DY 22: Posters I

Time: Wednesday 17:00–19:00 Location: Poster A

DY 22.1 Wed 17:00 Poster A

Associated Liquids from Electronic Structure Methods — •Eva Perlt, Marc Brüssel, Sebastian B. C. Lehmann, Michael v. Domaros, and Barbara Kirchner — Wilhelm-Ostwald-Institute for Physical and Theoretical Chemistry, University of Leipzig, Linnéstr. 2, D-04103 Leipzig, Germany

The investigation of liquid phases by means of electronic structure methods is still a demanding task due to the high computational cost and the large number of molecules that need to be considered. One approach modeling the liquid phase with the aid of statistical thermodynamics is the Quantum Cluster Equilibrium theory. In this contribution we present the basic methodology and its implementation in the Peacemaker program.[1] Furthermore, the extension of the theory to binary mixtures and the realization in the Mice code are introduced.[2] The application of the programs is demonstrated at the example of two case studies: The first deals with the structure of pure hydrogen fluoride. Therefor, explicitly correlated methods have been employed and a basis set extrapolation has been carried out. Second, the binary mixture of water and dimethyl sulfoxide at several mole fractions and the Excess Gibbs free energy of the mixture have been studied.

[1] B. Kirchner, C. Spickermann, S. B. C. Lehmann, E. Perlt, J. Langner, M. v. Domaros, P. Reuther, F. Uhlig, M. Kohagen, M. Brüssel, *Comp. Phys. Comm.* **182**, 1428-1446 (2011)

[2] M. Brüssel, E. Perlt, S. B. C. Lehmann, M. v. Domaros, B. Kirchner, *J. Chem. Phys.* **135**, 194113 (2011)

DY 22.2 Wed 17:00 Poster A

Free-Energy Fluctuations and Chaos in the Sherrington-Kirkpatrick Model — •Christoph Norrenbrock[1], Timo Aspelmeier[1], and Alexander K. Hartmann[2] — [1]Georg-August-Universität Göttingen, Göttingen (Germany) — [2]Carl-von-Ossietzky Universität Oldenburg, Oldenburg (Germany)

We consider the mean-field Ising spin glass (Sherrington-Kirkpatrick model [1]) regarding its sample-to-sample fluctuations of the free-energy. It has been shown [2] that these fluctuations are related to bond chaos, which refers to the property that the equilibrium state changes completely by an infinitesimal change of the bond strength. Taking this connection into account, it has been shown analytically using replica methods [2] that the exponent μ, governing the growth of the fluctuations with the system size N, is bounded by $\mu \leq \frac{1}{4}$.

In contrast to previous studies (e.g. [3]), where the fluctuations in the mean-field model were investigated numerically at zero temperature only, we calculate μ at finite temperature by simulating chaos. For this purpose, we compute spin-overlaps between systems with slightly different bond-assignments. These systems ($N = 16$ up to $N = 512$) were simulated by Monte-Carlo simulations using the parallel tempering method.

[1] Sherrington, D., Kirkpatrick, S., Phys. Rev. Lett. 35, 1792 (1975)
[2] Aspelmeier, T., Phys. Rev. Lett. 100, 117205 (2008)
[3] Boettcher, S., Eur. Phys. J. B 46, 501 (2005)

DY 22.3 Wed 17:00 Poster A

An entropy based model-free definition of causal coupling strength for multivariate time series — •Jakob Runge[1,2], Jobst Heitzig[1], and Jürgen Kurths[1] — [1]Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, D–14412 Potsdam, Germany — [2]Department of Physics, Humboldt University, Newtonstr. 15, D–12489 Berlin, Germany

We discuss the problem of defining a causal coupling strength between components of a multivariate time series if no underlying model is assumed. This is in contrast to methods like cross-correlation or granger causality. The method is based on conditional mutual information and utilizes the concept of graphical models. We investigate how our measure relates to model systems where a coupling strength is known and discuss its limitations.

DY 22.4 Wed 17:00 Poster A

Simulating flexible polymers in a potential of randomly distributed hard disks — Sebastian Schöbl, •Johannes Zierenberg, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Germany

Recently, we performed equilibrium computer simulations of a two-dimensional pinned flexible polymer exposed to a quenched disorder potential consisting of hard disks [1]. Throughout the study, we applied two conceptionally different algorithms, an off-lattice growth algorithm and a multicanonical Monte Carlo method, in order to cross-check the results obtained. We measured the the end-to-end distribution and the tangent-tangent correlations and investigated the scaling behavior of the mean square end-to-end distance for short chains. While the influence of the potential in the low-density case is merely marginal, it was possible to show that it dominates the configurational properties of the polymer for high densities.

[1] S. Schöbl, J. Zierenberg, and W. Janke, Phys. Rev. E 84, 051805 (2011)

DY 22.5 Wed 17:00 Poster A

Influence of rounding errors on the quality of heuristic optimization algorithms — •Martin Ransberger[1], Ingo Morgenstern[1], and Johannes Josef Schneider[2] — [1]Faculty of Physics, University of Regensburg, 93040 Regensburg, Germany — [2]Department of Physics, Mathematics, and Computer Science, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

Simulated annealing and search space smoothing are both widely used optimization algorithms. While simulated annealing overcomes barriers in the energy landscape at finite temperatures, search space smoothing intends to remove these barriers, such that a greedy algorithm is sufficient to find the global minimum. Rounding errors in the calculation of the energy landscape can affect the quality of the results and even lead to a new physical behavior.

In this presentation, we thoroughly investigate the effect of rounding errors on the energy landscape and their influence on optimization processes with simulated annealing and search space smoothing. We present computational results for the traveling salesman problem.

DY 22.6 Wed 17:00 Poster A

Understanding water and water mixtures by phenomenological considerations — •Lotta Heckmann and Barbara Drossel — Institut für Festkörperphysik, TU Darmstadt, Germany

Understanding the behavior of water and water mixtures is of large relevance for biological systems. For this reason, the properties of bulk water, especially its phase behavior and its anomalies, have been subject of investigation until today. One approach to gain further insight into the special characteristics of water is the use of very simplified models that do not represent specific molecular properties, but rather aim to match general properties of water. We follow the spirit of Ben-Naim (2009) and investigate a 1D-model consisting of point masses and simple interaction potentials for which we analyze conditions under which a phase behaviour similar to that of water is observed. Since the model contains only very few parameters, we can thereby understand in more detail which ingredients are indispensable for a model that describes correctly the phase behaviour of water. Our long-term objective is to analyze the phase behaviour of water and water mixtures in confinement, for which we also perform molecular dynamics simulations.

DY 22.7 Wed 17:00 Poster A

Effects of hydrodynamic interactions in heterogeneous nucleation of colloids — •Dominic Röhm and Axel Arnold — Institute for Computational Physics, Universität Stuttgart, 70569 Stuttgart, Germany

Nucleation, the early stage of crystal growth, is still a rather poorly understood process. We investigated the heterogeneous nucleation in a colloidal model system near a wall using Molecular Dynamics computer simulations. In our coarse-grained simulations, the particles interact via a screened Coulomb (Yukawa-) potential representing charged colloids in water. Our focus lies on the influence of the hydrodynamic interaction, which is often neglected, since nucleation is considered as a quasi-static process. However, recent experiments have shown, that the kind of thermalization of the sample has a drastic influence on the nucleation rate.

In our simulations, we incorporated hydrodynamic nteractions by coupling the particles to a lattice fluid. Since the computation of the hydrodynamic interaction is still orders of magnitude more expensive than classical interactions, we have recently enabled our MD simulation software ESPResSo to employ GPUs for the calculation of the lattice fluid. By this, we can investigate systems, that previously required a small computer cluster, using a single GPU. Using a cluster equipped with GPUs, allows us to systematically investigate the influence of hydrodynamics on the heterogeneous nucleation, and explain why laminar flow conditions, can lead to enhanced nucleation by preordering.

DY 22.8 Wed 17:00 Poster A

Modelling Electrokinetic Phenomena with Lattice-Boltzmann and explicit Ions — •Georg Rempfer, Stefan Kesselheim, Dominic Röhm, and Christian Holm — Institute for Computational Physics, University of Stuttgart, 70569 Stuttgart, Germany

We report that we can successfully simulate electrokinetic phenomena like electro-osmotic flow in arbitrary geometries utilizing coarse-grained molecular dynamics simulations. We use point like particles to represent the ions, which interact via Lennard-Jones and Coulomb potentials. The long ranged Coulomb contribution is calculated with the P3M algorithm. To incorporate the hydrodynamic particle-particle and particle-wall interactions, we couple the point particles to a GPU accelerated, thermalized lattice-Boltzmann fluid. All implementations are readily available in the ESPResSo simulation package. With this method, we can successfully reproduce results obtained via the electrokinetic equations as demonstrated with slit-pore and cylindrical systems and we are able to treat systems beyond the validity of the electrokinetic equations like systems including multivalent ions.

DY 22.9 Wed 17:00 Poster A

Scale-free enumeration of self-avoiding walks on critical percolation clusters — •Niklas Fricke and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Germany

We present a new method for exact enumeration of self-avoiding walks on critical percolation clusters. It can handle very long walks by exploiting the clusters' low connectivity and self-similarity. In 2D we were able to enumerate walks of more than 1000 steps with over 10^{170} conformations. The exponents ν and γ, governing the scaling behavior of the end-to-end distance and the number of configurations, as well as the connectivity constant μ could thus be determined with unprecedented accuracy. The method will help answering long-standing questions regarding this particular problem and might be extended to similar systems. Furthermore, it can be used to check and gauge other methods, analytical and numerical.

DY 22.10 Wed 17:00 Poster A

Nonlinear analysis of Diffusion Tensor Imaging (DTI) data of human brain neuron tracts — •Johanne Hizanidis[1], Panayiotis Katsaloulis[1], Dimitris Verganelakis[2], and Astero Provata[1] — [1]National Center for Scientific Research Demokritos, Athens, Greece — [2]Biomedical Institute Euromedica Encephalos, Athens, Greece

Magnetic Resonance Imaging (MRI) is a widely used medical non-ionizing and non-invasive imaging method for the accurate visualization of the human brain's internal. A recently developed MRI technique, the so-called Diffusion Tensor Imaging (DTI) Tractography allows the in-vivo spatial study of white matter neuronal fibers, with a resolution of the order of mm. DTI measures the local properties of water diffusion between the axons of the tracts producing 2D or 3D images, in which shape represents the architecture of fibers and color corresponds to the diffusion direction. In earlier studies, fractal geometries were employed to describe the architecture of the human brain. Fractal analysis was used to determine the degree of statistical self-similarity characterizing the neuron network corresponding to a certain part of the brain. In this work, we analyze the statistical properties of the local density distribution of water molecules in the brain, as obtained from the 3D DTI images and develop a nonlinear mathematical model to describe the dynamics of this structure which fit the real data. The quantitative measures extracted from the data could potentially be used as a diagnostic tool (index) enabling the discrimination between healthy and damaged (from accidents, diseases or age) white matter.

DY 22.11 Wed 17:00 Poster A

Desynchronizing effect of high-frequency stimulation in a generic cortical network model — Markus Schütt and •Jens Christian Claussen — Institut für Neuro- und Bioinformatik, Universität zu Lübeck

Transcranial Electrical Stimulation (TCES) and Deep Brain Stimulation (DBS) are two different applications of electrical current to the brain used in different areas of medicine. Both have a similar frequency dependence of their efficiency, with the most marked effects around 100 Hz. We apply superthreshold electrical stimulation, specifically depolarizing DC current, interrupted at different frequencies, to a simple model of a population of cortical neurons which uses phenomenological descriptions of neurons by Izhikevich and synaptic connections on a similar level of sophistication. With this model, we are able to reproduce the optimal desynchronization around 100Hz, as well as to predict the full frequency dependence of the efficiency of desynchronization, and thereby to give a possible explanation for the action mechanism of TCES.

[1] Markus Schütt and Jens Christian Claussen (submitted)

DY 22.12 Wed 17:00 Poster A

Auditory Stimulation to induce sleep slow oscillations — •Hong-Viet Ngo[1], Jan Born[2,3], Jens Christian Claussen[1], and Matthias Mölle[2,3] — [1]Institut für Neuro- und Bioinformatik, Univ. Lübeck — [2]Dept. of Neuroendocrinology, Univ. Lübeck — [3]Dept. of Medical Psychology and Behavioral Neurobiology, Univ.Tübingen

Slow oscillations, a hallmark of slow wave sleep, are collective cortical oscillations appearing in mammals during slow wave sleep, and have a typical spectral peak frequency around 0.8 Hz in humans. Recent studies have demonstrated a beneficial role of slow wave sleep for the consolidation of memories, which can even be enhanced by electrical stimulation [1]. Here, we use acoustical stimulation to probe to what extent an enhancement of slow oscillations is possible.

[1] L.Marshall, H.Helgadottir, M.Mölle, J.Born, Nature 444, 610 (2006)

DY 22.13 Wed 17:00 Poster A

Introducing Ca-dependent plasticity into cortical up/down-state models — •Michael Schellenberger and Jens Christian Claussen — Institut für Neuro- und Bioinformatik, Universität zu Lübeck

Multiple studies have shown that sleep and especially the so called slow wave sleep is essential for the development of memories. However the exact mechanisms remain unknown. Therefore we investigate a biophysical model proposed by Compte et al. [1] which shows those characteristic oscillations of the membrane voltage. We introduce long term plasticity due to a Ca-dependent plasticity rule, which is based both on the trafficking and the phosphorylation/dephosphorylation of AMPA-receptors in the postsynaptic spine. In different simulations we compare several aspects of the original and the modified model and investigate the dynamical properties of the neurons with respect to the generation of long term potentiation.

[1] A. Compte et al., J. Neurophysiol 89, 2707 (2003)

DY 22.14 Wed 17:00 Poster A

Multiscale entropy of heart rate fluctuations in patients with acromegaly — •Mirjana M Platiša[1], Svetozar Damjanović[2], and Vera Gal[1] — [1]Institute of Biophysics, School of Medicine, Belgrade University, Belgrade, Serbia — [2]Institute of Endocrinology, Clinical Center Serbia, Belgrade, Serbia

Recent evidence suggests that the loss of complexity in time-series may be a generic feature of pathologic dynamics. Hence, we have studied complexity of the time-series of heart interbeat (RR) intervals in patients with acromegaly using multiscale entropy (MSE). ECG was recorded during sleeping period in 10 patients with acromegaly (AP), and 7 age matched (AM) healthy subjects and 7 young healthy subjects. The whole data time-series of RR intervals were analyzed. The MSE curve profiles were different for these three groups. Complexity measure obtained over scale one is the highest in young healthy subjects and there is no difference between AP and AM subjects. However, at higher scales complexity is the highest in AP, and slightly higher in young subject than in AM group. These results reveal that long range heart rhythm complexity is significantly influenced by the excess of growth hormone.

DY 22.15 Wed 17:00 Poster A

Effects of mechanical motion on electrical excitation of the heart — •Stefan Fruhner[1,2], Harald Engel[1], and Markus Bär[2] — [1]Institut für Theoretische Physik, TU Berlin — [2]Physikalisch-Technische Bundesanstalt, Berlin

Computer models of cardiac excitation often include a very precise physiological description and accurately account for anatomical details like fibre orientation or heterogeneity of heart tissue but neglect cardiac motion. On the other hand it might be essential for a deeper understanding of the mechanisms of arrhythmias like tachycardia and fibrillation. To address this fact challenging mathematical approaches need to be implemented and thoroughly validated.

In this work we try to incorporate experimentally estimated motion into computer simulations. Time-resolved magnetic resonance images (MRI) were recorded in order to create finite element meshes that allow to map mechanical motion on statically performed simulations.

A tagged acquisition protocol was chosen so that cardiac motion can be extracted for a set of distinct points within the myocardial region. Myocardial fibre orientations were allocated algorithmically. Intra- and extracellular domains are treated separately utilizing a bidomain approach. The impact of cardiac motion on artificially generated biosignals like the electrocardiogram (ECG) or the magnetocardiogram (MCG) is demonstrated.

Our approach also offers the opportunity to calculate the mechanical stresses during cardiac contraction from experimental data.

DY 22.16 Wed 17:00 Poster A

Up- down state switching in a conductance- based cortical model — •Arne Weigenand, Thomas Martinetz, and Jens Christian Claussen — Institut für Neuro- und Bioinformatik, Universität zu Lübeck

Cortical slow oscillations occur in the mammalian brain during deep sleep and have been shown to contribute to memory consolidation, an effect that can be enhanced by electrical stimulation. As the precise underlying working mechanisms are not known it is desired to develop and analyze computational models of slow oscillations and to study the response to electrical stimuli. In this paper we employ the conductance based model of Compte *et al.* [J Neurophysiol **89**, 2707] to study the effect of electrical stimulation. First we reproduce the experimental results of electrical stimulation in ferret brain slices by Shu *et al.* [Nature **423**, 288] from the conductance based model. The electrical stimulation leads to collective responses which we observe to depend on the timing of the stimulus with respect to the state of the slow oscillation. To quantify the network response on stimulation we calculate the phase response curve for the conductance based network model. Within the up state stimulation leads to a shortening of the up state, or phase advance, whereas during the up-down transition a prolongation of up states is possible, resulting in a phase delay. Finally we derive the phase response curve also for the simple mean-field model by Ngo *et al.* [epl Europhysics Letters **89**, 68002] and find that the qualitative shape is preserved.

[1] A. Weigenand, T. Martinetz and J.C. Claussen, submitted

DY 22.17 Wed 17:00 Poster A

Rigorous selection theory of free dendritic growth in a flow — •Martin von Kurnatowski and Klaus Kassner — Otto-von-Guericke-University Magdeburg, Department of Theoretical Physics, Universitätsplatz 2, 39106 Magdeburg

The problem of a crystal growing freely in its undercooled melt is governed by heat transport. The two-phase boundary takes a nearly parabolic shape. This dendrite is stabilized by *anisotropic* surface tension which acts as a singular perturbation and selects the growth velocity and the length scale of the pattern. So far, the selection problem has usually been treated with the Kruskal-Segur-method [1], which is only applicable to linear field equations.

We extend this method with the asymptotic Zauderer decomposition scheme. This powerful combination is able to deal with many unsolved problems in crystal growth such as *nonlinear* convective effects. An equation determining the shape of the dendrite is derived from the diffusion-advection equation. Only at this point, a particular flow velocity field has to be inserted, which we approximate as a potential flow. Subsequently, a solution to this equation is constructed by asymptotic matching in the complex plane using WKB techniques. Shape and growth velocity are finally selected by numerical integration of a local equation close to the singular point of the problem.

[1] M. Ben Amar, Phys. Rev. A 41, p. 2080 (1990)

DY 22.18 Wed 17:00 Poster A

Biofilm growth in shear flows — •Jörn Hartung and Björn Hof — Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen

The formation of biofilms in water distribution systems and medical equipment has detrimental effects (e.g. decrease in efficiency of water conduits and emergence of health risks). Pathogenic microorganisms capable of biofilm formation can spoil potable water and easily lead to infections in humans. Furthermore, biofouling in water distribution pipes decreases the cross section available for the bulk flow and increases the surface roughness which in turn leads to higher friction losses.

We investigate the influence of the Reynolds number on biofilm formation for laminar flow in the regime 500<Re<5000. While generally biofilms grow faster at low Reynolds numbers where the shear stresses are small, we surprisingly find a maximum growth for 1000<Re<2000. An explanation for this behaviour could be that the transport rate of nutrients is limited at small Reynolds numbers leading to lesser amounts of attached biofilm material. At increasing Reynolds numbers shear forces become more pronounced and facilitate detachment. At high Reynolds number we find in addition that the biofilms disturb the initially laminar flow and trigger turbulence which leads to a large drag increase.

DY 22.19 Wed 17:00 Poster A

The Three-Body Model of a Micro-swimmer — •Jayant Pande[1], Kristina Pickl[2], Jan Götz[2], Klaus Iglberger[3], Klaus Mecke[1], Ulrich Rüde[2,3], and Ana-Sunčana Smith[1] — [1]Institut für Theoretische Physik, Universität Erlangen-Nürnberg, Erlangen, Germany — [2]Lehrstuhl für Systemsimulation, Universität Erlangen-Nürnberg, Erlangen, Germany — [3]Zentralinstitut für Scientific Computing, Universität Erlangen-Nürnberg, Erlangen, Germany

Engineered micro-devices which are capable of moving alone through a fluid can be of crucial importance in various fields of science. The simplest model of such a micro-device has been introduced by Najafi and Golestanian, and consists of three spheres connected by two arms which move in a non time-reversible fashion. This geometry has been analyzed by Golestanian and Ajdari and by Felderhof, under the assumption that the deformations of the swimmer's arms and the forces driving them are known, respectively. We expand these two approaches by taking higher order terms into account, and find the regime of their agreement. For sinusoidal driving forces, we show that the movement of the arms is restricted by the geometrical parameters, which imposes an upper bound on the velocity. We also extend the three-sphere model by replacing some or all of the spheres in the swimmer by cylindrical capsules, thus introducing some inherent asymmetry to the swimmer design, thereby affecting the swimming efficiency. All analytical results are presented in conjunction with those from a simulation framework employing a rigid-body engine coupled to a Lattice-Boltzmann fluid solver.

DY 22.20 Wed 17:00 Poster A

Motions of aligned object with adjustable chiralities in the stirring-driven flow under the low Reynolds number condition. — •Sung-chih Su and Peilong Chen — No.300, Jhongda Rd., Jhongli City, Taoyuan County 32001, Taiwan (R.O.C.)

Chiral structures of organisms or molecules influence their migration. To study the relation between the structure and the dynamic of a chiral object, we have observed the motion of a chiral sample which moves in a driven flow under the low Reynolds number condition (Re ~0.1). The sample is a three-piece *H* shape object (size is 2cm) whose center stick always aligns in the vertical direction. A vertical rod that revolves in a cylindrical container (radius=10cm) stirs the liquid inside (depth=20cm). On the top view, this sample has the *X* shape with a crossing angle ranging from -90 to 90 degrees, and an intrinsic orientation was defined by the angle bisector. The handedness of a sample depends on the sign of the crossing angle. Under the temperature control and density match, the trajectories in the frame rotating with driving rod are steady closed loops on the horizontal plane with their size expanding with the absolute value of the crossing angle. A pair of samples with opposite handedness has the same spin frequency with the driving rod. Their intrinsic orientations also have the same dependence on spatial position except for the absolute value of the crossing angle ranging between 70 to 85 degrees in which the opposite handed ones have a difference in their intrinsic orientations. We also observe the coupled trajectories and spins of two chiral objects.

DY 22.21 Wed 17:00 Poster A

Molecular dynamics simulations of capillary rise in nanochannels — •Christian Thome and Heiko Rieger — Theoretische Physik, Universität des Saarlandes, Campus E2 6, D66123 Saarbrücken

The capillary rise of liquid-air interfaces, so called menisci, in nanometer scale pores displays time-dependencies that deviate from macroscopic laws like Lucas-Washburn. Motivated by experiments on the spontaneous imbibition in nano-porous vycor glass we study with the help of molecular dynamics simulations the capillary rise of fluid in nano-pores, nano-pore-junctions and nano-pore-intersections. We focus on the quantitative characterizaion of the influence of the wall / fluid particle interaction strength and present results for the fluid propagation, interface morphology and fluid density fluctuations.

DY 22.22 Wed 17:00 Poster A

Strömungsfeld und Widerstand bei der Bewegung von Luftblasen in einer Flüssigkeit. — •Heinz Preuss — 31785 Hameln, Sedanstr. 6

In einer als Fall- bzw. Steigrohrviskosimeter gestalteten transparenten Flasche mit Duschgel konnten Vergleichsmessungen zur Bewegung von Luftblasen und von Kugeln aus Stahl und Quarz durchgeführt werden (s. Vortrag DD16.6 Münster 2011). Für beide Arten von Versuchskörpern konnte die für Newton'sche Flüssigkeiten charakteristische quadratische Abhängigkeit der Steig- bzw. Sinkgeschwindigkeit vom Kugeldurchmesser gefunden werden. Der Bewegungswiderstand erwies sich aber für Luftblasen als nur halb so groß wie für starre Versuchskörper. In Anlehnung an die analytische Herleitung der Stokes-Beziehung ($Fw=6\pi\eta Rv$) durch Sommerfeld (Arnold Sommerfeld, Vorlesungen über theoretische Physik, Band 2: Mechanik der deformierbaren Medien. Leipzig 1945, S. 237 ff., neu bei: Harri Deutsch 1992) wird nach Abänderung der Grenzbedingungen das Geschwindigkeitsfeld um die bewegte Luftblase berechnet und mit dem Geschwindigkeitsfeld um eine starre Kugel verglichen. Es wird der Versuch der Herleitung einer modifizierten Stokes-Beziehung mit Faktor 3 statt 6 diskutiert.

DY 22.23 Wed 17:00 Poster A

DDES Simulation of the turbulent wake of a fractal square grid — Hannes Hochstein[1], Stefan Weytemeier[1], Bernhard Stoevesandt[2], and •Joachim Peinke[1] — [1]ForWind - Center for Wind Energy Research, Institute of Physics, University of Oldenburg — [2]IWES - Fraunhofer Institute for Wind Energy and Energy Systems

The wake of the flow through a fractal square grid was simulated, using the open-source CFD code OpenFOAM. In 2007, Hurst published an article about fractal grids. Those grids produce turbulence on a range of different scales, which influent each other, and have very different properties than all previously documented turbulent flows and is even considered to define a new class of turbulence. This turbulence is able to keep its homogenity and isotropy further downstream than classical, one-scale-generated turbulence. This, and the fact that real wind energy converters are exposed to multi-scale turbulence, makes the fractal generated turbulence interesting as inflow boundary condition for a CFD simulation of a wind energy converter.

The simulation was carried out using the delayed detached eddy simulation (DDES) of OpenFOAM. The goal of the work was to simulate the governing anomalous turbulence properties qualitively, to maintain their good usability as a inflow boundary condition. The first results of the simulation were compared with similar wind tunnel experiment data, which showed a pretty good agreement of the main turbulence properties like turbulence intensity, skewness and flatness of the flow velocity.

DY 22.24 Wed 17:00 Poster A

Gaussian vortex approximation to the instanton equations of two-dimensional turbulence — •Kolja Kleineberg and Rudolf Friedrich — Institute for Theoretical Physics, University of Münster, Germany

We investigate two dimensional turbulence within the instanton formalism. The instanton formalism determines the most probable field in a stochastic classical field theory starting from the Martin-Siggia-Rose path integral. To this end, we derive a history dependent equation for the Langrangian velocity and vorticity field using a point vortex approach. A variational ansatz using elliptical vortices leads to a set of evolution equations for the positions and the shapes of the vortices. We discuss the relationship of this dynamical system to the inverse cascade process of two-dimensional turbulence.

DY 22.25 Wed 17:00 Poster A

Fraktale Beschreibung turbulenter Windfelder — •Martin Menke — ForWind - Center for Wind Energy Research, Institute of Physics, University of Oldenburg

Mit Hilfe eines Modells zur generation einer fraktalen Grenzfunktion sollen turbulente Windfelder charakterisiert werden. Es wird auf den Zusammenhang zwischen dem geschlossenen analytischen Ausdruck einer solchen Grenzfunktion und einer Weierstraß-Mandelbrot-Funktion eingegangen. Desweiteren wird die Analyse und Auswertung turbulenter Daten in Form intermittenter Verteilungen der Geschwindigkeitsinkremente, Strukturfunktionen und Energiespektren berücksichtigt.

DY 22.26 Wed 17:00 Poster A

New anemometers for turbulent flow measurements on different scales — •Hendrik Heisselmann, Jaroslaw Puczylowski, Michael Hölling, and Joachim Peinke — ForWind - Center for Wind Energy Research, Institute of Physics, University of Oldenburg

Experimental investigations of turbulent flows are an essential tool for the characterization of turbulence and the validation of simulations. Therefore, highly resolving and robust sensors are needed for different length scales.
We present two new drag-based sensors developed at the University of Oldenburg, which make use of the laser pointer principle also known from atomic force microscopy. This technique allows for the detection of small displacements of a sphere in case of the *sphere anemometer* and the deflection of a tiny cantilever in case of the *2D Laser-Cantilever-Anemometer* (2D LCA), respectively.
The *2D LCA* was developed for measurements on small scales of turbulent flows in two dimensions with high temporal resolution comparable x-wire anemometry. We present data acquired with a cantilever on the scale of $35\,\mu m \times 140\,\mu m$ (width $\times$ length) in turbulent laboratory flows and compare it to data from a commercial x-wire anemometer.
As an alternative to standard sensors for wind energy applications, the new *sphere anemometer* was designed for the simultaneous two dimensional measurement of turbulent atmospheric flows on a spatial scale of several cm. In our contribution, comparative measurements in turbulent flows performed with sphere anemometer, cup anemometer and sonic anemometers will be presented.

DY 22.27 Wed 17:00 Poster A

Directed percolation model for turbulence transition in shear flows — •Korinna Allhoff[1] and Bruno Eckhardt[2] — [1]Institut für Festkörperphysik, TU Darmstadt — [2]Fachbereich Physik, Philipps-Universität Marburg

We analyze a 1+1-dimensional directed percolation system as a model for the spatio-temporal aspects of the turbulence transition in pipe flow and other shear flows. Space and time are discrete, and the model is characterized by two parameters: one describes the probability to remain turbulent in the next step, the other characterizes the spreading of turbulence to the neighboring cells. The transition to a persistent turbulence is evident in mean field arguments, but the actual values are considerably renormalized by fluctuations. Extensive numerical tests show that the model falls into the universality class of one-dimensional directed percolation. We conclude with a discussion of the spreading of localized perturbations and an extension to two-dimensional systems.

DY 22.28 Wed 17:00 Poster A

Detached-Eddy Simulation of the MEXICO wind turbine with OpenFOAM — •Henry Plischka, Ivan Herraez, Bernhard Stoevesandt, and Joachim Peinke — ForWind - Center for Wind Energy Research, Institute of Physics, University of Oldenburg

A better understanding of wind turbines aerodynamics is necessary to increase the overall energy yield achieved by wind turbines.It also plays a crucial role in reducing the loads on the wind turbine blades and the whole structure. In this scope we conducted the present work which is a part of the project MexNext IEA Wind (Task 29). A very important part of this investigation is the analysis of the radial component of the velocity on the wind turbine blades. Indeed, it seems that this radial velocity yields to a vortex located at the middle of the blade. To gain a more detailed insight on the physics of such a secondary flow, a Detached Eddy Simulation (DES) was conducted with the open source CFD-software OpenFOAM. The simulations were validated with wind tunnel measurements of the MEXICO project and with CFD-simulations from other partner institutions of the MexNext project.

DY 22.29 Wed 17:00 Poster A

Identifying Heat Transport Processes in Turbulent Rayleigh-Bénard Convection via a PDF Equation Approach — •Johannes Lülff[1], Richard J.A.M. Stevens[2], Michael Wilczek[1], Rudolf Friedrich[1], and Detlef Lohse[2] — [1]Institute for Theoretical Physics, University of Münster, Wilhelm-Klemm-Straße 9, 48149 Münster, Germany — [2]Department of Science and

Technology and J. M. Burgers Center for Fluid Dynamics, University of Twente, PO Box 217, 7500 AE Enschede, The Netherlands

Rayleigh-Bénard convection, i.e. the convection of a fluid enclosed between two plates that is driven by a temperature gradient, is the idealized setup of a phenomenon ubiquitous in nature and technical applications. Of special interest for this system are the statistics of turbulent temperature fluctuations, which we are investigating for a fluid enclosed in a cylindrical vessel.

To this end, we derive an exact evolution equation for the probability density function (PDF) of temperature from first principles. Appearing unclosed terms are expressed as conditional averages of velocities and heat diffusion, which are estimated from direct numerical simulations.

Our theoretical framework allows to connect these statistical quantities to the dynamics of Rayleigh-Bénard convection, giving deeper insights into the temperature statistics and transport mechanisms in different regions of the fluid volume, i.e. in the boundary layers, the bulk and the sidewall regions.

DY 22.30 Wed 17:00 Poster A

Functional renormalisation flow equation for Burgers' equation — •Steven Mathey, Jan Martin Pawlowski, and Thomas Gasenzer — Institut für theoretische physik, Universität Heidelberg, Heidelberg, Germany

The stochastic Burgers' equation is studied as a toy model for Navier-Stokes turbulence. Starting from the "quantum" effective action we derive renormalisation flow equations for the viscosity and the correlation functions. We investigate the different fixed points.

DY 22.31 Wed 17:00 Poster A

Time-delayed and spatially nonlocal feedback control of front or pulse propagation — •Anna Kuznetsova, Markus A. Dahlem, and Eckehard Schöll — Institut für Theoretische Physik, TechnischeUniversität Berlin, Berlin, Germany

We study spatio-temporal dynamics of front or pulse propagation in reaction-diffusion systems with time-delayed or spatially non-local feedback control in one spatial dimension. We consider one- or two-variable reaction-diffusion models with cubic nonlinearity (the Schlögl model and the FitzHugh-Nagumo model). We investigate the effects of a time-delayed and spatially nonlocal feedback control on the speed of the front or pulse propagation in dependence on the time scale separation parameter ε and construct bifurcation diagrams as a function of ε.

Supported by DFG through SFB 910.

DY 22.32 Wed 17:00 Poster A

Applications of variable delay dynamics: Stability of regenerative chatter in machining with spindle speed variation — •Andreas Otto and Günter Radons — Institute of Physics, 09107 Chemnitz, Germany

Undesired vibrations in machining cause poor surface finish, increased tool wear, noise and machine tool damage. The main reason are unstable self-excited vibrations, which are called regenerative chatter. In this sense the chatter stability limit is an upper bound for the material removal rate.

Regenerative chatter in machining processes can be modeled by delay differential equations, where the value of the time delay is related to the period of rotation of the workpiece or cutting tool spindle. The implementation of an active spindle speed variation enables the modulation of a time-varying delay which can stabilize unstable chatter vibrations and allows stable cutting processes with higher material removal rates.

A method for an approximation of the chatter stability limit [1] is presented, which gives a simple connection between the stability limit for constant and time-varying delay. It can be used to estimate the efficiency or to find optimal parameters of the spindle speed variation.

[1] A.Otto, G. Kehl, M. Mayer and G. Radons, Stability analysis of machining with spindle speed variation, *Adv. Mater. Res.* **223**, 600-609 (2011).

DY 22.33 Wed 17:00 Poster A

Complex behavior in diffusively coupled systems with variable delay — •Jian Wang and Günter Radons — Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany

In ubiquitous natural and laboratory situations the action of time delayed signals is a crucial ingredient to understand the dynamical behavior of these systems. A frequently encountered situation is that the length of the delay time changes with time. With the introduction of varying delay, a simple system can exhibit complicated behavior. In this study, we consider diffusively coupled extended systems, including coupled map lattice models and reaction diffusion equations, and investigate the system dynamic of such systems with variable delay. Lyapunov exponents and dynamical structure factors are calculated. Various classes of observed space-time structures are characterized and compared to the situation with constant delay.

DY 22.34 Wed 17:00 Poster A

Stability of frequency-locked solutions on a ring of coupled phase oscillators with distributed delays — •Lucas Wetzel[1], Saul Ares[1], Luis G. Morelli[2], Andrew C. Oates[2], and Frank Jülicher[1] — [1]Max Planck Institute for the Physics of Complex Systems — [2]Max Planck Institute of Molecular Cell Biology and Genetics

We study systems of identical coupled phase oscillators, introducing a delay distribution that weights the contributions to the coupling arising from different past times. We have previously shown that for any coupling topology where each oscillator has an equal number of neighbors, the frequency and stability of the phase-locked solutions only depend on the first moment of the delay distribution.

In this contribution I will explore the stability of frequency-locked solutions where all oscillators synchronize to a common global frequency, but keep constant nonzero phase differences with respect to one another. We find analytical expressions, confirmed through numerical simulations, for the stability and conclude that distributed delays can change the stability of frequency-locked solutions.

DY 22.35 Wed 17:00 Poster A

Wave nucleation and stabilization in curved media — •Frederike Kneer, Sebastian Boie, Eckehard Schöll, and Markus A. Dahlem — Institut für Theoretische Physik, TU Berlin

We analyzed nucleation of wave segments on curved two-dimensional excitable media stabilized by feedback control. As a generic model of excitation waves in reaction-diffusion media, we used a FitzHugh-Nagumo system in 2 spatial dimensions. In order to find the nucleation threshold, we used feedback control on deformed excitable media such as tori or flat surfaces with local humps or folds. The main results are twofold. First, investigating excitation waves on a torus, we show that the Gaussian curvature of the excitable medium changes the nucleation threshold in a systematic way, i.e. on a negative Gaussian curved area the nucleation size is smaller (higher excitability). Second, and more surprisingly, we observed that a positive Gaussian curvature can even induce a change of stability. We are motivated to study excitation waves in deformed media by neuronal waves in the folded cortex.

DY 22.36 Wed 17:00 Poster A

Surfactant-induced gradients in the 3D Belousov-Zhabotunsky reaction — •Dennis Kupitz[1], Sergio Alonso[2], Markus Bär[2], and Marcus Hauser[1] — [1]Abteilung Biophysik, Institut für Experimentelle Physik, Otto-von-Guericke-Universität Magdeburg, Germany — [2]Physikalisch-Technische Bundesanstalt, Fachbereich 8.4, Berlin, Germany

Scroll waves are prominent patterns formed in 3D excitable media, and they have been found to be at the basis of some types of cardiac arrhythmias. Experimentally, scroll waves dynamics is often studied by optical tomography in the Belousov-Zhabotinsky reaction, which produces CO_2 as an undesired product. Addition of small concentrations of a surfactant is a popular method to suppress or retard CO_2 bubble formation. We report that in closed reactors even these low concentrations of surfactants are sufficient to generate vertical gradients of excitability which are due to gradients in CO_2 concentration. In reactors open to the atmosphere such gradients can be avoided. Gradients are shown to induce a twist onto vertically oriented scroll waves, while a twist is absent in scroll waves in a gradient-free medium. The effects of the CO_2 gradients are explained by a numerical study, where we modified the Oregonator model to account for the production of CO_2 and for its advection against the direction of gravity. The numerical simulations confirm the role of solubilized CO_2 as the source of the vertical gradients of excitability in reactors closed to the atmosphere.

[1] D. Kupitz, S. Alonso, M. Bär, M.J.B. Hauser, Phys. Rev. E 84, 056210 (2011).

DY 22.37 Wed 17:00 Poster A

Interaction between a scroll wave and a perpendicular gra-

dient — •Patricia Dähmlow and Marcus Hauser — Abteilung Biophysik, Institut für Experimentelle Physik, Otto-von-Guericke-Universität Magdeburg, Germany

Scroll waves are the 3D counterparts of spiral waves occurring in excitable media. They play an important role in the formation of cardiac arrhythmias like ventricular tachycardia and fibrillation. In the heart, gradients are often introduced by the layering of heart tissue; however scroll waves may adopt any orientation with respect to these gradients.

The dynamics of scroll waves is sensitive to gradients of excitability that have a component parallel to the filament of the scroll [1]. Such gradients may induce a twist in the scroll. Using optical tomography, we investigate the interaction of a scroll wave in the Belousov-Zhabotinsky reaction with a gradient of excitability oriented perpendicularly to the filament. Perturbations of the originally perpendicular orientation between filament and gradient twist the scroll wave. When this process sets in at the two ends of the filament, the scroll wave suffers twists of opposite handiness, which form a nodal plane, where the scroll remains untwisted.

[1] C. Henze, E. Lugosi, A.T. Winfree, Can. J. Phys. 68, 683 (1990)

DY 22.38 Wed 17:00 Poster A

Local coupling of non-linear oscillators studied in the Bhelousov-Zhabotinsky reaction — •Claudia Lenk[1], Mario Einax[2], Philipp Maass[2], and Michael Koehler[1] — [1]Institut für Chemie und Biotechnik, Technische Universität Ilmenau, Germany — [2]Fachbereich Physik, Universität Osnabrück, Germany

Pattern formation in reaction-diffusion (RD) systems is important in many areas as, for example, embryonic development, catalytic activity or population dynamics. These systems commonly exhibit a modular structure with coupled subunits, like the cells of the embryo. To investigate the influence of the modular structure onto the dynamical patterns in RD systems we conduct experiments of the Bhelousov-Zhabotinsky reaction in a Nafion® membrane or a silica gel with a structured catalyst distribution and compare them with corresponding numerical studies of the FitzHugh-Nagumo equations. In particular we analyse the influence of the oscillator size, distance and shape onto the strength of the coupling between neighbouring spots of high catalyst concentration. In dependence of the oscillator distance, a bifurcation into two different patterns, a spiral wave and a target pattern, is found. Generally the emerging dynamical patterns depend sensitively on the initial conditions and we present first results for predicting the type of dynamical pattern.

DY 22.39 Wed 17:00 Poster A

Dynamics of scroll rings in confined geometry — •Arash Azhand, Teresa Reinhard, Rico Buchholz, and Harald Engel — Institut für Theoretische Physik, TU Berlin, Hardenbergstr. 36, EW 7-1, D- 10623 Berlin

The undamped propagation of three-dimensional travelling waves has been observed in a variety of dissipative active media including chemical waves, temperature waves in solid fuel combustion, and waves of electric activity in heart tissue, for example. We study modifications to the intrinsic dynamics of such scroll waves caused by perturbations originating from the surrounding boundaries during wave propagation in confined geometry. In particular, we focus on the evolution of scroll rings interacting with Neumann type boundaries in thin layers of the photo-sensitive Belousov-Zhabotinsky reaction. The experimental results are compared to numerical simulations with the underlying Oregonator model.

DY 22.40 Wed 17:00 Poster A

Fluctuations, linear response and heat flux of an aging system — Juan Ruben Gomez-Solano[1,2], •Artyom Petrosyan[1], and Sergio Ciliberto[1] — [1]Laboratoire de Physique (UMR CNRS 5672), ENS de Lyon, 46, allée d'Italie, F-69364 Lyon CEDEX 07, France. — [2]Current address: Universität Stuttgart, 2. Physikalisches Institut Pfaffenwaldring 57, 70569 Stuttgart, Germany.

We experimentally measure the fluctuations of the position of a colloidal particle confined bz an optical trap in an aging gelatin after a fast quench and its linear response to an external perturbation. We compute the spontaneous heat flux from the particle to the bath due to the nonequilibrium assemblage of the gel. We show that: 1) the heat fluctuations satisfy the fluctuation theorem and 2) the mean heat flux is quantitatively related to the violation of the fluctuation-dissipation theorem as a measure of the broken detail balance during the aging process.

DY 22.41 Wed 17:00 Poster A

Limited validity of the transient fluctuation theorem for instantaneous entropy differences in Langevin dynamics — •Hendrik Niemeyer and Jochen Gemmer — Universität Osnabrück, Barbarastraße 7, D-49069 Osnabrück

We investigate the validity of the transient fluctuation theorem for entropies which are only a function of the current state of the system ("instantaneous entropies"). While it is a well-known fact that the transient fluctuation theorem always holds for Langevin systems in non-equilibrium steady states (Kurchan, 1998) this is not true for Langevin systems featuring exponential relaxation and a naturally arising instantaneous entropy defintion which is quadratic in the observable of interest. The transient fluctuation theorem then only holds in the limit of small observation times and small entropy defintions starting far away from equilibrium.

DY 22.42 Wed 17:00 Poster A

Driven transport in lattice gases with nearest-neighbor interactions and general couplings to particle reservoirs — •Marcel Dierl, Philipp Maass, and Mario Einax — Fachbereich Physik, Universität Osnabrück, Barbarastraße 7, 49076 Osnabrück, Germany

Nonequilibrium steady states of lattice gases with nearest-neighbor interactions are studied that are driven between two reservoirs. A generic feature of these systems is the emergence of density oscillations close to the system boundaries. These oscillations lead to phases of the bulk density which cannot be predicted by the minimum and maximum current principles. These principles are suited only for very special bulk-adapted couplings of the system to the reservoirs. It is shown that an approach based on time-dependent density functional theory can cope with the density oscillations and successfully predicts phase diagrams of bulk densities to a good approximation under arbitrary boundary-reservoir couplings.

DY 22.43 Wed 17:00 Poster A

Fluctuation of work and heat of the isothermal expansion of an ideal gas — •Johannes Hoppenau and Andreas Engel — Institut für Physik, Carl von Ossietzky Universität, 26111 Oldenburg

Recently stochastic thermodynamics gave rise to unexpected results, such as the Jarzynski equation. The Jarzynski equation relates the average exponential work done under an non-equilibrium transformation to the difference of the free energy between the end and start state. As in illustrative example we present a model for the isothermal expansion and compression of an ideal gas and investigate the probability of the work done and the heat transferred during the transformation. Lua and Grosberg did an similar analysis for an adiabatic expansion and compression. Both results together may be used to investigate the efficiency of an Carnot cycle far from the quasi static limit.

DY 22.44 Wed 17:00 Poster A

Nonlinear Dynamics of Coupled Oscillators with Localized Energy Dissipation — •Rita Leite and Lutz Schimansky-Geier — Institut für Physik, Humboldt-Universität zu Berlin, 12489 Berlin

In this work we investigate the thermally activated transition dynamics of a harmonically coupled one-dimensional oscillator chain. In contrast to previous work [Henning et al., EPL (2007)], in which the collective escape dynamics of purely deterministic system initiated/supported by modulation instability (Breathers) [Dauxois et al., Phys. Rev. Lett., Vol. 70 (1993)] has been considered, in our model, the oscillator chain is coupled to an external heat bath. The latter is modeled by a single Brownian particle evolving a purely harmonic on-site potential. The units of the oscillator chain evolve/are located in a one-dimensional, nonlinear, asymmetric on-site potential and they are not affected by the effects of damping and noise.

Depending on the chosen boundary conditions (open or periodic boundary conditions), we observe a resonance behavior of the average crossing time as a function of the coupling strength κ. In the weak coupling limit the fluctuations of the heat bath are only weakly transferred to the chain and consequently crossing events are rare. With increasing coupling the system is thermalized rapidly, resulting in a minimum of the average crossing time. The latter increases proportional to e^{κ} with further growing coupling strength. Spatially localized modulation instability can not be detected in this model for the chosen anharmonicity parameter and fluctuation strength.

DY 22.45 Wed 17:00 Poster A

Stochastic description of a bistable frustrated unit — •Hannes Nagel[1], Wolfhard Janke[1], and Hildegard Meyer-Ortmanns[2] — [1]Institut für theoretische Physik, Universität Leipzig, Postfach 100920, D-04009 Leipzig — [2]School of Engineering and Science, Jacobs University Bremen, P.O. Box 750561, D-28725 Bremen

Coupled positive and negative feedback loops are often found in biological systems that support oscillations. Here we consider genetic regulatory circuits. Two species of proteins A and B interact by activation/repression of their respective expression: A activates the production of itself as well as that of B, which in turn represses A. Starting from a previous deterministic study of that model we chose a fully stochastic approach to learn about the effect of the inherent noise in such (typically small) systems.

DY 22.46 Wed 17:00 Poster A

Glassy dynamics of kinks in stripe phases — •Christian Riesch, Günter Radons, and Robert Magerle — Institut für Physik, Technische Universität Chemnitz, D-09107 Chemnitz, Germany

The formation of stripes can be observed in many physical systems, including block copolymers, thin magnetic films and Rayleigh-Bénard convection. We investigate numerically the dynamics of two well-known models of stripe formation, the diblock copolymer equation and the Swift-Hohenberg equation. The systems are prepared in an ordered initial state consisting of parallel stripes, which is then subjected to thermal fluctuations during the simulation. We find that already a small amount of noise is sufficient to induce a characteristic glassy dynamics, which is revealed in time correlation functions of the local stripe orientation as well as the local curvature. We attribute this glassy behavior to the fluctuation of kinks in the stripes. Both correlation functions are found to scale as $C(t, t_w) \sim t_w^{-b} \cdot f(t/t_w)$, a scaling form commonly found in other glass-forming systems.

DY 22.47 Wed 17:00 Poster A

Mean-field approach to coherence resonance in a coupled oscillator systems — •Paul Geffert, Valentin Flunkert, and Eckehard Schöll — Technische Universität Berlin, Germany

Many nonlinear systems exhibit noise-induced oscillations, when driven by a stochastic force. Coherence resonance – the optimal coherence of oscillations at a certain noise strength – is ubiquitous in these systems and has important applications.

We discuss coherence resonance in a generic Hopf normal form model inspired by a laser system. By applying a mean field approximation, we obtain analytic expressions for the correlation time and the signal to noise ratio. Using the same tools, we discuss noise induced oscillations of two coupled Hopf normal form systems.

We find that with a low noise intensity in one system it is possible to control the correlation time and the full width at half maximum only with the noise from the coupled oscillator.

DY 22.48 Wed 17:00 Poster A

Complex Dynamics of Quantum Dot Lasers Under Optical Injection — •Christian Otto, Johannes Pausch, Kathy Lüdge, and Eckehard Schöll — Technische Universität Berlin, Germany

We study the influence of nonlinear carrier lifetimes on the complex dynamics of a quantum dot (QD) laser under optical injection.

The dynamics of a QD laser is crucially affected by the damping rate of its turn-on relaxation oscillations, which in turn is determined by the carrier lifetimes in the QDs. We derive the carrier lifetimes by microscopical calculations of the Coulomb scattering rates between the discrete QD levels and the surrounding quantum well acting as a carrier reservoir. This yields non-constant and unequal carrier lifetimes for electrons and holes in the QDs, which are nonlinear functions of the reservoir carrier densities.

Depending on the band-structure, the lifetimes of electrons and holes in the QDs can be similar or drastically different. Further they can be fast or slow compared to the carrier lifetimes in the carrier reservoir. We study the locking behavior as well as more complex bifurcation scenarios close to the boundaries and outside of the locking region. The dynamics is investigated by means of direct numerical integration and path continuation techniques.

A stronger damping of the turn-on relaxation oscillations leads to smaller regions of complex dynamics and enlarges the range of stable frequency-locked continuous wave operation. An optimal value of the carrier lifetimes is found that maximizes the range of stable operation.

DY 22.49 Wed 17:00 Poster A

Attractor dimension at the transition to chaos synchronization for networks with time-delayed couplings — •Steffen Zeeb and Wolfgang Kinzel — Theoretische Physik III, Universität Würzburg

A network of nonlinear units interacting by time-delayed couplings can synchronize to a common chaotic trajectory. Although the transmission time may be very long the units are completely synchronized without time shift.

We investigate the attractor dimension at this transition to complete chaos synchronization. In particular, for networks of iterated maps we determine the Kaplan-Yorke dimension from the spectrum of Lyapunov exponents which is calculated analytically for Bernoulli maps and numerically for Tent maps. However, we argue that the Kaplan-Yorke conjecture cannot be true at the transition. For the synchronized state the Lyapunov exponents perpendicular to the synchronization manifold cannot contribute to the attractor dimension. Consequently, the Kaplan-Yorke dimension has to be discontinuous at the transition. We calculate the magnitude of this jump for different networks.

The Kaplan-Yorke dimension is an upper bound for the correlation dimension. Using the method of Grassberger & Procaccia we calculate the correlation dimension for networks of iterated Bernoulli and Tent maps. For Bernoulli networks the correlation dimension jumps at the transition to synchronization whereas for Tent maps the correlations dimension is continuous. We conclude that for some systems the Kaplan-Yorke conjecture yields qualitatively incorrect results.

DY 22.50 Wed 17:00 Poster A

Geometry of inertial manifolds probed via a Lyapunov projection method — •Hong-liu Yang[1] and Günter Radons[2] — [1]Institute of Mechatronic, D-09126 Chemnitz, Germany — [2]Chemnitz University of Technology, D-09107 Chemnitz, Germany

A method for determining the dimension and state space geometry of inertial manifolds of dissipative extended dynamical systems is presented. It works by projecting vector differences between reference states and recurrent states onto local linear subspaces spanned by the Lyapunov vectors. A sharp characteristic transition of the projection error occurs as soon as the number of basis vectors is increased beyond the inertial manifold dimension. Since the method can be applied using standard orthogonal Lyapunov vectors, it provides a simple way to determine also experimentally inertial manifolds and their geometric characteristics.

DY 22.51 Wed 17:00 Poster A

Singularities in the delay-time distribution of 2D scattering systems — •Stefan Majewsky[1] and Holger Schanz[2,3] — [1]Computational Physics Group, Technische Universität Dresden, Institut für Theoretische Physik, 01062 Dresden — [2]Institut für Maschinenbau, Hochschule Magdeburg-Stendal, 39114 Magdeburg — [3]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden

We investigate scattering systems where the probability distribution of the time delay shows logarithmic singularities and thus a clustering of delay times near some system-specific values. The effect can be understood as a generalization of caustics to the time domain. Its dynamical origin are saddle points in the time delay function. They arise either due to the details of the dynamics in the scattering region or, in some trivial cases, as a side-effect of a coordinate transformation. We use small clusters of non-overlapping potentials as model systems and study both the classical and the quantum time delay.

DY 22.52 Wed 17:00 Poster A

Active self-organization of disordered arrangements of orientation preference in cortical networks — •Juan Daniel Florez Weidinger, Wolfgang Keil, and Fred Wolf — Max Planck Institute for Dynamics and Self-organization and Bernstein Center for Computational Neuroscience, Gottingen,

Many response characteristics of neurons in the brain, including orientation tuning in the primary visual cortex, are believed to arise by dynamical self-organization. The spatial arrangements of tuning properties across the cortex show fundamental interspecies differences. While in primates and carnivores orientation preference form organized orientation maps, in rodents it appears to be randomly distributed. It has been shown that orientation maps in different species realize a common design which can be quantitatively explained by dynamical self-organization. It remains unclear whether a similar approach can also explain rodent functional organization. Here we present an analytically tractable symmetry-based model of the activity-dependent development of orientation selectivity that can describe both types of organization. In the model neurons interact in a distance dependent manner both with isotropic and with orientation selective inhibition and excitation. By symmetry this model has a large set of exact map solutions. Analytically examining their stability, we find that with strong short-range inhibition all map solutions become unstable. We show numerically that in this regime, disordered arrangements become the attractor state of the network.

DY 22.53 Wed 17:00 Poster A

Lattice Boltzmann simulation of thermal convection in a thin film — Markus Abel[3], Luca Biferale[2], Mauro Sbragaglia[2], and •Henning Krüsemann[1] — [1]Universität Potsdam — [2]Università degli Studi di Roma Tor Vergata — [3]Nancy Université

Rayleigh-Bénard convection in thin films has been observed but not yet systematically investigated. Despite being well-studied, the topic still poses open problems, mainly related with scaling at extremely high Rayleigh numbers. Here, we go the opposite direction in considering convection in a very thin film with the aim to study the influence of the forces acting on very small scales, i.e. mainly surfactant forces and disjoining pressure. In detail, we use the shallow water approximation to get a closed set of equations for the thin film evolution. By means of a two-population Lattice-Boltzmann model we explore the dynamics of the system and compare it to a conventional 2D Rayleigh-Bénard system.