with one big cluster growing in the center of the shock wave, and a step-like stationary velocity profile. In the wet case, the shock wave has a non-zero width which is marked by two symmetric heavy clusters performing breathing oscillations with slowly increasing amplitude. All three models have the same asymptotic energy dissipation law, which is important in the context of the free cooling scenario. For the early stage of the shock formation and asymptotic oscillations we provide analytical results as well.

DY 24.45 Wed 16:00 Poster D

Extension of the entropy fluctuation theorem to non-equilibrium phase transitions — •Axel Fingerle and Stephan Herminghaus — MPI for Dynamics and Self-Organization, Bunsenstr. 10, D-37073 Göttingen, Germany

The Gallavotti-Cohen fluctuation theorem [1] is one of the few exact results known for chaotic systems in non-equilibrium states. It predicts that the fluctuations Δs_{p} of the phase space volume obey the symmetry relation $P(\Delta s_{\mathrm{p}}) = \exp\left(\Delta s_{\mathrm{p}}\right)\, P(-\Delta s_{\mathrm{p}})$. We point out that for wet granular matter the assumption of time reversibility in the GCFT is not fulfilled and that the phase space volume is conserved, $\Delta s_{\mathrm{p}} \equiv 0$, so that the Gallavotti-Cohen entropy Δs_{p} does not contribute to entropy production. We also show that the similar definition $\Delta s_E = \ln P(\Delta E)/P(-\Delta E)$, in terms of exchanged heat, ΔE, at oscillating walls is not linear in ΔE, so that the distribution $P(\Delta E)$ does not fulfill the symmetry relation, in contrast to observations [2,3] of dry granular matter with less statistics. Finally it is shown that this non-linearity is an instable branch of entropy as a function of energy, $\partial s/\partial E < 0$, which corresponds to the fluid-gas transition of wet granular matter [4].

[1] G. Gallavotti and E.G.D. Cohen, Phys. Rev. Lett. **74**, 2694 (1995).
[2] K. Feitosa and N. Menon, Phys. Rev. Lett. **92**, 164301 (2004).
[3] A. Puglisi, *et al.*, Phys. Rev. Lett. **95**, 110202 (2005).
[4] A. Fingerle, K. Röller and S. Herminghaus, submitted.

DY 24.46 Wed 16:00 Poster D

Surface Melting and Leidenfrost Effect in Wet Granular Matter — •Klaus Röller, Axel Fingerle, and Stephan Herminghaus — MPI for Dynamics and Self-Organization, Bunsenstr. 10, D-37073 Göttingen, Germany

We report two vertical phase separations occurring in wet granular matter when placed on top of a sinusoidally oscillating bottom plate. The system has been studied by means of a molecular dynamic simulation which takes the hysteretic liquid bridge force between wetted particles into account [1]. For low accelerations of the shaking bottom plate we observe a pure solid phase. At a certain value of the acceleration, the top layer starts to melt as indicated by the height de-

pendent diffusion coefficient. As the acceleration is increased further, the height of the fluid phase floating on top of the solid phase grows until it diverges at a well defined solid to fluid transition. As we increase the acceleration further a second vertical phase separation sets in: the condensed phase hovers on top of a gas phase, quite reminiscent of the classical Leidenfrost effect. This is the first observation of density inversion in wet granular matter. The chunk above the gas is thermally isolated by the low heat conductivity of the gas in which the upward stream of injected energy is dissipated in frequent ruptures of liquid bridges. Finally, above an acceleration depending on the filling height the condensed phase evaporates completely.

[1] Advances in Physics **54**, 221 (2005).

DY 24.47 Wed 16:00 Poster D

The Phase Diagram of Wet Granular Matter under Vertical Agitation — •Axel Fingerle, Klaus Röller, and Stephan Herminghaus — MPI for Dynamics and Self-Organization, Bunsenstr. 10, D-37073 Göttingen, Germany

Wet granular matter has numerous industrial applications and there is some phenomenological knowledge about soil liquefaction caused by earth quakes for such systems. We provide physical insight in the critical behavior of wet granular matter under vertical agitation. The minimal capillary model [1,2] has been applied to simulations, and a continuum descriptions for wet granular matter has been derived. We could reveal two distinct mechanism for phase transitions far from thermal equilibrium, which are confirmed by experiments: The *solid-fluid* transition sets in when the vertical acceleration Γ of the plates confining the wet granulate is strong enough to overcome the cohesion force of the interstitial liquid phase. The *fluid-gas* transition defines a critical line at a mean squared velocity $\langle v^2 \rangle$ of the shaking, which is proportional to the surface tension of the wetting liquid. Furthermore, there are two disjoint domains of solid-gas and fluid-gas coexistence in the Γ-v-plane. We introduced dynamical order parameters to quantify the states of wet granular matter and derived a local equation of state. With these results and the piecewise symplectic structure of the capillary model, wet granular matter serves as a paradigmatic system for nonequilibrium physics with favorable mathematical properties.

[1] S.H., Adv. Phys. **54**, 221 (2005).
[2] A.F. and S.H., Phys. Rev. Lett. **97**, 078001 (2006).

DY 24.48 Wed 16:00 Poster D

Fluctuations due to the nonlocal character of collisions — •Klaus Morawetz — Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — Max Planck Institute for the Physics of Complex Systems, Noethnitzer Str. 38, 01187 Dresden, Germany

It is shown that the collision integral describing the nonlocal character of collisions leads to the same mean-field fluctuations in the one-particle distribution as proposed by Boltzmann-Langevin pictures. It is argued that this appropriate collision integral contains the fluctuation-dissipation theorems in equilibrium itself and therefore there is no need to assume additionally stochasticity. This leads to tremendous simplifications in numerical simulation schemes. [nucl-th/0609025]

DY 24.49 Wed 16:00 Poster D

Spatiotemporal memory in a one-dimensional reaction-diffusion system — •Knud Zabrocki[1], Steffen Trimper[1], and Michael Schulz[2] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, 06099 Halle (Saale), Deutschland — [2]Fachbereich Physik, Universität Ulm, 89069 Ulm, Deutschland

To analyze possible generalizations of reaction-diffusion schemes due to feedback coupling and memory effects we investigate simple scalar evolution equations for the mass density or the probability density where long-range correlations and time delay are coupled. The influence of such a spatiotemperal delay is studied in a reaction-diffusion model. All processes within a sphere of radius $R(t) = \kappa t^{\alpha}$ around a certain spatial point contribute to the instantaneous reaction and diffusion process. Due to the competition between both processes and the delay the system features a non-trivial stationary state. The resulting concentration profiles are calculated analytically for a ballistic behavior with $\alpha = 1$ and for an additional local diffusive transport with $\alpha = \frac{1}{2}$. Moreover the concentration profile offers an anisotropic behavior due to the delay. The model is exactly soluble.

DY 24.50 Wed 16:00 Poster D

Ageing, intermittency and metastability in spin glass systems — •Andreas Fischer[1], Karl Heinz Hoffmann[1], and Paolo Sibani[2] — [1]Institut für Physik, Technische Universität Chemnitz, D-09107 Chemnitz, Germany — [2]Fysisk Institut, Odense Universitet, Campusvej 55, DK5230 Odense M, Denmark

Spin glasses are important prototypes for complex systems. They show numerous different phenomena including intermittency, metastability and ageing. Complex dynamical behavior is revealed in the low-temperature regime, especially below the spin glasses transition temperature. There a variety of features can be found, which show the systems' inability to attain thermodynamic equilibrium with its ambient during observable time scales. The resulting ageing and memory effects have been observed in many experiments. In particular spin glasses are good model systems as their magnetism provides an easy and accurate measurable observable representing important information about the systems state.

In order to understand the features observed, different model approaches have been applied for describing the systems internals. One prominent example of these model systems is the so called L-S-tree, a hierarchical model of the complex systems' state spaces within the low-temperature regime. The L-S-tree has proven its applicability by various successful reproductions of experimentally observed features.

Here we show some newly observed spin glass features and how these can be reproduced by L-S-tree models.

DY 24.51 Wed 16:00 Poster D

Shear fluidisation of wet granulates — •Seyed Habibollah Ebrahimnazhad Rahbari, Martin Brinkmann, and Stephan Herminghaus — Dynamics of Complex Fluids, Max- Planck Institute for Dynamics and Self- Organization, Bunsenstr. 10, 37073 Göttingen, Germany

The fluidization of dense wet granular matter in the presence of externally applied shear forces is examined by molecular dynamics-type simulations in two and three dimensions. The granulate is modeled as an assembly of frictionless soft discs, respectively, spheres with a bidisperse size distribution. A short ranged constant attractive force accounts for liquid bridges between adjacent spheres, including the hysteretic nature of capillary interaction [1]. As reported in earlier works on similar models of wet granulates by Schultz [2] and Goll [3], a critical transition between a quiescent and a fluidized state is observed as the amplitude of the shear forces is increased. Since it has been suggested that Lennard-Jones potentials may be too soft to account for the jamming effects at high density [3], we alternatively examined interactions via Hertzian forces. Different dynamic regimes are identified and characterized by the magnitude of drift motion, particle diffusion and the spatial distribution of stresses. In our simulations, shear forces are generated either through a spatially varying force field or by sliding side walls being decorated with a immobilized monolayer of particles.

[1] S Herminghaus, *Adv. Phys.* **54**: 221, (2005)
[2] M Schulz et al., *Phys. Rev. E* **67**: 052301 (2003)
[3] C M Goll and K Mecke, *private communication*

DY 24.52 Wed 16:00 Poster D

El Nino and the Delayed Action Oscillator — •Rudolf Andreas Römer, Ian Boutle, and Richard Taylor — Department of Physics and Centre for Scientific Computing, University of Warwick, Coventry CV4 7AL, UK

We study the dynamics of the El Nino phenomenon using the mathematical model of delayed-action oscillator (DAO). Topics such as the influence of the annual cycle, global warming, stochastic influences due to weather conditions and even off-equatorial heat-sinks can all be discussed using only modest analytical and numerical resources. Thus the DAO allows for a pedagogical introduction to the science of El Nino and La Nina while at the same time avoiding the need for large-scale computing resources normally associated with much more sophisticated coupled atmosphere-ocean general circulation models. It is an approach which is ideally suited for student projects both at high school and undergraduate level.

DY 24.53 Wed 16:00 Poster D

Numerical simulation of the air flow through a pipe organ for the purpose of identification of sound anomalies — •Werner Jürgens and Markus Abel — UP Transfer GmbH an der Universität Potsdam, Am Neuen Palais 10, 14469 Potsdam

Some pipe organs exhibit an irregular pipe sound, which can partly be ascribed to perturbations in the air supply. However, the details of this process, which can involve multiple pipes, are insufficiently understood.

In order to determine the nature and origin of the perturbations, the present investigation focuses on the wind chest of an organ. The wind chest is located below the pipes and supplies them with air.

The velocity and pressure distributions of the flow inside the wind chest are calculated numerically. By this means, it is possible to study how disturbances propagate inside the wind chest and how they affect the sound generated by the pipes.

DY 24.54 Wed 16:00 Poster D

Dynamik turbulenter Strukturen in einem Rayleigh Bénard System — •Michael Langner und Joachim Peinke — Institut für Physik, Universität Oldenburg

Wir präsentieren experimentelle Ergebnisse eines Rayleigh Bénard Systems bei hohen Rayleighzahlen (10^9). Der experimentelle Aufbau besteht aus einer zylindrischen Zelle von 30cm Durchmesser und ebensolcher Höhe. Die Temperaturdifferenzen im System betragen maximal etwa $20°C$. Bei den von uns durchgeführten Geschwindigkeitsmessungen kommt ein Doppler Ultraschall Anemometer zur Anwendung, welches eine Datenerfassung entlang einer frei wählbaren Linie erlaubt (Ortsauflösung 3mm, Zeitauflösung 150ms). Insbesondere analysieren wir das Verhalten der "Large Scale Circulation", indem wir die Geschwindigkeiten entlang zweier sich kreuzenden Linien in der Nähe der unteren Heizplatte untersuchen. Anhand der statistischen Analyse dieser Daten sollen Übergänge zwischen unterschiedlichen Zuständen des System identifiziert werden.

DY 24.55 Wed 16:00 Poster D

Phase field simulations for drops and bubbles — •Rodica Borcia and Michael Bestehorn — Lehrstuhl Statistische Physik/ Nichtlineare Dynamik, Brandenburgische Technische Universität Cottbus, Erich-Weinert-Straβe 1, 03046, Cottbus, Germany

Recently we proposed a phase field model to describe Marangoni convection in a compressible fluid of van der Waals type far from criticality [Eur. Phys. J. B **44** (2005), 101]. The model previously developed for a two-layer geometry is now extended to drops and bubbles. A randomly distributed initial density evolves towards drops in a vapor atmosphere or bubbles in a liquid, depending on the total mass. Finally, as applications, we report on numerical simulations for drop Marangoni migration in a temperature gradient and for drop spreading on a solid surface.

DY 24.56 Wed 16:00 Poster D

Statistical analysis of coherent structures in transitional pipe flow — Tobias Schneider, Bruno Eckhardt, and •Jürgen Vollmer — Fachbereich Physik, Philipps Universität, 35032 Marburg, Germany

The transition to turbulence in pipe flow is an outstanding problem in fluid dynamics. Although linear stability theory suggests that the laminar state always remains stable, the transition to turbulence occurs at rather moderate flow speeds. Recently, computer simulations and the numerical discovery of unstable travelling waves have supported a transition scenario that is inspired by ideas from dynamical systems theory. According to these ideas, the transition is connected with a strange saddle that forms in the state space of the system in the neighbourhood of the travelling waves. One indicator for this saddle is the transient appearance of the travelling waves in the flow field. Time traces of correlation functions clearly show regions dominated by four or six vortices, in agreement with experimental observations. We study the time spent near each travelling wave and characterise the dynamics by transition probabilities between the states. This allows us to make a first and empirically feasible step towards an analysis of the turbulence characteristics in terms of travelling waves.

DY 24.57 Wed 16:00 Poster D

Blocking method in model reduction for nonlinear dynamics — •Thorsten Bogner — Condensed Matter Theory, Fakutät für Physik,* Universität Bielefeld, Postfach 100131, D-33501 Bielefeld, Germany

In many fields where nonlinear dynamical systems arise, e.g. fluid dynamics, already advanced numerical methods are known. Unfortunately, these methods often lead to a very high dimensional description if an acceptable error bound is desired. In these cases model reduction can simplify the numerical description significantly. It can also make new applications possible, where speed is necessary or computational power is limited.

An established method in model reduction is the Proper Orthogonal Decomposition (POD) that aims on finding a subspace of the phase space that can reproduce the dynamics 'optimally'. This is based on the spatial correlation matrix, which is numerically approximated from sample trajectories. It has the disadvantage, that the large system has to be solved to perform the POD.

Instead of treating the large system directly, we use a blocking method to get an approximate POD of the full system. Also an iteration is possible to increase the accuracy. For our method only calculations on small systems are necessary. This leads to a significant reduction of work load and memory size for the POD itself.

We test our method on the linear 1D diffusion equation as a toy modell with is also accessible analytically. Further we introduce nonlinearities resulting in the Burgers equations and the KPZ equation.

DY 24.58 Wed 16:00 Poster D

Combined path-following and time integration methods applied to lubrication equations — •Philippe Beltrame and Uwe Thiele — Current address: Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, D-01187 Dresden, Germany

Pattern formation in thin liquid films represents a highly nonlinear phenomena far from equilibrium. To understand the evolution beyond the weakly nonlinear stage requires a numerical treatment of the of the full nonlinear system either by time integration of the dynamics or by path-following to track the (relative) equilibria directly. We develop a code unifying the time integration and path following tasks for generic lubrication equations [1] following similar projects for the Navier-Stokes equations [2]. However, the presence of the bilaplacian operator in the curvature term deteriorates drastically the Jacobian matrix conditioning which is the crucial point in such methods. Furthermore the presence of an ultrathin precursor film (typically below 100 nm thickness) leads to a strong scale separation for macroscopic drops. In order to tackle these specific problems we developed an original algorithm using exponential propagation. The code proves its reliability and efficiency compared to more classical methods. Our common numerical framework is applied to 2D sliding drops and 2D/3D depinning problem.

References [1] Oron, A et al. Reviews of Modern Physics, 1997, 69, 931-980 [2] Tuckerman, L. et al., Doedel (Eds) Bifurcation analysis for timesteppers Springer, New York, 2000

DY 24.59 Wed 16:00 Poster D

Dynamics of Vortex Filaments in Layered Media — •Pavel Popov, Alexey Romanov, and Konstantin Chukbar — Russian Research Center "Kurchatov Institute", Moscow, Russia

We perform theoretical investigation of the dynamics of a single vortex filament in layered superconducting structures, assuming the conductivity between layers to be zero. The language we use is purely classical, quantum effects being responsible only for the finite size and internal structure of vortex kernel, and for discretization of its amplitude. Using the general fact that generalized vorticity $\Omega = \nabla \times \vec{P}$ is freezed into motion of medium (in our case, superconducting electrons $\vec{P} = m\vec{v} - q\vec{A}/c$) we derive the equations that allow us to get the velocity of medium motion and thus describe self-induced dynamics of a vortex filament. Similar problems have already been solved in the cases of hydrodinamic media and isotropic charged fluids.

Particularly, we consider linear waves on infinitely thin vortex filament. For this case we obtain dispersion relation and find out that, due to anisotropy, there is significant dependece of filament behaviour on the angle of its slope: when the inclination is larger than the critical value filament oscilations become unstable. Next, we get dispersion relations for various longitudial and transverse modes for a vortex with finite kernel size. We note that consideration of the energy of a finite vortex suggests that it could also be unstable (although, this is not the case with linear approximation).

DY 24.60 Wed 16:00 Poster D

Higher-order study of vesicle dynamics in shear flow — •Gerrit Danker and Chaouqi Misbah — LSP, UJF-Grenoble 1 and CNRS, BP 87, 38402 Saint Martin d'Hères, France

Vesicles, which consist of a closed fluid membrane surrounding a Newtonian liquid, have been studied extensively in recent years. They can, for example, act as simple mechanical models of biological cells in an external flow, giving insights into challenging problems like blood rheology.

Recent experiments [1] and theoretical studies in the small excess area limit [2] demonstrate that vesicles in a shear flow display differ-

ent dynamical behaviour, depending on the viscosity contrast between inner and outer fluid. For small viscosity contrast one observes a time-independent vesicle shape with fixed orientation in the flow (tank-treading) and for sufficiently large viscosity ratio an unsteady motion (either tumbling or vacillating-breathing). We extend the analytical study in [2] to higher order in the excess area and discuss consequences for vesicle dynamics and applications to rheology of dilute vesicle suspensions [3].

[1] V. Kantsler and V. Steinberg, Phys. Rev. Lett. **96**, 036001 (2006).
[2] C. Misbah, Phys. Rev. Lett. **96**, 028104 (2006).
[3] G. Danker and C. Misbah, preprint (2006).

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LONGITUDINAL HEAT FLOWS IN COLLISIONLESS ANISOTROPIC PLASMAS, ARISING IN MHD MOTIONS. — •IGOR GRIGORIEV[1] and VLADIMIR PASTUKHOV[2] — [1]RRC "Kurchatov Institute" Moscow Russia — [2]RRC "Kurchatov Institute" Moscow Russia

Magnetohydrodynamic motions of finite-beta collisionless plasmas with anisotropic pressure confined by magnetic field are considered. For convenience and simplicity we analyze Z-pinch-like magnetic configuration with purely azimuthal magnetic field. Non-axisymmetric Alfven modes are analyzed within one-fluid MHD-like model, however, perturbations of longitudinal and transversal plasma pressures are calculated from kinetic equation using path-integral method. It is shown that adiabats of Chew-Goldberger-Low fail their applicability in the case of low-frequency (below bounce-frequency) non-axisymmetric plasma perturbations due to arising longitudinal energy fluxes. The obtained pressure perturbations are used to analyze the stability of non-axisymmetric (Alfven) modes.

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Temperature fluctuations in a heated free jet measured by a new microscopic temperature sensor — •FLORIAN HEIDEMANN, MARCO MUNZEL, and ACHIM KITTEL — University of Oldenburg, D-26111 Oldenburg

Turbulence is a phenomenon whose basic principles are still not well understood. One approach to investigate its nature is the charaterization of passiv scalars such as temperature. With a new developed fast thermosensor we are able to measure the temperature fluctuations in a heated free jet of water in a water tank with high spatial and temporal resolution at different positions and for different flow velocities. The used nozzle has a diameter of $2mm$, which provides a laminar flow with a rectangular velocity profile at the outlet. The sensor is based on a miniaturized thermocouple and has an active area of approx. $0.05\mu m^2$ and a response time of approx. $10\mu s$ in water with a temperature resolution of $50mK$ (measured with a bandwidth of $100kHz$). Our aim is to characterize the temperature fluctuations of the free jet with power spectra and increment distributions depending on the position perpendicular and parallel to the symmetry axis with respect to the nozzle.