Dynamics and Statistical Physics Division
Fachverband Dynamik und Statistische Physik (DY)

Holger Kantz
Max-Planck-Institut für Physik komplexer Systeme
Nöthnitzer Str. 38
01187 Dresden
kantz@pks.mpg.de

Overview of Invited Talks and Sessions

(lecture rooms H38, H42, H45, H46, and H47; poster B2 and C)

Plenary Talk of the division DY

PV X	Thu	8:30– 9:15	H1	**Complex Networks: From Statistical Physics to the Cell** — •Albert-Laszlo Barabasi

Invited and Topical Talks

DY 2.1	Mon	10:15–10:45	H45	**Noise during rest enables the exploration of the brain's dynamic repertoire** — •Viktor Jirsa
DY 5.1	Mon	14:00–14:30	H45	**Nonlinear dynamics and control of migraine waves** — •Markus Dahlem
DY 7.1	Tue	9:30–10:00	H46	**Directing Brownian motion: Negative mobility and beyond** — •Ralf Eichhorn
DY 8.11	Tue	12:30–13:00	H38	**Quantum search algorithms and quantum communication on networks** — •Gregor Tanner
DY 11.1	Tue	14:00–14:30	H38	**AC-driven quantum systems: cold atom ratchets and beyond** — •Sergey Denisov
DY 13.1	Wed	9:30–10:00	H47	**Glass transition in driven granular fluids** — •Annette Zippelius
DY 17.7	Wed	12:45–13:15	H38	**Anomalous Diffusion and Fractional Time** — •R. Hilfer
DY 19.1	Wed	14:00–14:30	H38	**Chaotic Scattering in Microwave Billiards With and Without Time-Reversal Invariance** — •Barbara Dietz
DY 24.1	Thu	9:30–10:00	H47	**Wind energy conversion - how statistical physics can improve our future energy supply** — •Stephan Barth
DY 24.10	Thu	12:30–13:00	H47	**Puzzles in Eulerian and Lagrangian turbulence** — •Rainer Grauer
DY 28.1	Thu	14:00–14:30	H47	**Static correlation functions of integrable quantum chains** — •Frank Göhmann
DY 31.1	Fri	10:15–10:45	H38	**Real-time transport and dynamics in strongly interacting one-dimensional systems** — •Fabian Heidrich-Meisner
DY 31.9	Fri	12:30–13:00	H38	**Noise controlled transport in constrained geometries** — •Fabio Marchesoni

Invited talks of the joint symposium SYEL

See SYEL for the full program of the Symposium.

SYEL 1.1	Mon	10:00–10:30	H1	**Energy Landscapes of clusters, glasses, and biomolecules** — •David Wales
SYEL 1.2	Mon	10:30–11:00	H1	**Order parameters and energy landscapes for protein folding and misfolding** — •Steven Plotkin
SYEL 1.3	Mon	11:00–11:30	H1	**Nuclear Spins Reveal the Microscopic Nature of Tunneling Systems in Glasses** — •Christian Enss
SYEL 1.4	Mon	11:30–12:00	H1	**Energy landscapes and phase transitions** — •Lapo Casetti
SYEL 1.5	Mon	12:00–12:30	H1	**Phase transitions in spin glasses** — •Peter Young
SYEL 1.6	Mon	12:30–13:00	H1	**Statistical physics of inverse problems** — •Riccardo Zecchina

Invited talks of the joint symposium SYAT

See SYAT for the full program of the Symposium.

SYAT 1.1	Wed	14:30–15:00	H1	**Aging, ergodicity breaking and universal fluctuations in continuous time random walks: Theory and (possible) experimental manifestations** — •Igor Sokolov
SYAT 1.2	Wed	15:00–15:30	H1	**Distinguishing anomalous from simple diffusion in crowded solutions and in cells with fluorescence correlation spectroscopy** — •Cecile Fradin, Daniel Banks, Shyemaa Shehata, Felix Wong, Robert Peters
SYAT 1.3	Wed	15:30–16:00	H1	**Exploring Diffusion in Nanostructured Systems with Single Molecule Probes: From Nanoporous Materials to Living Cells** — •Christoph Bräuchle
SYAT 2.1	Wed	16:30–17:00	H1	**The Lorentz model: a paradigm of anomalous transport** — •Felix Höfling
SYAT 2.2	Wed	17:00–17:30	H1	**Viscoelastic subdiffusion: from anomalous to normal** — •Igor Goychuk
SYAT 2.3	Wed	17:30–18:00	H1	**Phase transitions, liquid micro-compartments, and embryonic patterning** — •Clifford Brangwynne, Jöbin Gharakhani, Anthony Hyman, Frank Jülicher

Sessions

DY 1.1–1.11	Mon	10:15–13:00	H47	**Statistical Physics (general) I**
DY 2.1–2.10	Mon	10:15–13:00	H45	**Statistical Physics of Biological Systems I (joint session of BP + DY)**
DY 3.1–3.8	Mon	14:00–16:00	H42	**Complex energy landscapes (addendum to SYEL)**
DY 4.1–4.8	Mon	14:00–16:00	H47	**Statistical Physics (general) II**
DY 5.1–5.10	Mon	14:00–17:00	H45	**Statistical Physics of Biological Systems II (joint session of BP + DY)**
DY 6.1–6.56	Mon	16:00–18:00	Poster B2	**Poster Session I**
DY 7.1–7.12	Tue	9:30–12:45	H46	**Stochastic processes, brownian motion, and transport**
DY 8.1–8.11	Tue	10:00–13:00	H38	**Quantum Dynamics, Decoherence, and Quantum Information I**
DY 9.1–9.9	Tue	10:00–12:15	H47	**Granular Matter/ Contact Dynamics I**
DY 10.1–10.9	Tue	14:00–16:15	H46	**Nonlinear Dynamics I**
DY 11.1–11.8	Tue	14:00–16:15	H38	**Quantum Dynamics, Decoherence, and Quantum Information II**
DY 12.1–12.6	Tue	14:30–16:00	H47	**Soft Matter I**
DY 13.1–13.11	Wed	9:30–12:30	H47	**Granular Matter/ Contact Dynamics II**
DY 14.1–14.9	Wed	10:15–12:45	H44	**Networks: From Topology to Dynamics I (joint session of BP, DY, SOE)**
DY 15.1–15.4	Wed	10:00–11:00	H46	**Reaction Diffusion Systems**
DY 16.1–16.6	Wed	9:30–11:00	H38	**Anomalous Transport I (talks contributed by BP)**
DY 17.1–17.7	Wed	11:15–13:15	H38	**Anomalous Transport II (talks contributed by DY)**
DY 18.1–18.11	Wed	14:00–17:30	H48	**Glasses I (joint session of CPP, DF, DY)**
DY 19.1–19.15	Wed	14:00–18:15	H38	**Quantum Chaos**
DY 20.1–20.7	Wed	14:30–16:15	H47	**Phase Transitions and Critical Phenomena I**
DY 21.1–21.5	Wed	16:30–17:45	H47	**Soft Matter II**
DY 22.1–22.1	Thu	9:30–10:15	H44	**Networks: From Topology to Dynamics II (joint session of BP, DY, SOE)**
DY 23.1–23.10	Thu	10:15–13:00	H44	**Networks: From Topology to Dynamics III (joint session of BP, DY, SOE)**
DY 24.1–24.10	Thu	9:30–13:00	H47	**Turbulence and wind energy**
DY 25.1–25.11	Thu	9:45–12:30	H38	**Glasses II (joint session of CPP, DF, DY)**
DY 26.1–26.7	Thu	14:00–16:00	H44	**Networks: From Topology to Dynamics IV (joint session of BP, DY, SOE)**
DY 27.1–27.5	Thu	16:00–17:15	H44	**Networks: From Topology to Dynamics V (joint session of BP, DY, SOE)**
DY 28.1–28.7	Thu	14:00–16:00	H47	**Phase transitions and Critical Phenomena II**
DY 29.1–29.8	Thu	14:00–16:00	H46	**Spatially Extended Dynamical Systems**
DY 30.1–30.53	Thu	16:00–18:00	Poster C	**Posters II**
DY 31.1–31.9	Fri	10:15–13:00	H38	**Statistical Physics far from Equilibrium**

DY 32.1–32.9	Fri	10:15–12:30	H47	**Fluid Dynamics**
DY 33.1–33.7	Fri	10:45–12:30	H46	**Nonlinear Dynamics II**

Annual General Meeting of the Dynamics and Statistical Physics Division

Donnerstag, 25.3.2010 19:00–20:00 Raum H 46

- Bericht
- Verschiedenes

DY 1: Statistical Physics (general) I

Time: Monday 10:15–13:00 Location: H47

DY 1.1 Mon 10:15 H47

Magnetic Anisotropy due to the Casimir Effect — •Georgo Metalidis[1] and Patrick Bruno[2] — [1]Institut für Theoretische Festkörperphysik, Karlsruher Institut für Technologie, D-76131 Karlsruhe, Germany — [2]European Synchrotron Radiation Facility, BP 220, F-38043 Grenoble Cedex, France

We show that the Casimir interaction between a ferromagnetic and a non-magnetic mirror gives rise to a magnetic anisotropy in the ferromagnetic layer. The anisotropy is out-of-plane for an optically isotropic non-magnetic plate. If the non-magnetic plate has a uniaxial optical anisotropy (with optical axis in the plate plane), we find an in-plane magnetic anisotropy. In both cases, the magnetization orientation with the lowest energy is given by the competition between polar, longitudinal and transverse contributions to the magneto-optical Kerr effect, and will depend on the interplate distance. Results for a magnetic plate made out of iron, and non-magnetic plates of gold (optically isotropic), quartz, calcite and barium titanate (all uniaxially birefringent) are presented.

DY 1.2 Mon 10:30 H47

Calculating statistical field theories beyond the mean-field level by employing self-interaction renormalized actions — •Stephan Baeurle[1], Garii Efimov[2], and Evgenij Nogovitsin[3] — [1]Institut für Physikalische und Theoretische Chemie, Universität Regensburg, Universitätstr. 31, 93053 Regensburg, Germany — [2]Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, 141980 Dubna, Russia — [3]Institute of Solution Chemistry, Russian Academy of Sciences, 153045 Ivanovo, Russia

Mean-field theories are widely used as comparative theoretical tools throughout all areas of natural and engineering sciences. They are capable in many instances to deliver useful insights in properties and behavior of multi-body systems at relatively moderate computational costs. However, there are a multitude of cases where the mean-field approach provides either inaccurate or even qualitatively wrong results. In this presentation we introduce a new beyond mean field calculation approach based on an alternative exact formulation of the partition function integral, which relies on the method of Gaussian equivalent representation GER originally developed in quantum field theory. With this new approach, we remove divergent contributions from the action, related to particle self-interaction, by employing the concept of normal product in conjunction with Cauchy's integral theorem. We show that the related thermodynamic and structural quantities possess better approximation characteristics and statistical convergence properties in Monte-Carlo sampling, than the ones derived from the original field-theoretic formulation of the partition function integral.

DY 1.3 Mon 10:45 H47

Fast Converging Path Integrals for Time-Dependent Potentials — •Antun Balaž[1], Ivana Vidanović[1], Aleksandar Bogojević[1], and Axel Pelster[2,3] — [1]Scientific Computing Laboratory, Institute of Physics Belgrade, Belgrade, Serbia — [2]Fachbereich Physik, Universität Duisburg-Essen, Duisburg, Germany — [3]Universität Potsdam, Campus Golm, Potsdam-Golm, Germany

We calculate the short-time expansion of the propagator for a general many-body quantum system in a time-dependent potential to orders that have not been accessible before, thus extending a previously developed approach for time-independent potentials [1]. To this end the propagator is expressed in terms of a discretized effective potential, for which we derive and analytically solve a set of recursion relations [2]. Such a discretized effective potential can be used to substantially speed up numerical Monte Carlo simulations for path integrals, or to set-up various analytic approximation techniques to study dynamic properties of quantum systems in time-dependent potentials. The analytically derived results are numerically verified by treating several simple one-dimensional models.

[1] A. Balaž, A. Bogojević, I. Vidanović, A. Pelster, Phys. Rev. E **79**, 036701 (2009)
[2] A. Balaž, I. Vidanović, A. Bogojević, A. Pelster, arXiv:0912.2743

DY 1.4 Mon 11:00 H47

Quantum master equations in phase space applied to the Brownian motion in a periodic potential: comparison of various kinetic models for Wigner's function — Liam Cleary[1], •William T. Coffey[1], William J. Dowling[1], Yuri P. Kalmykov[2], and Serguey V. Titov[3] — [1]Trinity College Dublin, Ireland — [2]Université de Perpignan, France — [3]Russian Academy of Sciences, Russia

A comparison of the master equations for the time evolution of the Wigner distribution function $W(x,p,t)$ in phase space (x,p) for various quantum kinetic models of dissipation is presented by considering the quantum Brownian motion of a particle in a cosine periodic potential $V(x) = -V_0\cos(x/x_0)$. The dynamic structure factor, averaged spectrum of the structure factor and escape rate are evaluated for each model via matrix continued fractions in the manner customarily used for the classical Fokker-Planck equation. The escape rates so yielded are compared with that given analytically by the quantum-mechanical reaction rate solution of the Kramers turnover problem.

DY 1.5 Mon 11:15 H47

Quantum–induced symmetry breaking explains infrared spectra of CH_5^+ isotopologues — •Alexander Witt, Sergei D. Ivanov, and Dominik Marx — Lehrstuhl für Theoretische Chemie, Ruhr-Universität Bochum, Bochum, Germany

Protonated methane, CH_5^+, has been investigated intensively using a host of different experimental and theoretical techniques since decades, see Ref. [1] for a review. The challenge to theory arises from its shallow potential energy surface which leads to dynamical equivalence of the hydrogen atoms often referred to as "scrambling". It has been shown that this is driven by quantum fluctuation effects of the nuclei [2].
Ab initio MD in combination with techniques based on Feynman's formulation of quantum statistical mechanics in terms of path integrals allows us to fully reproduce the experimental IR spectra of all isotopologues of CH_5^+. Moreover, an analysis technique developed in–house enables full assignment of spectral features to molecular motions.
[1] P. Kumar P. and D. Marx, Phys. Chem. Chem. Phys. **8**, 573 (2006)
[2] D. Marx and M. Parrinello, Nature **375**, 216 (1995)

DY 1.6 Mon 11:30 H47

Shape Dependent Partition Sums of Bounded Systems — •Anatoly Danilevich and Klaus Mecke — Institut für Theoretische Physik Universität Erlangen-Nürnberg, Staudtstrasse 7, 91058 Erlangen, Germany

We consider classical many-particle systems bounded by an arbitrarily shaped convex container $\mathcal{D} \subset \mathbb{R}^d$. In the asymptotic limit $\mathcal{D} \to \mathbb{R}^d$ thermodynamic potentials are expected to be extensive, meaning to be a linear combination of $d+1$ Minkowski functionals $M_i(\mathcal{D})$ (e.g. the volume, the surface area, etc.) and correction terms which decrease exponentially with the size of $\mathcal{D}$ [1]. This conjecture has been tested analytically for Ising models and for a cluster expansion of a continuous fluid model in the grandcanonical ensemble.

[1] P. König, R. Roth and K. Mecke, Phys. Rev. Lett. **93**, 160601 (2004).

DY 1.7 Mon 11:45 H47

Tensorial Minkowski Functionals as Shape Measures for Experimental Data — •Sebastian Kapfer, Klaus Mecke, and Gerd E. Schröder-Turk — Friedrich-Alexander-Universität, Erlangen, Germany

In order to establish structure–function relationships for cellular and inhomogeneous materials, quantitative and robust 'shape measures' are required that succinctly characterise the geometry of the material. In particular, if the quantities of interest are direction-dependent, tensor-valued shape measures are essential. We demonstrate that Minkowski Tensors characterise the anisotropy of disordered media in a robust way. We show that Minkowski tensors can be directly applied to experimental datasets. This is illustrated specifically for microscopy and tomography images.

Minkowski Tensors, also offering a firm mathematical foundation, consequently are promising candidates for shape measures.

For details see also: Schroeder-Turk et al., Journal of Microscopy 2009.

DY 1.8 Mon 12:00 H47

Foundation of Statistical Mechanics under experimentally realistic conditions — •Peter Reimann — Fakultät für Physik, Universität Bielefeld

We demonstrate the equilibration of isolated macroscopic quantum systems, prepared in non-equilibrium mixed states with significant population of many energy levels, and observed by instruments with a reasonably bound working range compared to the resolution limit. Both properties are fulfilled under many, if not all, experimentally realistic conditions. At equilibrium, the predictions and limitations of Statistical Mechanics are recovered. Finally, the imitation of statistical ensembles by pure (zero entropy) states is discussed [1].

[1] P. Reimann, Phys. Rev. Lett. 101, 190403 (2008); 99, 160404 (2007)

DY 1.9 Mon 12:15 H47

Performance potential for simulating spin models on GPU — •Martin Weigel — Institut für Physik, KOMET 331, Johannes Gutenberg-Universität Mainz, Staudinger Weg 7, 55127 Mainz

Over the last couple of years it has been realized that the vast computational power of graphics processing units (GPUs) could be harvested for purposes other than the video game industry. This power, which at least nominally exceeds that of current CPUs by large factors, results from the relative simplicity of the GPU architectures as compared to CPUs, combined with a large number of parallel processing units on a single chip. To benefit from this setup for general computing purposes, the problems at hand need to be prepared in a way to profit from the inherent parallelism and hierarchical structure of memory accesses. In this contribution I discuss the performance potential for simulating spin models, such as the Ising or Heisenberg models as well as the Edwards-Anderson spin glass, on GPU as compared to conventional simulations on CPU. Different algorithms, including Metropolis and cluster updates, as well as computional tricks such as multi-spin coding are taken into account.

DY 1.10 Mon 12:30 H47

Performance optimization of a thermoelectric generator with linear material profiles in a 1D setup — •Knud Zabrocki[1], Eckhard Müller[1], Wolfgang Seifert[2], and Steffen Trimper[2] — [1]Institute of Materials Research, German Aerospace Center (DLR), D-51170 Köln, Germany — [2]Martin Luther University Halle-Wittenberg, D-06099 Halle (Saale), Germany

Graded and segmented thermoelectric elements have been studied for a long time with the aim of improving the performance of thermogenerators that are exposed to a large temperature difference. The global optimization of a performance parameter is commonly based on a one-dimensional continua-theoretical model. Following the proposal by Müller et al., the temperature profile $T(x)$ can be calculated within a model-free setup directly from the 1D thermal energy balance, e. g. based on an independent and free variability of the material parameters the Seebeck coefficient, the electrical and thermal conductivities, $S(x), \sigma(x)$ and $\kappa(x)$ is assumed primarily. Thus the optimum current density can be determined from the maximum of the global performance parameter. Here, an analytical solution of the 1D thermal energy balance has been found for constant gradients based on Bessel functions. For particular cases of linear material profiles the authors present results for the optimization of performance parameters like the electrical power output P_{el} and the efficiency η of a thermogenerator (TEG). These results are compared with another analytical model, the constant property model (CPM) and a suitable reference for the performance is discussed.

DY 1.11 Mon 12:45 H47

Multi-GPU Accelerated Monte Carlo Simulations of the 2D Ising Model — •Benjamin Block, Peter Virnau, and Tobias Preis — Institut für Physik, Universität Mainz, Deutschland

A modern graphics processing unit (GPU) is able to perform massively parallel scientific computations at low cost. We present an implementation of the checkerboard algorithm for the two dimensional Ising model which utilizes multiple GPUs—as provided by next generation supercomputers. By combining CUDA (compute unified device architecture) with MPI (message parsing interface) on the CPU level we overcome the memory limitations of the single GPU which enables us to simulate significantly larger systems. On our test setup we were able to accelerate calculations up to 350-fold on 4 GPUs—in comparison to a single CPU core implementation. As proof of concept we reproduce the critical temperature of the 2D Ising model using finite size scaling techniques.

DY 2: Statistical Physics of Biological Systems I (joint session of BP + DY)

Time: Monday 10:15–13:00 Location: H45

Invited Talk DY 2.1 Mon 10:15 H45

Noise during rest enables the exploration of the brain's dynamic repertoire — •Viktor Jirsa — Theoretical Neuroscience Group CNRS, ISM UMR6233, Marseille Luminy, France

At rest certain cortical regions of the human brain consistently show temporally coherent activity. In humans, these resting state networks have been shown to greatly overlap with functional architectures present during consciously directed activity, which motivates the interpretation of rest activity as day dreaming, free association, stream of consciousness, and inner rehearsal. Here, we show that comparable resting state networks emerge from a stability analysis of the network dynamics using biologically realistic primate brain connectivity, although anatomical information alone does not identify the network. We specifically demonstrate that noise and time delays via propagation along connecting fibres are essential for the emergence of the coherent fluctuations at rest. The combination of anatomical structure and time delays creates a space-time structure of the couplings in which the neural noise enables the brain to explore various functional configurations representing its dynamic repertoire.

DY 2.2 Mon 10:45 H45

Constrained Branching Random Walks as a minimal model for adaptive evolution — •Oskar Hallatschek — Biologische Physik und Evolutionäre Dynamik, MPI DS, Goettingen

Models of both sexual and asexual adaptation in well-mixed populations usually lead to solitary waves of adaptation. This means that the fitness distribution of the population assumes the form of a wave and moves to higher fitness at a certain speed of adaptation. This nonequilibrium steady state is easy to obtain in simulations but usually hard to analyze due to lack of detailed balance. Here, we introduce an analytically tractable minimal model that captures the essence of fitness waves of adaptation: i) a branching random walk of genotypes. ii) a global constraint that keeps the populations size finite. We show that for certain constraints an exact solution can be found. This exact solution, which can be summarized as a deterministic PDE with a peculiar cutoff, also turns out to approximate conventional models of adaptation in an unprecedented accuracy.

DY 2.3 Mon 11:00 H45

The number of adaptive paths in fitness landscapes with sign epistasis — •Jasper Franke[1], Alexander Kloezer[1], Joachim Krug[1], and J. Arjan G.M. de Visser[2] — [1]Institut für Theoretische Physik, Universität zu Köln — [2]Laboratory of Genetics, Wageningen University

A mutation of an organism's (genotypic or phenotypic) configuration has a higher probability of becoming fixed in the population if it increases the mutant's degree of adaptation to the environment (the organism's 'fitness'). A sequence of fitness-improving mutations forms an adaptive path along which the population can evolve. This concept of accessible paths plays an important role in determining the possible configurations that can be reached by evolutionary adaptation.

Since the mapping from configuration to fitness is biochemically only partially understood, several statistical models have been proposed trying to capture the essential features.

In this contribution, we consider the expected number of accessible paths and the probability of not having any accessible paths at all. We present analytic and numerical results for three statistical models for fitness landscapes and compare these results to data for the fitness landscape of the fungus *Aspergillus niger*.

DY 2.4 Mon 11:15 H45

Active Transport on Biological Networks — •Ines-Kristin Weber[1], Philip Greulich[1,2], and Ludger Santen[1] — [1]Department of Theoretical Physics, Saarland University, 66041 Saarbrücken — [2]Department of Theoretical Physics, Cologne University, 50937 Cologne

Active transport processes are vital for living cells. They are used, e.g. for structure formation, cell signaling and motion of cells. An large number of transport processes is carried out by molecular motors, i.e. specialized proteins that are able carry cargo along the cytoskeleton. The cytoskeleton is an inhomogeneous network of polar filaments which determines the cell shape and guides the motion of molecular motors.

In this work we investigate the relation between network structure and dynamics of molecular motors, whereat we consider computer generated filament networks as well as realistic structures of the cytoskeleton. The real cytoskeleton structures are obtained from light microscopy images which are preprocessed by automated image analysis procedures to localize fluorescent marked microtubules. Molecular motors are modeled as stochastic self-driven particles. By means of computer simulations and a phenomenological approach we investigate the formation of clusters on the different kinds of networks. We observe cluster formation at all size scales, even for small particle densities [1].

[1] P. Greulich, L. Santen, arXiv:0904.3890v1

DY 2.5 Mon 11:30 H45

Estimating molecule numbers based on fluctuations — •Andreas Ruttor and Manfred Opper — Technische Universität Berlin

Microarray experiments and other methods used to analyze biochemical systems are often not calibrated, so that results are given in arbitrary units. In this case the actual amount of molecules involved in the reactions remains unknown. However, fluctuations visible in the data set can be used to estimate it. For that purpose we use a diffusion model based on stochastic differential equations, which describe the dynamics of the reaction system. Here, two sources of fluctuations have to be taken into account: Observation noise, caused by the measurement process, is usually independent of the state of the system. But internal noise is the result of discrete reaction events occurring at random points in time. Therefore its size is directly related to the number of molecules per arbitrary unit, which is included in the model as a parameter. By solving the backward Fokker-Planck equation of the diffusion model in the weak noise limit, it is possible to calculate the likelihood of all observations. Maximizing this quantity with respect to the parameters leads to an estimate of the molecule numbers per arbitrary unit. Additionally, the uncertainty of this calibration can be obtained by calculating the Laplace approximation of the marginal posterior distribution.

DY 2.6 Mon 11:45 H45

Clustering in self-propelled particle systems — •Fernando Peruani[1] and Markus Baer[2] — [1]Service de Physique de l Etat Condense, CEA Saclay, 91191 Gif-sur-Yvette, France — [2]Physikalisch-Technische Bundesanstalt, Abbestr. 2-12, 10587 Berlin, Germany

Self-propelled particle systems exhibit a rich irreversible clustering dynamics. Independently of the initial condition, these systems reach a steady state cluster size distribution which depends on particle density and noise intensity. We show that the aggregation process can be described by a set of Smoluchowski equations whose functional form is independent of the symmetry of the velocity alignment rule or interaction forces. For a given density (noise intensity) there is always a critical noise intensity (density) at which the cluster size distribution becomes critical, with a exponent 4/3. Below the critical point, the cluster size distribution is exponential and the system exhibits a characteristic cluster size. Above the critical point, the cluster size distribution can be well fitted by a power-law with a second peak at large cluster sizes. The exponent of the power-law is a function of the noise intensity, resp. of particle density.

DY 2.7 Mon 12:00 H45

A Colloidal Approach to Protein Adsorption — •Olaf Leidinger and Ludger Santen — Fachrichtung Theoretische Physik, Universität des Saarlandes

We investigate the unspecific adsorption of proteins, which are modeled as polydisperse colloidal particles. The particle-particle interactions are described in the framework of the DLVO theory, including steric repulsion, electrostatic and van der Waals interactions. Furthermore we introduce internal degrees of freedom representing different conformations of the model proteins at the surface.

By means of extensive Monte Carlo simulations we reproduce the experimentally observed characteristics of the biofilm-formation[1,2]. The adsorption kinetics can be divided into three intervals: Initially the adsorption is limited by the flux of particles to the surface. At low concentrations the proteins spread at the surface in order to optimize the binding to the surface. At higher concentrations the adsorbed proteins are compacted due to particle-particle interactions and finally the surface coverage saturates. These dynamical regimes can be identified in experimental and theoretical investigations of the adsorbed amount. The comparison between experimentally and theoretically generated biofilms is completed by a detailed analysis of the point patterns connected to the adsorbed particles, which is carried out by means of integral measures.

[1] A. Quinn et al 2008 EPL 81 56003 (6pp)
[2] M Bellion et al 2008 J. Phys.: Condens. Matter 20 404226 (11pp)

DY 2.8 Mon 12:15 H45

All-or-none protein-like folding transition of a flexible homopolymer chain — •Wolfgang Paul[1], Mark Talor[2], and Kurt Binder[3] — [1]Institut für Physik, Martin-Luther-Universität, 06099 Halle — [2]Department of Physics, Hiram College, Hiram, Ohio 44234, USA — [3]Institut für Physik, Johannes-Gutenberg-Universität, 55099 Mainz

We report a first-order all-or-none transition from an expanded coil to a compact crystallite for a flexible polymer chain. Wang-Landau sampling is used to construct the complete density of states for square-well chains up to length 256. Analysis within both the microcanonical and canonical ensembles shows a direct freezing transition for finite length chains with sufficiently short-range interactions. This type of transition is a distinctive feature of "one-step" protein folding and our findings demonstrate that a simple homopolymer model can exhibit protein-folding thermodynamics. We also discuss how this finding depends on the range of the attractive interaction. Chains assume an expanded coil conformation at high temperatures and a crystallite structure at low temperatures. For large well diameters, with decreasing temperature a chain undergoes a continuous coil-globule (collapse) transition followed by a discontinuous globule-crystal (freezing) transition. For small well diameters the collapse transition is preempted by the freezing transition and thus there is a direct first-order coil-crystal phase transition.

DY 2.9 Mon 12:30 H45

Genome Folding at the 30 nm Scale — •Philipp M. Diesinger[1] and Dieter W. Heermann[2] — [1]Institute of Theoretical Physics, Heidelberg, Germany / MIT, Cambridge, USA — [2]Institute of Theoretical Physics, Heidelberg

We present a Monte Carlo model for genome folding at the 30-nm scale with focus on linker-histone and nucleosome depletion effects. Depletion of linker histones and nucleosomes affects, massively, the flexibility and the extension of chromatin fibers. Increasing the amount of nucleosome skips can lead either to a collapse or to a swelling of chromatin fibers. We show that depletion effects may even contribute to chromatin compaction. Furthermore, we find that predictions from experimental data for the average nucleosome skip rate lie exactly in the regime of maximum chromatin compaction.

We determine the nucleosome pair distribution function of chromatin. We show that chromatin nanostructure might in principle be accessible by 2D high-resolution light microscopy: Our simulations show that even in the case of fibers with depletion effects and after a projection, the main dominant peaks can still be identified.

Furthremore, we compare our simulations with 5C data of a gene desert as well as FISH data and find that only fibers with random depletion of linker histones or nucleosomes can explain the probability of random chromatin contacts on small length scales that play an important role in gene regulation. Missing linker histones and nucleosomes might not just be randomly occuring simple unavoidable defects but instead they might even play a regulatory role in gene expression.

DY 2.10 Mon 12:45 H45

Statistical aspects of trypanosome's motility — •Vasily Zaburdaev[1,2], Sravanti Uppaluri[3], Thomas Pfohl[3,4], Markus Engstler[5], Holger Stark[2], and Rudolf Friedrich[6] — [1]Harvard University, Cambridge, USA — [2]Technical University of Berlin, Berlin, Germany — [3]MPI for Dynamics and Self-Organization, Göttingen, Germany — [4]University of Basel, Basel, Switzerland — [5]University of

Würzburg, Würzburg, Germany — [6]University of Münster, Münster, Germany

Trypanosome is a parasite causing the sleeping sickness. The way it moves in the blood stream and penetrates various obstacles is the area of active research. Our goal was to investigate a free trypanosomes' motion in the planar geometry. Our analysis of trypanosomes' trajectories reveals that there are two correlation times - one is associated with a fast motion of its body and the second one with a slower rotational diffusion of the trypanosome. We propose a system of Langevin equations to model such motion. One of its peculiarities is the presence of multiplicative noise predicting higher level of noise for higher velocity of the trypanosome. Theoretical and numerical results give a comprehensive description of the experimental data such as the mean squared displacement, velocity distribution and auto-correlation function.

DY 3: Complex energy landscapes (addendum to SYEL)

Time: Monday 14:00–16:00 Location: H42

DY 3.1 Mon 14:00 H42

Coupling in glass-forming systems: From MD simulation to generalized KCM models — •Christian Rehwald and Andreas Heuer — Institut für Physikalische Chemie, Westfälische Wilhelms-Universität Münster, 48149 Münster

Macroscopic glass-forming systems can be regarded as superposition of coupled elementary units, whose dynamics can in turn be described within the framework of the potential energy landscape and the concept of metabasins. This treatment of supercooled liquids leads to "coupled energy landscapes" for which we present a different concept to describe this coupling.

We study a binary mixture Lennard-Jones liquid for different system sizes and calculate local waiting times generated by particle displacements to gain detailed information about coupling events. While the waiting time distributions of local exchange events can be used to measure the coupling strength, the identification of the underlying processes requires greater effort. For this purpose we use the iso-configurational ensemble of a suitably prepared configuration to understand in detail the response to a single local relaxation event. Furthermore, we work out the essential differences between strong and weak coupling.

These MD results can be used to define a generalized KCM model. It turns out that the model can reproduce many properties of glass-forming systems, e.g. different finite size effects of D and τ_α or the growth of dynamical length scales (χ_4).

DY 3.2 Mon 14:15 H42

Phase diagrams of nanoparticles in various thermodynamic ensembles: Lattice-based Monte-Carlo Simulations of Pt-Rh — •Christian Stahl, Johan Pohl, and Karsten Albe — Institut für Materialwissenschaft, TU Darmstadt, Petersenstr. 32, D-64287 Darmstadt

The equilibrium phase diagrams of Pt-Rh nanoparticles, which represent a binary model system with order-disorder transitions, are investigated as a function of particle size. Lattice-based Monte-Carlo simulations in the canonical and semi-grand canonical ensemble are carried out using a refined bond-order simulation (BOS) mixing model. With decreasing particle size, order-disorder transitions shift towards lower temperatures and higher Pt concentration, while phase fields of ordered intermetallic phase broaden and the two-phase areas shrink, which is mainly due to Pt segregation to the surface. Furthermore, we observe that the order-disorder transition becomes of second order for small particles, which is reflected in the size-dependence of Warren-Cowley short range order parameters. Finally, we investigate the phase transition in the microcanonical ensemble using a novel simulation technique for direct sampling of the density of states and hence the entropy of the system. In the region of high energy that is not accessible in the canonical and semi-grand canonical ensemble, we observe decomposition of the components.

DY 3.3 Mon 14:30 H42

Ground states of random-field Ising magnets around the upper critical dimension — •Björn Ahrens and Alexander K. Hartmann — University of Oldenburg

We consider the random-field Ising magnet (RFIM) around the upper critical dimension which is $d_u = 6$. The RFIM consists of ferromagnetically coupled Ising spins with an additional quenched local random field. To ensure unique ground-states we choose Gaussian random fields with zero mean and a tuneable standard deviation h. When varying h, each realization of the disorder exhibits a rather complex energy landscape, in particular close to the ferromagnetic-paramegnetic phase transition. We obtain the ground state numerically [A.K. Hartmann, Practical Guide to Computer Simulations, World Scientific 2009]. For each realisation of disorder we map the random field to a graph with suitible chosen edge capacities [Picard and Ratliff, Networks 5, 357 (1975)]. For these graphs we calculate the maximum flow using a fast max-flow/min-cut algorithm, developed in algorithmic graph theory, which allows us to address large system sizes. Therein the minimum cut corresponds to a ground-state configuration of the system.

Using finite-size scaling, we obtain critical scaling exponents for correlation length, energy, magnetisation and susceptibility. The results for $d = 5$ to $d = 7$ are compared with the mean-field exponents of the RFIM, since from $d_u = 6$ on the mean-field exponents are expected to hold.

DY 3.4 Mon 14:45 H42

A dedicated algorithm for calculating ground states for the triangular random bond Ising model — •Oliver Melchert and Alexander K. Hartmann — Institut für Physik, Universität Oldenburg, Carl-von-Ossietzky Str. 9-11, 26111 Oldenburg, Germany

Triggered by the exchange of ideas between computer science and theoretical physics, several disordered systems with complex energy landscapes can now be analyzed numerically exact through computer simulations [1] by using fast combinatorial optimization algorithms.

For example, the ground-state problem for the planar $2d$ random bond Ising model (RBIM) can be mapped to an auxiliary minimum-weight perfect matching problem, solvable in polynomial time. Consequently, the GS properties as well as minimum-energy domain wall (MEDW) excitations can be analyzed for large systems [2].

Here, we introduce a dedicated algorithm for the $2d$ RBIM on planar triangular lattices that improves on the running time of existing algorithms. Further, we investigate the critical behavior of the corresponding $T = 0$ ferromagnet to spin-glass transition, signaled by a breakdown of the magnetization, using finite-size scaling analyses of the MEDW excitation energy. Finally, we contrast our numerical results with previous simulations and presumably exact results [3].

[1] A.K. Hartmann, *Practical Guide to Computer Simulations*, World Scientific (2009)
[2] OM, and A.K. Hartmann, Phys. Rev. B **79** (2009) 184402
[3] J. Bendisch, Physica A 245 (1997) 560

DY 3.5 Mon 15:00 H42

Free-energy barriers of the 3D Edwards-Anderson-Ising spin glass model — •Andreas Nussbaumer, Elmar Bittner, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, D-04009 Leipzig, Germany

We investigate the three-dimensional Edwards-Anderson-Ising spin glass model using a combination of the multioverlap algorithm and parallel tempering methods. By using this combined algorithm we are able to perform simulations at much lower temperatures for the Edwards-Anderson-Ising model than previous studies. This is necessary to investigate the spin glass phase well below the spin-glass transition $T_g = 1.109(10)$ [M. Hasenbusch et al., Phys. Rev. B 78, 214205 (2008)]. In this talk we focus on the hierarchy of free-energy barriers which we determined from the measured overlap distributions for lattices up to $L = 12^3$ and temperatures down to $T = 0.5$.

DY 3.6 Mon 15:15 H42

Lower critical dimension of vector spin glasses — •Frank Beyer and Martin Weigel — Institut für Physik, KOMET 331, Johannes-Gutenberg-Universität Mainz, Staudinger Weg 7, 55099 Mainz, Germany

The free energy landscape of $O(n)$ vector spin glasses is simplified considerably in the limit of an infinite number of spin components ($n \to \infty$), i.e., for the spherical spin glass. This simplification comes about through the fact that in the limit of a large number of spin components the ground state of a finite system occupies only a finite-dimensional subspace in spin space. As a consequence, for each system size there exists a finite, critical number n^* of spin components above which the ground-state energy does not change upon further adding spin dimensions, such that the system effectively describes a spherical spin glass. Here, this observation is exploited for investigating the stability of the ordered phase of the spherical spin glass as a function of the spatial dimension of the lattice. Using the concept of the defect energy, we numerically determine the stiffness exponents for lattices of various spatial dimensions $d = 2, 3, \ldots$ and use these results to estimate the lower critical dimension of the model. The results are compared to estimates resulting from field-theoretic calulcations.

DY 3.7 Mon 15:30 H42

Investigation of overlaps between quasioptimum configurations of a multidisperse packing problem — •Johannes J. Schneider, Michael Kwasnicki, Andre Müller, and Elmar Schömer — Center for Computational Research Methods in Natural Sciences, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

We consider a multidisperse system of N hard disks with integer radii $r_i = i$, $i = 1, \ldots, N$, which have to be packed in a circular environment in the way that the radius of the circumcircle is minimized. With our packing algorithm, which was rated by the Time Magazine to be one of the 50 best inventions of the year 2009, we were able to match or beat all world records established during an international contest, in which 155 groups from 32 countries competed [1]. Besides these new world record configurations, we obtained a huge number of quasi optimum solutions. We could show that the subspace of these quasi optimum solutions exhibits an ultrametric structure [2]. Here we have a more precise look at the matrix of overlap values between the various quasioptimum configurations and show whether block structures such as in Parisi's solution of the SK model occur.

[1] A.M., J.J.S., E.S., Phys. Rev. E 79, 021102, 2009.
[2] J.J.S., A.M., E.S. Phys. Rev. E 79, 031122, 2009.

DY 3.8 Mon 15:45 H42

Efficient exploration of energy landscapes — •Martin Mann[1] and Konstantin Klemm[2] — [1]Bioinformatik, University of Freiburg, Germany — [2]Bioinformatik, University of Leipzig, Germany

Many physical and chemical processes, such as folding of biopolymers, are best described as dynamics on large combinatorial energy landscapes. A concise approximate description of dynamics is obtained by partitioning the micro-states of the landscape into macro-states. Since most landscapes of interest are not tractable analytically, the probabilities of transitions between macro-states need to be extracted numerically from the microscopic ones, typically by full enumeration of the state space.

Here we suggest a Markov chain Monte-Carlo sampling method for transition matrix estimation [1]. The idea is to explicitly explore boundaries between macro-states. To this end, we confine the dynamics into a single macro-state b and find and count possible transitions from b to all adjacent macro-states. This strategy allows to select the regions of the landscape to be explored and to tune the desired accuracy of the estimated transition probabilites. At difference with earlier approaches, the memory requirement scales linearly with the number of non-zero transition probabilities to be determined.

For landscapes of the number partitioning problem and an RNA switch molecule we show that the method allows for accurate probability estimates with significantly reduced computational cost.

[1] M. Mann, K. Klemm, e-print arXiv:0910.2559

DY 4: Statistical Physics (general) II

Time: Monday 14:00–16:00 Location: H47

DY 4.1 Mon 14:00 H47

Naproxen particle by RESS: A molecular dynamic study. — •Frank Römer and Thomas Kraska — University of Cologne, Department of Chemistry, Luxemburger Straße 116, D-50939 Köln

With a recently developed method (*J. Phys. Chem. C* **113**, 19028-19038, 2009) we study the formation of Naproxen particles by expansion of a supercritical solution (RESS) by means of molecular dynamics simulation. For this investigation we propose a new potential model for Naproxen. The employed van der Waals parameters are based on the TraPPE model. The charges and intramolecular interactions due to internal degrees of freedom are obtained from *ab initio* calculations. We analyze the bulk properties of the Naproxen model as well as those of small particles. The expansion path of a Naproxen/CO_2 solution is compared to the napthalene/CO_2 system. For a wide range of pre-expansion conditions (310 K - 400 K) we determine the nucleation rates and compare them to calculations with the the classical nucleation theory.

DY 4.2 Mon 14:15 H47

Molecular dynamics simulation of nucleation in binary systems — •Stephan Braun and Thomas Kraska — University of Cologne, Department of Chemistry, Luxemburger Str. 116, D-50939 Köln

The vapour-liquid nucleation of the binary system n-nonane/methane is investigated by molecular dynamics simulation. The supersaturation of the system is achieved by cooling down the system during expansion in order to closely mimic the real process which is for example applied in practice to separate heavy compounds from natural gas.

The expansion is simulated via a stepwise enlargement of the simulation box with short equilibration runs in between. From these simulations one obtains several details of the nucleation process, which are difficult or impossible to obtain from experiments. These are the early stages of nucleation and growth taking place on the nanosecond time scale. The simulations provide information on the way how binary supercritical systems nucleate on the molecular scale as well as on nucleation rates and critical cluster sizes. Since the n-nonane clusters contains a large amount of methane molecules the composition of the clusters is analysed with respect to the mole fractions to get a better understanding of the properties of the clusters.

DY 4.3 Mon 14:30 H47

Size Distribution and Correlation Functions of Hanging Dew Droplets — •Tobias Lapp[1], Johannes Blaschke[1], Andrew Scullion[2], Jürgen Vollmer[1], and Björn Hof[1] — [1]MPI for Dynamics and Self-Organization, 37073 Göttingen, Germany — [2]Carleton University, Ottawa, Ontario K1S 5B6

The formation, growth and coarsening of dew droplets on flat surfaces has widely been studied in the physics literature under the keyword "Breath Figures". As an experimental setup we built a vapor chamber not too dissimilar to a steam cooker: A cell with water is heated from below. The water partially evaporates and condenses on a cooled ceiling plate. Applying a dark field illumination technique yields high resolution images of the droplets that we analyze to measure the droplet size distribution and the pair correlation function of droplets.

We compare the experimental data to numerical simulations to investigate how the interplay of coalescence and dripping of droplets yields locally correlated droplet patterns. Moreover, we use the pair correlation function to formulate a Boltzmann equation for the evolution of the size distribution.

DY 4.4 Mon 14:45 H47

Particle density distributions in hard sphere crystals — •Stefan Görig and Martin Oettel — Jo-Gu Uni Mainz, Deutschland

We discuss the shape of the density profiles around the fcc lattice sites in hard sphere crystals with bulk packing fractions near coexistence. Monte Carlo results for the peak width and the anisotropy are compared with results from density functional theory (DFT) using fundamental measure functionals. Crystal free energies computed with a novel simulation method agree well with the corresponding DFT results. Furthermore we discuss the applicability of the phase field crystal ansatz (using a local free energy density) to the hard sphere system in view of further applications for nucleation and growth processes.

DY 4.5 Mon 15:00 H47

Randomly driven hysteresis — •Sven Schubert and Günter Radons — Chemnitz University of Technology, D-09107 Chemnitz

Many physical and technical systems are characterized by non-trivial hysteretic behavior. Topical examples are porous materials, shape memory alloys, and magnetic nanoparticles. The fact that external fields are often entirely erratic leads to the question how hysteretic systems respond to random processes. Hence we are interested in autocorrelation or spectral properties, respectively, of Preisach hysteresis models driven by stochastic input scenarios.

Starting from a known scenario, the case of uncorrelated input signals, where long-term correlations and $1/f$-noise could emerge due to hysteresis [1], we investigate the role of long-term correlations in input signals for hysteretic systems using numerical simulations. For systematic investigations, firstly, we establish a method to compute correlated input processes that allows us to determine the probability density and long-term autocorrelation decay of the input signal. Secondly, different hysteresis outputs are computed and, lastly, their correlation decay is analyzed.

Our investigation indicates that correlations in the input signal compete with hysteretically induced correlations. This results in two regimes: (1) long-time tails of input correlation survive in the output correlation or (2) we observe long-time tails due to hysteresis, as if they were induced by δ-correlated input. In the latter case long-term correlations due to hysteresis cover faster decaying input correlations.

[1] G. Radons, Phys. Rev. Lett. **100**, 240602 (2008).

DY 4.6 Mon 15:15 H47

Phase space master equations for the Lipkin-Meshkov Hamiltonian — •Bernard P.J. Mulligan[1], William T. Coffey[2], Yuri P. Kalmykov[3], and Serguey V. Titov[4] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Trinity College Dublin, Ireland — [3]Universite de Perpignan, France — [4]Russian Academy of Sciences, Russia

The spin system with the Lipkin-Meshkov Hamiltonian

$$\beta\hat{H}_S = -\xi\hat{S}_X - \sigma\hat{S}_Z^2$$

(ξ and σ are external and internal field parameters) is treated as a nonaxially symmetric example of the phase space description of spin dynamics using a master equation for the quasiprobability distribution function of spin orientations in the representation (phase) space of the polar angles (analogous to the Wigner phase space distribution for translational motion). The master equation yields (via the Wigner-Stratonovich transformation of the density matrix) the solution as a Fourier series in the spherical harmonics with Fourier coefficients given by the statistical moments in a manner analogous to the classical distribution. In particular we take the values of S = 1/2,1.

DY 4.7 Mon 15:30 H47

Investigation of multidisperse packing problems in higher dimensions — •Andre Müller, Sebiha Sahin, Elmar Schömer, and Johannes J. Schneider — Center for Computational Research Methods in Natural Sciences, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

Recently, a benchmark contest was performed in which a multidisperse system of hard disks with different integer radii $r_i = i$, $i = 1, \ldots, N$ had to be packed in a circular environment in the way that the radius of the circumcircle around these disks is minimized. With our packing algorithm, which was rated by the Time Magazine as one of the 50 best inventions of the year 2009, we were able to match and beat all world records established during the contest. Now we extend our approach to higher dimensions $D \geq 3$ and present results for the dynamics of the optimization process, the scaling laws for optimum values, and the properties of quasioptimum solutions.

DY 4.8 Mon 15:45 H47

Effect of critical adsorption of binary solvent on distribution of ionic solute near a charged surface. — •Anna Maciolek[1,2] and Alina Ciach[1] — [1]Max-Planck Institut fuer Metallforschung, Heisenbergstr. 3, 70569 Stuttgart — [2]Institute of Physical Chemistry of Polish Academy of Sciences, Kasprzaka 44/52, 01-224 Warszawa, Poland

We study near-critical binary mixtures containing ionic solutes near a charged wall preferentially adsorbing one component of the solvent. Within a Landau-Ginzburg approach extended to include electrostatic interactions and the chemical preference of ions for one component of the solvent, we find that critical adsorption changes significantly distribution of ions near the wall. This may have important implications in confining geometries, in particular, for an electrostatic interactions of colloids in a binary near-critical solvent.

DY 5: Statistical Physics of Biological Systems II (joint session of BP + DY)

Time: Monday 14:00–17:00 Location: H45

Invited Talk DY 5.1 Mon 14:00 H45

Nonlinear dynamics and control of migraine waves — •Markus Dahlem — Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

Migraine is a dynamical disease. A mechanism is presented by which traveling wave patterns, which cause migraine, are formed in the 2D folded human cortex. The predicted wave is maintained only transiently but with a characteristic form (shape and size). Such patterns contradict the established image of a migraine wave engulfing one cortical hemisphere, but we found that they are in agreement with our results obtained from a study using functional magnetic resonance imaging. The mechanism is based on an unstable particle-like wave solution that exists in generic reaction-diffusion media of activator-inhibitor type. This solution can vanish in a saddle-node bifurcation if excitability is globally controlled. This creates a bottleneck region in phase space that sucks in all sufficiently largely perturbed cortical states (ignition phase in migraine). While, as a consequence, recovery is slowed down, a pattern with universal space and time scales emerges. Our bifurcation analysis is also supported by numerical simulations. Moreover, it is shown analytically that such confined waves favor certain cortical geometries. Consequences are discussed for the design and application of biomedically engineered devices that can be used in therapeutic approaches to intelligently target migraine waves by changing the bottleneck passage time and thus more quickly revive the physiological state of the cortex.

DY 5.2 Mon 14:30 H45

Using GFRD to Study Pattern Formation due to the Interplay of Active and Passive Transport — •Thomas Sokolowski, Nils Becker, Laurens Bossen, Thomas Miedema, and Pieter Rein ten Wolde — FOM Institute AMOLF, Science Park 113, 1098 XG Amsterdam, The Netherlands

Cells exploit the interplay of active transport along cytoskeletal tracks and cytosolic passive diffusion to establish a wide range of spatial patterns of functional proteins, mRNA and specialized organelles. Such systems are not well-stirred, so standard simulation techniques can be very expensive while coarse-graining may be inappropriate.

Green's function reaction dynamics (GFRD) is an exact event-driven chemical simulation scheme based on analytical solutions of the Smoluchowski equation with appropriately chosen boundary conditions. For sufficiently low particle concentrations up to 1uM it allows for spatially resolved stochastic simulations of many-particle-systems with an efficiency orders of magnitude higher as compared to common Brownian dynamics schemes.

Based on GFRD we develop a framework which allows for a spatio-temporal stochastic simulation of both active and diffusive movement in different geometries to study pattern formation arising from the interplay the two transport types.

DY 5.3 Mon 14:45 H45

Prokaryotic Chromosome Organization in the Context of Entropy, Confinement and Tethering Interactions — •Miriam Fritsche and Dieter W. Heermann — Institute for Theoretical Physics, University of Heidelberg, Philosophenweg 19, 69120 Heidelberg, Germany

Prokaryotic chromosomes are physically organized and condensed into an intricately structured DNA-protein complex called a nucleoid. The large-scale physical structure might arise from protein mediated inter-

actions that can form both inter and intra-chromosome tethers as well as anchoring the chromosome to the membrane of the nucleoid or to protein scaffolds [1]. Motivated by recent experiments that capture E. coli nucleoid structure using three spectrally distinct, fluorescently-labeled genetic loci [2], we analyze single-locus and two-locus positioning distributions in the theoretical framework of a coarse-grained polymer model taking into account excluded volume, confining geometries as well as tethering interactions therewith shedding light into the mechanisms governing E.coli nucleoid structure between replication cycles.

[1] W.F. Marshall, Current Biology 12, 158 (2002)
[2] P.A. Wiggins, K. Cheveralls, J.S. Martin, R. Lintner, J. Kondev, private communication

DY 5.4 Mon 15:00 H45

Velocity distributions of foraging bumblebees in the presence of predators — •Friedrich Lenz[1], Thomas C. Ings[2], Lars Chittka[2], Aleksei V. Chechkin[3], Holger Kantz[4], and Rainer Klages[1] — [1]Queen Mary University of London, School of Math. Sci., UK — [2]Queen Mary University of London, School of Biol. & Chem. Sci., UK — [3]Inst. for Theo. Physics, NSC KIPT, Kharkov, Ukraine — [4]Max Planck Institute for the Physics of Complex Systems, Dresden

We analyse changes in the flight behaviour of foraging bumblebees under varying environmental conditions, measured in a laboratory experiment by Ings and Chittka[1]. We estimate parameters for different plausible velocity distributions by maximising their likelihood and compare their goodness of fit by applying the Akaike Information Criterion. Using Quantile-Quantile-plots we check for deviations between the estimated probability distributions and the data. We also discuss differences in these distributions for different individual bumblebees. On this basis, we look for systematic changes of the distributions due to the presence of different kinds of artificial spiders.

[1] Thomas C. Ings and Lars Chittka. Current Biology, 18(19):1520-15 24 (2008)

DY 5.5 Mon 15:15 H45

Modelling a flexible sheet swimmer with stochastic rotation dynamics — •Sujin Babu and Holger Stark — Institut für Theoretische Physik Technische Universität Berlin

The dynamics of microorganisms in a viscous fluid has recently received considerable attention in the physics community. It has been reported that some microorganisms (such as the African Trypanosome) make use of hydrodynamic flow fields to evade attack from antibodies. The flexible cell body of the African Trypanosome possesses some bending rigidity due to its cytoskeleton. To mimic the cell body of such an organism, we introduce a flexible sheet that is impenetrable to the surrounding fluid. The flow fields around such a sheet are simulated by stochastic rotation dynamics. I will explain how we couple the flexible sheet to the viscous fluid. Then I will discuss the drag coefficients of the sheet and investigate how it swims under the influence of appropriately applied forces.

15 min. break

DY 5.6 Mon 15:45 H45

The first passage problem for diffusion through a cylindrical pore with sticky walls — •Nicholas A. Licata[1,2] and Stephan W. Grill[1,2] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany

We calculate the first passage time distribution for diffusion through a cylindrical pore with sticky walls. A particle diffusively explores the interior of the pore through a series of binding and unbinding events with the cylinder wall. Through a diagrammatic expansion we obtain first passage time statistics for the particle's exit from the pore. Connections between the model and nucleocytoplasmic transport in cells are discussed.

DY 5.7 Mon 16:00 H45

A growth model for bacterial flagella — •Maximilian Schmitt, Reinhard Vogel, and Holger Stark — Institut für Theoretische Physik, TU Berlin

Bacterial flagella of e.g. E.coli consist of up to 30000 flagellin molecules which are arranged in a hollow tube with outer and inner diameters of 20nm and 3nm, respectively, and a length of up to $20\mu m$. When the flagellum grows, flagellin molecules are transported through the hollow core of the filament and attached at its tip.

As a model for this growth process, we extend one model system of non-equilibrium statistical mechanics, the ASEP (Asymmetric Simple Exclusion Process), to an exclusion process on a growing lattice. In this one-dimensional model, particles enter the lattice with rate α, travel forward with jump rate q and backward with rate p. At the tip particles can transform into a new lattice site with rate γ.

Monte Carlo simulations and mean-field approximations both give the same phase diagram in (α, γ) phase space with distinct low density, high density and maximal current phases. In case of symmetric dynamics ($q = p$) both low density and high density phase vanish, which is in agreement with the SSEP (Symmetric Simple Exclusion Process). Special attention is put on the tip velocity with which the length L of the flagellum grows. It shows an unstable fixed point at $q = p$. For $q > p$ the model is ballistic with $\langle L^2 \rangle \sim t^2$, for $q = p$ diffusive with $\langle L^2 \rangle \sim t$, and for $q < p$ sub-diffusive with a tip velocity slower than single-file diffusion: $\langle L^2 \rangle \sim t^{1/6}$.

DY 5.8 Mon 16:15 H45

Long-range protein coupling mediated by critical low-energy modes of tubular lipid membranes — Sylvain Monnier[1,3], Sergei B. Rochal[2], •Andrea Parmeggiani[3], and Vladimir L. Lorman[1] — [1]LPTA, CNRS, University of Montpellier II, 34095 Montpellier, France — [2]Physical Department, South Federal University, 344090 Rostov-on-Don, Russia — [3]DIMNP, CNRS, University of Montpellier II, 34095 Montpellier, France

Tubular lipid membranes (TLMs) are nanoscopic cylindrical assemblies that play a fundamental role in many intracellular and intercellular processes like protein trafficking, signaling and organelle morphogenesis. TLMs can be generated by a sum of mechano-chemical actions, ranging from mechanical forces produced by motor proteins pulling at one TLM-end up to the specific chemical activity of membrane proteins.

We develop a theory of TLM instabilities under longitudinal force and pressure difference constraints. Two qualitatively different critical low-energy modes are shown to define the stability domain boundaries. The analysis allows to introduce a new framework describing TLM-protein coupling, adsorbed protein-protein interaction and protein cluster nucleation on a TLM. In particular, bare TLM mechanical instabilities strongly influence protein-TLM coupling and protein desorption from the TLM. Model predictions can be directly tested in experiments involving nanomechanical devices extracting TLM over a large spectrum of mechanochemical conditions.

DY 5.9 Mon 16:30 H45

Protein folding trajectories and free energy landscapes in a coarse-grained model — •Katrin Wolff[1], Michele Vendruscolo[2], and Markus Porto[1] — [1]Institut für Festkörperphysik, TU Darmstadt, Germany — [2]Department of Chemistry, University of Cambridge, UK

We study protein free energy landscapes and folding dynamics from completely unfolded to folded structures using a coarse-grained model biased towards the native state. Proteins are modeled as a chain of uniform thickness with bending rigidity (tube model [1]) with a bias towards the native structure based on a one-dimensional representation of the structure (structure profile). This approach is conceptually very different from those relying on the assumption of minimal frustration (such as Gō-models) since it does not favour the formation of contacts between specific residues but mediates 'connectivity' of residues, that, much like hydrophobicity, describes a residue's propensity to form contacts. We show that the 'effective connectivity' profile [2] constitutes a suitable bias towards the native structure [3] and investigate free energy landscapes, heat capacity curves and typical folding trajectories and compare our results to experimental folding behaviour and results from (much more computationally expensive) molecular dynamics simulations.

[1] T.X. Hoang *et al.*, Proc. Natl. Acad. Sci. USA **101**, 7960 (2004).
[2] U. Bastolla *et al.*, Proteins **73**, 872 (2008).
[3] K. Wolff, M. Vendruscolo, and M. Porto, PMC Biophysics **1**, 5 (2008)

DY 5.10 Mon 16:45 H45

Intrinsic fluctuations in stochastic delay models of gene regulation — •Tobias Galla — Theoretical Physics, School of Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK

We study the effects of intrinsic noise on stochastic delay systems within an expansion in the inverse system size. It is shown that

the stochastic nature of the underlying dynamics can induce sustained quasi-cycles in parameter ranges where the deterministic system does not show oscillatory behaviour. We compute the power spectra of these stochastic oscillations analytically, in good agreement with simulations. The theory is applied to a simple gene regulatory system representing the basic motif of an auto-inhibitory feedback loop and motivated by its relevance to somite segmentation. Such systems often contain only a small number of molecules, leading to significant fluctuations in mRNA and protein concentrations, and the proposed mechanism of enhanced stochastic oscillations may therefore be applicable.

Reference: Tobias Galla, Phys. Rev. E 80 (2009) 021909

DY 6: Poster Session I

Time: Monday 16:00–18:00 Location: Poster B2

DY 6.1 Mon 16:00 Poster B2

Statistics of distinguishable particles and resolution of the Gibbs paradox of the first kind — •Hjalmar Peters — Universität Karlsruhe

In physics, there are two distinct paradoxes, which are both known under the name of "Gibbs paradox". In the following, the spurious increase in entropy when combining two gases of the same kind will be referred to as the Gibbs paradox of the first kind (GP1). The GP1 only arises if the gases consist of distinguishable particles. The analysis of the GP1 shows that, for systems of distinguishable particles, it is generally uncertain of which particles they consist. For the statistical description of a system of distinguishable particles, an underlying set of particles, containing all particles that in principle qualify for being part of the system, is assumed to be known. Of which elements of this underlying particle set the system is composed, differs from microstate to microstate. The uncertainty about the particle composition contributes to the entropy of the system. Systems for which admissible compositions with equal particle number are equiprobable will be called *harmonic*. Harmonic systems with the same underlying particle set are always correlated; hence, for harmonic systems, the entropy is no longer additive and loses its thermodynamic meaning. A quantity derived from entropy is introduced, the *reduced entropy*, which, for harmonic systems, replaces the entropy as thermodynamic potential. It can be shown that distinguishable and indistinguishable identical classical particles are physically equivalent. The resolution of the GP1 is demonstrated applying the previously found results.

DY 6.2 Mon 16:00 Poster B2

Cutting the Energy Range in Multicanonical Monte Carlo Simulations — •Steffen Karalus[1,2], Wolfhard Janke[1], and Michael Bachmann[2] — [1]Institut für Theoretische Physik, Universität Leipzig, Germany — [2]Soft Matter Systems Research Group, Institut für Festkörperforschung (IFF-2), Forschungszentrum Jülich, Germany

For a bead-and-spring polymer model, we investigate the dependence of several observables on the energy boundaries in a multicanonical Monte Carlo simulation. As expected, the results of the reweighting of statistical quantities to a certain temperature deviate seriously if a substantial part of the corresponding energy distribution lies outside the predefined energy range. However, structural quantities like the end-to-end distance are less affected than the energy itself.

DY 6.3 Mon 16:00 Poster B2

From an atomistic to a path integral representation of molecules in adaptive simulation — •Adolfo Poma and Luigi Delle Site — Max Planck Institute for Polymer Research, Ackermannweg 10, D - 55128 Mainz , Germany

We present a method to carry out an adaptive representation from a classical to a quantum description of molecules. This method captures the delocalization of particles from its quantum contribution, which mainly affects the static properties in liquids. This approach is tested on a model system of tetrahedral molecules. A coarse grained (CG) procedure was used to reduce the number of degrees of freedom from a path integral representation (QM) to one effective CG site. Our method maintains the thermodynamic equilibrium among the two description allowing the change of representation on the fly. Our studies will address the possibility of studying the process of bond breaking in soft matter systems.

DY 6.4 Mon 16:00 Poster B2

Quantum corrections in the strong friction limit: Perturbation theory and applications — •Stefan A. Maier and Joachim Ankerhold — Institut für Theoretische Physik, Universität Ulm, Albert-Einstein-Allee 11, 89069 Ulm, Germany

The strong friction regime at low temperatures is analyzed systematically starting from the formally exact path integral expression for the reduced dynamics. This quantum Smoluchowski regime allows for a type of semiclassical treatment in the inverse friction strength so that higher order quantum corrections to the original quantum Smoluchowski equation [PRL **87**, 086802 (2001), PRL **101**, 11903 (2008)] can be derived. Drift and diffusion coefficients are determined by the equilibrium distribution in position and are directly related to the corresponding action of extremal paths and fluctuations around them. The inclusion of higher order corrections reproduces the quantum enhancement above crossover for the decay rate out of a metastable well exactly. Our results are also applied to study transport in quantum ratchets.

DY 6.5 Mon 16:00 Poster B2

Coupling different levels of resolution in molecular dynamics. — •Simon Poblete, Matej Praprotnik, Kurt Kremer, and Luigi Delle Site — Max-Planck-Institut fuer Polymerforschung, Mainz, Germany.

Simulation schemes that allow to change molecular representation in a subvolume of the simulation box while preserving the equilibrium with the surrounding introduce conceptual problems of thermodynamic consistency. In this work we present a general scheme based on thermodynamic arguments which ensures thermodynamic equilibrium among the molecules of different representation. The robustness of the algorithm is tested for two examples, namely an adaptive resolution simulation, atomistic/coarse-grained, for a liquid of tetrahedral molecules and an adaptive resolution simulation of a binary mixture of tetrahedral molecules and spherical solutes.

DY 6.6 Mon 16:00 Poster B2

Shape and Pinching-Off of Dew Droplets — •Johannes Blaschke, Tobias Lapp, Björn Hof, and Jürgen Vollmer — MPI for Dynamics & Self-Organization, 37073 Göttingen, Germany

For sessile droplets of a circular cap shape Family and Meakin have shown that the size distribution of dew droplets on flat surfaces is described by a scaling law [1]. In the case of water droplets hanging from a substrate the scaling ansatz has to be augmented to account for shape distortion by gravity and droplets dripping off.

The distorted 3-dimensional profile, $h(r)$, for such stationary hanging droplets is determined by minimizing the total energy functional (for rotationally-symmetric droplets) [2]:

$$E[h(r)] = \pi \int_0^R r \left(2\sigma \sqrt{1 + h'(r)^2} - \rho g\, h(r)^2 \right) \mathrm{d}r$$

We explore the effect of gravity on the relationship of volume, $V(R) = 2\pi \int_0^R r h(r)\, \mathrm{d}r$, to radius of the wetted area on the substrate, R, and how this is dependent on the contact angle.

An analysis of the energetic stability of these droplet profiles yields the maximum size of the droplets before they are ripped off the substrate by gravity. In order to verify the model, real droplets of a known volume are hung off a substrate and their profiles are compared to the theoretical predictions. Finally, the implications on Family and Meakin's scaling theory are discussed.

[1] F. Family, P. Meakin, Phys. Rev. A **40**, 3836 (1989)
[2] H. C. Wente, Pacific J. Math. **88**, 421 (1980)

DY 6.7 Mon 16:00 Poster B2

Monte Carlo simulations without detailed balance — •Heitor Fernandes, Martin Weigel, and Tanja Schilling — Institut für Physik, Johannes-Gutenberg-Universität Mainz, Staudinger Weg 7, D-55099 Mainz, Germany

Monte Carlo simulations are used to study simple systems where the underlying Markov chain satisfies the necessary condition of global balance but does not obey the more restrictive condition of detailed balance. These non-reversible Markov chains generate correct stationary distributions and have been used for a long time with the aim of decreasing autocorrelation times between consecutive measurements in sequential updates for spins systems and, e.g., for the checkerboard decomposition used in parallel architectures.

The aim of this work is to explore schemes where non-reversible dynamics is present. Our approach is based on splitting the dynamics into a set of replicas, where each of them represents a biased movement in reaction-coordinate space. This introduction of an additional bias in a given replica is compensated for by choosing an appropriate dynamics on the other replicas such as to ensure the validity of global balance.

We start by applying this method to a mean field Ising model, splitting the system into two replicas: one trying to increase magnetization and the other trying to decrease it. For this simple test system, our results show that the altered dynamics is able to reduce the dynamical critical exponent, in agreement with results from Turitsyn et al. (arXiv:0809.0916). Generalizations of this scheme to 2D-Potts models using canonical and multicanonical ensembles are discussed.

DY 6.8 Mon 16:00 Poster B2

Domain walls and optimal droplets in the SOS model — •Karsten Schwarz and Heiko Rieger — Theoretische Physik, Universität des Saarlandes

Domain walls, optimal droplets and disorder chaos at zero temperature are studied numerically for the solid-on-solid model on a random substrate. The ensemble of random curves represented by the domain walls obeys Schramm's left passage formula with $\kappa = 4$ (or $\kappa \approx 3$ for two ends not fixed) whereas their fractal dimension is $d_s = 1.25$, and therefore their behaviour can't be described by a Schramm-Loewner evolution. We also investigated optimal droplets with a lateral size between L and $2L$ and detected the same fractal dimension as we found for the domain walls above. But the energy for these low excited states saturates at a value of $\mathcal{O}(1)$ for $L \to \infty$. So arbitrarily large excitations exist which cost only a small amount of energy.

DY 6.9 Mon 16:00 Poster B2

Spin dynamics: quantum master equation in phase space for a spin in a uniform external field — •Bernard P.J. Mulligan[1], William T. Coffey[2], Yuri P. Kalmykov[3], and Serguey V. Titov[4] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Trinity College Dublin, Ireland — [3]Universite de Perpignan, France — [4]Russian Academy of Sciences, Russia

The dynamics of a quantum spin in an external field is presented in the representation (phase) space of polar and azimuthal angles via a master equation for the quasiprobability distribution of spin orientations, allowing the averages of quantum mechanical spin operators to be calculated just as the classical case from the Weyl Symbol of the operator. The phase space master equation has essentially the same form as the classical Fokker-Planck equation, allowing existing solution methods (matrix continued fractions, integral relaxation times, etc.) to be used.

DY 6.10 Mon 16:00 Poster B2

Entropy of lattice triangulations — •Johannes Reinhard and Klaus Mecke — Institut für theoretische Physik Universität Erlangen-Nürnberg, Staudtstraße 7, 91058 Erlangen, Germany

Unimodular triangulations of a rectangular planar grid of size $m \times n$ are an important tool in computational geometry and statistical physics. They have an extensive entropy in the macroscopic limit, i.e. the number of possible triangulations scales as $e^{s_0 mn}$. We define an energy functional with a known ground-state degeneracy and calculate the number of triangulations using a multicanonical sampling Monte Carlo algorithm. We test the results against the exact number of triangulations, which is known for systems smaller than 6×7. Bulk and surface terms are determined for the entropy.

Our scheme can be generalized and applied for solving approximately a multitude of combinatorial problems. As a by-product we obtain the distributions of edge-lengths and vertex-degrees in random lattice triangulations.

DY 6.11 Mon 16:00 Poster B2

Investigation of a highly frustrated point packing problem — •Andre Müller, Sebiha Sahin, Michael Kwasnicki, Frederic Stein, Tobias Preis, Elmar Schömer, and Johannes J. Schneider — Center for Computational Research Methods in Natural Sciences, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

We consider a highly frustrated point packing problem. The task of this problem is to place a proposed number of points on the nodes of a square lattice in the way that the radius of the circumcircle around the points is minimized and that each Euclidean distance value between each pair of points only occurs once. We show that this latter constraint leads to a large frustration effect by comparison with the corresponding unfrustrated system. We solve this problem by using simulated annealing, study the dynamics of the cooling process, and demonstrate that this problem exhibits interesting features, including scaling laws, e.g., for the radius of the circumcircle.

DY 6.12 Mon 16:00 Poster B2

Investigation of the kissing number problem — •Sebiha Sahin, Andre Müller, Elmar Schömer, and Johannes J. Schneider — Center for Computational Research Methods in Natural Sciences, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

We consider a problem which originates in its current form from a famous dispute between Sir Isaac Newton and the Scottish mathematician David Gregory in the year 1694. The question was how many equal spheres can touch a sphere of the same radius in their midst, without any overlaps. Newton correctly thought that the limit was 12; Gregory thought that a 13th could fit. The proof that Newton was correct was provided by Schütte and van der Waerden in 1953. Only for a few higher dimensions, the value of this kissing number is exactly known. Mostly, only lower and upper bounds to the kissing number can be estimated. We propose a heuristic optimization approach to this problem in higher dimensions and study the dynamics of the optimization process.

DY 6.13 Mon 16:00 Poster B2

Morphometric Relationship for Thermodynamic Properties of Confined Hard Sphere Fluids — Stefan Kuczera, •Klaus Mecke, and Gerd Schröder-Turk — Institut für Theoretische Physik 1, Universität Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen, Germany

Thermodynamical properties of confined fluids depend on the shape of the confining cavity. König *et al.* have shown by density functional theory that for hard-sphere fluid and for simple pore shapes this dependence is expressed as a simple linear combination of four terms, namely the volume of the cavity, its interfacial area and integrated mean curvature and its Euler characteristic [1]. We extend this work by studying the equilibrium fluid density in cavities of complex shape by grand-canonical Monte Carlo simulation. The confining cavities are given by the periodic labyrinthine domains bounded by so-called triply-periodic minimal or constant mean curvature surfaces. The complexity of these cavity shapes is (a) the negative Gaussian curvature of the pore-solid interface and (b) their labyrinthine character with finite domain thicknesses. We numerically determine the boundary terms of thermodynamic quantities and compare them with analytic results.

[1] P.-M. König, R. Roth, and K. Mecke, Morphological thermodynamics of fluids: shape dependence of free energies, Phys. Rev. Lett. 93, 160601 (2004)

DY 6.14 Mon 16:00 Poster B2

Multithreading Monte Carlo simulations of polymer models — •Jonathan Gross[1], Wolfhard Janke[1], and Michael Bachmann[2] — [1]Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, 04009 Leipzig, Germany — [2]Soft Matter Systems Research Group, Institut für Festkörperforschung (IFF-2), Forschungszentrum Jülich, 52425 Jülich, Germany

We discuss the advantages of parallelization by multithreading on multicore CPUs and GPUs for parallel tempering Monte Carlo computer simulations of an exemplified bead-spring model for homopolymers. Since the sampling of a large ensemble of conformations is a prerequisite for the precise estimation of statistical quantities such as typical indicators for conformational transitions like the peak structure of the specific heat, the advantage of a strong increase in performance in Monte Carlo simulations cannot be overestimated. Employing multithreading on standard multicore CPUs is a first step and utilizing the massive power of the large number of cores on graphics processing units (GPUs), available in modern but standard graphics cards, is a

second one. We have compared both approaches and find a noticeable increase of efficiency when porting parts of the code to the GPU.

DY 6.15 Mon 16:00 Poster B2

Folding and unfolding of a triple-branch DNA hairpin molecule with four conformational states — •Sandra Engel[1], Anna Alemany[2,3], Nuria Forns[2,3], Philipp Maass[1], and Felix Ritort[2,3] — [1]Fachbereich Physik, Universität Osnabrück, Germany — [2]Departament de Física Fonamental, Universitat de Barcelona, Spain — [3]CIBER-BBN Networking center on Bioengineering, Biomaterials and Nanomedicine, Spain

Single-molecule experiments provide new insights into biological processes hitherto not accessible by measurements performed on bulk systems. Here we report on a study of the kinetics of a triple-branch hairpin molecule with four conformational states by pulling experiments with optical tweezers and theoretical modelling. Three distinct force rips associated with different transitions between the conformational states are observed in the folding and unfolding trajectories. By applying transition rate theory to a free energy model of the molecule, probability distributions for the first rupture forces of the different transitions are calculated. Good agreement of the theoretical predictions with the experimental findings is achieved for various pulling speeds.

DY 6.16 Mon 16:00 Poster B2

Genome Folding at the 30 nm Scale — •Philipp M. Diesinger[1] and Dieter W. Heermann[2] — [1]Institute of Theoretical Physics, Heidelberg, Germany / MIT, Cambridge, USA — [2]Institute of Theoretical Physics, Heidelberg

We present a Monte Carlo model for genome folding at the 30-nm scale with focus on linker-histone and nucleosome depletion effects. Depletion of linker histones and nucleosomes affects, massively, the flexibility and the extension of chromatin fibers. Increasing the amount of nucleosome skips can lead either to a collapse or to a swelling of chromatin fibers. We show that depletion effects may even contribute to chromatin compaction. Furthermore, we find that predictions from experimental data for the average nucleosome skip rate lie exactly in the regime of maximum chromatin compaction.

We determine the nucleosome pair distribution function of chromatin. We show that chromatin nanostructure might in principle be accessible by 2D high-resolution light microscopy: Our simulations show that even in the case of fibers with depletion effects and after a projection, the main dominant peaks can still be identified.

Furthremore, we compare our simulations with 5C data of a gene desert as well as FISH data and find that only fibers with random depletion of linker histones or nucleosomes can explain the probability of random chromatin contacts on small length scales that play an important role in gene regulation. Missing linker histones and nucleosomes might not just be randomly occuring simple unavoidable defects but instead they might even play a regulatory role in gene expression.

DY 6.17 Mon 16:00 Poster B2

Morphological Influences on Colloidal Transport in Porous Structures — •Christian Scholz[1], Yujie Li[1,2], and Clemens Bechinger[1,2] — [1]2. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany — [2]Max-Planck-Institut für Metallforschung, Heisenbergstrasse 3, 70569 Stuttgart, Germany

The morphological properties of artificial quasi two-dimensional micro porous structures are studied and related to transport properties of colloidal particles on a single particle level. The structure of the samples which are created with soft lithography are characterized using pore size distributions, percolation thresholds and Minkowski functionals, where the Euler index is used as a fast and robust measure to identify differences between designed and fabricated structures. We present first results where we demonstrate how small changes in the sample morpholoy lead to significant differences in the particle trajectories and the corresponding mean squared displacements.

DY 6.18 Mon 16:00 Poster B2

Diffusive Transport of light in a two-dimensinal disordered packing of disks:analytical approach to transport mean free path — •Zeinab Sadjadi[1] and MirFaez Miri[2] — [1]Theoretische Physik, Universität des Saarlandes, 66041 Saarbrücken, Germany — [2]Institute for Advanced Studies in Basic Sciences, Zanjan, 45195-1159, Iran

We study photon diffusion in a two-dimensional random packing of monodisperse disks as a simple model of granular media and wet foams. We employ ray optics to follow a light beam or photon as it is reflected by the disks. For the intensity reflectance at the disks two models are presented. In the first model the intensity reflectance of disks is assumed to be a constant r . We present an analytic theory based on persistent random walk of photons and express the transport-mean-free path l^* in terms of the velocity of light in the disks and host medium, radius R and packing fraction of the disks, and the intensity reflectance. Then in a more realistic model we choose the Fresnel intensity reflectance and take into account the dependence of intensity reflectance on the incident angle of light, refractive indices if disks and host medium and other parameters. We examine our analytic results by performing numerical simulation.

DY 6.19 Mon 16:00 Poster B2

Quantitative analysis of fluctuations and irreversibility of optically trapped microspheres — •Olaf Ueberschär and Friedrich Kremer — Universität Leipzig; Institut für Experimentelle Physik I; Linnéstraße 5; D-04103 Leipzig

We present an experimental verification of several universal theorems of stochastic thermodynamics by means of optical tweezers. The theoretical and experimental investigation of this novel branch of modern thermodynamics promises in various ways to be of great benefit for the quantitative understanding and application of processes at the micro- and nanometre scale in the fields of physics, biochemistry and applied technology. Utilizing the formal framework established by U. Seifert and others around 2005 and following the experimental approaches of G. M. Wang et al. first published in 2002, we experimentally demonstrate the validity of several pertinent fluctuation theorems for special non-equilibrium states of optically trapped colloids. Our results in this context exceed the scope of Wang et al. 2002-2005 by a considerable margin. Fluctuation theorems which came into the focus of theoretical research about 15 years ago describe the emergence and quantitative evolution of macroscopic irreversibility from the microscopic point of view of stochastic thermodynamics. Moreover, we present a new method for the experimental determination of the radius and the temperature of a single optically trapped colloid by directly analyzing the thermal equilibriums fluctuations of the bead. This technique may be utilized for the optimisation of several other optical tweezers experiments which show a high requirement for quantitative precision.

DY 6.20 Mon 16:00 Poster B2

Directed Brownian motion of asymmetric particles in a time-dependent potential — •Martin Reichelsdorfer and Klaus Mecke — Institut für Theoretische Physik, Universität Erlangen-Nürnberg, Staudstr. 7, 91058 Erlangen

The motion of an asymmetrically shaped particle in a heat-bath can be directed if it is kept far away from thermal equilibrium. This can be achieved by a time-dependent spatial-symmetric potential. As a model system a hard convex body with one translational degree of freedom which experiences an harmonic restoring force with exponentially decreasing spring constant is studied in an ideal gas. Fluctuation theorems are tested and the efficiency is determined.

DY 6.21 Mon 16:00 Poster B2

Effect of negative resistance in the transport of a dimer system — •Steffen Martens[1], Dirk Hennig[2], and Lutz Schimansky-Geier[1] — [1]Department of Physics, TSP, Humboldt Universität zu Berlin, Newtonstrasse 15, 12489 Berlin, Germany — [2]Department of Mathematics, University of Portsmouth, Lion Terrace, Portsmouth, Hampshire PO1 3HF

The one-dimensional as well as the two-dimensional overdamped Langevin dynamics of a dimer system consisting of two harmonically interacting components are studied. Both components are absorbed at the same spatially periodic substrate potential and are coupled to the same external heat bath. In contrast to previous works, we consider the impact of an inhomogeneous forcing, viz., an external localized point force applied at only one of the two components, on the dynamic of the dimer system. For the one-dimensional case, two accurate approximations for the center of mass mobility and its diffusion coefficient are obtained for weak and strong couplings. It turns out that the mobility of a dimer as a function of the competing length scales of the system, that are the period of the substrate potential and the equilibrium distance between the two constituents, shows a resonance behavior. More precisely there exist a set of optimal parameter values maximizing the mobility. Interestingly, while in the one-dimensional case the mobility

as a function of the noise strength is a monotonic function of the latter in 2D we found the effect of negative resistance, i.e., the mobility possesses a minimum at a finite value of the noise strength for a given overcritical external force magnitude.

DY 6.22 Mon 16:00 Poster B2

Application of the Maximum Entropie Method for Heterogeneous Diffusion Systems — •Mario Heidernätsch, Michael Bauer, and Günter Radons — Chemnitz University of Technology, D-09126 Chemnitz, Germany

Nowadays a range of experimental methods is used for the investigation of single molecule diffusion. Especially Single Molecule Tracking (SMT) and Fluorescence Correlation Spectroscopy (FCS) are suitable methods to probe small systems with high temporal or spatial resolution. However, as the examined systems became smaller, environmental inhomogeneities for instance on interfaces or of the surrounding liquid are causing observed heterogeneous diffusion processes. In FCS the Maximum Entropie Method (MEM) is a well tested technique to obtain a distribution of diffusivities from measured autocorrelation curves [1]. With the help of our distribution of scaled squared displacements [2] we are now able to apply the Maximum Entropie Method also in Single Molecule Tracking.

[1] P. Sengupta, K. Garai, J. Balaji, N. Periasamy, S. Maiti, Biophys. J. **84** (2003), pp 1977-1984
[2] M. Bauer, M. Heidernätsch, D. Täuber, C. von Borczyskowski, G. Radons, Diffusion Fundamentals III **11** (2009), pp. 70.1-70.2

DY 6.23 Mon 16:00 Poster B2

Characterization of heterogeneous single molecule diffusion in ultra-thin liquid films from the probability density of scaled squared displacements — •Michael Bauer and Günter Radons — Chemnitz University of Technology, 09107 Chemnitz, Germany

Our objective is to characterize the behavior of heterogeneous diffusion processes observed from single molecule trajectories. Such processes arise in many physical and biological applications, for instance in ultra-thin liquid films. A change of diffusion properties between different liquid layers and a projection of the particle's trajectory onto the two-dimensional plane lead to dynamic heterogeneities in the observed motion of the molecules [1]. Due to averaging, conventional methods like mean square displacement calculations conceal the effects originating from these inhomogeneities. Consequently, interesting parameters like distinct diffusion coefficients cannot be determined from averaged data. Hence, investigations based on the probability density of scaled squared displacements offer a promising approach to identify and characterize properties of the observed inhomogeneous diffusion process. We consider moments of the probability density and calculate time-dependent diffusion coefficients along with their fluctuations. Furthermore, our analysis is extended to static heterogeneities originating from modified compartments near the substrate. A map of probability densities enables the distinction between static and dynamic heterogeneities.
[1] M. Bauer et al., Diffusion Fundamentals 11(70):1–2, 2009.

DY 6.24 Mon 16:00 Poster B2

Brownian motion of heated particles — •Daniel Rings[1], Dipanjan Chakraborty[1], Markus Selmke[2], Romy Radünz[2], Frank Cichos[2], and Klaus Kroy[1] — [1]ITP, Uni Leipzig, Germany — [2]EXP1, Uni Leipzig, Germany

We derive the generalized Markovian description for the non-equilibrium Brownian motion of a heated particle in a simple solvent with a temperature-dependent viscosity. Our approximate analytical results for the generalized fluctuation-dissipation and Stokes-Einstein relations compare favorably with measurements of laser-heated gold nano-particles and provide a practical rational basis for emerging photothermal tracer techniques. We also compare our analytic results with a numerical solution of the hydrodynamic equations and find good agreement after a parameter-free but non-trivial rescaling. To gain insight into the microscopic basis for the effective equations and boundary conditions, we study the heat and solvent flow around the particle in molecular resolution by means of GPU-enhanced parallel MD simulations.

DY 6.25 Mon 16:00 Poster B2

Numerical calculation of the filter efficiency of fibrous aerosol filters — Egbert Zienicke and •Hartmut Grille — Institut für Physik, TU Ilmenau, 98684 Ilmenau, Gemany

An important environmental task is the suppression of soot emission from Diesel engines in traffic. New EU and US norms do not only set limits for the total mass of soot per km, but also prescribe the maximally allowed number of particles. The challenge for the construction of Diesel particle filters is the maximization of the filter effectivity and the minimization of the pressure drop.

The computation of the effectivity of a fibrous filter is based on the single fiber efficiency, which is obtained by numerical integration of the particle trajectories in the Kuwabara cell around a single fiber. The soot particle paths are influenced by (i) Stokes friction in the flow of the exhaust gas, (ii) Brownian motion and (iii) the particle inertia. The single fiber efficiency depends on the flow velocity, particle size, fiber diameter, the filter porosity, and the exhaust gas temperature. For the goal of designing more efficient filters a large part of this parameter space has to be treated with sufficient statistics. As each trajectory can be computed independently, this task is an ideal candidate for parallelization. This has been realized with Nvidia graphic cards in the CUDA frame work. We compare our numerically received single fiber efficiencies with experimental data and analytical approximations.

DY 6.26 Mon 16:00 Poster B2

Diffusive transport of ballistic particles in hard-spheres systems — •Markus Spanner[1], Felix Höfling[3], Gerd Schröder-Turk[1], Klaus Mecke[1], and Thomas Franosch[2,1] — [1]Institut für Theoretische Physik I, Universität Erlangen-Nürnberg, Staudtstr. 7, D-91058 Erlangen, Germany — [2]Arnold Sommerfeld Center for Theoretical Physics and CeNS, Department of Physics, Ludwig-Maximilians-Universität München, Theresienstr. 37, D-80333 München, Germany — [3]Rudolf Peierls Centre for Theoretical Physics, University of Oxford, 1 Keble Road, Oxford OX1 3NP, United Kingdom

We study critical diffusive transport in porous media at the percolation threshold by simulating the trajectories of ballistic tracer particles. The porous medium is given by quenched configurations of hard non-overlapping spheres and the size of the tracer particle is adjusted to be the largest possible sphere that can traverse the system in all directions, i.e. the system is at its percolation threshold. Results for the diffusion coefficient at different hard-sphere densities are compared with results for point-like tracers in systems of a Boolean model of uncorrelated overlapping spheres from [1]. Our system of correlated obstacles should represent a more realistic model for porous media than the previous system of uncorrelated spheres. We are interested if sub-diffusive motion in the hard-sphere system still has the same value for the exponent z in $\delta r^2(t) \propto t^{-2/z}$ as in the system of overlapping spheres with a point like tracer, because the probability for narrow channels in the system might or might not influence this exponent.
[1] F. Höfling, T. Franosch, E. Frey, Phys.Rev.Lett. 96, 165901(2006)

DY 6.27 Mon 16:00 Poster B2

Measuring Hindered Transport and Self-Diffusion by Means of Optical and NMR Methods — •Tom Kirchner[1], Christian Chmelik[1], Helge Bux[2], Jürgen Caro[2], Lars Heinke[1], Florian Hibbe[1], Tobias Titze[1], and Jörg Kärger[1] — [1]University of Leipzig, Faculty of Physics and Earth Science, Linnéstr. 5, D-04103 Leipzig, Germany — [2]Leibniz University Hannover, Callinstr. 3a, D-30167 Hannover, Germany

Infrared micro-imaging and pulsed field gradient NMR allow to obtain the transport and
selfdiffusivities of a probe molecule in the same host material and over comparable
length scales. In a systematic study, we compare directly both quantities in one and the same system,
namely methanol in a representatve of the famous novel group of nanoporous materials (MOF
ZIF-8). Following this approach, an unexpected behaviour has been obtained: the self-diffusion of
methanol notably exceeds the transport diffusion in a wide range of loadings. This finding is rationalized by considering the strong intermolecular interaction and
the dominating role of inter-cage hopping in mass transfer in the systems under study.

DY 6.28 Mon 16:00 Poster B2

Gas sensitivity in nanoporous crystalline metal oxide: a site-bond percolation approach — •Julia Dräger[1], Stefanie Russ[2], Claus-Dieter Kohl[3], and Armin Bunde[1] — [1]Institut für Theo-

retische Physik III, 35392 Giessen — [2]Freie Universität Berlin, 14195 Berlin — [3]Institut für Angewandte Physik, 35392 Gießen

By means of a site-bond percolation model we study numerically and analytically the gas-induced metal-insulator transition of thin films of nanoporous crystalline metal oxides. We model the layers by a network of intergranular contacts where the conductances of the grains (sites) and of the bonds depend on the amount of adsorbed gas molecules that extract electrons from the inner part of the grains, leaving a depletion zone. While below a critical gas concentration N_c the nanoporous structure is insulating due to the absence of a conducting percolating cluster, above N_c the conductance increases rapidly. Depending on the parameters of the system (layer thickness, average grain size, coordination number) we find two different scenarios: for systems of small grains and high porosity (i.e low coordination number) the transition from a conducting towards an insulating phase arises from the disappearance of conducting grains due to the lack of charge carriers. For systems of large grains and lower porosity, on the other hand, the transition is governed by the bond percolation effect, which reflects the influence of the depletion zone on the grain necks and thus on the bonds. Furthermore, we explore which details of the shape of the characteristic curve are due to percolation effects and which properties arise from the variation of the bonds.

DY 6.29 Mon 16:00 Poster B2

Anomalous transport in porous media III: Anomalous immiscible displacement — •Florian Doster[1] and Rudolf Hilfer[1,2] — [1]Institute for Computational Physics, University of Stuttgart, 70569 Stuttgart, Germany — [2]Institute for Physics, University of Mainz, 55099 Mainz, Germany

Two phase immiscible fluid displacement in porous media shows several anomalies when compared with experiments. The standard model has been extended by distinguishing percolating and nonpercolating phases [1]. In one dimension the theory reduces to a set of ten coupled nonlinear partial differential equations. In this contribution we present numerical simulations based on a judicious coice of abnormal diffusion terms. The numerical diffusion terms are needed to stabilize the nonlinear system of partial differential equations [2,3].

[1] R. Hilfer, Physica A **371**, 209 (2006)
[2] R. Hilfer and F. Doster, Transport in Porous Media, published online, doi: 10.1007/s11242-009-9395-0 (2009)
[3] F. Doster, P. Zegeling and R. Hilfer, Physical Review E (in print)

DY 6.30 Mon 16:00 Poster B2

Anomalous transport in porous media IV: Immiscible displacement in the diffusive limit — •Oliver Hönig[1], Florian Doster[1], and Rudolf Hilfer[1,2] — [1]Institut für Computerphysik, Universität Stuttgart, 70569 Stuttgart, Deutschland — [2]Institut für Physik, Universität Mainz, 55099 Mainz, Deutschland

We study anomalous capillary diffusion in porous media. Capillary diffusion arises during macroscopic multiphase flow when capillary forces become dominant. We extend recent results on a generalised fractional flow formulation [1] into the diffusive limit.

[1] F. Doster and R. Hilfer, preprint

DY 6.31 Mon 16:00 Poster B2

Anomalous diffusion in inhomogeneous viscosity landscapes — •Markus Burgis, Volker Schaller, Alexei Krekhov, and Walter Zimmermann — Theoretische Physik I, Universität Bayreuth, D-95440 Bayreuth

We find anomalous diffusive motion for Brownian particles in inhomogeneous viscosity landscapes and we investigate the dependence of the anomalous power laws on the shape of the viscosity land scape. For a Brownian particle placed in the vicinity of a local minimum of the viscosity subdiffusion is predicted.

In contrast superdiffusion is found for the particle in the vicinity of a local maximum of the viscosity as well as in the region of a linearly varying viscosity. In the case of a heated particle in a binary mixture with different viscosities for pure components the thermodiffusion (Soret effect) induces a concentration gradient around the particle and therefore simultaneously the viscosity gradient. This leads to anomalous diffusion of the particle affected by memory effects.

We compare the results of simulations based on the Langevin equation for the particle motion and diffusion equation for the concentration field with the appropriate model incorporated memory effects.

DY 6.32 Mon 16:00 Poster B2

Noise Effects in Ferromagnetic Systems — •Thomas Bose and Steffen Trimper — Martin-Luther-University, Halle, Germany

We study a model for ferromagnetic materials describing the propagation of spin waves under the influence of deterministic and stochastic forces. The analysis is performed referring to the classical limit by introducing a stochastic Landau-Lifshitz-Gilbert equation (LLG). The stochastic force has a finite correlation time τ leading to a non-Markovian process. The LLG is transformed into an equivalent equation for the corresponding probability distribution. Approximate equations for the mean values and the correlation functions, respectively, are derived. In general, the Gilbert damping leads to a decay of the spin wave amplitude. Whereas, this situation can change when both the deterministic and the stochastic forces act simultaneously on the system. In this case we found a phase diagram in terms of the Gilbert damping parameter α, the correlation strength of the random noises D and the correlation time τ.

DY 6.33 Mon 16:00 Poster B2

Power–Law Level–Statistics due to Dynamical Tunneling — Arnd Bäcker, Roland Ketzmerick, Steffen Löck, and •Normann Mertig — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Germany

We study level–spacing statistics for systems with a mixed phase space, in which regions of regular and chaotic dynamics coexist. Assuming statistical independence of the corresponding subspectra, spacings are described by the Berry–Robnik distribution. However, due to dynamical tunneling, regular and chaotic states are coupled. This leads to small avoided crossings which vary in size over many orders of magnitude, depending on the regular state involved. We demonstrate that this implies a power law of the level–spacing distribution for small spacings. It is analytically and numerically shown that the power-law exponent semiclassically scales linearly with the effective Planck constant.

DY 6.34 Mon 16:00 Poster B2

Transport in Correlated Random Media — •Otto Dietz[1], Ulrich Kuhl[1], Hans-Jürgen Stöckmann[1], Felix M. Izrailev[2], and Nykolay M. Makarov[2] — [1]Fachbereich Physik, Universität Marburg, Germany — [2]Instituto de Física, Universidad de Puebla, Mexico

We investigate the microwave transport properties of quasi-one-dimensional channels with correlated disorder. The correspondence between quantum and classical wave equations allows to use classical waves to understand electron transport properties in new low dimensional materials like nanowires and graphene stripes. Theoretical studies predict that the transport should strongly depend on the correlation of the disorder for bulk [1] and surface [2] disorder. These correlations can be created by inserting brass bars or copper cylinders into the waveguide and allow for a precise prescription of the transport properties of a given frequency region. Previous studies could confirm these results [3] in a one-dimensional channel with bulk disorder. We were able to expand these observations to various types of disorder. We found a strong non-evanescent transport unpredicted by theory in disordered systems in a frequency range where only evanescent transport is expected. This shows the limit of the propagating mode model and allows for estimating the range of its applicability in new nano experiments.

[1] J. C. Hernández Herrejón et al., Physica E 40, 3137 (2008).
[2] M. Rendón et al., Phys. Rev. B 75, 205404 (2007).
[3] U. Kuhl et al., Phys. Rev. Lett. 100, 126402 (2008).

DY 6.35 Mon 16:00 Poster B2

Singular statistics revised — •Timur Tudorovskiy, Ulrich Kuhl, and Hans-Jürgen Stöckmann — Fachbereich Physik, Renthof 5, D-35032 Philipps-Universität Marburg

We analyze the "singular statistics" of pseudointegrable Šeba billiards and show that taking into account growing number of resonances one observes the transition from "semi-Poissonian"-like statistics to Poissonian. This observation is in agreement with an argument that a classical particle does not feel a point perturbation. However, our findings contradict results reported earlier (P. Šeba, Phys. Rev. Lett. **64**, 1855 (1990)).

DY 6.36 Mon 16:00 Poster B2

Superconducting measurement of two microwave billiards with constant width shape — Stefan Bittner[1], Barbara Dietz[1], Maksim Miski-Oglu[1], Pedro Oria Iriarte[1], •Birgit

Quast[1], Achim Richter[1,2], and Florian Schäfer[1,3] — [1]Institute for Nuclear Physics Darmstadt — [2]ECT* Trento — [3]LENS, University of Florence

Convex quantum billiards of constant width are characterized by a phase space which is separated into two parts corresponding to clockwise and anti-clockwise motion. We present experimental results for two microwave billiards of constant width shape, where each part of phase space consists of a chaotic region and a tiny region of regular motion located around the separation line in the Poincaré surface of section. Classically, the transition from clockwise to anti-clockwise motion is forbidden, whereas in the quantum system this is possible via dynamical tunneling. The aim of the microwave experiments is the investigation of spectral properties and the tunneling effects, which leads to a splitting of the degeneracies due to the clockwise/anti-clockwise symmetry. The resonance spectra obtained by superconducting measurements primarily contain dubletts. The few existing singuletts are due to the diameter orbit and their location in the resonance spectra are predictable. Therefore our attention is concentrated on the dubletts and results on their spectral properties and their splittings will be presented. The work presented in this poster was supported by the DFG within the SFB634

DY 6.37 Mon 16:00 Poster B2

Quantum signatures of partial barriers in phase space — Arnd Bäcker, Roland Ketzmerick, and •Matthias Michler — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

In generic Hamiltonian systems classical transport in the chaotic sea is limited by partial barriers, which allow a flux Φ given by the turnstile area. Quantum mechanically they are even more restrictive for Planck's constant $h \gg \Phi$, while for $h \ll \Phi$ classical transport is recovered. This transition is qualitatively well understood, however, many quantitative questions are still open.

We construct a kicked system with a particularly simple phase-space structure, having two chaotic regions separated by one dominant partial barrier. We find a universal scaling with the single parameter Φ/h and the transition at $\Phi/h = \pi^2/4$. The results are not described by the random matrix model for partial barriers [Bohigas et. al. 1993]. Alternative quantum models for this transition are presented.

DY 6.38 Mon 16:00 Poster B2

Microwave measurements on graphene-like structures — •Sonja Barkhofen[1], Ulrich Kuhl[1], Hans–Jürgen Stöckmann[1], and Fabrice Mortessagne[2] — [1]Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany — [2]Laboratoire de Physique de la matière condensée, CNRS UMR 662, Université de Nice -Sophia Antipolis- 06108 Nice cedex 2, France

Electrons in graphene lattices close to the K point can be described by the Dirac equation because of their linear dispersion with k, thus allowing to study quantum electrodynamic phenomena in the solids [1]. We rebuilt graphene's hexagonal structure with high permittivity index discs in a microwave set-up. A tight binding regime for the coupling was found by varying the distance of two or three coupled scatterers. At the Dirac point a vanishing triangular density of states is found via reflection measurements, whereas measurements at corners showed edge states at the Dirac point.

[1] G.W. Semenoff, Phys. Rev. Lett. 51 (1984) 2449

DY 6.39 Mon 16:00 Poster B2

Reappearance of Flooded Regular States in Open Quantum Systems with a Mixed Phase Space — Arnd Bäcker[1], •Lars Bittrich[1], Roland Ketzmerick[1], Ulrich Kuhl[2], and Hans-Jürgen Stöckmann[2] — [1]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Germany — [2]Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, 35032 Marburg, Germany

For closed systems with a mixed phase space, it was shown that quantum mechanically flooding of regular islands may occur. This happens when the Heisenberg time is larger than the tunneling time from the regular region to the chaotic sea. In this case the regular eigenstates disappear. For open systems we investigate the phenomenon of flooding and disappearance of regular states, where the escape time occurs as an additional time scale. We discuss the reappearance of regular states in the case of strongly open systems. This is demonstrated numerically for quantum maps and experimentally for a mushroom shaped microwave resonator.

DY 6.40 Mon 16:00 Poster B2

Quality Factor Dynamics in Coupled Circular Microcavities — •Jeong-Bo Shim[1], Jan Wiersig[1], Mohamed Benyoucef[2], and Oliver Schmidt[2] — [1]Institut für Theoretische Physik, Universität Magdeburg, Postfach 4120, D-39016 Magdeburg, Germany — [2]Institute of Integrative Nanosciences, IFW Dresden, Helmholtzstr. 20, D-01069 Dresden, Germany

In this work, we study the spectral properties of two identical circular microdisks which are coupled through evanescent field. The system is experimentally realized with semiconductor quantum dots, and the spectrum and qualtiy factors of this system are traced, continuously varying the refractive index of one of the microcavities by heating. In this process, the spectrum shows clear level repulsion whenever the resonances are induced in both of the cavities. However, the quality factors are behaving in different ways depending on the symmetry. We analyze this observation theoretically and numerically and find a good agreement with the experimental data. Also, a simple theoretical model to grasp the physical essence of this system is presented.

DY 6.41 Mon 16:00 Poster B2

Temporal decay of open quantum billiards — Stefan Bittner[1], Bruno Camargo[1], Barbara Dietz[1], Maksim Miski-Oglu[1], •Pedro Oria-Iriarte[1], Birgit Quast[1], Achim Richter[1,2], and Florian Schäfer[1,3] — [1]Institut für Kernphysik, Technische Universität Darmstadt, D-64289, Darmstadt, Germany — [2]LENS, University of Florence, I-50019 Sesto-Fiorentino, Italy — [3]ECT, Villa Tambosi, Villazzano, I-38100 Trento, Italy

The decay probability in open quantum billiards with regular and chaotic dynamics is explored by means of experiments on superconducting microwave cavities with openings on the boundary. The scattering-matrix formalismus is used to quantify the leaked microwave flux at the opening. The decay behavior is closely related to the resonance widths. In the semiclassical regime, the decay resembles the corresponding classical probability of escape. The field distributions of some modes play also a crucial role.
This work is supported by DFG through SFB 634.

DY 6.42 Mon 16:00 Poster B2

Equivalence of transport coefficients in bath-induced and dynamical scenarios — •Robin Steinigeweg — Institute for Theoretical Physics, Technical University of Braunschweig, Mendelsohnstr. 3, D-38106 Braunschweig, Germany

We investigate the transport of a single excitation through a chain of weakly coupled subunits. At both ends the chain is exposed to baths which are incorporated by means of a master equation in Lindblad form. This master equation is solved by the use of stochastic unraveling in order to obtain excitation profile and current in the steady state. Completely diffusive transport is found for a range of model parameters, whereas signatures of ballistic behavior are observed outside this range. In the diffusive regime the conductivity is rather independent from the strength of the bath coupling and quantitatively agrees with the diffusion coefficient which has been derived from an investigation of the same model without baths. Also the ballistic behavior in the non-diffusive regime is in accord with results from this alternative approach.

DY 6.43 Mon 16:00 Poster B2

Diffusion in a finite, non-isotropic Anderson model — •Hendrik Niemeyer[1] and Robin Steinigeweg[2] — [1]University of Osnabrueck, Physics Departement, Germany — [2]University of Braunschweig, Physics Departement, Germany

We investigate the existence of diffusive dynamics at various wavelengths in a single-particle 3D Anderson model by solving the full time-dependent Schroedinger equation. This model features a coarse-grained structure: The lattice is divided into layers and the hoppings between layers differ from the hoppings within the layers. Criterions for the transport behaviour of the system are introduced by analyzing the time evolution of the expectation value of the Fourier components of the spatial particle density. We come to the conclusion that a diffusive corridor w.r.t. wavelengths exists featuring the same diffusion constant for every energy interval. This confirms results from the time-convolutionless projection operator technique applied to the same model.

DY 6.44 Mon 16:00 Poster B2

Dephasing in networks with traps: from Quantum to Ran-

dom Walk — •Tobias Schmid, Oliver Mülken, and Alexander Blumen — Albert-Ludwig Universität Freiburg, Physikalisches Institut

Earlier works have demonstrated the transfer of excitons on networks from initial sites to traps due to classical random motion in contrast to quantum motion. By utilising the Liouville-von-Neumann (LvN) equation approach, a simple dephasing via Lindblad operators in the quantum case is introduced. The transition between random and quantum motion depending on the coupling strength to the bath is observed for different networks. The limiting cases of coherent motion for weak coupling and as well as the Zeno limit for strong coupling are demonstrated.

DY 6.45 Mon 16:00 Poster B2

Thermodynamics of quantum systems: work and heat in finite systems — •Heiko Schröder and Günter Mahler — Universität Stuttgart, 1. Institut für Theoretische Physik, Pfaffenwaldring 57, 70550 Stuttgart, Germany

Over the past decade there has been growing interest in the thermodynamics of quantum systems and their parts. In order to tackle this challenge it is necessary to identify what thermodynamic role (heat or work source) each part plays in a given system and, thus, how the exchanged energy may be split into heat and work. We present a definition of finite quantum mechanical work sources and illustrate the concept by means of the behavior of a system consisting only of a single spin coupled to a harmonic oscillator [1]. We give a generalized definition of heat and work and measures for the quality of work transfer based on the previous results and the concept of a local effective measurement basis (LEMBAS [2]).

[1] H. Schröder and G. Mahler, arXiv:0911.5236
[2] H. Weimer et al., Europhys. Lett. 83 (2008), 30008

DY 6.46 Mon 16:00 Poster B2

Effective Quantum Jarzynski estimator for embedded subsystems — •Jens Teifel and Günter Mahler — Universität Stuttgart, Germany

We consider a composite quantum system. An effective description for local observables, e.g. energy, will be used in order to analyze the behavior of a given subsystem. This local behavior (process) might arise from external driving via an explicitly time-dependent local Hamiltonian or due to the effect of the surrounding quantum systems (or a combination of both). If the investigated subsystem is in a thermal state, we call the total state partially thermalized. Starting from such states we explore the possibility to formulate Jarzynski relations for the respective subsystems.

DY 6.47 Mon 16:00 Poster B2

Quantum Thermodynamics and periodic quantum measurements — •Thomas Jahnke and Günter Mahler — Universität Stuttgart, 1. Institut für Theoretische Physik, Pfaffenwaldring 57, 70550 Stuttgart

It is known from Quantum Thermodynamics [1] that the Schrödinger dynamics of a closed bi-partite quantum system typically enforces a stationary thermalized state on the smaller subsystem. This seems to be at variance with the common picture of classical statistics, according to which the individual system continues to move through its allowed space of microstates such that the respective thermal state is established as the infinite time average only.

Here we argue that the link between these two descriptions can be found in terms of observations from the outside: Projective measurements of the environment influence the system dynamics due to "cojumps" and destruction of system-environment correlations.

Concretely, we investigate a two-level system (TLS) coupled to an environment consisting of many spins, the magnetization of which is measured periodically. Considering the ensemble average, we derive an analytical solution for the dynamical attractor state reached after many measurements.

DY 6.48 Mon 16:00 Poster B2

Two Ising-coupled quantum spins in the presence of a bosonic bath — •Peter Philipp Orth[1], Karyn Le Hur[1], David Roosen[2], and Walter Hofstetter[2] — [1]Department of Physics, Yale University, New Haven, CT 06520, USA — [2]Institut für Theoretische Physik, Goethe Universität, 60438 Frankfurt/Main, Germany

A system of two coupled quantum spins in contact with a common harmonic oscillator bath is a paradigm for the study of the interplay between quantum control and dissipation. It also constitutes the elementary building block of a quantum computer. Using the time dependent numerical renormalization group (TD-NRG), we study the system's rich dissipative dynamics arising from the competition between spin-spin and spin-bath coupling, and compare it to a perturbative Bloch-Redfield approach. As an example, we show that spin oscillations can be synchronized using the bath induced interaction. We also address how the well-known localization quantum phase transition of the single spin-boson model is affected by the presence of a second spin. We employ the NRG to calculate the zero temperature phase diagram as a function of dissipation and Ising coupling, for both ohmic and subohmic baths. In the subohmic case, we study the scaling of spin expectation values and entanglement entropy close to the phase transition.

DY 6.49 Mon 16:00 Poster B2

Quantum Monte Carlo simulations for the dynamics of the spin-boson model with a structured environment — •Charlotte Escher and Joachim Ankerhold — Institut für Theoretische Physik, Universität Ulm, 89069 Ulm

Based on a numerically exact path integral Monte Carlo approach we investigate the real-time dynamics of the dissipative quantum mechanical two-state system. The dissipation in our case is due to the interaction with an environment whose spectral density is not purely Ohmic, but instead shows additional resonances at characteristic frequencies. Models with this kind of structured environment are of relevance for qubit devices in condensed matter systems and quantum optics (dissipative Jaynes-Cummings model).

DY 6.50 Mon 16:00 Poster B2

Scaling behaviour in a minimal model for block copolymer microdomain ordering — •Christian Riesch and Robert Magerle — Chemische Physik, TU Chemnitz, D-09107 Chemnitz

We simulate microphase separation and subsequent microdomain ordering processes in lamellae- and cylinder-forming block copolymers using a coarse-grained model, based on a modified Cahn-Hilliard equation. This model has often been studied by use of cell dynamics simulations. We compare the ordering of stripes in 2D simulations with the ordering of cylinders in thin films (3D simulations). Evolution of microdomain order is tracked by four different quantities. Orientational correlation length and average curvature represent global measures of order. Densities of characteristic defects, such as dislocations and disclinations, provide insight into the mechanisms promoting growth of long-range microdomain order. We discuss the influence of noise and film thickness on power laws observed in measures of order and compare different numerical techniques in terms of accuracy and efficiency.

DY 6.51 Mon 16:00 Poster B2

Multiscale modeling of nanostructured polymer materials using field-theoretic methodologies — •Stephan Baeurle[1], Takao Usami[2], and Andrei Gusev[3] — [1]Institut für Physikalische und Theoretische Chemie, Universität Regensburg, Universitätstr. 31, 93053 Regensburg, Germany — [2]Polymer Design Laboratory, Mitsubishi Chemical Group Science and Technology Research Center, Yokkaichi, Mie 510-0885, Japan — [3]Department of Materials, Institute of Polymers, ETH, CH-8093 Zurich, Switzerland

Understanding the chemistry and physics of polymer systems challenges scientists from a wide spectrum of research areas, ranging from polymer science to molecular electronic structure theory. One of the characteristic features of polymer systems is that their physics involve a multitude of different length and time scales, which generally render the determination of their structure and physical properties on a detailed level computationally exhaustive. To overcome this difficulty, novel field-theoretic methodologies based on the mean field approximation have been developed in the past decade for materials engineering, and have proven to deliver reliable results in the calculation of mesoscopic models of polymer melts and highly concentrated polymer solutions. In this presentation we demonstrate that the field-theoretic approach is not only an effective formalism for treating highly concentrated polymer systems on the mesoscopic level of description, but that it is also a promising theoretical tool, to solve the multiscale problems arising in the calculation of nanostructured polymer materials.

DY 6.52 Mon 16:00 Poster B2

Field-induced ordering, non-local susceptibilities and non-affine noise in 2D colloidal crystals — •Kerstin Franzrahe[1],

Surajit Sengupta[2], and Peter Nielaba[1] — [1]Department of Physics, University of Konstanz, Germany — [2]CAM, Indian Association for the Cultivation of Science, Jadavpur, Kolkata, India

Ordering phenomena in monolayers interacting with a substrate are studied by MC-simulations of binary hard-disk mixtures. Here the influence of a substrate is modelled by a 1D spatially periodic external potential. For the field-free case the thermodynamic stability of space-filling lattice structures for such mixtures is analysed[1]. As these structures are stable only in high pressure environments, the phase behaviour of a binary 50% mixture with a diameter ratio $\sigma_B/\sigma_A = 0.414$ exposed to a substrate potential is studied in detail[1-3].

Furthermore our focus is on the elasticity of 2D soft matter systems. Using a coarse graining procedure the local strain fields and hence the elastic moduli can be computed from the local displacement fields. We show that for a triangular, harmonic lattice coarse graining local strains obtained from MC-simulations generates non-trivial, non-local strain correlations. These may be understood within a generalised, Landau type elastic Hamiltonian[2,4]. Apart from the smooth, affine strain fields, this procedure also gives rise to a noise field made up of non-affine displacements. [1] K. Franzrahe, P. Nielaba, Phys. Rev. E **79**, 051505, (2009); [2] K. Franzrahe et al., J. Phys.: Cond. Mat. **20**, 404218, (2008); [3] K. Franzrahe, P. Nielaba, Phys. Rev. E **76**, 061503, (2007); [4] K. Franzrahe et al., Phys. Rev. E **78**, 026106, (2008).

DY 6.53 Mon 16:00 Poster B2

The Talbot effect observed in a liquid crystal convection experiment — •Stephan Messlinger, Wolfgang Schöpf, Ingo Rehberg, and Werner Pesch — Physikalisches Institut, Universität Bayreuth, 95440 Bayreuth

This poster is identical to DY 6.54.

DY 6.54 Mon 16:00 Poster B2

The Talbot effect observed in a liquid crystal convection experiment — •Stephan Messlinger, Wolfgang Schöpf, Ingo Rehberg, and Werner Pesch — Physikalisches Institut, Universität Bayreuth, 95440 Bayreuth

As first discovered by Talbot [1], light with a wavelength λ passing through any diffraction grating with wavelength Λ periodically reproduces images of the grating in regular distances $z_T = \Lambda^2/\lambda$ from the original plane. In this work, we describe the Talbot effect as observed with electroconvection patterns in liquid crystals. Electroconvection occurs when an alternating electric voltage of sufficient strength is applied perpendicularly to a thin liquid crystal layer [2]. The arising flow structures involve periodic modulations of the director field and hence of the refractive index in the layer plane. Thus, the layer acts as a specific amplitude and phase grating tunable by the frequency of the applied voltage in the range of $\Lambda = 5...50\,\mu$m. As a result, z_T varies from 0.1 to 10 mm, which is conveniently accessible in standard optical setups. We present a detailed comparison to recent theoretical analyses based on a wave optics approach in the limit of small λ/Λ [3]. This method presents a considerable improvement of the traditional treatment of shadowgraphy in the framework of geometrical optics [4].

[1] H. F. Talbot, Philos. Mag. 9, 401 (1836); L. Rayleigh, Philos. Mag. 11, 196 (1881). [2] A. Buka and L. Kramer, Pattern Formation in Liquid Crystals, Springer, 1996. [3] S. P. Trainoff and D. S. Cannell, Phys. Fluids 14, 1340 (2002). [4] S. Rasenat et al., Exp. Fluids 7, 412 (1989).

DY 6.55 Mon 16:00 Poster B2

Heisenberg antiferromagnets with exchange and on-site anisotropies — •Thanh-Chung Dinh[1], Reinhard Folk[1], David Peters[2], and Walter Selke[2] — [1]Institut für Theoretische Physik, JKU Linz, Austria — [2]Institut für Theoretische Physik, JARA-SIM and RWTH Aachen, Germany

We study Heisenberg antiferromagnets in a field with exchange and quadratic as well as quartic on-site anisotropies. Using, especially ground state considerations and Monte Carlo techniques for classical magnets on cubic lattices, we determine generic phase diagrams comprising antiferromagnetic, spin-flop, biconical, and paramagnetic phases. A variety of critical and multicritical scenarios are elucidated. Our results are compared to findings on related classical and quantum anisotropic antiferromagnets in lower dimensions.

Supported by the Austrian Fonds zur Förderung der wissenschaftlichen Forschung, project No. 19583-N20, and by the excellence initiative of the German federal and state governments.

References: [1] G. Bannasch and W. Selke, Eur. Phys.J. B69, 439 (2009); [2] R. Folk, Yu, Holovatch, and G. Moser, Phys. Rev.E78, 041124 (2008); [3] T.-C. Dinh and R. Folk, J. Physical Studies (2009, in print); [4] W. Selke, G. Bannasch, M. Holtschneider, I. P. McCulloch, D. Peters, and S. Wessel, Cond. Mat. Phys., Vol. 12 (4) (2009, in print).

DY 6.56 Mon 16:00 Poster B2

Study of the delocalised-localised critical transition frequency for phonons — •Sebastian Pinski and Rudolf Römer — University of Warwick, Coventry, CV4 7AL, United Kingdom

In electronic systems, unlike phononic, the mobility edge of disordered electrons is well known for the Anderson model of localization. In phononic cases it is widely believed that a similar transition exists, although evidence is slim and has been achieved mostly through the Coherent Potential Approximation. We introduce a direct diagonalisation routine to obtain all vibrational eigenmodes frequencies of a three-dimensional mass and spring model under varying degree of disorder. We find the Participation Ratios and Vibrational Density of States for system sizes L= 6, 8, 10, 12 and 15 and disorders whilst averaging over 2000 realisations for all disorder magnitudes. Preliminary results suggest that the delocalised-localised transition must exist very close to the upper end of the spectrum for all mass and spring disorders considered. A natural extension to this work is to employ the transfer matrix method to find the Lyapunov exponents of quasi one-dimensional phononic systems which should reveal an exact transition frequency.

DY 7: Stochastic processes, brownian motion, and transport

Time: Tuesday 9:30–12:45 Location: H46

Topical Talk DY 7.1 Tue 9:30 H46

Directing Brownian motion: Negative mobility and beyond — •Ralf Eichhorn — Nordic Institute for Theoretical Physics (Nordita), Stockholm, Sweden

The movement of a Brownian particle in a symmetric, periodic potential landscape under the influence of external driving forces is considered, and the response to a small static perturbation is studied. We show that quite unusual transport properties may arise. Specifically, average particle motion opposite to the static force (negative mobility) is observed. An intuitive explanation of the underlying physical mechanism, experimental realizations, and generalizations of this effect are presented.

DY 7.2 Tue 10:00 H46

Colloidal Transport Through Micro porous Media — •Yujie Li[1,2], Christian Scholz[2], and Clemens Bechinger[1,2] — [1]Max-Planck-Institut für Metallforschung, Heisenbergstrasse 3, 70569 Stuttgart, Germany — [2]2. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany

The transport properties of colloidal particles were studied on a single particle level in quasi two-dimensional disordered micro porous structures with a temporal resolution of 2 ms and spatial resolution of 0.3 μm. Different hydrodynamic dispersion mechanisms, such as Taylor dispersion, mechanical dispersion, and hold-up of particles in stagnant regions, were visualized in real space. In agreement with theoretical predictions, we find the mean square displacement (MSD) to increase with time t according to a power law $\langle X^2 \rangle \sim t^\alpha$, where α varies for different regimes. From the crossover between ballistic ($\alpha = 2$) and super diffusive ($\alpha > 1$) transport, the characteristic length ξ of the structures was estimated and compared with the structural correlation length ξ_0 defined in the flow direction. By plotting the average velocities as a function of the pressure drop, the permeabilities of different structures were derived and studied in accordance with the pore size.

DY 7.3 Tue 10:15 H46

Semiclassical treatment of a Brownian ratchet using the quantum Smoluchowski equation — •Liam Cleary[1], William T. Coffey[1], Yuri P. Kalmykov[2], and Serguey V. Titov[3] — [1]Trinity College Dublin, Ireland — [2]Université de Perpignan, France — [3]Russian Academy of Sciences, Russia

Quantum effects in the noninertial Brownian motion of a particle in a one-dimensional ratchet potential are treated in the high temperature and weak bath-particle coupling limit by solving a quantum Smoluchowski equation for the time evolution of the Wigner function in configuration space. In particular, an analytical expression for the stationary average drift velocity for constant driving forces is presented including quantum corrections to any order in Planck's constant. The corresponding frequency response is determined using continued fractions in both the linear approximation holding for small ac driving amplitude and in the nonlinear regime for arbitrary driving amplitude exhibiting pronounced ac induced frequency dependence of the dc component of the average drift velocity. Moreover, Shapiro steps are apparent in the dc characteristics for strong ac driving just as in the dc current-voltage characteristics of a point Josephson junction.

DY 7.4 Tue 10:30 H46

Steering the potential barriers: energetic ↻ entropic — •P. Sekhar Burada[1], Peter Hänggi[2], and Gerhard Schmid[2] — [1]MPI for the Physics of Complex Systems, Dresden, Germany — [2]University of Augsburg, Augsburg, Germany

We propose a new mechanism to alter the nature of the potential barrier when a biased Brownian particle under goes a constrained motion in narrow, periodic channels [1,2]. By rotating the external bias, the nature of the potential barrier changes from energetic to purely entropic which in turn effects the diffusion process inside the system. At an optimum angle of the bias, the average particle current exhibits a resonance-like peak. Moreover, the enhancement of the effective diffusion coefficient is efficiently controlled by the rotation angle. This mechanism enables the proper design of channel structures for transport of molecules and small particles. The approximative analytical predictions have been corroborated with precise Brownian dynamic simulations of the full dynamics.

[1]. P.S. Burada, P. Hänggi, F. Marchesoni, G. Schmid, and P. Talkner, *ChemPhysChem* **10**, 45 (2009).
[2]. D. Reguera, G. Schmid, P.S. Burada, J.M. Rubí, P. Reimann, and P. Hänggi, Phys. Rev. Lett. **96**, 130603 (2006).

DY 7.5 Tue 10:45 H46

Deterministic Josephson vortex ratchet made of intrinsic junctions — •E. Goldobin[1], H. B. Wang[2], B. Y. Zhu[3], C. Gürlich[1], M. Ruoff[1], S. Kim[2], T. Hatano[2], B. R. Zhao[3], Z. X. Zhao[3], D. Koelle[1], and R. Kleiner[1] — [1]Physikalisches Institut – Experimentalphysik II, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany — [2]National Institute for Materials Science, Tsukuba 3050047, Japan — [3]National Laboratory for Superconductivity, Institute of Physics, and Beijing National Laboratory for Condensed Matter Physics, Chinese Academy of Sciences, Beijing 100080, China

We demonstrate the operation of a deterministic fluxon ratchet made of a stack of 30 intrinsic Josephson junctions strongly coupled with each other. The ratchet has the shape of a gear with 20 asymmetric teeth (periods). It produces a rectified voltage of about 100 μV at a 12 GHz driving frequency. The effect of coupling between intrinsic junctions, has been studied within the framework of the 2D coupled sine-Gordon equations. We show that this type of device may provide record values of rectified voltage and others figures of merit.

DY 7.6 Tue 11:00 H46

The random phase property and the Lyapunov spectrum — •Rudolf A Römer[1] and Hermann Schulz-Baldes[2] — [1]Department of Physics and Centre for Scientific Computing, University of Warwick, Coventry CV4 7AL, UK — [2]Department Mathematik, FAU Erlangen-Nuernberg, Germany

A random phase property establishing a link between quasi-one-dimensional random Schrodinger operators and full random matrix theory is advocated. Briefly summarized it states that the random transfer matrices placed into a normal system of coordinates act on the isotropic frames and lead to a Markov process with a unique invariant measure which is of geometric nature. On the elliptic part of the transfer matrices, this measure is invariant under the full hermitian symplectic group of the universality class under study. While the random phase property can up to now only be proved in special models or in a restricted sense, we provide strong numerical evidence that it holds in the Anderson model of localization. A main outcome of the random phase property is a perturbative calculation of the Lyapunov exponents which shows that the Lyapunov spectrum is equidistant and that the localization lengths for large systems in the unitary, orthogonal and symplectic ensemble differ by a factor 2 each. In an Anderson-Ando model on a tubular geometry with magnetic field and spin-orbit coupling, the normal system of coordinates is calculated and this is used to derive explicit energy dependent formulas for the Lyapunov spectrum.

DY 7.7 Tue 11:15 H46

Diffusion and Extreme-Value Statistics — •Julien Randon-Furling — AG Rieger, Theoretische Physik, Univ. Saarland, Germany

The ubiquity of Brownian motion in both "natural" and "man-made" contexts (from particle diffusion to financial markets), together with its mathematical status as fundamental stochastic process, makes it of particular interest for theoretical physicists.

We shall review a number of new results involving Brownian motion, obtained using standard tools from statistical physics and linked to the statistics of extreme values. In particular, we will show how one can derive exact results on the geometry of the diffusion surface in 2 and 3 dimensions. These can be extended to so-called anomalous diffusion and other processes, eg partly Brownian - partly ballistic motion or collective motion, as we shall see in dimension 1 and/or 2.

DY 7.8 Tue 11:30 H46

Record statistics in improving populations — •Gregor Wergen and Joachim Krug — Institut für Theoretische Physik, Universität zu Köln

Record breaking events are relevant in many different areas of research. For instance in climatology records are important events which are often mentioned in current media coverage. Also in biology, economy or sports, records can be interesting. In most cases where records appear there is always the question if a record occurred just by chance or because of a real improvement. We considered the statistics of record-breaking events for random variables from distributions with an increasing mean value. While the statistics of records in time-independent and uncorrelated time-series is understood quite well, there are a lot of open questions for record events from distributions that are not-stationary. We derive a general expression for the probability for a record-breaking event in the case of an underlying distribution with a small linear drift. This expression can be evaluated for various elementary distributions. We compared our results to numerical simulations. The results are important for applications in climatology, where they can be used to predict the increase in the number of record events due to global warming.

DY 7.9 Tue 11:45 H46

Langevin description of subordinated Brownian motion in the presence of external potentials — •Stephan Eule[1] and Rudolf Friedrich[2] — [1]Max-Planck-Institut fuer Dynamik und Selbstorganisation, Goettingen — [2]Institut fuer Theoretische Physik, Westfaelische-Wilhelms-Universitaet Muenster

The role of external forces in systems exhibiting anomalous diffusion is discussed within the framework of Langevin equations. Since there exist different possibilities to include the effect of an external field the concept of biasing and decoupled external fields is introduced. This leads to two different forms of time-fractional Fokker-Planck equations. Complementary to the established Langevin equations for subordinated Brownian motion in a time-dependent external force-field by Magdziarz et al. the Langevin formulation of anomalous diffusion in a decoupled time-dependent force-field is derived.

DY 7.10 Tue 12:00 H46

Intrinsic common noise in a system of two coupled Brusselators — •Amitabha Nandi and Benjamin Lindner — Max-Planck Institut für Physik komplexer Systeme, Nöthnitzer Str. 38 01187 Dresden, Germany.

We investigate the effect of coupling two chemical subsystems through diffusion of chemical species. Such coupling schemes have been studied before at the level of macroscopic rate equations. Here we consider the Langevin description of the actual microscopic dynamics and show that diffusive coupling gives rise to a common noise term along with the elastic interaction. This term contributes negative or positive correla-

tions thereby changing the total correlation between the two systems. As a model example, we study two diffusively coupled Brusselator systems. We show that depending on the dynamical regime, the intrinsic common noise due to coupling affects total correlation significantly.

DY 7.11 Tue 12:15 H46

Thermally activated fragmentation in a simple polymer model — •Simon Fugmann and Igor M. Sokolov — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstraße 15, 12489 Berlin, Germany

We consider the thermally activated fragmentation of a homopolymer chain. In our simple model the dynamics of the intact chain is a Rouse one until a bond breaks and bond breakdown is considered as a first passage problem over a barrier to an absorbing boundary. Using the framework of the Wilemski-Fixman approximation we calculate activation times of individual bonds for free and grafted chains. We show that these times crucially depend on the length of the chain and the location of the bond yielding a minimum at the free chain ends. Based on these results we discus the effect of spacer molecules in polymer rupture experiments performed at a constant loading rate.

DY 7.12 Tue 12:30 H46

Power-law distributions and 1/f noise from nonlinear stochastic differential equations — •Bronislovas Kaulakys, Vygintas Gontis, and Julius Ruseckas — Institute of Theoretical Physics and Astronomy, Vilnius University, A. Gostauto 12, LT-01108 Vilnius, Lithuania

Power-law distributions of spectra, including $1/f^\beta$ noise, and scaling behavior in general are ubiquitous in physics and in many other fields. We consider a class of nonlinear stochastic differential equations, giving the power-law behavior of the spectra in any desirably wide range of frequency [1, 2]. Here the power-law behavior of spectrum is derived directly from the stochastic differential equations. The derivation expands the class of equations generating $1/f^\beta$ noise, provides further insights into the origin of $1/f^\beta$ noise and reveals that the power spectrum may be represented as a sum of the Lorentzian spectra [3].

[1] B. Kaulakys, J. Ruseckas, V. Gontis and M. Alaburda, Physica A **365**, 217 (2006).
[2] B. Kaulakys and M. Alaburda, J. Stat. Mech. P02051 (2009).
[3] J. Ruseckas and B. Kaulakys (to be published).

DY 8: Quantum Dynamics, Decoherence, and Quantum Information I

Time: Tuesday 10:00–13:00 Location: H38

DY 8.1 Tue 10:00 H38

Density dynamics in the anisotropic Heisenberg spin-1/2 chain at high temperatures: A current-autocorrelation approach to finite time and length scales — •Robin Steinigeweg — Institute for Theoretical Physics, Technical University of Braunschweig, Mendelsohnstr. 3, D-38106 Braunschweig, Germany

The transport of magnetization is investigated for the anisotropic Heisenberg spin-1/2 chain in the limit of high temperatures. The approach is essentially based on a connection between the evolution of the variance of an inhomogeneous nonequilibrium density and the current-autocorrelation function at finite times. Although this relationship is not restricted to the case of diffusive transport, it allows to extract a quantitative value for the diffusion constant in that case. By means of numerically exact diagonalization we indeed observe diffusive behavior for anisotropies which are larger than 1 and additionally confirm the diffusion coefficients which were obtained for these anisotropies from nonequilibrium bath scenarios.

DY 8.2 Tue 10:15 H38

Dissipative Excitonic Dynamics with Trapping — •Oliver Mülken, Tobias Schmid, Alexander Blumen, and Lothar Mühlbacher — Institut für Physik, Universität Freiburg, Freiburg, Germany

The trapping of excitations in systems coupled to an environment allows to study the quantum to classical crossover by different means. We show how to combine the phenomenological description by a non-hermitian Liouville-von Neumann Equation (LvNE) approach in the Lindblad form to the numerically exact Path Integral Monte-Carlo (PIMC) method, and examplify our results by considering coupled two-level systems. By varying the coupling strenght to the environment we are able to estimate the parameter range in which the LvNE approach yields satisfactory results. Moreover, by matching the PIMC results with the LvNE calculations we have a powerful tool to extrapolate the numerically exact PIMC method to long times.

References:

[1] Mülken et al., Phys. Rev. Lett 99, 090601 (2007).
[2] Mülken, Schmid, Blumen, and Mühlbacher, submitted (2009).
[3] Mülken and Mühlbacher, in preparation (2009)

DY 8.3 Tue 10:30 H38

Cold and hot finite quantum systems in contact: energy flow and temperature equilibration — •Alexey V. Ponomarev, Sergey Denisov, and Peter Hanggi — Institute of Physics, University of Augsburg, Germany

Relaxation toward the canonical state is commonly attributed to a situation where a small system of interest is coupled to a huge one (the Universe, a heat bath, etc). Here we focus on the case of two identical quantum systems composed of a finite number of bosons. Both the systems are initially prepared in Gibbs states at different temperatures, $\rho_A(T_A)$ and $\rho_B(T_B)$, and isolated from the external environment. Then the systems are brought into a thermal contact.

We demonstrate that the energy starts to flow from a "hot" system to a "cold" one until the system energies equilibrate. There are two possible distinguishable relaxation regimes. In the first regime, each of the systems evolves toward the state characterized by the arithmetic average of their initial density matrices, $\rho_A(T_A)/2 + \rho_B(T_B)/2$. The second regime substantiates what we would expect from the equilibration of two big, classical bodies: (i) both the quantum systems relax to the thermal (Boltzmann) states with equal temperatures; and (ii) the relaxation process has a quasistatic character, i. e. each system passes through a chain of intermediate thermal (Boltzmann) states. With that, we show for the first time that a non-equilibrium thermodynamic process can be reproduced within an isolated finite bipartite quantum system.

DY 8.4 Tue 10:45 H38

Quantum non demolition measurement of a single nuclear spin in a room temperature solid — Phillip Neumann[1], Johannes Beck[1], Matthias Steiner[1], Helmut Rathgen[1], •Florian Rempp[1], Navid Zarrabi[1], Florian Dolde[1], Philip Hemmer[2], Fedor Jelezko[1], and Jörg Wrachtrup[1] — [1]Universität Stuttgart, Deutschland — [2]A&M University,Texas

The measurement process and its interpretation are in the focus of quantum mechanics since its early days. Today's ability to isolate single quantum objects allows experimental demonstration of former "gedankenexperiments" like measurement induced quantum state collaps. Rapidly growing quantum technologies explore fundamental aspects of measurements in quantum computing, however for solid state systems such experiments require operation at very low temperatures. Here we show that projective quantum measurement can be performed on a single nuclear spin in diamond under ambient conditions. Using quantum non demolition (QND) readout we are able to detect quantum jumps and the quantum Zeno effect emphasising the addressability of fundamental questions of quantum mechanics in solids. Single shot measurements with fidelities exceeding 0.9 enable efficient state initialization, quantum error correction and entanglement pumping that is crucial for quantum information processing including measurement based schemes and distributed quantum networks.

DY 8.5 Tue 11:00 H38

The speed of Markovian relaxation towards the ground state — •Malte Vogl, Gernot Schaller, and Tobias Brandes — Institut für Theoretische Physik, Hardenbergstr. 36, D-10623 TU Berlin

For sufficiently low reservoir temperatures, it is known that open quantum systems subject to decoherent interactions with the reservoir relax towards their ground state in the weak coupling limit. Within the framework of quantum master equations, this is formalized by the Born-Markov-secular (BMS) approximation, where one obtains the system Gibbs state with the reservoir temperature as a stationary

state. When the solution to some problem is encoded in the (isolated) ground state of a system Hamiltonian, decoherence can therefore be exploited for computation. The computational complexity is then given by the scaling of the relaxation time with the system size n.

In this contribution [1] we study the relaxation behavior for local and non-local Hamiltonians that are coupled dissipatively with local and non-local operators to a bosonic bath in thermal equilibrium. We find that relaxation is generally more efficient when coherences of the density matrix in the system energy eigenbasis are taken into account. In addition, the relaxation speed strongly depends on the matrix elements of the coupling operators between initial state and ground state.

We show that Dicke superradiance is a special case of our relaxation models and can thus be understood as a coherence-assisted relaxation speedup.

[1.] M. Vogl, G. Schaller, and T. Brandes, arxiv:0908.1026v1.

DY 8.6 Tue 11:15 H38

Validity of the Landauer's principle in the quantum regime — •Stefanie Hilt[1], Janet Anders[2], Eric Lutz[1], and Saroosh Shabbir[2] — [1]Department of Physics, University of Augsburg, 86135 Augsburg, Germany — [2]Department of Physics, University College London, London, WC1E 6BT, UK

Landauer's principle gives a lower bound to the heat dissipated during the erasure of information. It is a key component of quantum information processing, since it provides a fundamental connection between information theory and thermodynamics. The validity of the erasure principle has been challenged constantly, especially in the quantum regime where entanglement plays an important role. We show that the Landauer bound holds even in the strong-coupling quantum regime.

DY 8.7 Tue 11:30 H38

Transport dynamics below the localization length in the 3-d Anderson model — •Jochen Gemmer[1], Robin Steinigeweg[2], and Hendrik Niemeyer[1] — [1]University Osnabrueck, Physics Departement — [2]University Braunschweig, Physics Departement

As wellknwon the Anderson model shows localization at all energies if the on-site disorder exeeds some critical value. However, below the critical disorder there are non-localized energy regimes, furthermore there may be relevant spatial dynamics on scales below the localization length at all regimes. We analyze those dynamics finding that they may be described as diffusive with quantitative diffusion coefficients and meaningful mean free paths, particle velocities, etc. This is shown to hold for all degrees of disorder up to the critical disorder.

DY 8.8 Tue 11:45 H38

Open quantum systems: The Third Law and the conundrum of negative specific heat — •Peter Hänggi — Universität Augsburg, Institut für Physik, Universitätsstr. 1, 86135 Augsburg

We consider the validity of the Third Law in open quantum systems and evaluate the specific heat C. Two routes for obtaining C are presented. The first one uses the measurement of the expectation of the system Hamiltonian while the second one is based on the reduced partition function of the open quantum system, which is the ratio of the partition functions of system plus bath and of the bath alone. Both descriptions yield results which are consistent with the Third Law of thermodynamics. Interestingly, the two methods produce different results that disagree even in their leading quantum corrections at high temperatures. As specific examples we use (i) a damped two-level fluctuator, (ii) a damped harmonic oscillator and (iii), a free particle coupled with finite friction strength to a bath. For zero coupling this latter system presents an exception to the validity of the Third Law (ideal gas of free particles). We detect parameter regimes for which the specific heat C of the open system is negative. This issue is contrasted with thermodynamic rigorous stability criteria and resolved. References:

[1-3] G. Ingold, P. Hänggi, and P. Talkner: *Specific heat anomalies of open quantum systems*, Phys. Rev. **E 79**, 061105 (2009); P. Hänggi, G. L. Ingold, and P. Talkner: *Finite quantum dissipation: the challenge of obtaining specific heat*, New J. Phys. **10**, 115008 (2008); P. Hänggi and G. L. Ingold: *Quantum Brownian motion and the third law of thermodynamics* Acta Physica Polonica **B 37**, 1537 (2006).

DY 8.9 Tue 12:00 H38

Simple stochastic simulation of open quantum systems — •Jürgen T. Stockburger — Universität Ulm, Institut für Theoretische Physik, 89069 Ulm

The quantum dynamics of a system coupled to a reservoir with Gaussian quantum fluctuations can be recast in the form of a stochastic Liouville-von Neumann (SLN) equation involving noise forces which are classical variables bearing the spectral properties of quantum statistical fluctuations [1]. Until recently, related numerical methods used either a linear or a normalized, nonlinear SLN equation. Linear equations yield simulations that are simple and stable but resource-intensive. Normalized equations yield faster convergence but suffer from instabilities, which have so far been curable [2] only by resorting to complicated algorithms. New hybrid or "soft normalization" methods lead to simulations which combine the advantages of both earlier approaches.

[1] Stockburger, J.T. and Grabert, H., *Phys. Rev. Lett.* **88**, 170407 (2002)

[2] Stockburger, J.T., *Chem. Phys.* **296**, 159 (2004)

DY 8.10 Tue 12:15 H38

Optimal coherent control of noisy and open quantum systems — •Rebecca Schmidt, Joachim Ankerhold, and Jürgen T. Stockburger — Universität Ulm, Institut für Theoretische Physik, 89069 Ulm

The coherent optimal control of quantum dynamics has become an important design paradigm in modern tailored-matter applications such as quantum information processing and ultracold atoms in addition to its established use in chemical physics. We extend Krotov's formulation of optimal control theory to noisy and open quantum systems, using an exact stochastic model for the quantum fluctuations of reservoir modes [1]. As a non-trivial test model we demonstrate optimal control of the harmonic oscillator under the control of simultaneous linear and parametric driving fields. As a concrete result, we find the potential of cooling translational motion without reference to internal degrees of freedom.

[1] Stockburger, J.T. and Grabert, H., *Phys. Rev. Lett.* **88**, 170407 (2002)

Invited Talk DY 8.11 Tue 12:30 H38

Quantum search algorithms and quantum communication on networks — •Gregor Tanner and Birgit Hein — School of Mathematical Sciences, University of Nottingham, University Park, Nottingham NG7 2RD, UK

Quantum search algorithms - both for an ordered list and on an extended network - are based on propagating a well known initial quantum state into a localised target state. Grover's algorithm, one of the corner stones of modern quantum information theory, predicts a square root speed up of a search protocol based on wave mechanics compared to a "classical" search. I will discuss extensions of Grover's ideas to searches on networks. I will summarise the connections between quantum random walks, quantum searches and quantum graphs, and will offer a new interpretation of a quantum search in terms of avoided crossings and localised defect states.

Setting up a communication channel between two parties is in fact closely related to a two-way search. Starting from this observation, it will be shown that wave mechanics can be used to send signals efficiently between a sender and a receiver where neither party knows the address of the other. Possible experimental realisations will be discussed.

DY 9: Granular Matter/ Contact Dynamics I

Time: Tuesday 10:00–12:15 Location: H47

DY 9.1 Tue 10:00 H47

Is random close packing of spheres well defined? — •Frank Rietz[1], Ralf Stannarius[1], Charles Radin[2], Harry L. Swinney[2], and Matthias Schröter[3] — [1]Univ. of Magdeburg — [2]Univ. of Texas at Austin — [3]MPI for Dynamics and Self-Organization Göttingen

The name random close packing refers to the experimental observation that some ways of packing of monodisperse beads (like vertical vibration or sedimentation) can't exceed a volume fraction of ≈64%. There are several competing theories for this phenomenon [1-3]. However, it is possible to surpass the random close packing limit by cyclic shearing [4]. We investigate the three-dimensional distribution of particles in such a shear cell. Index matching of the surrounding liquid provides access to the interior of the granular bed. A laser sheet is scanned through the sample and by adding a fluorescent dye to the liquid we can determine the particle positions. The experiment starts at packing fractions well below random close packing. After a few thousand cycles packing fractions above 64% are achieved. By means of the Voronoi cells we characterize the local packing densities and measure order parameters around the onset of random close packing. This allows us to comment on the question if random close packing is well defined.
[1] Torquato *et al.*; Phys. Rev. Lett. **84**, 2064 (2000). [2] Kamien & Liu; Phys. Rev. Lett. **99**, 155501 (2007). [3] Radin; J. Stat. Phys. **131**, 567 (2008). [4] Nicolas *et al.*; Eur. Phys. J. E **3**, 309 (2000).

DY 9.2 Tue 10:15 H47

Random packings of spheres - Is there a limit on being loose? — •Matthias Schröter[1], Melissa Jerkins[2], and Harry L. Swinney[2] — [1]MPI for Dynamics and Self-Organization, Göttingen — [2]Center for Nonlinear Dynamics, UT Austin

A granular solid is defined by a finite yield stress; with decreasing volume fraction this yield stress vanishes and the sample turns into a granular fluid. The nature of this solid-liquid transition is still debatted. We will join the discussion by presenting experimental data how pressure, friction [1] and particle shape influence the phase boundary.
[1] Jerkins *et al.*, Phys. Rev. Lett. **101**, 018301 (2008)

DY 9.3 Tue 10:30 H47

Velocity Stratification through the Depth in Rapid Shear Flows of Granular Materials — •Birte Domnik[1], Christian Kröner[1], and Shiva P. Pudasaini[1,2] — [1]Steinmann Institut, Universität Bonn — [2]School of Science, Kathmandu University, Nepal

Appropriate rheology and boundary conditions are required in order to properly determine the dynamics of flow and the impact pressure induced by geophysical and industrial mass flows such as avalanches, debris flows and flow of granular materials. For simulations of ideal fluid, e.g., water, the no-slip is a generally accepted boundary condition which leads to reasonable results. However, it is observed in experiments and in the field that in rapid flow of granular material down the slopes, even the lowest particle layer in contact with the bottom boundary moves with a non-zero and non-trivial velocity. As the material friction substantially influences the flow velocities and also the depth profile an appropriate modelling of the boundary condition is important. In this talk, we present a new continuum mechanical model for rapid motion of granular material down slopes. Possible boundary conditions at the bottom like no-slip, free-slip and, in particular, enhanced approaches will be discussed. In the enhanced approach the bottom velocity can also depend on the bottom pressure. The simulation results demonstrate the applicability of the new model equations, particularly, in the regions where the strong shearing through the depth develops during the motion of the granular mass down the slope.

DY 9.4 Tue 10:45 H47

A Lattice Model with Fragmentation and Reagglomeration — •Alexander Weuster, Lothar Brendel, and Dietrich E. Wolf — Universität Duisburg-Essen, Fachbereich Physik and CeNIDE, 47048 Duisburg, Germany

Van der Waals forces play a major role in the formation-process of uncharged nanoparticles, since they exceed other forces, such as gravity. Agglomerates of ultra-fine cohesive particles, often referred to as nanopowders, can reach porosities up to 98 %. In fact, the porosity of a nanopowder plays a key-role in industrial application e.g. gas sensors, catalysts and diesel soot traps.

Aerosol aggregation processes produce fractal clusters, which increase, when deposited, the porosity of a nanopowder, in contrast to single particle deposition processes (Mädler et al. 2006). A new algorithm to create such a fractally substructured nanopowder was proposed by Schwager, Wolf and Pöschel(2008). Based on this work, we present a lattice model to generate such nanoparticle agglomerates in two and three dimensions. Fragmentation is done by a sieving procedure with a prescribed mesh size, followed by a ballistic deposition. Continous fragmentation and reagglomeration lead to a steady state configuration with a fractal substructure. By tuning the mesh size, the model is capable of producing agglomerates of arbitrarily high porosity. Results for fractal dimension, mass-distribution of the fragmentation process and scaling-relations are discussed.

DY 9.5 Tue 11:00 H47

Precursors of failure in granular systems — •Philipp Welker[1] and Sean McNamara[2] — [1]Institut für Computerphysik, Universität Stuttgart, Germany — [2]Institut de Physique de Rennes, Université de Rennes I, France

We study numerical simulations of large ($N \approx 10^4$) two-dimensional quasi-static granular assemblies subjected to a slowly increasing deviator stress ("biaxial test"). We report some peculiarities in the behavior of these packings that have not yet been adressed. The number of sliding contacts M_s is not necessarily related to stability: at approximatley half the peak stress, the increase of M_s slows down, a plateau develops, and a decrease follows.

The spatial organization of sliding contacts also changes: the formerly uniformly distributed sliding contacts become concentrated in certain regions in the second half of the simulation. This suggests that the loss of homogeneity occurs well before the appearance of shear bands. During the same period, events appear where M_s drops suddenly, and then rapidly recovers. We show that these events are in fact local re-arrangements in the packing, and that they are triggered by an instability. These events become more frequent as failure is approached. For these two reasons, these events are similar to the precursors recently observed in both numerical [1] and experimental [2], [3] studies of avalanches.
[1] L. Staron et al., *Phys. Rev. Lett.*, **89**, 204302 (2002).
[2] T. Scheller et al., *Phys. Rev. E*, **74**, 031311 (2006).
[3] M.A. Aguirre et al., *Phys. Rev. E*, **73**, 041307 (2006).

DY 9.6 Tue 11:15 H47

Temperature-induced liquid bridges — •Christoph Gögelein, Martin Brinkmann, Matthias Schröter, and Stephan Herminghaus — MPI für Dynamik und Selbstorganisation, Bunsenstr. 10, 37073 Göttingen

We all now that if we add a small amount of water to a heap of sand, the medium becomes paste-like since some of the grains get connected by liquid bridges. These bridges act as little springs between neighbouring particles stiffening the material. With wet sand, we can easily sculpture, for example, a sand castle [1]. We use a non-Brownian suspension of micrometer-large glass spheres dissolved in a critical binary liquid mixture to study the the physical properties of wet and dry granular matter. The suspending water-lutidine mixture exhibits a lower critical point leading to a phase separation slightly above ambient temperature. Within the two-phase region the water-rich phase wets the glass spheres and liquid bridges are formed between close-by particles. Thus, we can switch the bridges on by increasing temperature. We observe the temperature-induced formation of liquid bridges using a confocal microscope and calculate the cohesive force from bright field images.
[1] M. Scheel, et al., Nature Materials 7, 174 (2008)

DY 9.7 Tue 11:30 H47

Compressible kinematic modeling — •Claas Bierwisch and Michael Moseler — Fraunhofer-Institut für Werkstoffmechanik IWM, Wöhlerstr. 11, 79108 Freiburg

Granular discharge from a hopper through a slit orifice is studied using discrete element method simulations. A common continuum approach to describe the velocity field is given by kinematic modeling. This method is refined by considering volume fraction variations within the

flowing granular material. A relationship between the local volume fraction and a parameter which couples the horizontal and vertical velocity component was discovered. Considerable increase in accuracy is demonstrated by using this relationship in combination with the proposed compressible kinematic modeling.

DY 9.8 Tue 11:45 H47

Self-assembled granular walkers — •Zeina Khan[1], Audrey Steinberger[2], Ralf Seemann[1,3], and Stephan Herminghaus[1] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Laboratoire de Physique, Ecole Normale Supérieure de Lyon, Lyon, France — [3]Experimental Physics, Saarland University, Saarbrücken, Germany

We have observed that when a bi-disperse mixture of glass beads is moistened by a fluid and shaken sinusoidally in a vertical container, small clusters of beads take off from the surface of the pile and rapidly climb up the container walls against gravity. These self-organized clusters are held together and against the wall by liquid capillary bridges, and are led by one large grain with one or more small grains trailing behind. When similar clusters are placed on a horizontally vibrating substrate they self-align and travel horizontally along the axis of vibration with a ratchet-like motion. We report on properties of this novel system, such as the clusters' speed as a function of the asymmetry of the structure and the driving acceleration. We also present a model that accounts for the observed behavior.

DY 9.9 Tue 12:00 H47

On the dynamics of cartoon dunes — •Christopher Groh[1], Ingo Rehberg[1], and Christof A. Krülle[1,2] — [1]Experimentalphysik V, Universität Bayreuth, D-95440 Bayreuth, Germany — [2]Fakultät für Maschinenbau und Mechatronik, Hochschule Karlsruhe - Technik und Wirtschaft, D-76133 Karlsruhe, Germany

The spatio-temporal evolution of a downsized model for a barchan dune is investigated experimentally in a narrow water flow channel. We observe a rapid transition from the initial configuration to a steady-state dune with constant mass, shape, velocity, and packing fraction. The development towards the dune attractor is shown on the basis of four different starting configurations. The shape of the attractor exhibits all characteristic features of barchan dunes found in nature, namely a gently inclined windward (upstream) side, crest, brink, and steep lee (downstream) side. The migration velocity is reciprocal to the length of the dune and reciprocal to the square root of the value of its mass. The velocity scaling and the shape of the barchan dune is independent of the particle diameter. For small dunes we find significant deviations from a fixed height-length aspect ratio. Moreover, a particle tracking method reveals that the migration speed of the model dune is one order of magnitude slower than that of the individual particles. In particular, the erosion rate consists of comparable contributions from low energy (creeping) and high energy (saltating) particles. Finally, it is shown that the velocity field of the saltating particles is comparable to the velocity field of the driving fluid.

DY 10: Nonlinear Dynamics I

Time: Tuesday 14:00–16:15 Location: H46

DY 10.1 Tue 14:00 H46

Zero lag synchronization of a chaotic system with time delayed couplings — •Anja Englert and Wolfgang Kinzel — Institut für Theoretische Physik, Universität Würzburg, 97074 Würzburg

Zero-lag synchronization (ZLS) without self-feedback or adding a relay unit is demonstrated in an experiment of two mutually coupled chaotic semiconductor lasers. The mechanism is based on two mutual coupling delay times with certain integer ratios, where for a single mutual delay time ZLS cannot be achieved. This mechanism is also found for mutually coupled chaotic maps where its stability is analyzed using the Schur Cohn theorem for the roots of polynomials. The symmetry of the polynomials allows only specific integer ratios for ZLS. In addition a general argument for ZLS with several mutual coupling delay times is presented. This work was done in collaboration with Y. Aviad, M. Butkovski, I. Kanter, I. Reidler, M. Rosenbluh and M. Zigzag from Department of Physics, Bar-Ilan University, Israel. Paper to be published.

DY 10.2 Tue 14:15 H46

Distributed vs Fixed Delay in a System of Coupled Phase Oscillators — •Lucas Wetzel[1], Saúl 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

Systems of coupled oscillators with delay in the coupling are important for several physical, chemical, engineering, and biological phenomena. In cellular systems, such as the vertebrate segmentation clock, fluctuations in gene expression and transport of macromolecules introduce a variability in the time delay associated with cell to cell communication. In order to account for such variability, we consider the effects of distributed delays.

We study systems of phase oscillators with different coupling topologies, introducing a delay distribution that describes the contributions to the coupling arising from different past times. Surprisingly, our calculations show that for an arbitrary coupling topology where each oscillator is identical and coupled to the same number of oscillators within the system, the frequency of the fully synchronized states as well as the stability of such solutions only depend on the first moment of the distribution. The system is thus closely related to one with a fixed delay whose value equals the first moment of the distribution.

DY 10.3 Tue 14:30 H46

Pulsed time delayed feedback and the anticipation of chaotic dynamics — •Thomas Jüngling[1], Hartmut Benner[1], and Wolfram Just[2] — [1]Institute for Condensed Matter Physics, TU Darmstadt, Germany — [2]School of Mathematical Sciences, Queen Mary / University of London, United Kingdom

Feedback with time delay is widely known for its ability to induce an infinite number of dynamical degrees of freedom. Such an aspect normally prevents one from a deeper understanding of the relevant phase space structures. We present an example of a system with a pulsed delay term such that an infinite number of delay modes freezes out, with the dynamics taking place on a finite-dimensional subspace. Moreover, such a generic mechanism can be used to identify types of modulated time-delayed feedbacks which are able to induce superstable behaviour. We apply this concept for the purpose of anticipating chaotic synchronisation. The stability of synchronised states can be improved considerably by pulsed feedback. The validity of the theoretical considerations and their relevance for applications is demonstrated by experimental results as well.

DY 10.4 Tue 14:45 H46

Double entropic stochastic resonance — P. Sekhar Burada[1,2], •Gerhard Schmid[2], and Peter Hänggi[2] — [1]MPI for the Physics of Complex Systems, Dresden, Germany — [2]University of Augsburg, Augsburg, Germany

We demonstrate the appearance of a purely entropic stochastic resonance (ESR). This new phenomena is occurring in geometrically confined systems [1,2], where the irregular boundaries cause entropic barriers. The interplay between a periodic input signal, a constant bias and intrinsic thermal noise, leads to a resonant ESR phenomenon in which feeble signals become amplified. This new phenomenon is characterized by the presence of two peaks in the spectral amplification at corresponding optimal values of the noise strength. The nature of ESR, occurring when the origin of the barrier is entropic rather than energetic, offers new perspectives for novel investigations and potential applications. ESR by itself presents yet another case where one constructively can harvest noise in driven nonequilibrium systems.

[1] P. S. Burada, G. Schmid, D. Reguera, M. H. Vainstein, J. M. Rubi, and P. Hänggi, Phys. Rev. Lett. **101**, 130602 (2008).
[2] P. S. Burada, G. Schmid, D. Reguera, J. M. Rubi, and P. Hänggi, EPL **87**, 50003 (2009).

DY 10.5 Tue 15:00 H46

Periodic orbits in the sliding of graphite flakes — •Astrid

S. de Wijn, Claudio Fusco, and Annalisa Fasolino — Institute for Molecules and Materials, Radboud University Nijmegen, Heyendaalseweg 135, 6525 AJ Nijmegen, the Netherlands

Theoretical consideratons show that the sliding of an atomic layer weakly interacting with an incommensurate periodic substrate can occur with vanishingly low friction. Indeed, extremely low friction has been observed experimentally in several systems and this effect has been named superlubricity. However, there is recent evidence that the incommensurate superlubric state is destroyed by rotation of the sliding flake [2], leading to a commensurate state with high friction.

In this work, we study the dynamics of finite rigid graphite flakes on a graphite surface. In numerical simulations, we find that after an initial short period, the flake either rotates and locks into a commensurate orientation or it remains incommensurate and slides with extremely low friction. We construct a simple model system which captures the essential dynamics, and for which the stability can be investigate d analytically. We show that for a realistic system periodic orbits exist that correspond to the commensurate and incommensurate states and that they may be stable. We investigate the robustness of the incommensurate superlubric state against parameters such as sliding velocity and temperature.

[1] M. Dienwiebel et al., Phys. Rev. Lett. **92**, 126101 (2006).
[2] A.E. Filippov et al., Phys. Rev. Lett. **100**, 046102 (2008).

DY 10.6 Tue 15:15 H46

Scaling properties of bred- and Lyapunov vectors — •Sarah Hallerberg[1], Juan M. Lopez[2], Diego Pazo[2], and Miguel A. Rodriguez[2] — [1]Institut für Physik, TU Chemnitz — [2]Instituto de Fisica de Cantabria (IFCA), CSIC-Universidad de Cantabria, Santander

It has been demonstrated that the spatio-temporal dynamics of characteristic Lyapunov vectors in spatially extended chaotic systems can be related to properties of scale invariant growing surfaces [1]. We study now, whether similar scaling properties, can also be observed for bred vectors. Moreover we propose a new method to estimate Lyapunov exponents corresponding to the most expanding directions using bred vectors [2]. More precisely, the scaling properties of the perturbations allow us to associate a bred vector of a given amplitude to a specific Lyapunov vector within the first ten percent of the Lyapunov spectrum. In this contribution we extend the results obtained in previous studies for the Lorenz'96 model [3] to applications in a minimalistic climate model [4].

References: [1] D. Pazo et al. (2008) [2] E. Kalnay et al. (2002) [3] E. N. Lorenz (1998) [4] V. Lucarini et al. (2007)

DY 10.7 Tue 15:30 H46

Recurrence networks: A novel paradigm for nonlinear time series analysis — •Reik V. Donner[1,2,3], Yong Zou[3], Jonathan F. Donges[3,4], Norbert Marwan[3], and Jürgen Kurths[3,4] — [1]Max Planck Institute for Physics of Complex Systems, Dresden, Germany — [2]Institute for Transport and Economics, Dresden University of Technology, Germany — [3]Potsdam Institute for Climate Impact Research, Potsdam, Germany — [4]Department of Physics, Humboldt University of Berlin, Germany

We present a novel approach for analysing structural properties of dynamical systems based on time series. Starting from the concept of recurrences in phase space, the recurrence matrix of a time series is interpreted as the adjacency matrix of an associated complex network which links different points in time if the evolution of the considered states is very similar. A critical comparison of these recurrence networks with similar existing techniques is presented, revealing strong conceptual benefits of the new approach which can be considered as a unifying framework for transforming time series into complex networks that also includes other methods as special cases.

We demonstrate the presence of fundamental relationships between the topological properties of recurrence networks and the statistical properties of the phase space density of the underlying dynamical system. Hence, the network description yields new quantitative characteristics of the dynamical complexity of a time series, which substantially complement existing measures of recurrence quantification analysis.

DY 10.8 Tue 15:45 H46

Dämpfung einer schwingenden Masse durch ein freies Reibelement — •Alexander Maria Többens — DLR Deutsches Zentrum für Luft- und Raumfahrt, Institut für Aeroelastik, Göttingen, Deutschland — Drittes Physikalisches Institut, Göttingen, Deutschland

Der Vortrag behandelt die Dynamik eines eindimensionalen nichtlinearen Oszillators, bestehend auf einer horizontal schwingenden, periodisch getriebenen Masse und einer locker auf dieser aufliegenden zweiten Masse. Beide Körper wechselwirken über die an der Kontaktfläche auftretende trockene Reibung. Befindet die aufliegende Masse sich relativ zur schwingenden Masse in Bewegung, entzieht sie der Schwingung Energie, wirkt also als Dämpfer.

Der Oszillator dient als einfaches Modell für Vorgänge in Flugzeugtriebwerken, wo solche frei aufliegenden Reibelemente eingesetzt werden, um durch Luftkräfte angeregte Schwingungen der Rotorblätter zu dämpfen. Vorgestellt werden die mathematische Modellierung sowie numerische Untersuchungen der vielfältigen Dynamik des Systems.

DY 10.9 Tue 16:00 H46

Long lived chaotic transients in open Hamiltonian systems — •Tamás Kovács — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

We focus in this work on the finite time chaotic behavior in low dimensional dynamical systems, especially, the simple configurations in astrodynamics. Our numerical results show the existence of an invariant fractal object, the well known chaotic saddle, in the phase space that is responsible for the chaotic transients. We present several quantitative properties (escape rate, fractal dimension, Lyapunov exponent) of the saddle and compare them with the quantities in the permanently chaotic regime. Finally, the stickiness affect appearing close to KAM tori in Hamiltonian systems will be discussed.

DY 11: Quantum Dynamics, Decoherence, and Quantum Information II

Time: Tuesday 14:00–16:15 Location: H38

Topical Talk DY 11.1 Tue 14:00 H38

AC-driven quantum systems: cold atom ratchets and beyond — •Sergey Denisov — Institut fur Physik, Universitat Augsburg, Univeritatsstr. 1, 86135 Augsburg

I will start with a short introduction by using a simple model of an ac-driven quantum particle in a pulsating periodic potential ("flashing quantum ratchet"), and discuss the main mechanisms of current rectification. I will then present results on the theoretical treatment of the problem [1, 2], specify quantum features, and review the recent experimental realization of the quantum flashing ratchet with ultracold atoms [3]. Finally I will discussed two important issues: (i) the ability of coherent ac-driven quantum motors to perform a work against a constant bias and (ii) the performance of quantum motors in the presence of decoherence.

[1] S. Denisov, L. Morales-Molina, S. Flach, and P. Hanggi, Phys. Rev. A 75, 240604 (2006).
[2] A. V. Ponomarev, S. Denisov, and P. Hanggi, Phys. Rev. Lett. 102, 230601 (2009).
[3] T. Salger et al., Science 326, 1241 (2009).

DY 11.2 Tue 14:30 H38

Signatures of nonclassicality in the non-linear dynamics of an optomechanical system — •Jiang Qian and Florian Marquardt — Arnold Sommerfeld Center for Theoretical Physics, LMU, Munich, Germany

We study the non-linear dynamics in the quantum mechanical time-evolution of an optomechanical system. We discuss the time-evolution of the mechanical Wigner density and discuss the parameter dependence of nonclassical signatures. We describe a long-term steady state that significantly deviates from the semiclassical coherent state picture.

DY 11.3 Tue 14:45 H38

Dynamical typicality of quantum expectation values — •Christian Bartsch and Jochen Gemmer — Fachbereich Physik, Universität Osnabrück, Barbarastrasse 7, D-49069 Osnabrück, Ger-

many

We show that the vast majority of all pure states featuring a common expectation value of some generic observable at a given time will yield very similar expectation values of the same observable at any later time. This is meant to apply to Schrödinger type dynamics in high dimensional Hilbert spaces. As a consequence individual dynamics of expectation values are then typically well described by the ensemble average. Our approach is based on the Hilbert space average method. We support the analytical investigations with numerics obtained by exact diagonalization of the full time-dependent Schrödinger equation for some pertinent, abstract Hamiltonian model. Furthermore, we discuss the implications on the applicability of projection operator methods with respect to initial states, as well as on irreversibility in general.

DY 11.4 Tue 15:00 H38

Creation and destruction of entanglement by a nonequilibrium environment — •Max Ludwig[1], Klemens Hammerer[2], and Florian Marquardt[1] — [1]Department of Physics, Center for NanoScience, and Arnold Sommerfeld Center for Theoretical Physics, Ludwig-Maximilians-Universität München, Munich, Germany — [2]Institute for Theoretical Physics, University of Innsbruck, and Institute for Quantum Optics and Quantum Communication, Austrian Academy of Sciences, Innsbruck, Austria

Recent experiments try to cool nanomechanical resonators to the ground state by coupling them to nonequilibrium environments that originate either from electrons or cooper pairs in single electron transistors, or from photons inside an optical cavity. The ultimate goal of these experiments is the observation of quantum effects on macroscopic objects such as entanglement between coupled oscillators. This raises the general question of how nonequilibrium environments affect entanglement.

Here we show that there is an optimal dissipation strength for which the entanglement between two coupled oscillators is maximized. Below this value the cooling mechanism is too weak to overcome the influence of the thermal environment. Above this value, the dissipation via the nonequilibrium bath destroys entanglement. Our results are established with the help of a general framework of exact quantum Langevin equations valid for arbitrary bath spectra, in and out of equilibrium. We point out why the commonly employed Lindblad approach fails to give even a qualitatively correct picture.

DY 11.5 Tue 15:15 H38

Mechanically driven coherent photon dynamics in optomechanical systems — •Georg Heinrich[1], Jack Harris[1,2] und Florian Marquardt[1] — [1]LMU, Department für Physik, ASC, CeNS, München, Germany — [2]Yale University, Department of Physics, Department of Applied Physics, New Haven, CT, USA

The motion of micro- and nanomechanical objects can be coupled to electromagnetic fields. Such optomechanical systems provide new means to manipulate both light as well as mechanical motion and allow to explore the interaction of light and matter in a new regime at the boundary between quantum and classical physics. Besides the objective to eventually explore the quantum regime of mechanical motion, there have been several studies of the complex nonlinear dynamics of these systems. A recent development has introduced setups with multiple coupled optical and vibrational modes pointing the way towards integrated circuits. Here we present non-equilibrium photon dynamics in multimode systems due to the application of external, mechanical driving. This mechanically driven coherent photon dynamics can introduce the whole domain of strongly driven two- and multilevel systems to the field of optomechanics. In particular we consider the recently introduced setup consisting of a movable membrane, placed in the middle between two high-finesse mirrors, that tunnel-couples two optical modes residing in the left and the right half of the cavity, respectively. For mechanical driving of the membrane we predict Autler-Townes splittings, Rabi processes and Landau-Zener-Stueckelberg dynamics, all observable in the transmission spectrum of the system.

DY 11.6 Tue 15:30 H38

Random variable approach to dissipative spin dynamics and Landau-Zener transitions — •Peter Philipp Orth[1], Adilet Imambekov[2], and Karyn Le Hur[1] — [1]Department of Physics, Yale University, New Haven, CT 06520, USA — [2]Department of Physics and Astronomy, Rice University, Houston TX 77251, USA

We present a random variable approach to solve for the dynamics of a dissipative two-state system. Based on an exact functional integral description, our method reformulates the problem as that of non-unitary time evolution of a quantum state vector under a Hamiltonian containing random noise fields. This non-perturbative formalism goes beyond the frequently used Non-Interacting Blip Approximation (NIBA) and is particularly well suited to treat an explicitly time-dependent Hamiltonian. As an example, we consider the renowned Landau-Zener problem in the presence of an Ohmic bath with a large bath cutoff frequency ω_c. We identify an intermediate time regime where the energy separation of the two spin states is much larger than their tunneling coupling Δ, but still smaller than ω_c such that bath mediated spin transitions still occur. Such a situation can for example be realized with a cold atomic quantum dot setup. We also derive an approximate analytical expression for the decay of the upper spin state population in this regime, which agrees well with our numerical results.

DY 11.7 Tue 15:45 H38

Weak to strong values crossover in many body systems — •Alessandro Romito[1], Yuval Gefen[2], and Yaroslav Blanter[3] — [1]Karlsruher Institut für Technologie (KIT), Institut für Theoretische Festkörperphysik, 76128 Karlsruhe, Germany — [2]Department of Condensed Matter Physics, Weizmann Institute of Science, 76100 Rehovot, Israel — [3]Kavli Institute of Nanoscience, Delft University of Technology, Lorentzweg 1, 2628 CJ Delft, The Netherlands

Weak quantum measurement, as opposed to (strong) projective ones described by the projection postulate, provide partial information about the state of the system, while weakly disturbing it. A remarkably effect in this context is the appearance of "weak values" [1] as a result of a two-step measurement procedure – weak measurement followed by a strong one, where the outcome of the first measurement is kept provided a second post-selected outcome occurs. They have proven to be a remarkable concept in addressing fundamental aspects of quantum mechanics and applications to metrology. We have recently addressed the measurement of weak values in solid state physics.

Here I review some of the ideas associated with weak values, including the first proposal to observe weak values in a solid state system. I will then discuss the generalization of weak values to many-body systems specifically considering an electronic Mach-Zehnder interferometer. Within the same setup I will discuss the crossover between weak and strong values.

[1] Y. Aharonov, D. Z. Albert, L. Vaidman, Phys. Rev. Lett. 60, 1351-1354 (1988).

DY 11.8 Tue 16:00 H38

Anderson Localization of Solitons — Krzysztof Sacha[1,2], •Cord A. Müller[2,3], Dominique Delande[2], and Jakub Zakrzewski[1,2] — [1]Uniwersytet Jagielloński, Kraków, Poland — [2]Laboratoire Kastler-Brossel, UPMC, ENS, CNRS, Paris, France — [3]Physikalisches Institut, Universität Bayreuth, Germany

At low temperature, a quasi-one-dimensional ensemble of atoms with an attractive interaction forms a bright soliton. When exposed to a weak and smooth external potential, the shape of the soliton is hardly modified, but its center-of-mass motion is affected. We show that in a spatially correlated disordered potential, the quantum motion of a bright soliton displays Anderson localization. The localization length can be much larger than the soliton size and could be observed experimentally.

[1] Phys. Rev. Lett. 103, 210402 (2009)

DY 12: Soft Matter I

Time: Tuesday 14:30–16:00 Location: H47

DY 12.1 Tue 14:30 H47

^{2}H NMR study on the molecular motion of water in hydrated myoglobin — •Sorin Adrian Lusceac and Michael Vogel — Institut für Festkörperphysik, Technische Universität Darmstadt, Hochschulstr. 6, 64289 Darmstadt

The physiological properties of proteins are strongly dependent on the water dynamics (WD) in their hydration shell. Hence, ^{2}H NMR spin-lattice relaxation and solid-echo experiments were performed to investigate the WD in a water/myoglobin mixture. The obtained rotational correlation times agree with those from dielectric spectroscopy measurements. They can be described by an Arrhenius law in the high temperature range, with the possibility of a weak crossover to a second Arrhenius dependence at about 220K. No evidence for a fragile-to-strong transition, as proposed in literature[1], is found, consistent with results for hydrated elastin and collagen[2, 3]. From the spectral analysis, we conclude that at high temperatures (>230K) the WD is isotropic while at lower temperatures (<220K) anisotropic large-angle dynamics is observed. We performed random-walk simulations for several anisotropic WD models and discuss the resulting spectra in connection with the experimental results.

[1] S.-H. Chen et al., Proc. Natl. Acad. Sci. 103 (2006) 9012.
[2] M. Vogel, Phys. Rev. Lett. 101 (2008) 225701.
[3] S. A. Lusceac et al., Biochim. Biophys. Acta 1804 (2010) 41.

DY 12.2 Tue 14:45 H47

Mechanical Properties of Bilayer Membrane and Inclusion — •Giovanni Marelli — Institut für theoretische Physik Friedrich-Hund-Platz 1 D-37077 Göttingen

The presence of a hydrophobic inclusion in a bilayer membrane modifies the shape and the mechanical properties of the membrane. Due to the surface tension between the inclusion and the hydrophobic monomers the region around the inclusion is enriched in chains and the membrane bends around the defect. After the enriched zone the membrane is deplected and is prone to the formation of a pore. In this talk is presented a coarse-grained solvent-free model to study polymersome/nanoparticle and lipid vesicle/peptide inclusions. In the first system, we investigate the condition of stability of the nanoparticle with and without the presence of defectants that decrease the surface tension of the inclusion. In the second one the attention is placed upon to the radial profile of the bending of the membrane around the peptide, which is compared to a continum elastic model, to the increase of the membrane tension and to the packing effect of the lipids around the peptide.

DY 12.3 Tue 15:00 H47

Phase behavior of colloidal suspensions in critical solvents — •Thomas Friedrich Mohry[1,2], Anna Maciołek[1,2,3], and Siegfried Dietrich[1,2] — [1]Max-Planck-Institut für Metallforschung, Heisenbergstraße 3, D-70569 Stuttgart, Germany — [2]Universität Stuttgart, Institut für Theoretische und Angewandte Physik, Pfaffenwaldring 57, 70569 Stuttgart, Germany — [3]Institute of Physical Chemistry, Polish Academy of Sciences, Department III, Kasprzaka 44/52, PL-01-224 Warsaw, Poland

Colloidal systems are important both as model systems for statistical physics and for applications in material science. Close to a continuous phase transition of the solvent (e.g. the critical point of the mixing-demixing transition in a binary mixture) the correlated fluctuations result in an effective force between the immersed colloids, the so called critical Casimir forces. They exhibit the remarkable feature of universality and are sensitive to the temperature, the boundary conditions imposed by the colloids and the composition of the solvent. We present first theoretical results, concerning the influence of these critical Casimir forces on the phase behavior of the colloids.

DY 12.4 Tue 15:15 H47

Time-dependent primitive path analysis — •Jixuan Hou[1], Carsten Svaneborg[2], Gary Grest[3], and Ralf Everaers[1] — [1]École Normale Supérieure de Lyon — [2]University of Aarhus — [3]Sandia National Laboratories

The complex viscoelastic properties of polymer liquids are due to the presence of topological constraints on a molecular scale. On a microscopic scale chains can slide past each other, but their backbones cannot cross. The standard model of polymer dynamics, the tube model, assumes that entanglements confine chain fluctuations to a narrow tube-like region along a so-called *primtive path" which follows the coarse-grained chain contour.

Primitive paths were originally introduced in a thought experiment as the shortest paths into which chains with fixed endpoints can contract without crossing each other. A few years ago, we have shown how to perform a corresponding primitive path analysis (PPA) of computer generated conformations of atomistic or coarse-grained models of entangled polymer systems. We will first present our simulation results for entangled polymer melt which cover the entire range from loosely to tightly entangled polymers. The excellent agreement demonstrates that the tube model can make parameter-free, quantitative predictions for plateau moduli on the basis of a purely topological analysis. Then, we will discuss the extension of the primitive path analysis to strained systems as well as a time-dependent version of our original, time-saving algorithm. By using the time mapping, one can obtain the precise relaxation mudulus from free-end PPA.

DY 12.5 Tue 15:30 H47

The Shape of a Polymer in a Crowded Environment — Viktoria Blavatska[1], •Christian von Ferber[2,3], and Yurij Holovatch[1,4] — [1]Institute for Condensed Matter Physics, Lviv, UA — [2]Applied Mathematics Research Centre, Coventry University, UK — [3]Physikalisches Institut, Universität Freiburg — [4]Institut für Theoretische Physik, Universität Linz, AT

An environment with correlated obstacles may be used to model the crowded environment typically found in a biological cell. Does such a correlated environment change the universal conformations of a polymer in solution? We study the universal characteristics of the shape of a flexible polymer chain in an environment with correlated structural obstacles, with a power law decay x^{-a} of the correlation. To determine the universal behaviour of the polymer shape we apply the field-theoretical renormalization group approach in d dimensions and use the technique of a double expansion in the parameters $\varepsilon = 4 - d$ and $\delta = 4 - a$. The scaling exponents for the polymer are shown to depend on the disorder correlation. Further we estimate universal shape ratios, in particular the size ratio of the end-to-end and gyration radii $\langle R_e^2\rangle/\langle R_G^2\rangle$ as well as the averaged asphericity ratio $\hat{A}_d$. The results show that the asymmetry of the polymer shape is increased in crowded correlated environments as compared to the pure solution case.

DY 12.6 Tue 15:45 H47

Molecular Weight Dependence of Polymer Dynamics: A Molecular Dynamics Simulation Study — Andre Bormuth and •Michael Vogel — Institut für Festkörperphysik, Technische Universität Darmstadt, Hochschulstr. 6, 64289 Darmstadt

We perform molecular dynamics simulations for an all-atom model of poly(propylene oxide) to study the dependene of polymer melt dynamics on the molecular weight. The main focus is the regime of low molecular weights at the molecule-polymer crossover, i.e., chains comprised of N=2-100 monomers. Our studies include conformational transitions, structural relaxation, and Rouse dynamics. We find that the rates of conformational transitions, apart from weak chain end effects, do not depend on molecular weight and obey an Arrhenius law. However, upon cooling the heterogeneity of conformational dynamics increases and correlated forward-backward jumps, i.e., deviations from Markov behavior, become important. For the structural relaxation, a non-Arrhenius temperature dependence is accompanied by a more spatially heterogeneous nature of dynamics at lower temperatures. Mode-coupling theory captures some aspects of the glassy slowdown, but it does not enable a complete description. The structural relaxation time strongly increases with increasing molecular weight for short chains, while it is independent of chain length for sufficiently long chains N>30. The role of deviations from Gaussian chain statistics on the dynamical behavior is discussed.

DY 13: Granular Matter/ Contact Dynamics II

Time: Wednesday 9:30–12:30 Location: H47

Invited Talk DY 13.1 Wed 9:30 H47

Glass transition in driven granular fluids — •Annette Zippelius[1], Till Kranz[1], and Matthias Sperl[2] — [1]Institut für Theoretische Physik, Universität Göttingen, Friedrich-Hund Platz 1, 37077 Göttingen — [2]Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt, 51170 Köln

We study a homogeneously driven granular fluid at high volume fractions. A mode-coupling theory is derived for the stationary, non-equilibrium state, which is reached, when dissipation due to inelastic collisions is balanced by the driving, which is applied to the bulk of the fluid. As the density is increased beyond a critical value n_c we observe a glass transition indicated by a time persistent part of the van Hove correlation function. The transition is qualitatively similar to the corresponding one in the elastic fluid with however different values for the critical density as well as the exponents which characterize the slow dynamics preceding structural arrest. We also present results of event driven simulations, which reveal a plateau in the mean square displacement and a strong decrease of the diffusion constant as the glass transition is approached.

DY 13.2 Wed 10:00 H47

Glass-Transition for Dissipative Systems under Driving — •Till Kranz[1,2], Matthias Sperl[1,3], and Annette Zippelius[1,2] — [1]Institut für Theoretische Physik, Universität Göttingen — [2]MPI für Dynamik und Selbstorganisation, Göttingen — [3]Institut für Materialphysik im Weltraum, DLR Köln

In order to reach a steady state, granular (dissipative) systems need an external driving. One of the many possible methods is to fluidise the system by a fluctuating driving force. We extend the equilibrium mode coupling theory (MCT) of molecular fluids [1] to the steady state of such a randomly driven granular fluid. This allows us to calculate the coherent scattering function $\Phi(q,t) = \langle \rho_q(0) | \rho_q(t) \rangle$. We observe a mode coupling glass transition for all dissipation strengths characterized by a constant coefficient of normal restitution ϵ. The critical density φ_c increases with increasing dissipation. Close to the critical density we predict a two step relaxation of dynamical correlation functions. Both the plateau height f_q as well as the critical exponents differ from those found for equilibrium glass-formers.

[1] W. Götze, *Complex Dynamics of Glass-Forming Liquids: A Mode-Coupling Theory*, (Oxford University Press, 2009)

DY 13.3 Wed 10:15 H47

Driven two-dimensional granular fluids exhibit precursors to glass transition — •Iraj Gholami, Andrea Fiege, and Annette Zippelius — Institute of Theoretical Physics, University of Göttingen, Germany

We employ event-driven simulations of two-dimensional granular systems with constant coefficient of restitution to investigate its long-time behavior for different volume fractions up to 0.82. The driving is chosen such that momentum is conserved on local scales and a stationary state is reached, allowing us to calculate time dependent correlation functions and the mean square displacement. In order to avoid crystallization we use bi-disperse systems. The mean square displacement shows a pronounced plateau when increasing the volume fraction while the velocity autocorrelation function exhibits long-time tails $\propto t^{-1}$.

DY 13.4 Wed 10:30 H47

Networks of Wet Elastic Cylinders — •Ohle Claussen, Martin Brinkmann, and Stephan Herminghaus — MPI for Dynamics and Self-Organization Göttingen, Germany

Liquid bridges held between two cylindrical surfaces exert not only capillary forces onto the wetted bodies, they also induce torques. Depending on the tilt angle and separation of the surfaces, and controlled by the liquid volume or pressure a variety of liquid equilibrium shapes can be observed. Some of these liquid structures exert aligning torques which have an impact on the structure and mechanical behaviour of disordered networks of cylindrical fibres. We present numerical studies of the liquid morphologies arising in systems of macroscopic cylinders, as well as simulations of random elastic fibre networks based on an effective sliding bond model to account for the effect of capillary bridges. The growth of pores in such a network is investigated, and an alternative lattice gas model is presented to motivate the applicability of the effective model.

DY 13.5 Wed 10:45 H47

Fluidization of wet granulates under shear — Seyed H. Ebrahimnazhad Rahbari, Juergen Vollmer, Stephan Herminghaus, and •Martin Brinkmann — MPI for Dynamics and Self-Organization, 37073 Göttingen

It is a common experience that small amounts of a wetting liquid like water render sand a stiff and moldable material. The cohesive forces between the sand grains are caused by capillary bridges at the points of contact. Due to the finite strength of these bridges wet sand undergoes a transition from a solid to a fluidized state under an externally applied shear force. The transition between these two dynamic states is studied in a MD-type simulation of a two-dimensional assembly of bidisperse frictionless disks under the action of a cosine force profile. In addition to soft core repulsion the disks interact through a hysteretic and short ranged attractive force modeling the effect of the capillary bridges. In this model the transition between the fluidized and the solid state is discontinuous and hysteretic. As the system size is increased the opening of the hysteresis loop becomes smaller. The parameter dependence of the critical force for solidification is modeled by combining theoretical predictions based on free volume arguments with a detailed numerical exploration of the transition.

DY 13.6 Wed 11:00 H47

Acceleration, Clustering and Superlong Transients in a Billiard Model for Wet Granular Matter — Franziska Glassmeier, Diego Fregolente, Martin Brinkmann, and •Jürgen Vollmer — MPI for Dynamics and Self-Organization, Bunsenstr. 10, 37073 Göttingen, Germany

We generalize the collisions rules of the Sinai billiard to mimic collisions of two wet disks. The dissipative interaction of the disks leads to cooling and eventually to clustering. To work against this energy loss we shear the system by applying Lees-Edwards boundary conditions.

For sufficiently high shear rates the energy input due to shearing overcompensates the dissipative interaction such that the ensemble average of the particle energy $\langle E \rangle$ increases linearly. Energies are distributed according to an exponential function that scales with $\langle E \rangle$. This has unexpected consequences: Due to the very large energy fluctuations the system has a leak for all shear rates. Consequently, the disks may cluster even when started from very high energies.

Suprisingly, we observe an algebraic distribution of lifetimes. It is due to the non-compact phase space of the accelerating system. A relation of this phenomenon to Fermi acceleration in time-dependent billiards, and generalizations to more particles are discussed in the end.

DY 13.7 Wed 11:15 H47

Structure Factors of Driven Granular Fluids underlying Stokes Drag — •Andrea Fiege[1,2], Timo Aspelmeier[1,2], and Annette Zippelius[1,2] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Institute for Theoretical Physics, University of Göttingen, Germany

We study a monodisperse system of hard spheres which is subject to two dissipative mechanisms, the inelasticity of collisions and the loss of energy due to a drag force caused by a surrounding fluid, such that the Langevin equation of the system becomes $\frac{\mathrm{d}}{\mathrm{d}t}\mathbf{v}_i = -\gamma_S \mathbf{v}_i + \frac{\mathbf{F}_i}{m_i} + \boldsymbol{\xi}_i$, where $\mathbf{F}_i$ denotes the systematic force on the particle due to collisions and the energy source $\boldsymbol{\xi}_i$ provides a stationary state by adding random momentum to each particle. The drag force suppresses the random walk of the center of mass of the system caused by the random kicks. We introduce an event-driven algorithm that is capable of including a drag force and investigate the structure factors of the system.

DY 13.8 Wed 11:30 H47

Shear Band Patterns in Biaxial Shear Tests of Granular Materials — •Thomas Stegmann, Janos Török, Lothar Brendel, and Dietrich E. Wolf — Faculty of Physics and CeNIDE, University of Duisburg-Essen, 47048 Duisburg, Germany

The theory of minimal dissipation identifies the position of the optimal shear band in granular materials by minimizing the dissipation rate. The strength of the theory comes forward in non-trivial scenarios as modified Couette cell [1] and granular refraction [2]. In true biaxial

shear tests with frictionless walls the theory predicts ever changing shear band configurations that are optimal only for a given sample aspect ratio, with a constant angle equal to the Mohr-Coulomb angle and a constant macroscopic stress ratio [3]. A new quantity was introduced to identify shear bands in simulations which shows only partial agreement with the theory due to fluctuations and high degeneration of the optimum. This degeneracy can be decreased by introducing wall friction since there is only one shear band configuration which does not have any tangential velocity difference with the walls. It is expected that the stress ratio will be minimal at the optimal aspect ratio for this specific configuration. Apart from this point we expect to find shear band angles different from the Mohr-Coulomb angle. All theoretical results match very well with contact dynamics simulations.

[1] T. Unger et al., Phys. Rev. Lett. **92**, 214301 (2004).

[2] T. Unger, Phys. Rev. Lett. **97**, 018301 (2007).

[3] J. Török et. al. in Powders and Grains 2009, Melville NY, p. 417

DY 13.9 Wed 11:45 H47

Yield stress and shear modulus in frictional granular packing — •Jean-Francois Metayer[1], Donald Trey Suntrup III[2], Harry Swinney[2], Charles Radin[3], and Matthias Schroeter[1] — [1]MPI for Dynamics and Selforganization, Göttingen, Germany — [2]Center for Nonlinear Dynamics, University of Texas, Austin, USA — [3]Departments of Mathematics, University of Texas, Austin, USA

A granular system is able to behave like a solid (a sand pile for example) or like a liquid depending on the shear stress imposed on the material. This study is focused on the phase transition between those two states and its goal is to obtain an experimental phase diagram of a granular media in three dimensions.

The yield stress of our granular media is obtained by measuring the force, F, needed to pull-up a paddled immersed in a granular bed as a function of its packing fraction and the depth of immersion. Fluctuations of F give us access to a measurement of the shear modulus, G, as a function of the same parameters. Results we present here clearly evidence that the value of the shear stress, needed to unjam our granular media, and its shear modulus are strongly related to the packing fraction: for low packing fraction ($<\approx 0.59$) F and G are constant with ϕ whereas their value are highly dependant on ϕ for higher packing fraction.

DY 13.10 Wed 12:00 H47

Local Anisotropy in jammed spherical bead packs — •Gerd E. Schröder-Turk[1], Walter Mickel[1], Mohammad Saadatfar[2], Tim Senden[2], Matthias Schröter[3], Gary Delaney[4], Klaus Mecke[1], and Tomaso Aste[5] — [1]Theoretische Physik, Friedrich-Alexander Universität Erlangen-Nürnberg, Staudtstr. 7B, 91058 Erlangen — [2]Applied Maths, School of Physics, The Australian National University, 0200 ACT, Canberra, Australia — [3]Center for Nonlinear Dynamics and Dept. of Physics, University of Texas, Austin, TX 78712, USA — [4]CSIRO Mathematical and Information Sciences, Private Bag 33, Clayton South, VIC, 3168, Australia — [5]School of Physical Sciences, University of Kent, Canterbury, Kent, CT2 7NH, UK

We report significant structural anisotropy in disordered mono-disperse bead packs manifest in the shape of the Voronoi cells. This result is based on an analysis of several experimental and simulated packings. The anisotropy of the Voronoi cell shape is characterized by a robust method based on tensorial Minkowski functionals. The degree of anisotropy is found to decrease with increasing packing fraction ϕ for $0.55 \leq \phi \leq 0.64$ and to be insensitive to packing details and protocols. We observe a distinct change in the trend of the anisotropy when ϕ becomes larger than 0.64 and also when the system passes from unjammed to jammed configurations. The anisotropy of the Voronoi cell shape is a packing effect without significant alignment with the vertical or horizontal axes.

DY 13.11 Wed 12:15 H47

Unjamming of granular packings due to local perturbations — •reza shaebani[1], tamas unger[2], dietrich wolf[1], and janos kertesz[2] — [1]Computational and Statistical Physics Group, Department of Theoretical Physics, University of Duisburg-Essen, 47047 Duisburg, Germany — [2]Department of Theoretical Physics, Budapest University of Technology and Economics, H-1111 Budapest, Hungary

One of the most exciting research challenges for granular media is to provide better understanding of the onset of yielding. When the external load on a static assembly of grains is changed at a certain point the load may become incompatible with the inner structure of the packing and the solid state loses its stability. How exactly this happens on the grain scale and what are the key features of the transition between statics and flow are intriguing and unresolved problems.

In this study, the unjamming response of dense disordered granular media is investigated based on CD and MD simulations. We break the static structure of the packings by small local deformations and induce motion of particles. We determine the critical force of the local perturbation that is needed to break the mechanical equilibrium and examine the generated displacement field. We find that displacements decay as a power law of the distance from the perturbation point. We show that the decay exponent and the critical force are nonmonotonic and have a sharp maximum at the friction coefficient 0.1. We find that the mechanical response properties are closely related to the problem of force-indeterminacy.

DY 14: Networks: From Topology to Dynamics I (joint session of BP, DY, SOE)

Time: Wednesday 10:15–12:45 Location: H44

DY 14.1 Wed 10:15 H44

Stability of continuous vs. Boolean dynamics — •Fakhteh Ghanbarnejad and Konstantin Klemm — Department of Bioinformatics, University of Leipzig, Germany

Boolean networks are time- and state-discrete models of dynamical systems with many variables and quenched disorder in the couplings. The use of such discrete models makes large systems amenable to detailed analysis. The discretization, however, may bring about "artificial" behavior not found in the continuous description with differential equations. The usual definition of Boolean attractor stability is based on flipping the state of single nodes and checking if the system returns to the attractor, similar to a damage spreading scenario. This stability concept, however, does not reflect the stability of limit cycles in the corresponding continuous system of delay differential equations. Here we have a fresh look at the correspondence of stability definitions in continuous and discrete dynamics. We run extensive numerical simulations to test stability on various system architectures (networks). We establish a criterion for assessing stability of the continuous dynamics by probing the discrete counterpart.

DY 14.2 Wed 10:30 H44

Reliable Boolean networks with threshold functions — •Manuel Ross, Tiago Peixoto, and Barbara Drossel — Institut für Festkörperphysik, TU Darmstadt

Boolean networks are used to model biological networks, such as gene regulatory networks. The nodes of the networks are in this case interpreted as genes, and the state is taken as activity, discretised to Boolean values. An attractor trajectory of the Boolean network is equivalent to a periodic time evolution of the respective network. The usual approach to analyzing these models consists in studying the dynamics of a given network or ensemble. The reverse approach, which we take here, is to deduce the structure of a network from dynamical properties, done for instance by Lau et al. [1]. The dynamical property considered here is a robust sequence of states, i.e., the dynamical trajectory shall not change under perturbations in the update times. We consider the extreme case where the dynamics is reliable under any update sequence, so only one node can possibly change its state at any given moment in time. Such reliable networks were introduced recently in our group [2]. We now extend this work by permitting only threshold functions as update functions. This imposes severe restrictions on the possible reliable trajectories, in contrast to the original study, where all Boolean functions were permitted. We explore the consequences of this restriction for the statistical properties of the possible dynamical trajectories. These statistical properties are finally compared to microarray data. References: [1] K. Y. Lau et al. Phys. Rev. E, 75(5):051907, 2007. [2] T. Peixoto and B. Drossel. arXiv:0905.0925v1,

2009.

DY 14.3 Wed 10:45 H44

Contact networks and the spread of MRSA in hospitals — Lisa Brouwers[1], •Andrzej Jarynowski[1,2,3], Fredrik Liljeros[1], and Xin Lu[1] — [1]Stockholm University, S106 91 Stockholm, Sweden — [2]Department of Physics, Cologne University, Zülpicher Str. 77. 50937 Köln, Germany — [3]The UNESCO Chair of interdisciplinary studies, Wroclaw University, pl. M. Borna 9 50-204 Wrocław, Poland

The bacterium meticillin resistant Staphylococcus aureus(MRSA)is known to be the largest care related the infection problem. We investigated the Common Care Registry containing information about all patient visits within Stockholm County during the outbreak period with registry over diagnosed MRSA cases. Methods to analyze the contact network of persons visiting the same care unit is developed within the project as well as methods to analyze in what way network structure affects the transmission of MRSA. We study matrixes of disease transition in hospitals population(infected versus people, who could sent infection). In stationary case:(a)We have matrixes of estimators of that probabilities and other statisical properties of contact networks. In time evolution case:(b)We divided outbreak in smaller, periodical intervals and looked at how MRSA was spreading in time. Quasi-MCMC(Markov chain Monte Carlo) method and artificial networks(main parameter is number of contacts during specific time interval)help us to understand real- and simulated-paths of disease transition. Matrixes of probabilities(b)were used to find mechanism of change states(vectors of all population 0-health or 1-ill)and we can run quasi-MCMC to get most likely paths.

DY 14.4 Wed 11:00 H44

A novel threshold mechanism for epidemics on complex networks — •Vitaly Belik[1] and Theo Geisel[1,2] — [1]Max-Planck-Institut für Dynamik und Selbstorganisation — [2]Georg-August-Universität Göttingen

Recently much effort was devoted to modeling of spatial spread of infectious diseases, triggered by latest pandemics, such as SARS and H1N1 influenza. Theoretical understanding of different modeling frameworks and taken assumptions are substantial factors determining reliability of predictions based on the models. We investigate on an epidemiological model explicitly taking into account such an important factor of human mobility as tendency to move frequently among several most preferred locations rarely undertaking long trips. We considered complex network topologies as an underlying mobility network and discovered new threshold behavior of the global epidemic outbreak in terms of time spent on distant location. Our results are supported by extensive stochastic numerical simulations. We believe our findings contribute to understanding of epidemiological dynamics and development of effective control and preventive measures.

DY 14.5 Wed 11:15 H44

Stochastic load-redistribution model for cascading failures in interconnected systems — •Jörg Lehmann and Jakob Bernasconi — ABB Switzerland Ltd., Corporate Research, Segelhofstrasse 1K, CH-5405 Baden-Dättwil, Switzerland

We present a new class of stochastic models for cascading failure propagation in interconnected systems [1]. These models take into account, in a statistical sense, important physical characteristics of realistic load-redistribution mechanisms: (i) the load increments after a failure depend on the load of the failing element; (ii) the failed load is redistributed non-uniformly among the remaining elements. Within a Markov approximation, we are able to describe the cascading failure dynamics of these models in terms of a generalized branching process. This yields an analytical solution for the breakdown probability in the limit of large system sizes. The application to blackouts in power grids is discussed.

[1] J. Lehmann and J. Bernasconi, arXiv:0909.4185.

15 min. break

DY 14.6 Wed 11:45 H44

Synchronization in laser networks: From motifs to complex topologies with multiple delays. — •Thomas Dahms and Eckehard Schöll — Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

We investigate networks of delay-coupled lasers. These include small network motifs, i.e. uni- and bidirectional rings and linear chains, as well as complex topologies including random and small-world networks. The nodes of the networks are described by the widely used Lang-Kobayashi model. By extending the well-known master stability function to networks with time-delay and non-vanishing coupling terms, we are able to separate the local dynamics from the topology. This way we can predict stability of synchronization for any network topology simply by calculating the eigenvalues of the corresponding adjacency matrix. Besides in-phase synchronization, we also observe alternating anti-phase synchronization, where only the next-nearest neighbors are synchronized. Our approach provides deep insight and understanding of the connection between topology and stability of synchronization. While our results are obtained for laser networks, we stress that the results are applicable to a wider range of systems, since only the local dynamics in terms of the master stability function will differ for other models.

DY 14.7 Wed 12:00 H44

Dynamics of neural networks with delay — •Judith Lehnert, Thomas Dahms, Philipp Hövel, and Eckehard Schöll — Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

We investigate synchronization in networks of delay-coupled FitzHugh-Nagumo systems. The paramater values are chosen such that an uncoupled element operates in the excitable regime. However, the coupling acts as a noninvasive control force (Pyragas control) stabilizing the unstable periodic orbit of the synchronized oscillation of all elements. We calculate the master stability function, which denotes the maximum transverse Lyapunov exponent of the synchronization manifold as a function of the eigenvalues of the coupling matrix. Hereby we are able to demonstrate that all network topologies realized by excitatory coupling terms show stable synchronization in a wide range of coupling strengths and delay times.
Furthermore, we investigate small-world-like networks: In a regular network of neurons with excitatory coupling we randomly interpose additional inhibitory links. We show that this introduces a phase transition from the synchronized state to a desynchronized one as the number of these additional inhibitory links approaches a critical value.

DY 14.8 Wed 12:15 H44

Criticality in models of evolving neural networks — •Matthias Rybarsch and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28359 Bremen

We investigate self-organization mechanisms in models of evolving neural networks. Already simple spin models can exhibit self-regulated evolution towards a critical state and are used as toy models for self-tuning in biological neural networks [1]. Recent models as, for example, ref. [2] are defined closer to the biological details, resulting in more complex node dynamics and link evolution. Here, we study a correlation-dependent mechanism for self-organized connectivity evolution as introduced in ref. [1]. In particular we focus on a model that is biologically motivated, yet keeping the dynamics as simple as possible. We find that independently from initial connectivity, the network evolves to an average connectivity close to criticality in terms of damage spreading.

[1] S. Bornholdt and T. Roehl: Self-organized critical neural networks, Phys. Rev. E 67, 066118 (2003)

[2] A. Levina, J.M. Hermann, and T. Geisel: Dynamical Synapses Causing Self-Organized Criticality in Neural Networks, Nature Physics 3, 857-860 (2007)

DY 14.9 Wed 12:30 H44

Spreading Synchrony in Neural Networks with Non-Additive Interactions. — •Sven Jahnke[1,2,3], Raoul-Martin Memmesheimer[4], and Marc Timme[1,2,3] — [1]Network Dynamics Group, Max-Planck-Institute for Dynamics & Self-Organization, Germany — [2]Bernstein Center for Computational Neuroscience, Germany — [3]Georg-August-University, Göttingen, Germany — [4]Center for Brain Science, Faculty of Arts and Sciences, Harvard University, USA

Recent neuro-physiological experiments [1] revealed that the response of cortical neurons to simultaneous pre-synaptic stimulation may be supra-additively enhanced. This enhancement is due to active nonlinear waves on the dendrite of a neuron (dendritic spikes) and offers a mechanism to synchronize neural spiking activity. Here we study the impact of nonlinear coupling on the dynamics of large neural circuits provide evidence that nonlinear dendritic enhancement is capable of inducing propagation of synchrony [2]. This yields the possibilty to

generate patterns of precisely timed spiking activity, as observed in several neuro-physiological experiments. Our results indicate that and explains why densely connected feed-forward anatomy, as so far assumed in model studies [3], is not required for synchrony propagation but much more sparser connectivity is sufficient.

[1] Polsky, A., Mel, BW. and Schiller, J., Nature Neurosci. 7 (2004).
[2] Memmesheimer, RM. and Timme, M., Frontiers Comput. Neurosci., doi: 10.3389/conf.neuro.10.2008.01.009 (2008).
[3] Diesmann, M., Gewaltig, MO and Aertsen, A., Nature 402 (1999); Kumar, A., Rotter, S., and Aertsen, A., J.Neurosci. 28 (2007).

DY 15: Reaction Diffusion Systems

Time: Wednesday 10:00–11:00 Location: H46

DY 15.1 Wed 10:00 H46

Excitation patterns in inhomogeneous media from the FitzHugh-Nagumo equations and the Belousov-Zhabotinsky reaction — •Claudia Lenk[1], Mario Einax[1], J. Michael Koehler[1], and Philipp Maass[1,2] — [1]Institut für Physik, Technische Universität Ilmenau, 98684 Ilmenau, Germany. — [2]Fachbereich Physik, Universität Osnabrück, 49069 Osnabrück, Germany.

Spatial inhomogeneities of the control parameters in reaction-diffusion systems play a crucial role for the occurrence of self-excitatory sources like spiral waves and ectopic foci. Here we present a systematic analysis of locally reduced resting state stabilities and increased excitabilities in terms of dynamical phase diagrams based on the FitzHugh-Nagumo equations. These phase diagrams specify regions of spiral wave and ectopic activity in dependence of the size and strengths of the modified regions. We further study the mutual disturbance of wavefronts that emanate from two pacemakers and propagate in regions connected by a small bridge. In particular we address the question how this disturbance can lead to fibrillatory states. Our results are partly compared to experiments that we performed for the Belousov-Zhabotinsky reaction in a silica gel with a spatially inhomogeneous catalyst (Ferroin) distribution. In these experiments the coupling of catalyst spots arranged in 4x4 arrays is investigated in dependence of the spot size and spot distance.

DY 15.2 Wed 10:15 H46

Effects of discrete cell coupling on propagation of scroll waves in three-dimensional excitable media — •Sergio Alonso[1], Markus Bär[1], and Alexander V. Panfilov[2] — [1]Physikalisch-Technische Bundesanstalt, Berlin, Germany — [2]Utrecht University, Utrecht, The Netherlands

Wave propagation in the heart has a discrete nature due to the discrete intercellular connections via gap junctions. Although effects of discreteness on wave propagation has been studied for traveling waves and 2D vortices, its possible effects on 3D vortices (scroll waves) are largely unexplored. We study the effect of discrete cell coupling on wave propagation in a generic model of excitable medium and show that reduced cell coupling decreases the excitability of the waves in excitable lattices giving rise to negative line tension of scroll waves.

DY 15.3 Wed 10:30 H46

Inward Rotating Spiral Waves in Glycolysis — •Ronny Straube[1], Ernesto M. Nicola[2], and Thomas Mair[3] — [1]Systems Biology Group, Max-Planck-Institute for Dynamics of Complex Technical Systems, D-39106 Magdeburg — [2]Max-Planck-Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, D-01187 Dresden, Germany — [3]Biophysics Group, Institute of Experimental Physics, Otto-von-Guericke University, Universitätsplatz 2, D-39106 Magdeburg, Germany

The mechanisms for spiral wave formation in reaction-diffusion systems are well known. Much less is known about the conditions under which inward propagating waves can be observed. After their discovery in chemical model systems [1,2] anti-waves have now been generated as waves of glycolytic activity in an extract of yeast cells (under review), which represents a biochemical model system for the energy metabolism. We show that in such allosteric enzyme systems inward propagating waves can only emerge if the number of enzyme subunits is sufficiently large – in agreement with the octameric structure of yeast phosphofructokinase. In addition, we provide evidence that the formation of these anti-waves is favoured if the enzyme activation step exhibits negative cooperativity.

[1] V. K. Vanag, I. R. Epstein. Science **294**, 835-837 (2001).
[2] X. Shao et.al. Phys. Rev. Lett. **100**, 198304 (2008).

DY 15.4 Wed 10:45 H46

Pattern formation in neuronal ensembles coupled by the external medium — •Nikolaos Kouvaris, Felix Müller, and Lutz Schimansky-Geier — Institute of Physics, Humboldt University of Berlin, Newtonstr. 15, D-12489 Berlin, Germany

The variation of extracellular concentrations can affect the firing activity in neuronal fields. As an example we mention the release of potassium ions that lower the threshold of neurons. This process can influence strongly the behavior of single neurons and of large ensembles. We address this problem by studying simplified excitable units modeled as a FitzHugh - Nagumo system coupled to a third variable describing the exterior. The release of the chemical agent is due to the firing events. That leads to pattern formation in the spatially extended system ranging from spirals and moving clusters to inverted structures. As an abstract modification for the excitable system, we consider a discrete two-state excitable unit. Each state, firing or refractory, is characterized by a waiting time density depending on the external concentrations. We study the dynamics of a single unit embedded in the extracellular medium as well as interacting units in the spatially extended situation. In these models the neuronal interaction is only chemically via the released and diffusing substrate at large time scales. All other neuronal interaction is modeled as noise.

1. D. E. Postnov, F. Müller, R. B. Schuppner and L. Schimansky-Geier, Phys. Rev. E 80, 031921 (2009).
2. T. Prager, M. Falcke, L. Schimansky-Geier and M. Zaks, Phys. Rev. E 76, 011118 (2007).

DY 16: Anomalous Transport I (talks contributed by BP)

Time: Wednesday 9:30–11:00 Location: H38

DY 16.1 Wed 9:30 H38

Elucidating the origin of anomalous diffusion in crowded fluids — Jedrzej Szymanski and •Matthias Weiss — Cellular Biophysics Group, German Cancer Research Center, Heidelberg

Anomalous diffusion in crowded fluids, e.g. in the cytoplasm of living cells, is a frequent phenomenon. So far, however, the associated stochastic process, i.e. the propagator of the random walk, has not been uncovered. Here, we show by means of fluorescence correlation spectroscopy and simulations that the properties of crowding-induced subdiffusion are consistent with the predictions for fractional Brownian motion or obstructed (percolation-like) diffusion, both of which have stationary increments. In contrast, our experimental results cannot be explained by a continuous time random walk with its distinct non-Gaussian propagator.

Reference J. Szymanski & M. Weiss, Phys. Rev. Lett. 103, 038102 (2009).

DY 16.2 Wed 9:45 H38

Macromolecular crowding - probing the microscopic protein diffusion on nanosecond time scales — •Felix Roosen-Runge[1], Marcus Hennig[1,2], Fajun Zhang[1], Tilo Seydel[2], and Frank Schreiber[1] — [1]Institut für Angewandte Physik, Universität Tübingen, Germany — [2]Institut Laue-Langevin, Grenoble, France

In the cellular interior, macromolecules occupy high volume fractions.

This so-called macromolecular crowding affects both cellular structure and function, as reported from both simulations and kinetic measurements. From a dynamical point of view, however, protein diffusion in crowded media is far from understood. The nature of diffusion is expected to show different regimes of simple and anomalous diffusion, depending on the respective time and length scale.

Using quasi-elastic neutron scattering (QENS) at time scales of nanoseconds and length scales of several nanometers, we probe the self diffusion in crowded solutions of bovine serum albumin (BSA). The temperature dependence of the effective diffusion coefficient below thermal denaturation can be rationalised based on the Stokes Einstein relationship; addition of NaCl cause little or no changes. The concentration dependence is the most pronounced effect: the apparent diffusion coefficient, covering volume fractions ranging from 5% up to 40%, strongly decreases with increasing protein concentration. A careful deconvolution of rotational and translational contributions provides insights in the simple diffusive nature of protein motions probed by neutron backscattering. The findings are also discussed in comparison to results from colloid physics.

DY 16.3 Wed 10:00 H38

Electrostatic interactions modulate particle translocation in reconstituted mucus hydrogels — •Oliver Lieleg, Ioana Vladescu, and Katharina Ribbeck — FAS Center for Systems Biology, Harvard University, Cambridge, USA

Biological functional entities surround themselves with selective barriers which control the passage of certain classes of macromolecules while rejecting others. A prominent example of such a selective permeability barrier is given by mucus. Mucus is a biopolymer based hydrogel which lines all wet epithelial surfaces of the human body. It regulates the uptake of nutrients from our gastrointestinal system, adjusts itself with the menstrual cycle to control the passage of sperm, and shields the underlying cells from pathogens such as bacteria and viruses. In the case of drug delivery, the mucus barrier needs to be overcome for successful medical treatment. Despite its importance for both physiology and medical applications, the underlying principles which regulate the permeability of mucus remain enigmatic. Here, we analyze the mobility of microscopic particles in reconstituted mucin hydrogels. We show that electrostatic interactions between diffusing particles and mucin polymers regulate the permeability properties of reconstituted mucin hydrogels. As a consequence, various parameters such as particle surface charge, mucin density, and buffer conditions such as pH and ionic strength can modulate the microscopic barrier function of the mucin hydrogel. Our findings suggest that the permeability of a single biopolymer based hydrogel such as native mucus can be tuned to a wide range of settings in different compartments of our bodies.

DY 16.4 Wed 10:15 H38

Subdiffusive Dynamics in Dense Driven Granular Media — •Matthias Sperl and Elmar Staerk — DLR Cologne

Granular media is characterized by non-elastic collisions among particles and obstacles; collisions lead to dissipation of energy. This lost energy needs to be replenished to achieve a steady state, and such a non-equilibrium steady state is investigated in our experiments. The driving is realized in two dimensions on a vibrating table; the particles dynamics is monitored by high-speed cameras with a specially adapted long-time recording system: Several minutes of dynamics can be recorded with millisecond resolution. The dynamical window allows the identification of several decades of anomalous dynamics and respective exponents in the mean-squared displacement. We investigate two granular systems in their dense regime: (1) a granular Lorentz system, where a single particles explores an environment of quenched disorder, and (2) the glass-like dynamics of a system with many particles. In both cases, the resulting dynamics shows both remnants of their equilibrium counterparts and marked differences. E.g., results vary with differences in the rates of driving and dissipation. A comparison with results from theory and computer simulation will be performed.

DY 16.5 Wed 10:30 H38

Localization and glass formation of colloids confined in porous media — •Jan Kurzidim, Daniele Coslovich, and Gerhard Kahl — Institut für Theoretische Physik and Center for Computational Materials Science, Technische Universität Wien, Wiedner Hauptstraße 8-10, A-1040 Wien, Austria

Using molecular dynamics simulations we study the slow dynamics of a hard-sphere fluid confined in a matrix quenched from an equilibrated hard-sphere fluid [Kurzidim *et al.*, PRL **103**, 138303 (2009)], resembling the movement of hard colloids in porous environments. We observed the presence of both discontinuous and continuous glass transitions, anomalous diffusion, and a de-coupling of the time scales for the relaxation of the single-particle and the collective correlators. Our observations are consistent with many predictions of a recent extension of mode-coupling theory for so-called "quenched-annealed" systems. Notably, however, we found no evidence of the re-entrant regime in the kinetic diagram predicted by the theory. To provide a deeper insight into the microscopic details of the underlying processes, we calculated the quantities of interest separately for particles trapped in voids formed by the matrix and for particles that unrestrictedly move through the entire system. In order to evaluate the degree of universality of the observed phenomena, we extended our investigation to model colloids with soft interactions, employing both numerical solutions of the equations of the theory, and molecular dynamics simulations.

DY 16.6 Wed 10:45 H38

Anomalous transport in a medium subjected to phase transition — Daria Kondrashova, Jörg Kärger, and •Rustem Valiullin — Deprtment of Interface Physics, University of Leipzig, Leipzig, Germany

Diffusion in spatial structures created via invasion percolation may naturally exhibit anomalous properties. It is now becoming evident that phase transitions occurring in heterogeneous media, may also be described using the concept of invasion percolation [1]. Hence, transport properties of tracer particles in media subjected to phase changes can strongly be affected by the latter process, including conditions giving rise to anomalous transport patterns. In this work, we experimentally demonstrate that such fractal-like structures are developing during freezing and melting transitions of liquids in disordered mesoporous matrices. We show that the effective self-diffusivity in the pore space, occupied by the liquid phase at a given fraction, depends on a particular configuration of the frozen phase [2]. Interestingly, by using a porous material with tubular pore morphology, we were able to relate the phase transition kinetics to the propagation of the liquid-solid interfaces in the pores. Depending on temperature, this propagation itself is found to exhibit a spectrum of behavior from diffusive to anomalous. The data obtained may have implications for understanding anomalous transport in bio-systems such as lipid membranes.

1. Page, J. H., J. Liu, B. Abeles, H. W. Deckman and D. A. Weitz, Phys. Rev. Lett., 71, 1216 (1993). 2. Dvoyashkin, M., A. Khokhlov, R. Valiullin and J. Kärger, J. Chem. Phys., 129, 154702 (2008).

DY 17: Anomalous Transport II (talks contributed by DY)

Time: Wednesday 11:15–13:15 Location: H38

DY 17.1 Wed 11:15 H38

Anomalous lateral diffusion in a layered medium — •Eugene B. Postnikov[1] and Igor M. Sokolov[2] — [1]Staatliche Universität Kursk, Russland — [2]Institut für Physik Humboldt - Universität zu Berlin, Deutschland

We consider the marker's diffusion in a layered medium, with the lateral diffusion coefficient being the function y-coordinate, i.e. the problem described by the diffusion equation for the marker density $u(x,y,t)$

$$\partial_t u = D_x(y)\partial_{xx}u + D_y\partial_{yy}u$$

with anisotropic diffusion coefficient $\hat{D}$. We show that the mean density averaged over the height, $U(x,t)$, follows the Bachelor's one-dimensional diffusion equation with time-dependent diffusion coefficient

$$\partial_t U = D_x(t)\partial_{xx}U$$

and obtain the expression of $D_x(t)$. As an example, we discuss the exact analytical solution in the case of a parabolic distribution $D_y \sim y^2$, leading to the anomalous (superdiffusive) behavior of a mean-square displacement $< x^2 > \propto t^{3/2}$. This result is confirmed by the numerical solution.

The approach is applied for the continual description of experimental results on inhomogeneous molecular diffusion in layered structures of thin liquid films deposited on solid surfaces [J. Schuster, F. Cichos, C. von Borzcyskowski. Eur. Polym. J. **40** (2004) 993].

DY 17.2 Wed 11:30 H38

From Anomalous Deterministic Diffusion to the Continuous-Time Random Walk — •Markus Niemann and Holger Kantz — Max-Planck-Institut für Physik komplexer Systeme, Dresden

There are several stochastic models describing anomalous diffusion. The most common are the fractional Brownian motion and the Continuous-Time Random Walk (CTRW). The question arises how to choose the correct model for a given process. Our approach is to look for deterministic foundations of these models. We present a method how to derive a CTRW as asymptotic description of a deterministic diffusion process.

We have introduced a diagrammatic method to determine the joint probability distributions of CTRWs. This method is extended to allow couplings between steps. These couplings may arise from deterministic maps, thereby allowing a unified treatment of stochastic and deterministic systems. Often, these processes converge in the scaling limit to a CTRW without coupling between steps. We apply the theory to a diffusion process driven by a deterministic map of Manneville-Pomeau type. Depending on the parameter, one gets a transition from an uncoupled to a coupled CTRW and a transition from sub- to superdiffusion. These findings are well supported by numerical simulations.

DY 17.3 Wed 11:45 H38

Random walks on d-dimensional Sierpinski gaskets: Asymptotics, DSI, and Puzzles — •Sebastian Weber[1], Joseph Klafter[2,1], and Alexander Blumen[3] — [1]Freiburg Institute For Advanced Studies (FRIAS), University of Freiburg, Germany — [2]School of Chemistry, Tel Aviv University, Israel — [3]Theoretical Polymer Physics, University of Freiburg, Germany

We study the effect of the embedding dimension d of a random walk (RW) taking place on a d-dimensional Sierpinski gasket fractal in its classical and dual versions. In the limit of large d the spectral dimension d_s approaches 2 such that the RW dynamics, which is governed by the d_s, is expected to behave similarly to a RW on a 2 dimensional lattice. In sharp contrast to that, we observe much richer characteristics for the RW. First, the time discrete scale invariance (DSI) phenomena cause log-periodic oscillations, which increase in amplitude for larger d. Second, the asymptotic approach to theoretically predicted power-laws of standard RW observables is significantly altered, depending on the variant of the Sierpinski gasket used (classical or dual) and on d. Furthermore, we address the suitability of standard RW observables to determine the spectral dimension d_s. This analysis is of great practical relevance and shows unexpected, puzzling results.

DY 17.4 Wed 12:00 H38

Front propagation in an $A+B \to 2A$ reaction-subdiffusion system — •Daniela Froemberg and Igor M. Sokolov — Humboldt Universität Berlin

Using the Continuous Time Random Walks approach, we derive reaction-subdiffusion equations for the irreversible autocatalytic $A + B \to 2A$ reaction, which have an integro-differential form. We show that, in contrast to the case of normal diffusion where a constant minimal velocity of the front is attained, this minimal velocity is zero in the subdiffusive case. This suggests propagation failure. Numerical simulations show that this propagation failure corresponds to a front of a stable form whose velocity decays with time. The asymptotic behavior of this velocity decay can be obtained by a crossover argument.

DY 17.5 Wed 12:15 H38

Anomalous Transport in Porous Media I: Diffusion in Carbonate Rock — •S. Afach[1], B. Biswal[2], R. Held[3], V. Khanna[1], J. Wang[1], and R. Hilfer[1,4] — [1]Institut f"ur Computerphysik, Universit"at Stuttgart, 70569 Stuttgart — [2]S.V. College, University of Delhi, New Delhi 110021 Delhi, India — [3]StatoilHydro ASA, N-7005 Trondheim, Norway — [4]Institut f"ur Physik, Universit"at Mainz, 55099 Mainz

We study diffusion through multiscale carbonate rocks using a continuum pore scale reconstruction technique. The method combines crystallite information from two dimensional high resolution images with sedimentary correlations from a three dimensional low resolution tomographic image to produce a rock sample with calibrated porosity, structural correlation and diffusion coefficient [1].

[1] B. Biswal, R. Held, V. Khanna, J. Wang, R. Hilfer, Phys.Rev.E **80** 041301 (2009)

DY 17.6 Wed 12:30 H38

Anomalous transport in porous media II: Momentum diffusion in multiscale media — •Thomas Zauner[1] and Rudolf Hilfer[1,2] — [1]Institute for Computational Physics, University of Stuttgart, 70569 Stuttgart, Germany — [2]Institute for Physics, University of Mainz, 55099 Mainz, Germany

We study viscous momentum diffusion in porous media using lattice Boltzmann simulations. A crucial transport parameter describing momentum diffusion is permeability. It is determined by the underlying stochastic geometry at the pore scale. When the geometry exhibits structure at several scales, viscous dissipation becomes scale dependent. As a consequence the permeability may become scale dependent. We use a recently introduced multiscale model for carbonate rocks [1]. Carbonate rock is known for exhibiting anomalous transport phenomena. Two methodically different lattice Boltzmann implementations, with single- and multirelaxation time collision operator, are used for numerical calculations. We find anomalous behavior in the sense of scale dependent momentum diffusion.

[1] Biswal, B. and Oren, P. E. and Held, R. J. and Bakke, S. and Hilfer, R., Phys. Rev. E, 75, 2007.

Topical Talk DY 17.7 Wed 12:45 H38

Anomalous Diffusion and Fractional Time — •R. Hilfer — Institut für Computerphysik, Universit"at Stuttgart, 70569 Stuttgart — Institut für Physik, Universit"at Mainz, 55099 Mainz

The intimate relation between anomalous diffusion in the sense of Montroll and fractional diffusion equations has been known for a long time [1]. Its fundamental importance for the theoretical understanding of anomalous diffusion processes is reflected in a growing number of applications to experimental observations [2]. Generalized fractional Riemann-Liouville derivatives of general type appear in these applications. Recently an operational calculus of Mikusiński type was developed for the resulting generalized fractional diffusion equations and their mathematical treatment [3].

[1] R. Hilfer and L. Anton, Phys.Rev.E **51**, R848 (1995)
[2] R. Hilfer, in: *Anomalous Transport: Foundations and Applications* Part I, Chapter 2, pages 17-75, Wiley-VCH, Weinheim (2007)
[3] R. Hilfer, Y. Luchko, Z. Tomovski, Fractional Calculus and Applied Analysis **12**, 299 (2009)

DY 18: Glasses I (joint session of CPP, DF, DY)

Time: Wednesday 14:00–17:30 Location: H48

Invited Talk DY 18.1 Wed 14:00 H48

New Approach to the Old Problem: Cooperativity in Dynamics of Glass Forming Systems — •Alexei Sokolov — Oak Ridge National Lab and UT Knoxville, USA

The mechanism behind the steep slowing down of molecular motions upon approaching the glass transition remains a great puzzle. Most of the theories relate this mechanism to the cooperativity in molecular motion. In this talk we present estimates and analysis of the molecular cooperativity in many glass-forming systems. We demonstrate that the cooperativity length scale directly correlates to the dependence of the structural relaxation on volume. This dependence presents only one part of the mechanism of slowing down the structural relaxation. Our analysis reveals that another part, the purely thermal variation of the structural relaxation, does not have a direct correlation with molecular cooperativity. These results call for a conceptually new approach to the analysis of the mechanism of the glass transition and to the role of molecular coopertaivity in slowing down of structural relaxation.

DY 18.2 Wed 14:30 H48

THz Signatures of the Glass Transitions in Polymers — •Marco Reuter[1], Steffen Wietzke[2,3], Christian Jansen[2,3], Tilmann Jung[1], Sangam Chatterjee[1], Wiebke Dempwolf[4], Henning Menzel[4], and Koch Martin[1,3] — [1]Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, 35032 Marburg, Germany — [2]Institut für Hochfrequenztechnik, TU Braunschweig, Schleinitzstr. 22, 38106 Braunschweig, Germany — [3]Joint Optical Metrology Center, c/o TU Braunschweig, Fakultät für Elektrotechnik und Informationstechnik, Hans-Sommer-Str. 66, 38106 Braunschweig, Germany — [4]Institut für Technische Chemie, TU Braunschweig, Hans-Sommer-Str. 10, 38106 Braunschweig, Germany

The glass transition temperature of polymers is found with terahertz time-domain spectroscopy. In the region of the glass transition the thermo-quasi-optic coefficient changes noticeably. THz time-domain spectroscopy is a non-destructive and non-contact technique to analyse polymers.

DY 18.3 Wed 14:45 H48

The elusive nature of the Debye process in monohydroxy alcohols: A new approach with ^{2}H-NMR techniques — •Sebastian Schildmann, Catalin Gainaru, and Roland Böhmer — Experimentelle Physik III, Fakultät für Physik, Technische Universität Dortmund

Viscous monohydroxy alcohols, also water, exhibit a so called Debye process in their dielectric spectra. This relaxational feature corresponds to degrees of freedom which are about 100 times slower than those giving rise to the structural rearrangements (α-process). In spite of numerous experimental investigations [1], the nature of these slow "superstructure" relaxation modes is not agreed upon, although it is clear that they are to be related with the presence of hydrogen bonds. The Debye process separates from the structural process if the network is interrupted chemically by diluting or topologically by confining the system in pores. Here butanol diluted with bromobutane was studied with several ^{2}H-NMR techniques. Correlation times measured with stimulated-echo experiments are compared with data obtained from dielectric spectroscopy [2]. Spin-lattice relaxation times were measured for O-D deuterated samples to check how the hydrogen bonds affect the dynamics.

[1] M. Poeschl & H.G. Hertz, J. Phys. Chem. 98, 8195 (1994).
[2] T. El Goresy & R. Böhmer, J. Chem. Phys. 128, 154520 (2008).

DY 18.4 Wed 15:00 H48

Relaxation Kinetics of Nanoscale Indents in a Polymer Glass — •Armin Knoll, Dorothea Wiesmann, Bernd Gotsmann, and Urs Duerig — IBM Research - Zurich, 8803 Rueschlikon, Switzerland

Nanometer scale indents have been written in a cross-linked polystyrene sample, and their relaxation has been studied at annealing temperatures well below the glass transition of the polymer. The indents represent a highly nonequilibrium state of the polymer which is subjected to mechanical stress of up to 0.4 GPa and thermal quench rates on the order of 10^8 K/s during writing. It is shown that the relaxation towards equilibrium evolves logarithmically over more than 10 orders of magnitude in time. The relaxation kinetics are accurately described in terms of a thermally activated process with an energy barrier whose magnitude decreases linearly with the distance from equilibrium [1].

[1] A. Knoll, D. Wiesmann, B. Gotsmann, and U. Duerig, *Phys. Rev. Lett.*, **102**, 117801 (2009)

DY 18.5 Wed 15:15 H48

Studying the dynamics of water molecules on a complex lattice: KOH doped tetrahydrofuran clathrate hydrate — •Helge Nelson[1], Catalin Gainaru[1], Andre Nowaczyk[1], Sebastian Schildmann[1], Burkhard Geil[2], and Roland Böhmer[1] — [1]Experimentelle Physik III, Fakultät für Physik, TU Dortmund — [2]Institut für Physikalische Chemie, Universität Göttingen

Because of kinetic hindrance during the freeze-out of the protons in clathrate hydrates an orientational glass transition is observed. By adding minute amounts of ionic dopants, e.g., KOH, the timescale of ordering can be accelerated significantly and an ordered phase is reached [1]. We applied a combination of dielectric and ^{2}H-NMR techniques to study the lattice dynamics of the water molecules in a temperature range from 30 K to 260 K. The ^{2}H-NMR techniques include temperature dependent lineshape analysis, measurement of relaxation times, and the stimulated-echo technique. This combination allows the observation of dynamics in a broad frequency and temperature window. We found several reorientational processes on the lattice, which are absent in the undoped sample. In addition we were able to detect the phase transition into the proton ordered phase with both dielectric and NMR measurements close to 62 K.

[1] see O. Yamamuro, et al., Physica B 213, 405 (1995) and references cited therein.

15 min. break

Invited Talk DY 18.6 Wed 15:45 H48

Slow domains percolation in polymer melts and blends close to the glass transition: a unifying concept regarding bulk dynamics, dynamics in the vicinity of interfaces, and the physical properties of nanocomposites — •Didier R. Long — Laboratoire Polymères et Matériaux Avancés; CNRS/Rhodia; F-69192 Saint Fons, France.

Experiments have demonstrated over past 15 years that the dynamics in liquids close to and below the glass transition temperature is strongly heterogeneous, on the scale of a few nanometers and, independantly, that the glass transition temperature in the vicinity of interfaces can be very different from that in the bulk, with shifts either positive or negative depending on the interaction between the polymer and the interface. By considering thermally induced density fluctuations in the bulk, we proposed that the 3-D glass transition is controlled by the percolation of small domains of slow dynamics, which allows to explain the heterogeneous dynamics close to Tg. This model allowed then for interpreting a priori unrelated features of polymer dynamics: 1) the main feature of confinement effects on the dynamics; 2) Unique reinforcement, plastic and recovery behaviour of nano-filled elastomers; 3) ageing and rejuvenating dynamics polymeric liquids; 4)case II diffusion, which is how a solvent penetrates and finally melts a glassy polymer matrix.

Regarding these various issues, I will put the emphasis on how percolation of slow domains is key for explaining their main features.

DY 18.7 Wed 16:15 H48

Glass Transition of Molecules Sorbed in Zeolites — Özlen F. Erdem[1], •Dieter Michel[2], Pavel Sedykh[2], and Jürgen Haase[2] — [1]Max-Planck-Institute of Bioinorganic Chemistry, Stiftstraße 34-36, 45470 Mülheim an der Ruhr, Germany — [2]University of Leipzig, Faculty of Physics and Earth Sciences, Linnéstraße 5, 04103 Leipzig, Germany

Proton MAS NMR, nuclear spin relaxation, and deuteron NMR spectroscopy are combined to study the mobility of ethylene glycol molecules sorbed in various zeolites over a wide temperature range. The results obtained will be also compared with broad-band dielectric measurements and with previous extensive dielectric studies by Kremer *et al.* [1]. The main question is whether the adsorbed species show a so called single-molecule behavior characterized by an Arrhenius type temperature dependence of the correlation times or the respective dielectric relaxation times. In contrast, a Vogel-Fulcher-Tammann (VFT) type temperature dependence of the dielectric relaxation rate would point out collective motions and is typical for the appearance of a glass-transition. An important question is the competition between molecule-to-molecule and molecule-to-surface interactions.

[1] F. Kremer, A. Huwe, M. Arndt, P. Behrens, W. Schwieger, J. Phys. Cond. Mat. **11**, A175-A188 (1999); A. Huwe, F. Kremer, J. Kärger, P. Behrens, W. Schwieger, G. Ihlein, O. Weiss, F. Schuth, J. Mol. Liquids **86**, 173-182 (2000).

DY 18.8 Wed 16:30 H48

Molecular glass formers in hard and soft confinement probed by ^{31}P and ^{2}H NMR — •Daniel Bock, Sabine Gradmann, and Ernst Rössler — Experimentalphysik II, Universität Bayreuth

Low molecular glass formers confined in nanoporous silica matrices (hard confinement) are investigated by different ^{31}P and ^{2}H NMR methods such as spin-lattice-, spin-spin relaxation, line-shape and stimulated echo decay.

Decreasing the radius of the pores pronounced dynamic heterogeneities are observed. For example, the correlation function revealed by the stimulated echo exhibits a quasi-logarithmic decay in contrast to Kohlrausch decay in the bulk. As shown by 2D spectra the dynamic heterogeneities are transient in time, i.e., we observe exchange between slow and fast molecules. The effects are explained by assuming dynamics being inhomogeneous in space; that is the dynamics given by a correlation time $\tau(r)$ depend on the distance r from the confining

wall.

Similar NMR features are found for low molecular additives dissolved in polymer matrices (soft confinement). The additive dynamics are decoupled from those of the polymer, and liquid-like additive dynamics are revealed below T_g, i.e., in a solid polymer matrix. Again, strongly stretched correlation functions are observed.

DY 18.9 Wed 16:45 H48

Quantitative Lineshape Analysis for 1D- and 2D-Spectra of Amorphous Materials — •Jörn Schmedt auf der Günne, Sabarinathan Venkatachalam, Johannes Weber, and Yamini Avadhut — Department of Chemistry, Munich University (LMU), Germany

NMR is quantitative, is an often stated feature in magnetic resonance. In ^{1}H solid-state NMR the results from simple MAS experiments can be disappointing though. We present a model study [1] which identifies and quantifies different sources of errors and a new strategy which gives reliable results even under low resolution conditions.

A second aspect will be 2D deconvolution of the lineshapes of amorphous/glassy materials. We analyze the unexpected splittings in the 2D lineshape of many typical glasses with a new analytical fitting function. Based on these findings we suggest a structural model based on different subunits, which should also find their imprint in bulk properties.

[1] Y.S.Avadhut, D.Schneider, J.Schmedt auf der Günne, J. Magn. Reson. 201 (2009) 1-6.

DY 18.10 Wed 17:00 H48

Low-Frequency Excess Contribution in Simple Liquids Revealed by Fast Field Cycling NMR — •Roman Meier, Axel Herrmann, Robert Kahlau, Danuta Kruk, and Ernst Rössler — Experimentalphysik II, Universität Bayreuth, Germany

The main relaxation (α-relaxation) of simple liquids studied by dielectric spectroscopy is well described by a Cole-Davidson (CD) susceptibility. In particular the low-frequency limit follows a Debye behavior $\chi''_{DS} \propto \omega^1$. Applying fast field cycling (FFC) ^{1}H NMR and transforming the spin-lattice dispersion data T_1 into the susceptibility representation $\chi''_{NMR} \propto \nu/T_1$ we have discovered a low-frequency excess contribution for systems like glycerol and its homologues as well as fluoroaniline. The CD function fails to describe the data due to a retarded transition to the limit ω^1, i.e., a "shoulder" is observed on the low frequency side of the a-relaxation peak ($\omega\tau_\alpha < 1$) possibly reflecting a slower relaxation process. Actually only a few liquids like o-terphenyl and tristyrene studied by FFC NMR do not show this phenomenon. Collecting dispersion data over a large temperature range, the relaxation strength of the excess contribution is specified quantitatively. Measurements of dilution series of propylene glycol in deuterated chloroform proved an intermolecular origin of the excess contribution. Dilution experiments of deuterated in protonated glycerol suggest this additional contribution being also fully reflected by sole intramolecular spin-spin vectors. A possible explanation of this effect are transient molecular clusters due to chemical interactions (e.g. H-bonds).

DY 18.11 Wed 17:15 H48

Glass transition of colloidal particles with long-ranged interactions in two dimensions — •David Hajnal, Martin Oettel, and Rolf Schilling — Institut für Physik, Johannes Gutenberg-Universität Mainz, Staudinger Weg 7, D-55099 Mainz, Germany

We study the glass transition behavior of binary mixtures of colloidal particles with long-ranged dipolar interactions in two dimensions in the framework of mode-coupling theory (MCT). We first present a minimal model for the theoretical description of the thermodynamic properties of the experimental system studied by König et al. [1]. By applying MCT to this model, we determine its glass transition diagram, i.e. we calculate the variation of the critical interaction strength upon composition changes. Finally, we compare the mixing effects predicted by MCT for this model to both experiments [1] and MCT results for binary mixtures of hard disks [2].

[1] H. König, R. Hund, K. Zahn, and G. Maret, Eur. Phys. J. E **18**, 287 (2005).

[2] D. Hajnal, J. M. Brader, and R. Schilling, Phys. Rev. E **80**, 021503 (2009).

DY 19: Quantum Chaos

Time: Wednesday 14:00–18:15 Location: H38

Topical Talk DY 19.1 Wed 14:00 H38

Chaotic Scattering in Microwave Billiards With and Without Time-Reversal Invariance — •Barbara Dietz[1], Thomas Friedrich[2], Hanns L. Harney[3], Maksim Miski-Oglu[1], Achim Richter[1,4], Florian Schäfer[1,5], and Hans A. Weidenmüller[3] — [1]TU Darmstadt, D-64289 Darmstadt — [2]GSI Helmholtzzentrum für Schwerionenphysik GmbH, D-64291 Darmstadt — [3]MPI für Kernphysik, D-69029 Heidelberg — [4]ECT*, Villa Tombosi, I-38100 Villazzano — [5]LENS, University of Florence, I-50019 Sesto-Fiorentino

We discuss measurements of scattering amplitudes of a chaotic microwave resonator in the regime of isolated and overlapping resonances. Below a certain excitation frequency the resonator simulates a quantum billiard, whose eigenvalues manifest themselves in the spectra as resonances with average spacing d and width Γ. Violation of time-reversal (T) invariance is achieved with a magnetized ferrite inside the cavity. The experimental observables are complex scattering (S)-matrix elements, measured for the resonator with and without T invariance as a function of frequency. Particular emphasis is given to S-matrix correlation functions in the regime of weakly overlapping resonances, i.e. $\Gamma/d \simeq 1$, and their comparison to results from the theory of chaotic scattering developed in nuclear reaction theory. We also present results on the distribution of the S-matrix elements and higher order correlation functions. Here, a focus is the transition from the regime of weakly overlapping resonances to the Ericson regime, i.e. from non exponential to exponential decay of the system of resonances. This work was supported by the DFG within the SFB634

DY 19.2 Wed 14:30 H38

Geometric Phases of Exceptional Points in Time-Reversal Noninvariant Systems — Stefan Bittner[1], Barbara Dietz-Pilatus[1], Pedro Oria Iriarte[1], Maksim Miski-Oglu[1], Achim Richter[1,3], Hans A. Weidenmüller[2], Hanns L. Harney[2], and •Florian Schäfer[1,4] — [1]Institut für Kernphysik, Schlossgartenstraße 9, 64289 Darmstadt — [2]Max-Planck-Institut für Kernphysik, 69029 Heidelberg — [3]ECT*, Villa Tambosi, I-38100 Villazzano (Trento), Italy — [4]LENS, University of Florence, I-50019 Sesto-Fiorentino (Firenze), Italy

The eigenvectors of a two level system described by a non-Hermitian Hamiltonian coalesce at a so-called Exceptional Point, a phenomenon already investigated in numerous systems. In general, for a two-dimensional Hamiltonian the two components of each eigenfunction define an enclosing angle ϕ. Past experiments established for time-reversal invariant systems at an Exceptional Point a universal phase $\phi = \pi$. Here, we present results on experiments in microwave billiards with partial time-reversal invariance violation, induced by the presence of a magnetized ferrite. Two control parameters allow for a variation of the Hamiltonian. The experiments explore the parameter space in vicinity the of and at an Exceptional Point. The data allow for a reconstruction of the complete, complex-valued Hamiltonian. Using this information we demonstrate a sensitive dependence of ϕ at an Exceptional Point on the strength of time-reversal invariance violation.

This work is supported by DFG through SFB 634.

DY 19.3 Wed 14:45 H38

Semiclassical Transport and Diffraction Effects in Circular Billiards — •Tobias Dollinger[1], Daniel Waltner[1], Iva Březinová[2], Michael Wimmer[3], Klaus Richter[1], and Joachim Burgdörfer[2] — [1]Institute for Theoretical Physics, University of Regensburg, Universitätsstraße 31, 93053 Regensburg, Germany — [2]Institute for Theoretical Physics, Vienna University of Technology, Wiedner Hauptstraße 8-10, 1040 Vienna, Austria — [3]Leiden Institute of Physics, Leiden University, Niels Bohrweg 2, 2333 CA Leiden, The Netherlands

In the present work we investigate the magnetoconductance of two dimensional circular billiards by numerical and analytical means. In ballistic chaotic cavities semiclassical theories have provided remarkably accurate analytical descriptions of interference phenomena, such as weak localization. However, previous examinations of the circular billiard have indicated that the standard trajectory based techniques do not describe the weak localization effect in this nongeneric setup sufficiently well. The significance of diffractive orbits in this context has been emphasized in earlier works. This is supported by our numerical findings. Moreover we present a semiclassical formalism specialized for the description of the underlying classical system and discuss the consequences of incorporating diffraction.

DY 19.4 Wed 15:00 H38

Trace Formula for Dielectric Cavities — •Stefan Bittner[1], Barbara Dietz[1], Maksim Miski-Oglu[1], Pedro Oria-Iriarte[1], Birgit Quast[1], Achim Richter[1,2], and Florian Schäfer[1,3] — [1]Institut für Kernphysik Darmstadt — [2]ECT* Trento — [3]Università degli Studi di Firenze

Microlasers and dielectric microcavities have gained great interest due to possible applications in e.g. telecommunications and as a new type of wave-dynamical billiards. Especially the correspondence between ray- and wave-optics in these systems is being intensely studied. Recently, a trace formula for dielectric cavities has been proposed [1], which provides a connection between the density of states of the cavity and the periodic orbits of the corresponding billiard. In order to test this trace formula experimentally, we have measured the spectra of circular and square dielectric microwave resonators. The length spectra were compared to the prediction of the trace formula and large deviations were observed. These are attributed to the fact that only resonances with long lifetimes can be observed experimentally. Moreover, the systematics of observed and unobserved modes must be taken into account for an understanding of the experimental length spectra. The work presented in this talk was supported by DFG within SFB 634.

[1] Bogomolny *et al.*, Phys. Rev. E **78**, 056202 (2008).

DY 19.5 Wed 15:15 H38

Fractal Weyl law in a three-disk microwave system — •Alexander Potzuweit, Ulrich Kuhl, and Hans-Jürgen Stöckmann — Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany

The transport properties of systems with a classical chaotic repeller are particularly intriguing. It had been predicted that the distribution of the poles of the scattering matrix should obey a fractal Weyl law with an exponent depending on the fractal dimension of the classical chaotic repeller[1]. From microwave measurements in an open symmetry-reduced three-disk system, we extract the resonances using the powerful technique of harmonic inversion[2]. By variation of the distance-to-radius parameter we find a qualitative good agreement between the experimental parameter dependence and the prediction from the fractal Weyl law.

[1] W. T. Lu, S. Sridhar, M. Zworski, Phys. Rev. Lett. 91, 154101(2003)
[2] J. Wiersig, J. Main, Phys. Rev. E 77, 36205(2008)

DY 19.6 Wed 15:30 H38

Regular-to-Chaotic Tunneling Rates: From the Quantum to the Semiclassical Regime — •Steffen Löck[1], Arnd Bäcker[1], Roland Ketzmerick[1], and Peter Schlagheck[2] — [1]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Germany — [2]Département de Physique, Université de Liège, 4000 Liège, Belgium

In systems with a mixed phase space, regular islands are dynamically separated from the chaotic sea, while quantum mechanically these phase-space regions are connected by dynamical tunneling. We derive a prediction of dynamical tunneling rates of regular states to the chaotic sea by combining the direct regular-to-chaotic tunneling mechanism in the quantum regime with an improved resonance-assisted tunneling theory in the semiclassical regime. For systems with one or multiple dominant nonlinear resonances we find excellent agreement to numerics.

DY 19.7 Wed 15:45 H38

Dynamical tunneling in 4D area preserving maps — Arnd Bäcker, Roland Ketzmerick, and •Martin Richter — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

Higher dimensional systems show a very involved phase-space structure including complex regular regions interwoven with the Arnol'd web. For such systems we want to investigate the regular-to-chaotic tunneling rates. We focus on 4D area preserving maps. As a first step we introduce some simple models with well separated chaotic and regular regions and visualize them by sections through the 4D phase space. We present a prediction of tunneling rates using the fictitious integrable system approach which has been developed for lower dimensional systems.

15 min. break

DY 19.8 Wed 16:15 H38

Levy distribution in many-body quantum systems — •Sergey Denisov, Alexey V. Ponomarev, and Peter Hanggi — Institute of Physics, University of Augsburg, Germany

Levy distribution is known to describe a whole range of complex phenomena: classical chaotic transport, processes of subrecoil laser cooling, fluctuations of stock market indices, time series of single molecule blinking events, bursting activity of small neuronal networks, to name a few. The appearance of Levy distribution in a system output is a strong indicator of a long-range correlation "skeleton" which conducts system intrinsic dynamics.

Using two complimentary approaches, the canonical and the grand-canonical formalisms, we discovered that the momentum distribution of N strongly interacting (hard-core) bosons at finite temperatures confined on a one-dimensional optical lattice obeys the Levy distribution. The tunable Levy spline reproduces momentum distributions up to one recoil momentum. Our finding allows for calibration of complex quantum many-body states by using a unique scaling exponent.

[1] A. V. Ponomarev, S. Denisov and P. Hanggi, arXiv:0907.4328

DY 19.9 Wed 16:30 H38

Signatures of quantum chaos in mesoscopic many-body effects — •Martina Hentschel and Georg Röder — MPI für Physik komplexer Systeme, Dresden

Many-body effects have been a key interest in condensed matter physics for many years. We study them for mesoscopic, rather than for bulk, systems in the context of photoabsorption spectra (x-ray edge problem) and focus on deviations from the bulk (metallic) case as well as on quantum-chaos signatures such as the geometry-dependence of the photoabsorption cross section. It is determined by two counteracting many-body effects, known as Anderson orthogonality catastrophe and Mahan's exciton. They result from the system's many-body response to the sudden, localized perturbation given by the core hole that is left behind when the x-ray excites an electron. We find characteristic deviations from the metallic case that are strongest near the system boundary, as a result of the prominent correlation between the wave function (that drops to zero) and its derivative (that is correspondingly large). As a consequence, the photoabsorption cross section develops a pronounced peak, in contrast to a rounded signature for metals and a slight peak away from the system boundary. We furthermore study the dependence on the system geometry and find that level degeneracies, possible in ballistic quantum dots of regular, rather than chaotic, shape trigger considerable changes in the orthogonality catastrophe response that altogether becomes somewhat stronger.

DY 19.10 Wed 16:45 H38

Increase of conductance fluctuations with Ehrenfest time in presence of tunnel barriers — •Daniel Waltner[1], Jack Kuipers[1], Cyril Petitjean[1], Philippe Jacquod[2], and Klaus Richter[1] — [1]Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany — [2]Physics Department, University of Arizona, Tucson, AZ 85721, USA

We study the effect of tunnel barriers on the Ehrenfest-time dependence of universal conductance fluctuations (UCF) for classically chaotic systems. In the case of strong coupling to the leads UCF are independent of the Ehrenfest time: this was observed numerically in [1] and then explained analytically in [2]. In the case of very opaque tunnel barriers, that we consider here, an increase of UCF with increasing Ehrenfest time is observed in numerical simulations that we address analytically in this talk.

[1]J. Tworzydło *et al.*, Phys. Rev. B **69**, 165318 (2004); P. Jacquod and E. V. Sukhorukov, Phys. Rev. Lett. **92**, 116801 (2004).
[2]P. W. Brouwer and S. Rahav, Phys. Rev. B **74**, 075322 (2006).

DY 19.11 Wed 17:00 H38

Coupling fidelity in a microwave billiard — •Bernd Köber[1], Ulrich Kuhl[1], Hans-Jürgen Stöckmann[1], Dmitry Savin[2], Thomas Gorin[3], and Thomas Seligman[4] — [1]Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany — [2]Department of Mathematical Sciences, Brunel University, Uxbridge UB8 3PH, UK — [3]Departamento de Fisica, Universidad de Guadalajara, Guadalajara C.P. 44840, Jalisco, Mexico — [4]Instituto de Ciencias Fisicas, Universidad Nacional Autonoma de Mexico, Cuernavaca, Mexico

In former microwave fidelity studies we found for global perturbation an agreement with prediction from random matrix theory [1], whereas in case of a local perturbation an algebraic decay was found [2]. In this presentation we use the coupling to an external channel as a perturbation parameter, which is inherent to systems to be used for quantum computing. The scattering fidelity is the parametric cross-correlation function, normalized by the auto-correlation function $f^{(\lambda)}(t) = \langle \hat{S}^{(\lambda)}(t)\hat{S}(t)\rangle / \langle |\hat{S}(t)|^2\rangle$, where $\hat{S}(t)$ is a scattering matrix element in the time domain, the brackets denote an ensemble average, and λ is the perturbation parameter. The cross-correlation can be rewritten as an auto-correlation with an effective parameter, allowing a direct application of the VWZ approach [3]. The experimentally found fidelity decay is algebraic and in perfect agreement with theory.

[1] R. Schäfer et al., Phys. Rev. Lett. 95184102 (2005).
[2] R. Höhmann et al., Phys. Rev. Lett. 100, 124101 (2008).
[3] J. J. M. Verbaarschot et al., Phys. Rep. 129, 367 (1985).

DY 19.12 Wed 17:15 H38

The density of states of chaotic Andreev Billiards — •Thomas Engl, Jack Kuipers, and Klaus Richter — Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg,Germany

Quantum cavities, like quantum dots, have markedly different properties depending on whether their classical counterparts are chaotic or not. Connecting a superconductor to such a dot leads to remarkable effects, most notably the appearance of a hard gap in the excitation spectrum of chaotic systems. Andreev billiards are interesting examples of structures built by superconductors connected to a normal metal, and each time an electron hits the superconducting part it is retro-reflected as a hole (and vice-versa).

Using a semiclassical framework for systems with chaotic dynamics, we show how this reflection, along with the interference due to subtle correlations between the classical paths of electrons and holes inside the system, are ultimately responsible for this phenomenon. Furthermore, we are able to see how a magnetic field inside the system or phases inside the superconductor can remold and eventually suppress the gap.

DY 19.13 Wed 17:30 H38

Moments of the Wigner delay times — Gregory Berkolaiko[1] and •Jack Kuipers[2] — [1]Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, USA — [2]Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany

The Wigner time delay is a measure of the time spent by a particle inside the scattering region of an open system. For chaotic systems, the statistics of the individual delay times (whose average is the Wigner time delay) are thought to be well described by random matrix theory. Here we present a semiclassical derivation showing the validity of random matrix results. In order to simplify the semiclassical treatment, we express the moments of the delay times in terms of correlation functions of scattering matrices at different energies. In the semiclassical approximation, the elements of the scattering matrix are given in terms of the classical scattering trajectories, requiring one to study correlations between sets of such trajectories. We describe the structure of correlated sets of trajectories and formulate the rules for their evaluation to the leading order in inverse channel number. This allows us to derive a polynomial equation satisfied by the generating function of the moments. Along with showing the agreement of our semiclassical results with the moments predicted by random matrix theory, we infer that the scattering matrix is unitary to all orders in the semiclassical approximation.

Arxiv:0910.0060

DY 19.14 Wed 17:45 H38

Fano resonances under the influence of absorption or decoherence — •Stefan Gehler[1], Ulrich Kuhl[1], Hans-Jürgen Stöckmann[1], Andreas Bärnthaler[2], Stefan Rotter[2], Florian Libisch[2], and Joachim Burgdörfer[2] — [1]Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany — [2]Institute for Theoretical Physics, TU Vienna, A-1040 Vienna, Austria

We present theoretical and experimental results on the modification of Fano resonances [1] due to the effect of decoherence [2]. Specifically, our theoretical calculations demonstrate how the asymmetry parameter of Fano resonances in the transmission of microwaves through a metal cavity is affected by the dissipation in the cavity walls. In these dissipative systems the way in which the Fano asymmetry parameter deviates from its fully coherent value is characteristically different from dephasing systems where flux is conserved. These characteristic differences are explored and confirmed in microwave experiments on rectangular metal cavities with varying dissipation strengths.

[1]U. Fano, Phys. Rev. 124 (1961) 1866
[2]S. Rotter, U.Kuhl, F. Libisch, J. Burgdörfer, H.-J. Stöckmann, Physica E 29 (2005) 325-333

DY 19.15 Wed 18:00 H38

Transport and weak localisation of Bose-Einstein condensates in two-dimensional billiards — •Timo Hartmann[1], Juan Diego Urbina[1], Cyril Petitjean[1], Klaus Richter[1], and Peter Schlagheck[2] — [1]Institute for Theoretical Physics, University of Regensburg, D-93040 Regensburg, Germany — [2]Département de Physique, Université de Liège, 4000 Liège, Belgium

The possibility to induce artificial magnetic gauge potentials for matter waves [1] and to create almost arbitrarily shaped confinement potentials [2] makes it now interesting and feasible to study coherent transport of Bose-Einstein condensates through various mesoscopic structures. Previous theoretical studies have focused on the question how coherent backscattering in disordered potentials is modified by the presence of the atom-atom interaction [3]. We now study the analogous scenario of weak localisation in ballistic billiard geometries which exhibit chaotic classical dynamics. Therefore we numerically investigate the quasi-stationary propagation of a condensate through such structures within the mean-field approximation. The transmission is measured as a function of the magnetic field and of the non-linearity. A trend towards inversion of the signal of weak localisation is visible. We discuss the results from a semiclassical point of view.

[1] Y.-J. Lin et al., Phys. Rev. Lett. **102** 130401 (2009)
[2] K. Henderson et al., New J. Phys. **11**, 043030(2009)
[3] M. Hartung et al., Phys. Rev. Lett. **101**, 020603 (2008).

DY 20: Phase Transitions and Critical Phenomena I

Time: Wednesday 14:30–16:15 Location: H47

DY 20.1 Wed 14:30 H47

Monte Carlo simulations of the 3d-Ising model in cylindrical geometry — •Dorothea Wilms, Peter Virnau, and Kurt Binder — Johannes Gutenberg-Universität, Mainz

The three dimensional Ising model in cylindrical geometry can be regarded as a model system for the study of nanopores. As a quasi one dimensional system, it also exhibits a rather interesting "phase behavior": At low temperatures, the tube is either filled with liquid or gas and the densities are similar to those in the bulk. When we approach a "pseudo-critical point" (below the critical point of the bulk) several interfaces appear and the tube contains both liquid and gas phases. As expected, the transition depends on the size of the tube and occurs at lower temperatures for larger cylinders.

DY 20.2 Wed 14:45 H47

MC simulations regarding the melting transition in a 2d hard disc fluid — •Marc Radu[1] and Tanja Schilling[2] — [1]Johannes Gutenberg Universität, Mainz, Deutschland — [2]Université du Luxembourg, Luxembourg, Luxembourg

We present a computer simulation study on the two-dimensional hard disc fluid. We prepared configurations inside the liquid, the hexatic and the solid phase in which the particles were coupled to the sites of a triangular lattice via a harmonic potential. The spring constant was decreased so that we could observe transitions from a state with long-ranged positional and orientational order to the state with the particular ordering characteristic. We compared our results with recent experiments carried out using colloidal particles in an optical trap. Finally we calculated the defect free energies of dislocations by using an algorithm to compute free energies of disordered structures.

DY 20.3 Wed 15:00 H47

Free-energy barrier of the evaporation/condensation transition — •Elmar Bittner, Andreas Nussbaumer, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, D-04009 Leipzig, Germany

The formation and dissolution of equilibrium droplets at a first-order phase transition is one of the longstanding problems in statistical mechanics. Quantities of particular interest are the size and free energy of a "critical droplet" that needs to be formed before the decay of the metastable state via homogeneous nucleation can start. To study this phenomenon, we performed several Monte Carlo simulations of the 2D Ising model with nearest-neighbour couplings on a square lattice. By using Jarzynski's equality [Phys. Rev. Lett. 78, 2690 (1997)], we measured the free-energy barrier in a nonequilibrium setup and compare the data with results obtained by equilibrium simulation techniques.

DY 20.4 Wed 15:15 H47

Flat histogram Monte Carlo study of the order parameter distribution — •Anjan Prasad Gantapara[1], Wolfhard Janke[2], and Rudolf Hilfer[1,3] — [1]Institute for Computational Physics, University of Stuttgart, 70569 Stuttgart, Germany — [2]Institute for Theoretical Physics, University of Leipzig, D-04009 Leipzig, Germany — [3]Institute for Physics, University of Mainz, 55099 Mainz, Germany

The order parameter distribution of the two dimensional Ising model is studied using a flat histogram Monte Carlo method. Periodic, free and fixed boundary conditions are considered in our simulations. The effect of the boundary conditions on the order parameter distribution is studied at temperatures below, above, and at the critical point. These finite lattice size simulations corroborate some theoretically predicted results [1,2]. The accuracy of the Monte Carlo results is discussed by comparing them with exactly enumerated values for small lattice sizes.
[1] R. Hilfer and N. B. Wilding, Journal of Physics A: Mathematical and General **28**, L281 (1995).
[2] S. Shlosman, Communications in Mathematical Physics **125**, 81 (1989).

DY 20.5 Wed 15:30 H47

The thermodynamic Casimir effect in the neighbourhood of the λ-transition: A Monte Carlo study of an improved three-dimensional lattice model — •Martin Hasenbusch — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, 12489 Berlin, Germany

We discuss the thermodynamic Casimir effect in thin films in the three dimensional XY universality class. Based on the results of Monte Carlo simulations of an improved lattice model we compute the universal finite size scaling function θ that characterizes the behaviour of the thermodynamic Casimir force in the neighbourhood of the critical point. We discuss corrections to the universal finite size scaling behaviour. We compare with experiments on films of ^{4}He near the λ-transition, previous Monte Carlo simulations of the XY model on the simple cubic lattice and field-theoretic results.

DY 20.6 Wed 15:45 H47

Critical Casimir forces under external control — •Ursula Nellen[1], Laurent Helden[1], and Clemens Bechinger[1,2] — [1]2. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart — [2]Max-Planck-Insitut für Metallforschung, Heisenbergstr. 3, 70563 Stuttgart

That a confinement of critical fluctuations exerts a force on the boundaries was predicted by Fisher and de Gennes in 1978. However the first direct measurement of these critical Casimir forces could be obtained only recently [1]. Beside their exquisite temperature dependence critical Casimir forces respond to external fields. Here we study the variety of control parameters opening up novel perspectives for e.g. self assembly of colloidal particles or microfluidic systems. Using total internal reflection microscopy (TIRM) we measure forces acting on a colloidal particle suspended in a critical water-2,6-lutidine mixture. We demonstrate how a continuous variation in the chemical surface properties changes amplitude and sign of the critical Casimir force [2]. From temperature scans the scaling behavior for weak surface fields can be extracted. In addition we explore how critical Casimir forces can be influenced by external electric fields.
[1] C. Hertlein et al., Nature 451 (2008) 172,
[2] U. Nellen et al., EPL 88 (2009) 26001

DY 20.7 Wed 16:00 H47

Critical exponents of the three-dimensional Anderson transition from multifractal analysis — •Louella Judy Vasquez[1], Alberto Rodriguez[1], Rudolf Römer[1], and Keith Slevin[2] — [1]Department of Physics and Centre for Scientific Computing, University of Warwick, Coventry CV47AL, United Kingdom — [2]Department of Physics, Graduate School of Science, Osaka University, 1-1 Machikaneyama, Toyonaka, Osaka 560-0043, Japan

We use high-precision, large system-size wavefunction data to analyse the scaling properties of the multifractal spectra around the disorder-induced three-dimensional Anderson transition in order to extract the critical exponent ν of the localisation length. We study the scaling law around the critical point of the generalized inverse participation ratios $P_q = \langle|\psi_i|\rangle^2$ and the singularity exponent α_0, defined as the position of the maximum of the multifractal spectrum, as functions of the degree of disorder, the system size, and the box-size used to coarse-grained the wavefunction amplitudes. The values of α_0 are calculated using a new method entirely based on the statistics of the wavefunction intensities [Phys. Rev. Lett. 102, 106406 (2009)]. Using finite size scaling analysis, we find agreement with the values of ν obtained from transfer matrix calculations.

DY 21: Soft Matter II

Time: Wednesday 16:30–17:45 Location: H47

DY 21.1 Wed 16:30 H47

Generalized-Ensemble Monte Carlo Simulations of Polymer Adsorption on Nanostrings — •Thomas Vogel and Michael Bachmann — Soft Matter Systems Research Group, Institut für Festkörperforschung (IFF-2), Forschungszentrum Jülich, 52425 Jülich, Germany

We study the conformational behavior of polymers adsorbed at nanostrings as a limiting case of adsorption on nanocylinders or nanotubes [1,2]. We report on results of generalized-ensemble Monte Carlo simulations of a flexible bead-stick polymer interacting with an attractive linelike substrate. Varying the string attraction strength and its effective thickness, we identify different conformational phases for the adsorbed polymers. There are, for example, phases dominated by collapsed globules attached to the string and monolayer conformations wrapping the string in a very ordered way. Results on the thermodynamics of transitions between structural phases are discussed and shapes of low-energy states are presented [3].
[1] A. Milchev and K. Binder, J. Chem. Phys. **117**, 6852 (2002)
[2] I. Gurevitch and S. Srebnik, Chem. Phys. Lett. **444**, 96 (2007)
[3] T. Vogel and M. Bachmann, preprint (2009)

DY 21.2 Wed 16:45 H47

A Gibbs free energy model for compressible polymer blends. Application for describing diffusion in compressible multicomponents systems — •Elian Masnada and Didier R. Long — CNRS/Rhodia UMR5268 Lyon (France)

We propose a Gibbs free energy model for describing the thermodynamics of compressible polymer blends, or polymer-solvent systems. Most of such models require the introduction of ad-hoc equation of state relations for each component, as well as an ad-hoc equation of

state for the blend. The model we propose is self-contained in the sense that we derive the equation of state of the blends, and that the latter gives the equation of state of the pure liquid in the case when the other component is absent. We show how we can compare the predictions of our model to experimental data such as the predictions of spinodal lines, or the calculation of an effective Flory interaction parameter which can be compared to experimental data. We show how our model allows for recovering the usual expression of the RPA (structure factor) of incompressible polymer blends, in the limit of large bulk modulus K (as compared to the osmotic modulus). Our model allows for calulating the effect of the pressure on the compatibility of polymer blends, either in the case of low temperature spinodal decomposition (UCST) or in the case of high temperature decomposition (LCST). Our model contains a smaller number of adjustable parameters than previously published models, which all have a physical meaning. We will also discuss how this free energy model can be used for describing the diffusion of various species in out of equilibrium situations.

DY 21.3 Wed 17:00 H47

Manipulation of colloidal crystal structures by confinement — •Andrea Fortini and Matthias Schmidt — Theoretische Physik II, Universität Bayreuth, Universitätsstraße 30, 95440 Bayreuth, Germany

We study the phase behavior of hard-sphere colloidal particles confined between impenetrable walls using extensive Monte Carlo computer simulations. We extend the results of our previous studies [Schmidt and Löwen. Phys. Rev. Lett. 1996, 4552 , Fortini and Dijkstra. J. Phys.: Condens. Matter, 2006 L371] by considering more complex and experimentally relevant confinement geometries. We find a sequence of non closed-packed equilibrium structures that depends on the hard spheres packing fraction and the degree of confinement. We discuss the stability phase diagram of the different phases and the experimental realization of the model.

DY 21.4 Wed 17:15 H47

Heterodyne electrophoretic light scattering of a interacting colloidal system — •Martin Medebach — Stranski Laboratory, Technische Univeristät Berlin, Strasse des 17.Juni 124, 10623 Berlin

A heterodyne light scattering technique is used to measure the electrophoretic flow behavior of a concentrated, deionized colloidal suspension. It was found that the measured power spectra show an increase of the frequency-integrated intensity with the electric field. Because the number of particles should remain constant this finding is unusual. Further on, the width of the spectra depends linearly on the electric field. Although the system is interacting an influence of the structure factor on the spectra is apparently missing. A model that explains the intensity effect and the missing structural influence on the spectra will be discussed in detail.

DY 21.5 Wed 17:30 H47

Electroconvection in a Liquid Crystal under a Symmetry Breaking Magnetic Field — •Andreas Walter, Wolfgang Schöpf, and Ingo Rehberg — Experimentalphysik V, Universität Bayreuth, 95440 Bayreuth

We investigate homeotropically aligned MBBA under the influence of electric and magnetic fields. MBBA has a negative dielectric anisotropy and a positive anisotropy of the magnetic susceptibility. Thus, when placed between two parallel electrodes, electroconvection takes place only after a symmetry breaking bend Fréedericksz transition.

A magnetic field is applied perpendicular to the driving electric field in order to establish a preferred direction within the system. We report on results for the primary instability, i.e. the Fréedericksz transition.

In contrast to the planar orientation, electroconvection occurs as a secondary bifurcation. Motivated by theoretical expectations, we search for a subcritical bifurcation leading to oscillating behaviour.

DY 22: Networks: From Topology to Dynamics II (joint session of BP, DY, SOE)

Time: Thursday 9:30–10:15 Location: H44

Invited Talk DY 22.1 Thu 9:30 H44

Wave localization in complex networks — •Jan W. Kantelhardt[1], Lukas Jahnke[1], Richard Berkovits[2], and Shlomo Havlin[2] — [1]Institut für Physik, Fachgruppe Theoretische Physik, Martin-Luther-Universität Halle-Wittenberg, 06099 Halle (Saale), Germany — [2]Minerva Center and Department of Physics, Bar-Ilan University, Israel

Complex networks can show transitions from phases with propagating modes to localized phases without transport. In the simplest case such a transition is caused by breaking the network, a classical percolation transition. Wave-like excitations, on the other hand, can exhibit a quantum phase transition (Anderson-like transition) already when the network is still intact. We suggest that this type of localization-delocalization transition could become experimentally observable in optical networks composed of fibers and beam splitters on an optical table. We study the phase transition numerically by level statistics of the eigenvalues for coherent waves in scale-free networks. We show that a strong clustering of the links, i. e., a high probability of closed triangles in the network structure, can induce the transition to localized states. Clustering thus represents a new degree of freedom that can be used to induce and study phase transitions in complex networks.

DY 23: Networks: From Topology to Dynamics III (joint session of BP, DY, SOE)

Time: Thursday 10:15–13:00 Location: H44

DY 23.1 Thu 10:15 H44

Detection of Mesoscopic Role-Structure in Complex Networks — •Joerg Reichardt[1], Roberto Alamino[2], and David Saad[2] — [1]UC Davis, CA — [2]Aston University, Birmingham

Not all nodes are created equal in complex networks. Rather, they play diverse roles in the functioning of a network and their role is reflected in the network's link structure. Hence, structural analysis can be used to infer the latent roles and functions of nodes purely based on connectivity data. Currently, network structure is studied at three different levels. At the macro level, global network properties such as degree distributions, path-lengths, diameters or clustering coefficients are investigated. At the micro level, properties of individual nodes and edges such as centrality indices or rank functions such as page-rank are studied. The study of the meso-scale, which aims at studying joint properties of groups of nodes, so far has mainly been focussed on the detection of cohesive subgroups of nodes, so-called communities.

The talk will show that, though important, communities are only one special case of a much wider class of mesoscopic structures called "stochastic block structures". This name comes from the fact that latent classes of roles and their resultant patterns of connectivity in a network account for salient block structure in the adjacency matrix of a network when the rows and columns are ordered according to these latent roles.

We present an effective and accurate algorithm that performs this task employing a purely Bayesian approach, show that it outperforms competing approaches and present applications to real world data sets that open new frontiers of research in the study of both structure, function and evolution of complex networks from a mesoscopic perspective.

DY 23.2 Thu 10:30 H44

Structuring k-partite networks by decomposition into overlapping communities — •Florian Blöchl[1,3], Mara L. Hartsperger[1,3], Volker Stümpflen[1], and Fabian J. Theis[1,2] — [1]Institute for Bioinformatics and Systems Biology, Helmholtz Zentrum München — [2]Department of Mathematics, TU München — [3]Equal contributors

With increasing availability of large-scale networks we face the chal-

lenge to interpret these data in a comprehensive fashion. A common solution is a decomposition into modular building blocks, so–called communities. Prominent examples are functional modules in protein interactions. However, the integration of heterogeneous resources results in networks with nodes of multiple colors. Although existing algorithms address this issue, they identify separated, disjoint clusters by assigning each node to exactly one cluster. This is far from reality, where e.g. proteins are commonly part of many complexes or pathways.

We present a novel algorithm for detecting overlapping communities in k-partite graphs. It determines for each node a fuzzy degree-of-membership to each community. Moreover, we additionally estimate a weighted backbone graph connecting the extracted communities. The method is fast and efficient, mimicking the multiplicative update rules employed in algorithms for non-negative matrix factorization.

Results on a disease-gene-protein complex graph show significantly higher homogeneity within the complex and disease clusters than expected by chance. However, the algorithm is readily applicable to other domains with similar problems.

DY 23.3 Thu 10:45 H44

Large-deviation properties of random graphs — •Alexander K. Hartmann — Institut of Physics, University of Oldenburg

The large-deviation properties of different types of random graphs are studied using numerical simulations. In particular the number of components and the graph diameter are considered. The distributions of these quantities are obtained down to very small probabilities like 10^{-700} using finite-temperature Monte Carlo and Wang Landau simulations. Different graphs ensembles as Erdös-Renyi, small-world and scale-free graphs are studied as a function of suitable control parameters. The parameter-dependend changes of the distributions are recorded, indicating the presence of non-standard transitions.

In particular, the distributions of the diameter are often given by Gumbel distributions, except right at a percolation transition, or are very close to Gumbel distributions.

DY 23.4 Thu 11:00 H44

Coupled Order Parameter Systems on Scale-free Networks — •Christian von Ferber[1,2], Reinhard Folk[3], Vasyl Palchykov[4], and Yurij Holovatch[3,4] — [1]Applied Mathematics Research Centre, Coventry University, UK — [2]Physikalisches Institut, Universität Freiburg — [3]Institut für Theoretische Physik, Universität Linz, AT — [4]Institute for Condensed Matter Physics, Lviv, UA

We analyse a system of two scalar order parameters on a complex scale-free network in the spirit of Landau theory. To add a microscopic background to the phenomenological approach we also study a particular spin Hamiltonian that leads to coupled scalar order behavior using the mean field approximation. This set up may describe a model of opinion formation where e.g. opinions on a party a candidate are coupled. Our results show that the system is characterised by either of two types of ordering: either one of the two order parameters is zero or both are non-zero but have the same value. While the critical exponents do not differ from those of a model with a single order parameter on a scale free network there are notable differences for the amplitude ratios and susceptibilities. Another peculiarity of the model is that the transverse susceptibility is divergent at all $T < T_c$ when $O(n)$ symmetry is present. This behavior is related to the appearance of Goldstone modes.

DY 23.5 Thu 11:15 H44

Discontinuous Phase Transitions in Random Network Percolation — •Jan Nagler[1,2], Anna Levina[1,3], and Marc Timme[1,2,3] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen — [2]Institute for Nonlinear Dynamics, Faculty of Physics, University of Göttingen — [3]Bernstein Center for Computational Neuroscience (BCCN) Göttingen

The transition to extensive connectedness upon gradual addition of links, known as the percolation phase transition, provides a key prerequisite for understanding networked systems [1]. Until recently, random percolation processes were thought to exhibit continuous transitions in general, but now there is numerical evidence for discontinuities changes of the order parameter in certain percolation processes [2]. Here we present the concepts of weakly and strongly discontinuous percolation transitions and explain the microscopic mechanisms underlying them. We study both numerically and analytically under which conditions the order parameter may change discontinuously and classify the type of transition in dependence on the dynamics of cluster joining [3].

[1] G. Grimmett, Percolation (Springer Verlag, Heidelberg,1999).

[2] D. Achlioptas, R. M. D'Souza, J. Spencer, Explosive Percolation in Random Networks, Science 323: 1453 (2009); R. M. Ziff, PRL 103, 045701 (2009); F. Radicchi and S. Fortunato, PRL 103, 168701 (2009); Y. Cho et al., PRL 103, 135702 (2009).

[3] J. Nagler, A. Levina, and M. Timme, unpublished (2009).

15 min. break

DY 23.6 Thu 11:45 H44

Evidence for power-law anti-correlations in complex networks — •Diego Rybski[1], Hernán D. Rozenfeld[2], and Jürgen P. Kropp[1] — [1]Potsdam Institute for Climate Impact Research, 14412 Potsdam, Germany — [2]Levich Institute, City College of New York, New York, NY 10031, USA

We propose a degree analysis to quantify spatial correlations in complex networks. The approach considers the degrees along shortest paths in the networks and quantifies the correlations. In this work, the Barabasi-Albert (BA) model, a fractal network model, and examples of real-world networks are studied. While for the BA model the correlations show exponential decay, in the case of the fractal networks the correlations show a power-law behavior indicating long-range correlations. The results suggest that the analysis provides complementary information to the fractal dimension as measured with box covering.

DY 23.7 Thu 12:00 H44

What scales in multiscale human mobility networks? — •Rafael Brune[1,2], Christian Thiemann[1,2], and Dirk Brockmann[1] — [1]Northwestern University, Evanston, USA — [2]Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen, Deutschland

Although significant research effort is currently devoted to the understanding of complex human mobility and transportation networks, their statistical features are still poorly understood. Specifically, to what extent geographical scales impose structure on these networks is largely unknown. Statistical properties of these networks have been obtained either for large scale networks or on small scale systems, indicating significant differences between the two. We will present a systematic investigation of various single scale mobility networks extracted from a comprehensive multiscale proxy network, covering sequential length scales of a few to a few thousand kilometers. We will report that certain properties such as mobility flux distribution are universal and independent of length scale, whereas others vary systematically with scale. Furthermore we investigate the relation of a series of network characteristics as a function of scale and analyze how the different length scales interact in the embedding multiscale network.

DY 23.8 Thu 12:15 H44

The tomography of human mobility – what do shortest-path trees reveal? — •Christian Thiemann[1,2], Daniel Grady[1], and Dirk Brockmann[1] — [1]Eng. Sci. & Appl. Math, Northwestern University, Evanston, IL, USA — [2]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany

Similar to illustrating the anatomy of organs using pictures of tissue slices taken at various depths, we construct shortest-path trees of different nodes to create tomograms of large-scale human mobility networks. This tomography allows us to measure global properties of the system conditioned on a reference location in the network to gain a fuller characterization of a node. It also suggests a canonical coordinate system for representing complex networks and dynamical processes thereon in a simplified way, revealing a new symmetry in the human mobility networks we investigated. Furthermore, introducing the notion of tree similarity, we devised a new technique for clustering nodes with similar topological footprint, yielding a unique and efficient method for community identification and topological backbone extraction. We applied these methods to a multi-scale human mobility network obtained from the dollar-bill-tracking site wheresgoerge.com and to the U.S. and world-wide air transportation network.

DY 23.9 Thu 12:30 H44

Fusion in complex networks — •Carlus Deneke, Angelo Valleriani, and Reinhard Lipowsky — Max-Planck-Institut für Kolloid- und Grenzflächenforschung, Department of Theory and Bio-Systems, Potsdam, Germany

In real world networks, part of the information about the nodes and edges is often missing or unaccessible and single nodes might in reality

consist of several nodes or subgraphs. Since these hidden structures may have a strong impact on the dynamical processes, it is important to investigate how the network properties change at different levels of resolution.

In this contribution, we investigate scale-free networks, in which randomly chosen couples of neighboring nodes are iteratively integrated or fused into single nodes. We introduce different fusion mechanisms and compare their effects on simple network properties such as the degree distribution and the degree correlations. By means of numerical simulations and analytical calculations, we show that the network properties change steadily under the iterated fusion steps.

We finally discuss possible connections to real world networks.

DY 23.10 Thu 12:45 H44

Properties of transport networks need to be invariant under coarse graining — •Fabian J. Theis[1,2], Florian Blöchl[1], and Dirk Brockmann[3] — [1]Helmholtz Zentrum München, Germany — [2]Department of Mathematics, TU Munich, Germany — [3]Engineering Sciences and Applied Mathematics, Northwestern University, USA

Transport networks can rarely be observed directly, especially not across many scales. Instead, the flow between two locations can now only be estimated from proxy data. This results in the need for spatial averaging, so we commonly only observe a histogram of the actual distributions. We denote this process as coarse graining.

In this contribution we analyze which network properties are invariant under coarse graining, following the rationale that we can only infer such properties of the true underlying transport network from the proxy data. We show that shortest-path distances, which cannot take self-loops into account, are a poor distance measure in such networks. Instead we illustrate that a distance based on random walks, namely mean fast hitting time (MFHT), is much more adequate for such type of networks. Moreover, we show that community measures are coarse-graining invariant.

Taken together, we can develop a coarse graining method that leaves MFHT fully invariant: we first cluster the nodes into communities via hierarchical clustering of the mean commute time matrix. We then reconstruct a weighted graph connecting our communities, solving a distance realization problem, which we recently addressed in (Wittmann et al., TCS 2009). We illustrate the method on toy and real networks.

DY 24: Turbulence and wind energy

Time: Thursday 9:30–13:00 Location: H47

Topical Talk DY 24.1 Thu 9:30 H47

Wind energy conversion - how statistical physics can improve our future energy supply — •Stephan Barth[1,2], Matthias Wächter[1,2], Tanja Mücke[1,2], and Joachim Peinke[1,2] — [1]ForWind - Center for Wind Energy Research, Oldenburg, Germany — [2]University of Oldenburg, Institute of Physics, Oldenburg, Germany

Renewable energy sources will play an important role in Europe's future energy supply and for the next decades wind energy will be the major contributor of all renewables. Although being a mature and proven technique with more than 120 GW installed capacity worldwide, future installation plans require further improvements - especially looking at offshore wind energy. Engineers from numerous disciplines have committed themselves to this task. However, an energy supply with a high penetration of wind energy will require modern concepts of statistical physics, too: Wind turbines can be seen as dynamic systems, continuously excited by turbulent fluctuations and therefore showing a quite complex behavior. The commonly used engineering models can not grasp this complex behavior properly. To some extend this leads to a tremendous underestimation of extreme events, e.g. gusts, mechanical loads, et cetera. Modern methods of time series analysis and nonlinear methods provide a more profound description of the wind energy conversion process. We present applications from wind fields to production of electricity itself.

15 min. break

DY 24.2 Thu 10:15 H47

Lift measurements in turbulent flow — •Jörge Schneemann, Pascal Knebel, and Joachim Peinke — ForWind, University of Oldenburg, Institute of Physics, Germany

We present lift measurements in a wind tunnel on a FX 79-W-151A airfoil using simultaneously two different methods in laminar and turbulent flow. The first method measures the pressure distributions on the wind tunnel walls to calculate the lift coefficient. This method was shown to work in laminar flow before. The second method measures the lift forces directly on the mounting of the airfoil with a strain gauge based system. Simultaneous measurement gives the opportunity to compare the results of both methods. Hereby, the wall pressure method was proven to obtain good time averaged results in turbulent flow.

Lift was measured in several turbulent inflows with different turbulence intensities Ti generated by grids. Lift forces in the stall range of the foil increased with Ti. One of the grids had a fractal geometry (fractal grid). The turbulence generated by this grid differs from turbulence generated by 'classic grids' in the distribution of the velocity increments. This leads to a different behaviour of the airfoil: Lift fluctuations measured in the stall range of the foil were much higher in the wake of the fractal grid than those in the wake of a classical grid with higher Ti. This suggests a nonlinear behaviour of the airfoil for which research is ongoing.

DY 24.3 Thu 10:30 H47

Turbulenzerzeugung mit aktiven Gittern — •Pascal Knebel und Joachim Peinke — ForWind, Carl von Ossietzky Universität Oldenburg

Wir stellen ein neu entwickeltes aktives Gitter für unseren Windkanal vor bei dem mit digitalen Schrittmotoren 16 Gitterstäbe mit Klappen unabhängig angesteuert werden können. Im Vergleich zu einem passiven Gitter konnten mit unterschiedlichen Anregungsprotokollen in Turbulenzmessungen hinter dem Gitter die Skalenbereiche für Leistungsspektren und Strukturfunktionen erheblich hin zu großen Skalen vergrößert werden. Die großskalige Dynamik wird dabei im wesentlichen durch die Dynamik der Gitteransteuerung erzielt. Die genaueren Untersuchungen ergeben je nach Wahl der Anregungsprotokolle unterschiedliche Übergangsverhalten zwischen der durch das Gitter aufgeprägten großskaligen Dynamik und der sich selbst einstellenden kleinskaligen turbulenten Dynamik. Diese Erscheinung wird im Zusammenhang mit Phasenübergängen diskutiert.

DY 24.4 Thu 10:45 H47

Eulerian and Lagrangian statistics in compressible fluid turbulence — •Christian Schwarz and Rainer Grauer — Institut für Theor. Physik I, Ruhr-Universität Bochum

In order to get insight in statistical properties of turbulent compressible flows numerical simulations using a conservative shock capturing CWENO scheme were performed. In particular, the connection between the PDFs of the Eulerian and Lagrangian velocity increments will be discussed and compared to recent theories developed for incompressible flows. Due to the compressibility of the flow the influence of the density fluctuations can clearly be seen in the velocity increments as well as in the corresponding structure functions. A way to take into account the effect of compressibility on the statistics will be presented.

In order to get long time statistics especially necessary in compressible flows a new framework *cudaHYPE* is under development. This framework solves the compressible Euler equations on a cluster of graphics cards. First results will be presented.

DY 24.5 Thu 11:00 H47

Bridging Lagrangian and Eulerian fluctuations in electron MHD turbulence — •Martin Rieke and Rainer Grauer — Institut für Theor. Physik I, Ruhr-Universität Bochum

Electron MHD is especially suited for addressing the relation between Lagrangian and Eulerian fluctuations since this system allows a direct energy cascade in two space dimensions. Using the CUDA framework for GPU computing, high resolution and long time statistics can be achieved to determine transition probabilities between Eulerian and Lagangrian fluctuation. The results are compared to known models

for Navier-Stokes turbulence.

DY 24.6 Thu 11:15 H47

Measurement of Lagrangian Particle Trajectories by Digital in-line Holography — •Tim Homeyer, Christoph Hindriksen, Gerd Gülker, and Joachim Peinke — ForWind, University of Oldenburg, Institute of Physics, Germany

A digital holographic in-line setup was used to track particles in a small turbulence chamber. Different particle validation methods have been tested to filter out speckles and to enhance accuracy of the longitudinal particle coordinates. In first measurements particle trajectories were measured and visualized together with fitted spline curves. A pronounced decrease of the standard deviation of the particle coordinates with respect to their spline curves was achieved.

DY 24.7 Thu 11:30 H47

Anomalous Region in Fractal Flows — •Stefan Weitemeyer[1], Joachim Peinke[1], and Christos Vassilicos[2] — [1]ForWind, University of Oldenburg, Institute of Physics, Germany — [2]Imperial College, Department of Aeronautics, London, UK

Fractal grids produce high turbulence intensities and high Reynolds numbers.
Using different fractal grids in four different wind tunnels, we studied by hot wire measurements which grid parameters determine the properties of the flow behind the grid. We focused on a region close to the grid where the flow is intermittent and carried out statistical analyses. Flatness values much higher than three and skewness values below zero both reflect the presence of highly energetic bursts in this region. Furthermore we studied the two-point correlations and found the flow to be intermittent on all scales. In our current research we want to determine if the flow behind the fractal grid is a superposition of 'classical grid flows' or if the fractal structure of the grid creates a completely different kind of flow.

DY 24.8 Thu 11:45 H47

Dynamic alignment in supersonic compressible MHD turbulence — •Christoph Beetz, Jürgen Dreher, and Rainer Grauer — Institut für Theor. Physik I, Ruhr-Universität Bochum

It is fairly known that in compressible MHD turbulence the compressibility remains on a very low level although the supersonic, turbulent motion of the gas develops strong shocks which are a typical property of compressible flows. Following an idea of Boldyrev (2005) for incompressible turbulence, we investigate the possibility of a dynamical alignment of the velocity- and the magnetic field. Such a non-perfect scale-dependent alignment would on the one hand explain the quasi-incompressibility of the velocity, admitting on the other hand shock formation in the density. To address this question, high resolution numerical simulations of compressible, supersonic MHD-turbulence with a strong background magnetic field were performed with our framework *racoon*.

DY 24.9 Thu 12:00 H47

Finite-size effects in the dynamics of neutrally buoyant particles in turbulent flow — •Holger Homann[1], Jérémie Bec[2], and Rainer Grauer[1] — [1]Institut für Theoretische Physik I, Ruhr-Universität Bochum, 44780 Bochum — [2]Laboratoire Cassiopée UMR6202 Observatoire de la Côte d'Azur BP4229, 06304 Nice Cedex 4, France

The dynamics of neutrally buoyant particles transported by a turbulent flow is investigated for spherical particles with radii of the order of the Kolmogorov dissipative scale or larger. The pseudo-penalisation spectral method that has been proposed by Pasquetti et al. (2008) is adapted to integrate numerically the simultaneous dynamics of the particle and of the fluid. Such a method gives a unique handle on the limit of validity of point-particle approximations, which are generally used in applicative situations. Analytical predictions based on such models are compared to result of very well resolved direct numerical simulations. Evidence is obtained that Faxén corrections give dominant finite-size corrections to velocity and acceleration fluctuations for particle diameters up to four times the Kolmogorov scale. The dynamics of particles with larger diameters is dominated by inertial-range physics, and is consistent with predictions obtained from dimensional analysis.

15 min. break

Invited Talk DY 24.10 Thu 12:30 H47

Puzzles in Eulerian and Lagrangian turbulence — •Rainer Grauer — Institut für Theor. Physik I, Ruhr-Universität Bochum

Basic and elementary questions which arise in the context of fully developed turbulent systems are still open and discussed controversially. Some of these questions are:

- What is the relation between Eulerian longitudinal and transversal structure functions?
- Is there a relation between Eulerian and Lagrangian fluctuations?
- Can we say something about the energy spectrum in slightly more complex systems as e.g. in magnetohydrodynamical turbulence?

In my talk, I will present different viewpoints and possible solution strategies.

DY 25: Glasses II (joint session of CPP, DF, DY)

Time: Thursday 9:45–12:30 Location: H38

DY 25.1 Thu 9:45 H38

Dynamics of soft spheres beyond the hard-sphere limit — •Michael Schmiedeberg and Andrea J. Liu — University of Pennsylvania, Department of Physics and Astronomy, 209 South 33rd Street, Philadelphia, PA 19104-6396, USA

In the limit of low pressures the dynamics of model glass-forming liquids with finite-ranged repulsive interactions are universal. In that limit, where the product of the pressure and the particle volume is small compared to the interaction energy, soft sphere systems behave as hard spheres, so that the dynamics correspond to those of the hard-sphere glass transition and depend only on the ratio of temperature to the product of pressure and the particle volume. However, at higher pressures relative to the interaction energy, there are deviations from this universal behavior that depend on the inter-particle potential. We consider a bidisperse system consisting of soft spheres that repel each other according to a power law potential δ^α where δ is the particle overlap. By using molecular-dynamics simulations, we determine relaxation times as a function of temperature and pressure. We find that the deviations from hard-sphere behavior can be collapsed onto a single curve that depends on $p^{1/\alpha}$.

DY 25.2 Thu 10:00 H38

Correlation between the Diffusion Dynamics and Vibrational Modes of a Model Glass Former — •Oliver Rubner and Andreas Heuer — Institute of Physical Chemistry, University of Münster, Corrensstr. 30, D-48149 Münster, Germany.

In this work we investigate the vibrational modes from computer simulations on a 65 particle binary Lennard-Jones Mixture (BMLJ65) and compare them with the self diffusion dynamics of the particles. As a measure for the dynamics we use the propensities per particle as obtained from an isoconfigurational ensemble which has been introduced by Harrowell (PRL 93, 135701 (2004))

The diffusion dynamics can also be explained in terms of waiting times of the system in inherent structures or metabasins. We compare these waiting times to the vibrational frequencies of the corresponding inherent structures. From this analysis we present the time dependence of the vibrational frequencies which can give some insight into the underlying potential energy surface on which the motion of the system takes place.

DY 25.3 Thu 10:15 H38

Assessing the predictive power of the Reverse Monte Carlo Method for amorphous systems — •Christian Robert Müller[1], Michael Schuch[2], and Philipp Maass[2] — [1]Theoretical Physics II, Technische Universität Ilmenau, 98684 Ilmenau, Germany. — [2]Fachbereich Physik, Universität Osnabrück, 49069 Osnabrück, Germany.

The quality of structural models generated by the Reverse Monte Carlo

(RMC) method in a typical application to amorphous systems is investigated. To this end diffraction data from a molecular dynamics (MD) simulation of a lithium silicate glass are calculated and used to generate RMC models with different protocols and starting configurations. This allows us to directly compare structural properties of the RMC models with the original MD structures and hence assess the predictive power of the RMC method. It is found that partial distribution functions and properties on small length scales are well reproduced by the RMC modeling. However, properties in the medium-range order, as, for example, ring size distributions are not well captured. We further show that certain medium-range order features of the RMC models can be a mere consequence of the chosen starting configuration when using commonly applied RMC protocols. Due care therefore has to be exercised when extracting structural features from RMC models in the medium-range order regime and when using corresponding information as a basis for subsequent studies of ion transport properties.

DY 25.4 Thu 10:30 H38

Dielectric noise pattern of the Debye- and α-process in a monohydroxy alcohol — •Tobias Gamp, Andreas Reiser, and Christian Enss — Kirchhoff-Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, 69120 Heidelberg

Based on the validity of the fluctuation dissipation theorem, dielectric polarization noise spectroscopy allows to measure the dielectric function of a sample electrically non-driven. 2-Ethyl-1-hexanol is one of the prototypical and widely studied glass-forming liquids showing a Debye-like relaxation and the α-peak, the latter associated with the structural relaxation. Since the Debye process is practically invisible in caloric measurements but prominent in conventional dielectric spectroscopy the question whether it could be caused by the presence of electric fields is debated. We show dielectric noise spectra - both voltage and current power spectral densities - and conventional dielectric spectra. Within our experimental resolution and the validity of the fluctuation dissipation theorem both sets of data are in agreement, indicating that the presence of an external field is not necessary for the occurrence of such a Debye peak.

DY 25.5 Thu 10:45 H38

Glass transition in high dimensions — •Bernhard Schmid and Rolf Schilling — Institut für Physik, Johannes Gutenberg-Universität Mainz, Staudinger Weg 7, D-55099 Mainz, Germany

We have studied the glass transition of hard spheres with diameter σ for dimensions $d \to \infty$ in the framework of mode-coupling theory (MCT). Assuming that the direct correlation function equals the Mayer function in the limit of high dimensions, we have solved numerically the MCT equations [1] up to $d = 800$. The numerical results for the critical collective and self nonergodicity parameters $f_c(k;d)$ and $f_c^{(s)}(k;d)$ exhibit no Gaussian k-dependence even for $d = 800$. Instead they can be represented by a master function, which vanishes for $k\sigma > \hat{k}_0 d^{3/2}$ with $\hat{k}_0 \cong 0.15$. Inspired by these results, we were able to prove analytically that $f_c(k;d)$ converges to $f_c^{(s)}(k;d)$ for $k\sigma = O(d)$ and $d \to \infty$ and that the critical packing fraction is given by $\varphi_c(d) \sim d^2 2^{-d}$. The non-Gaussian character of $f_c(k;d)$ and $f_c^{(s)}(k;d)$ implies that the hard sphere glass at $\varphi_c(d)$ is not a harmonic solid, even in the limit of high dimensions.

[1] M. Bayer, J.M. Brader, F. Ebert, M. Fuchs, E. Lange, G. Maret, R. Schilling, M. Sperl and J.P. Wittmer, Phys. Rev. E **76**, 011508 (2007)

DY 25.6 Thu 11:00 H38

Brownian dynamics simulation of extensional shear flow in dense colloidal hard-sphere systems — •Olaf Herbst[1] and Thomas Voigtmann[1,2] — [1]Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt (DLR), 51170 Köln, Germany — [2]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany

Using a novel algorithm based on on event-driven MD simulations adapted for Brownian dynamics, we examine an extensional flow of colloidal particles with periodic boundary conditions. We study the slow dynamics of dense hard-sphere systems when shear rates are high enough to interfere with the slow (alpha) relaxation time. Characteristic features such as the mean-square displacement as a function of time will be discussed for a variety of system parameters.

DY 25.7 Thu 11:15 H38

The influence of the method of glass preparation and ambient conditions on diffusion of alkaline-earth ions in mixed cation glasses — •Michael Grofmeier and Hartmut Bracht — Institut für Materialphysik, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149 Münster

Diffusion of alkaline-earth ions in mixed alkali (A) alkaline-earth (M) glasses of the composition xA2O*(3-x)MO*4SiO2 with 0<x<3 was investigated by means of the radiotracer diffusion technique below the respective glass transition temperatures. Our previous studies reveal a distinct dependence of the diffusion behavior of the alkaline-earth ions on the composition x and type of cations in the glass. Additional experiments on the alkaline-earth ions mobility in sol-gel derived glasses of the same composition were performed in this work in order to determine whether the mixed cation effect in alkali-alkaline-earth silicate glasses also holds for sol-gel derived thin glass films. We found that the diffusion behavior of cations in mixed cation silicate glasses is independent of the way of glass preparation. Further diffusion measurements under reducing atmosphere demonstrate a retarded mobility of the alkaline-earth cations.

DY 25.8 Thu 11:30 H38

Crystallization and structural investigation of Eu-doped fluorozirconate-based glass ceramics. — •Christian Passlick[1], Bernd Ahrens[1,2], Bastian Henke[1,2], Jacqueline A. Johnson[3], and Stefan Schweizer[1,2] — [1]Centre for Innovation Competence SiLi-nano®, Martin Luther University of Halle-Wittenberg, Karl-Freiherr-von-Fritsch-Str. 3, 06120 Halle (Saale) — [2]Fraunhofer Center for Silicon Photovoltaics, Walter-Hülse-Str. 1, 06120 Halle (Saale) — [3]Department of Materials Science and Engineering, University of Tennessee Space Institute, Tullahoma, TN 37388, USA

A series of Eu-doped fluorozirconate-based glass ceramics has been developed for medical and photovoltaic applications. In the first case, the materials can be used as x-ray scintillators or x-ray storage phosphors, in the latter case as down-converting top layers for highly efficient solar cells. The glasses are based on a modified ZBLAN composition, i.e. a mixture of Zr, Ba, La, Al, and Na fluorides. They are additionally doped with chlorine ions to initiate the growth of $BaCl_2$ nanocrystals upon thermal processing. Eu^{2+} ions are incorporated into the nanocrystals during the annealing procedure enabling a strong fluorescence upon ultraviolet or x-ray excitation. The nanocrystal size and structural phase depend significantly on the heating conditions and Eu doping level. X-ray diffraction patterns show a structural phase change of the $BaCl_2$ nanocrystals from hexagonal to orthorhombic as annealing temperatures are increased. DSC experiments were performed to obtain activation energies, thermal stability parameters and information on the crystal growth mechanisms.

DY 25.9 Thu 11:45 H38

Time-resolved optical spectroscopy on Er-doped fluorozirconate-based glasses for efficient up-conversion — •Ulrich Skrzypczak[1], Manuela Miclea[1], Jacqueline A. Johnson[2], and Stefan Schweizer[1,3] — [1]Centre for Innovation Competence SiLi-nano®, Martin Luther University of Halle-Wittenberg, Karl-Freiherr-von-Fritsch-Str. 3, 06120 Halle (Saale) — [2]Department of Materials Science and Engineering, University of Tennessee Space Institute, Tullahoma, TN 37388, USA — [3]Fraunhofer Center for Silicon Photovoltaics, Walter-Hülse-Str. 1, 06120 Halle (Saale)

Fluorozirconate(FZ)-based glasses have shown their potential as hosts for rare-earth (RE) ions such as Er, in these glasses REs show emissions that would be quenched in other glasses. Such material systems are of practical interest for photon up-conversion. For photovoltaic applications, the efficiency of bifacial solar cells could be vastly improved by an up-converting back layer. Up-conversion is the sequential absorption of two or more low-energy infrared photons by a RE ion followed by subsequent emission of a visible photon. This process is dependent on the intermediate level lifetime of the RE ion, which is determined by the phonon energies of the host material. Low phonon energy glasses like FZ glasses are thus desirable hosts. The lifetimes of the energy levels involved in the up-conversion process are investigated by time-resolved spectroscopy. Short laser pulses at different wavelengths are used for excitation; the emissions are detected via time-correlated photon counting. The radiative and non-radiative decay processes in Er-doped FZ glasses are analyzed and discussed.

DY 25.10 Thu 12:00 H38

Spectral down-conversion in Sm-doped borate glasses for photovoltaic applications — •Marcel Dyrba[1], Paul-Tiberiu Miclea[2,3], and Stefan Schweizer[1,2] — [1]Centre for Innova-

tion Competence SiLi-nano®, Martin Luther University of Halle-Wittenberg, Karl-Freiherr-von-Fritsch-Str. 3, 06120 Halle (Saale) — [2]Fraunhofer Center for Silicon Photovoltaics, Walter-Hülse-Str. 1, 06120 Halle (Saale) — [3]Institute of Physics, Martin Luther University of Halle-Wittenberg, Heinrich-Damerow-Str. 4, 06120 Halle (Saale)

Samarium fluorescence in glasses has attracted much attention in the past two decades, in particular for studies on spectral-hole burning, excited state absorption, and laser properties. Here, a class of Sm-doped borate glasses has been developed for photovoltaic applications. The fluorescent glass is placed on top of a solar cell and, in the case of Sm^{3+} doping, converts the incident violet/blue part of the solar spectrum to red light which is more efficiently absorbed by the solar cell. The chemical base composition of borate glasses consists of the network former boron oxide and metal oxides as network modifiers. The spectroscopic properties of Sm^{3+}, in particular the fluorescence efficiency, are significantly influenced by the electron negativity of the network modifier. Some of the glasses are additionally doped with silver oxide. Subsequent heat treatment causes reduction of the doped silver ions and leads to the formation of metallic silver nanoparticles. The effect of the local field enhancement around the Sm^{3+} ions, which is due to surface plasmons from the silver nanoparticles being close by, is investigated.

DY 25.11 Thu 12:15 H38

Raman spectroscopy on barium halide nanoparticles in fluorozirconate-based glasses — •Charlotte Pfau[1], Paul-Tiberiu Miclea[2,3], and Stefan Schweizer[1,2] — [1]Centre for Innovation Competence SiLi-nano®, Martin Luther University of Halle-Wittenberg, Karl-Freiherr-von-Fritsch-Str. 3, 06120 Halle (Saale) — [2]Fraunhofer Center for Silicon Photovoltaics, Walter-Hülse-Str. 1, 06120 Halle (Saale) — [3]Institute of Physics, Martin Luther University of Halle-Wittenberg, Heinrich-Damerow-Str. 4, 06120 Halle (Saale)

Rare-earth(RE) doped fluorozirconate-based glasses show enhanced fluorescence properties when they are additionally doped with Cl or Br ions, which initiate the growth of $BaCl_2$ or $BaBr_2$ nanocrystals, respectively, upon thermal processing. The REs are incorporated into the nanocrystals during the annealing procedure enabling a strong fluorescence upon excitation. A critical parameter for the fluorescence efficiency is the non-radiative decay process from the excited to the ground state. Non-radiative decay processes are determined by the phonon energies of the host system. Low phonon energy systems such as $BaCl_2$ or $BaBr_2$ are desirable hosts for fluorescent ions. The size and structural phase of the nanocrystals depend significantly on the heating conditions; consequently, a series of chlorine- or bromine-doped fluorozirconate-based glasses were analyzed to determine their phonon energy spectra by Raman spectroscopy. For comparison, the phonon spectra of bulk $BaCl_2$, and $BaBr_2$ were investigated.

DY 26: Networks: From Topology to Dynamics IV (joint session of BP, DY, SOE)

Time: Thursday 14:00–16:00 Location: H44

DY 26.1 Thu 14:00 H44

A sequence-based framework for simulating the evolution of gene regulatory networks — •Thimo Rohlf — Programme d'Epigenomique, Genopole Campus 1 - Genavenir 6, 5 rue Henri Desbruères, F-91030 Évry cedex, France — Max-Planck-Institute for Mathematics in the Sciences, Inselstr. 22, D-04103 Leipzig, Germany

An increasing amount of experimental data on global properties of genome organization across various species and phyla is becoming available, suggesting general principles as, e.g., scaling relationships or spatial regularities of gene distribution on DNA. A second level of information is accessible with gene regulatory networks, that control the space-time pattern of gene expression; here, similar (statistical) patterns of conserved regularities are observed. What can Statistical Physics contribute to tackle the question, which of these properties arose from combinatorial and architectural constraints, and which may have been shaped primarily by evolution? I will introduce and discuss a sequence-based artificial genome model that allows an integrative approach to model the emergence of genomic information at the levels of DNA sequence, regulatory networks and phenotype evolution. In particular, the following questions will be addressed: (1) Which types of network properties could be explained from combinatorial/statistical properties of genomes (random genome model), (2) how do they change in evolving genomes, in particular when (3) selective pressure is present, e.g. stabilizing selection for certain patterns of gene activity (phenotypes).

DY 26.2 Thu 14:15 H44

Evolution based on centrality: Bistability between hierarchical and destructured networks — •Claudio J. Tessone[1], Matteo Marsili[2], and Michael König[1] — [1]Chair of Systems Design, D-MTEC ETH Zürich — [2]International Centre for Theoretical Physics Abdus Salam

We study a model of network evolution in which agents attempt to become the most central ones in a network. Considering purely strategic interactions, when agents try to maximise their centrality in the network, the best strategy for them is to create links with the most central agent among those they are not still connected to. Conversely, for link removal, the most efficient strategy is to remove a link to the least central node, among the neighbours. This condition leads to a self-reinforcing mechanism signalled by the emergence of highly centralised networks. These networks have the property of nestedness: for any two agents i and j, if the degree of agent i is lower than that of j, the neighbourhood of i is contained within the neighbourhood of j. Moreover, this mechanism simplifies the computational effort needed by the agents to identify their best strategy.

Interestingly, such structures only can appear if all the agents have been developing it. If disturbances, –such as decay of edges, introduced by finite of link life-time– are in place, we show that ergodicity in the system disappears. Under these conditions two equilibrium states can coexist for a given set of parameters: one where such hierarchical structure emerges; another where a completely random network prevails.

DY 26.3 Thu 14:30 H44

Network evolution driven by spectral profile — •Sebastian Weber[1] and Markus Porto[2] — [1]Freiburg Institute For Advanced Studies (FRIAS), University of Freiburg, Germany — [2]Institut für Festkörperphysik, Technische Universität Darmstadt, Germany

A large class of real world networks evolve over time, constantly changing and adapting their topology with respect to criteria imposed on the dynamics they mediate. The properties of the dynamics is ultimately determined by its spectral profile, which is the eigenvalue spectrum of the associated operator. This operator inevitably involves the network's adjacency matrix, establishing the connection between topology and dynamics. Using the graph Laplacian or Kirchhoff matrix and its spectral profile as an example, the former being central in a wide class of physical processes (random walks, harmonic interaction networks, etc.) on networks, we show that a network evolution scheme recently developed by us is able to successfully evolve networks to display a given spectral profile's essential features [1].
[1] S. Weber and M. Porto, submitted.

15 min. break

DY 26.4 Thu 15:00 H44

Adaptive network approach to the collective motion of self-propelled agents — •Anne-Ly Do[1], Cristian Huepe[2], Gerd Zschaler[1], and Thilo Gross[1] — [1]MPI for the Physics of Complex Systems, Dresden — [2]unaffiliated National Science Foundation grantee

Swarming is a showcase example of emergent behavior in complex many-particle systems. Previous modeling approaches rely on continuum theories or on individual based simulations and are difficult to study analytically as emergent-level equations are either complicated or not available at all. Here we propose an analytically tractable approach that bases on an adaptive network formulation. The nodes of this network represent individual animals while the links represent mutual awareness and therefore potential interaction between the linked individuals. Over time links are constantly created and broken as the movement of agents reshapes the network of contacts. Simultaneously the direction of movement can change as a result of the interactions

with neighbors in the contact network. By means of moment closure approximation we derive an emergent-level description of the system and study it with the tools of nonlinear dynamics. We show that the system exhibits a phase transition from an unpolarized state, where no order motion occurs, to a state of collective motion, thus reproducing the results of recent swarming experiments.

DY 26.5 Thu 15:15 H44

The backbone of the climate network — •Jonathan Friedemann Donges[1,2], Yong Zou[1], Norbert Marwan[1], and Jürgen Kurths[1,2] — [1]Potsdam Institute for Climate Impact Research, P.O. Box 601203, 14412 Potsdam, Germany — [2]Department of Physics, Humboldt University Berlin, Newtonstr. 15, 12489 Berlin, Germany

We propose a method to reconstruct and analyze a complex network from data generated by a spatio-temporal dynamical system, relying on the nonlinear mutual information of time series analysis and betweenness centrality of complex network theory. We show, that this approach reveals a rich internal structure in complex climate networks constructed from reanalysis and model surface air temperature data. Our novel method uncovers peculiar wave-like structures of high energy flow, that we relate to global surface ocean currents. This points to a major role of the oceanic surface circulation in coupling and stabilizing the global temperature field in the long term mean (140 years for the model run and 60 years for reanalysis data). We find that these results cannot be obtained using classical linear methods of multivariate data analysis, and have ensured their robustness by intensive significance testing.

DY 26.6 Thu 15:30 H44

Personalized recommendation in Collaborative Tagging Systems — •Zi-Ke ZHANG — chemin du musee, CH1700, Fribourg, Switzerland

Personalized recommender systems are confronting great challenges of accuracy, diversification and novelty, especially when the data set is sparse and lacks accessorial information, such as user profiles, item attributes and explicit ratings. Collaborative tags contain rich information about personalized preferences and item contents. We are trying to find an efficient yet simple way to make use of tags to provide better recommendations.

DY 26.7 Thu 15:45 H44

What network analysis can tell us about car-scrap bonus: the linchpins of modern economy — •Florian Blöchl[1], Fabian J. Theis[1,2], and Eric O'N. Fisher[3] — [1]Institute for Bioinformatics and Systems Biology, Helmholtz Centre Munich — [2]Department of Mathematics, TU Munich — [3]California Polytechnic State University

An input-output matrix collects good flows between different economic sectors, structural units of the economy like "Agriculture" or "Pharmaceuticals". This matrix can be viewed as a directed weighted network. We analyze input-output graphs for a wide set of countries collected by the OECD. These networks contain only 40 nodes, but are almost fully connected and have quite strong self-loops.

We apply two measures of node centrality, both relying on different properties of random walks on the graphs: random walk centrality and a new measure we called count-betweenness. The latter is similar to Newman's random walk betweenness, but allows for directed graphs and incorporates self-loops. Both measures give similar and reasonable results. For instance, we find that in Luxembourg the most central sector is "Finance and Insurance", in Brazil "Food Products", and in Germany "Motor Vehicles". Thus, car-scrap bonus really aimed at the linchpin of Germany's economy.

The sectors' rankings are quite different, however some sectors are important in most countries while others are never. We therefore additionally structure the data by hierarchically clustering countries. Thereby we achieve clusters that well coincide with geographical proximity or developmental status.

DY 27: Networks: From Topology to Dynamics V (joint session of BP, DY, SOE)

Time: Thursday 16:00–17:15 Location: H44

DY 27.1 Thu 16:00 H44

Eat the specialist: Some results on the stability of 100 billion food webs — •Thilo Gross — Max-Planck Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden

Ecological food webs are complex networks of feeding interactions, describing who-eats-who in an ecosystem. Previous theoretical results suggest that the dynamical stability of these webs should decrease with increasing number of species and network connections. Yet, large and densely-linked webs found in nature are highly stable. Identification of the properties promoting stability is therefore an important goal of ecological research. The approach of generalized modeling enables us to investigate the local stability of steady states in these webs with a higher degree of generality and efficiency than previous simulative approaches. Because of the complexity of the problem, a general food web model contains several thousand unknown parameters. However, the numerical efficiency of the generalized models is such that tens of billions of different realizations of plausible webs can be analyzed in reasonable computational time. This provides a sound basis for the statistical exploration of the high-dimensional parameter space. In this talk I will demonstrate the application of generalized modeling, in simple examples and in large food webs. The latter reveals certain topological properties having a strong impact on network stability.

DY 27.2 Thu 16:15 H44

Regular graph properties of the plasmodial vein network of the slime mould *Physarum polycephalum* — Werner Baumgarten and •Marcus Hauser — Otto-von-Guericke-Universität Magdeburg, Abteilung Biophysik, Institut für Experimentelle Physik, Universitätsplatz 2, 39106 Magdeburg, Germany

The plasmodium of the slime mould *Physarum polycephalum* is a single multi-nucleate giant amoeboid cell. It forms a characteristic two-dimensional vein network, where the apical end of the plasmodium extends to search for new food sources, while the dense network of tubular veins is in charge of transport of protoplasm throughout the giant cell.

A graph theoretical analysis of the vein network of the *Physarum polycephalum* strain HU195×HU200 reveals that the nodes have exclusively the degree 3, i.e., each node connects to exactly three veins. This means that the vein network of this slime mould forms a regular cubic graph, and hence does not show small-world properties. The intensities of the edges (the vein segments) connecting a pair of nodes differ, thus forming a weighted graph. The distributions of the lengths and areas of the veins follow exponential distributions, while their widths are distributed either log-normally or normally. Interestingly, these functional dependencies are robust during the entire evolution of the growing plasmodial vein network of *Physarum polycephalum*.

DY 27.3 Thu 16:30 H44

Feedback-mediated control of a spiral wave in a bidomain model of cardiac tissue — •Ekaterina Zhuchkova, Vladimir Zykov, and Harald Engel — Institut für Theoretische Physik, Technische Universität zu Berlin, Berlin, Germany

At the moment anti-tachycardia pacing (ATP) is the only low-energy therapy for ventricular tachyarrhythmias and it would be desirable since it prevents adverse side effects. However, ATP is not robust since its success/failure depends on many factors [1]. Using realistic bidomain model for simulation of electrical activity in cardiac tissue together with a simplified Fenton-Karma ionic model for a cell, we show that spiral waves in the heart could be eliminated by repetitive extracellular stimulation. A spiral wave core can be guided towards boundaries by feedback forcing along a one-dimensional registering electrode [2]. Every time the spiral wave front is tangent to the registering electrode, an extracellular current is applied through stimulating electrodes. The amplitude of the stimulation is much less than the single-shock defibrillation threshold, which gives a possibility to use the proposed method as an alternative low-voltage defibrillation strategy.

[1] E. Zhuchkova and H. Engel, Robustness of local forcing in inhibition of reentry, IPACS Open Access Library (2009), accepted.

[2] J. Schlesner, V. S. Zykov, H. Brandtstädter, I. Gerdes and H. Engel, Efficient control of spiral wave location in an excitable medium with localized heterogeneities, NJP 10, 015003 (2008).

DY 27.4 Thu 16:45 H44

Linking Molecular Simulations and Systemic Modelling — •Tihamer Geyer and Volkhard Helms — Zentrum für Bioinformatik, Universität des Saarlandes, D-66123 Saarbrücken

When modeling biological systems there is a gap of scales between the systemic models that try to describe the metabolism of a complete cell and the molecular biological descriptions focussing on the detailed processes of a single enzyme. We therefore proposed an agent based approch that allows to bridge between the two regimes.

For this, we set up the individual enzymes from their microscopic elementary reactions like the binding of a metabolite molecule to a binding site or the transfer of an electron from one site inside the protein to another. The respective numbers of these protein "building blocks" are then connected to metabolite pools via standardized connectors to set up the metabolic system under consideration. This pools-and-proteins model can thus be used to "convert" detailed molecular biological knowledge into a systems biological model for analyzis of the complete system.

To develop and test our approach we used the bacterial photosynthetic apparatus. But even for the "boringly" well-known system, many of the detailed kinetic constants were unknown. By comparing the behavior of the complete system to time-dependent experiments, we could determine the values and sensitivities of all parameters of our model. The thus parametrized protein modules allowed for new insights into their inner working and can be re-used to set up other, related systems.

DY 27.5 Thu 17:00 H44

About scaling in the growth of clubs and communities — Lu Xin[1], Diego Rybski[2], and •Fredrik Liljeros[1] — [1]Department of Sociology, Stockholm University, S-106 91 Stockholm, Sweden — [2]Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, 14412 Potsdam, Germany

Many systems comprise emergent power-laws in the growth rates with respect to the size of the units such as companies or cities. Here we study online communities and investigate the growth properties of clubs and social communities. We find power-law relations for the average growth rate and for the standard deviation. The quality of the data permits to analyze the growth – complementary to (temporal) correlations – on the basis of individuals behaving in a social context.

DY 28: Phase transitions and Critical Phenomena II

Time: Thursday 14:00–16:00 Location: H47

Topical Talk DY 28.1 Thu 14:00 H47

Static correlation functions of integrable quantum chains — •Frank Göhmann — Bergische Universität Wuppertal, Germany

Recently the structure of the correlation functions of the Heisenberg-Ising chain has been completely resolved. After an appropriate regularization they all factorize into sums over products of the one-point function and a single special neighbour two-point function. This resembles the situation with free fermions, and, indeed, what is behind is a remarkable free fermionic structure on the space of (quasi-) local operators on the spin chain. It allows us, for instance, to calculate short-range correlators over the full phase diagram directly in the thermodynamic limit. Numerical values of the correlators can be obtained with arbitrary precision by solving simple and well-behaved integral equations. I shall explain the basic notions behind the factorization and I shall illustrate them with examples. I further advocate the hypothesis that factorization is the characteristic feature of possibly all integrable quantum chains.

DY 28.2 Thu 14:30 H47

Ultrametricity and hierarchical clustering for Ising spin glasses — •Alexander K. Hartmann[1] and Helmut G. Katzgraber[2] — [1]Institut of Physics, University of Oldenburg, Germany — [2]Department of Physics & Astronomy, Texas A&M University, USA

We present results from computer simulations [1], in particular Monte Carlo simulations using the parallel tempering approach, to test for ultrametricity [2] and clustering properties [3] in spin-glass models. We use a one-dimensional Ising spin glass with random power-law interactions where the universality class of the model can be tuned by changing the power-law exponent. We find [4] signatures of ultrametric behavior both in the mean-field and non-mean-field universality classes for large linear system sizes. Furthermore, we confirm the existence of nontrivial connected components in phase space via a clustering analysis of configurations.

[1] A.K. Hartmann, *Practical Guide to Computer Simulations*, (World Scientific, 2009)
[2] R. Rammal *et al.*, Rev. Mod. Phys. **58**, 765 (1986)
[3] G. Hed, A.K. Hartmann, D. Stauffer, and E. Domany, Phys. Rev. Lett. **86**, 3148 (2001)
[4] H.G. Katzgraber and A.K. Hartmann, Phys. Rev. Lett. **102**, 037207 (2009)

DY 28.3 Thu 14:45 H47

Non-equilibrium phase transition in an exactly solvable driven Ising model with friction — •Alfred Hucht, Sebastian Angst, and Dietrich E. Wolf — Fakultät für Physik, Universität Duisburg-Essen, D-47048 Duisburg

A driven Ising model with friction due to magnetic correlations has recently been proposed by Kadau et al. [1]. The non-equilibrium phase transition present in this system is investigated in detail using analytical methods as well as Monte Carlo simulations [2]. In the limit of high driving velocities v the model shows mean field behavior due to dimensional reduction and can be solved exactly for various geometries. The simulations are performed with three different single spin flip rates: the common Metropolis and Glauber rates as well as a multiplicative rate. Due to the non-equilibrium nature of the model all rates lead to different critical temperatures at $v > 0$, while the exact solution matches the multiplicative rate. Finally, the cross-over from Ising to mean field behavior as function of velocity and system size is analysed in one and two dimensions.

[1] D. Kadau et al., Phys. Rev. Lett. 101, 137205 (2008)
[2] A. Hucht, Phys. Rev. E 80 (in press), arXiv:0909.0533

DY 28.4 Thu 15:00 H47

Microcanonical phase diagrams of short-range ferromagnets — •Michael Kastner[1] and Michel Pleimling[2] — [1]National Institute for Theoretical Physics, Stellenbosch 7600, South Africa — [2]Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061-0435, USA

A phase diagram is a graph in parameter space showing the phase boundaries of a many-particle system. Commonly, the control parameters are chosen to be those of the (generalized) canonical ensemble, such as temperature and magnetic field. However, depending on the physical situation of interest, the (generalized) microcanonical ensemble may be more appropriate, with the corresponding control parameters being energy and magnetization. We show that the phase diagram on this parameter space looks remarkably different from the canonical one. The general features of such a microcanonical phase diagram are investigated by studying two models of ferromagnets with short-range interactions. The physical consequences of the findings are discussed, including possible applications to nuclear fragmentation, adatoms on surfaces, and cold atoms in optical lattices.

DY 28.5 Thu 15:15 H47

Polymers in crowded environment under stretching force: globule-coil transitions — •Wolfhard Janke[1] and Viktoria Blavatska[1,2] — [1]Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, 04009 Leipzig, Germany — [2]Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine, 79011 Lviv, Ukraine

We study flexible polymer macromolecules in a crowded (porous) environment, modeling them as self-attracting self-avoiding walks on site-diluted percolative lattices in space dimensions $d = 2$ and 3. The influence of stretching force on the polymer folding and properties of globule-coil transitions are analyzed. Applying the pruned-enriched Rosenbluth chain-growth method (PERM), we estimate the transition temperature T_Θ between collapsed and extended polymer configurations and construct the phase diagrams of the globule-coil coexistence

when varying temperature and stretching force. The transition to a completely stretched state, caused by applying force, is discussed as well.

[1] V. Blavatska and W. Janke, Phys. Rev. E **80**, 051805 (2009).

DY 28.6 Thu 15:30 H47

First-order-like Behavior at the Adsorption Transition of Short Polymers in the Microcanonical Ensemble — •Monika Möddel[1], Wolfhard Janke[1], and Michael Bachmann[2] — [1]Institut für Theoretische Physik, Universität Leipzig — [2]Institut für Festkörperforschung, Theorie II, Forschungszentrum Jülich

The understanding of the cooperative effects of structure formations at substrates requires systematic studies of mesoscopic aspects. We perform such a study focusing on the adsorption transition [1,2]. This is conveniently and to our knowledge for the first time done by a detailed microcanonical analysis [2] of densities of states obtained by extensive multicanonical Monte Carlo computer simulations.

For short chains and strong surface attraction, the microcanonical entropy turns out to be a convex function of energy in the transition regime, indicating that surface-entropic effects are relevant. Albeit known to be a continuous transition in the thermodynamic limit of infinitely long chains, the adsorption transition of polymers with finite length thus exhibits a clear signature of a first-order-like transition, with coexisting phases of adsorbed and desorbed conformations.

[1] M. Möddel, M. Bachmann, and W. Janke, J. Phys. Chem. B 113, 3314 (2009).

[2] M. Möddel, M. Bachmann, and W. Janke, preprint.

DY 28.7 Thu 15:45 H47

Conformal invariance and Schramm Loewner evolution (SLE) in the 2d random field Ising magnet — •Jacob Stevenson — Johannes Gutenberg-Universität Mainz

Random field Ising magnets have no thermodynamic phase transition in two dimensions, however there is strong evidence that connected spin domains percolate at a finite random field strength. Thus even though the total magnetization remains zero, the domains diverge in length scale. We examine ground state domain walls near this percolation transition finding strong evidence that they are conformally invariant and that they satisfy Schramm (stochastic) Loewner evolution (SLE_κ) with parameter $\kappa = 6$. These stringent requirements, which hold for normal 2d percolation, permit exact calculation of properties such as the fractal dimension of domain walls and allow the powerful techniques of conformal field theory to be aimed at the random field Ising magnet.

DY 29: Spatially Extended Dynamical Systems

Time: Thursday 14:00–16:00 Location: H46

DY 29.1 Thu 14:00 H46

Modeling of the gamma- and theta waves propagation in the region CA3 of hippocampus. — •Anastasia I. Lavrova[1] and Eugene B. Postnikov[2] — [1]Institut für Physik Humboldt - Universität zu Berlin, Deutschland — [2]Staatliche Universität Kursk, Russland

It is known that hippocampus is a structure required for processes of learning and memory [1]. Gloveli et al. [2] reported that the dynamics of neuron network of CA3 region exhibits some types of oscillations, so called gamma (30-80 Hz) and theta(4-12Hz) rhythms. These oscillations are responsible for information transmission, storage, and spatial encoding [1,2]. Also, it have been shown that gamma and theta rhythms are generated by different types of cells in CA3 region of hippocampus. The minimal network scheme, describing connections between different types of cells and its detailed model have been studied in [1,2]. We construct the simple discrete model based on the scheme suggested in [2], which reproduces important physical characteristics of the oscillations of all cells types: the period, amplitude and phase shift. This model allows to analyze an influence of synaptic connections between cells on the mention characteristics. Moreover, we consider a space distribution of the minimal network elements and noise in the interaction between them. We study how the noise can influence on the strength of the cells interaction and gamma and theta waves propagation. 1. Gloveli T., Dugladze T.,Rotstein H.,Traub R., Monyer H., Heinemann U., Whittington M., Kopell N., PNAS, V.102 13295-300,(2005) 2. Tort A., Rotstein H., Dugladze T., Gloveli T., Kopell N., PNAS, V.104, 13490-95, (2007)

DY 29.2 Thu 14:15 H46

effect of mean flow in spiral turbulence — •hira affan and rudolf friedrich — Institute for Theoretical Physics, University of Muenster, Wilhelm-Klemm-Str. 9, D-48149 Muenster, Germany

Spiral turbulence in Rayleigh-Benard convection is studied numerically in the framework of generalized Swift Hohenberg equations. The model equation consist of an order parameter equation for the temperature field coupled to an equation for the mean flow field. In contrast to previous work nonlinearities in the dynamics of the mean flow are retained leading to a two dimensional Navier-Stokes equation coupled to a Swift-Hohenberg equation. We present detailed investigations of nonlinear effects due to the interaction of nonlinear two dimensional flows and the pattern forming process.

DY 29.3 Thu 14:30 H46

Chaotic spatial soliton rays in smooth two-dimensional optical lattices — •Ramaz Khomeriki[1,2,3] and Jerome Leon[3] — [1]Max-Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany — [2]Department of Physics, Tbilisi State University, 3 Chavchavadze, 0128 Tbilisi, Georgia — [3]Laboratoire de Physique Théorique et Astroparticules, Université Montpellier 2, Montpellier, France

The light ray of a spatial soliton in an optical film whose refractive index is smoothly modulated (wavelength much larger than the typical soliton width) in both spatial directions is shown to possess chaotic regimes for which the propagation is erratic. This is interpreted as a parametric driven pendulum, obtained by what we believe to be a new perturbative approach of the Maxwell equation. These findings are then demonstrated to compare well to the eikonal law of light ray propagation (nonlinearity compensates diffraction).

REFERENCES:

R. Khomeriki, J. Leon, Phys. Rev. A, 80, (2009) 033822

R. Khomeriki, J. Leon, Optics Letters, 34, (2009) 3376

DY 29.4 Thu 14:45 H46

Substrate Mediated Condensation and Pattern Formation in Thin Liquid Films — •Michael H. Köpf, Svetlana V. Gurevich, and Rudolf Friedrich — Institute for Theoretical Physics, University of Münster, Wilhelm-Klemm-Straße 9, D-48149 Münster

The formation of regular stripe patterns during transfer of surfactant monolayers onto solid substrates is investigated. Two coupled differential equations describing the surfactant density and the height profile of the water subphase are derived within the long-wavelength approximation. If the transfer is carried out in the vicinity of a surfactant first-order phase transition, the interaction with the substrate plays a key role. This effect is included in the surfactant free-energy functional via a height dependent external field. Using transfer velocity and lateral pressure as control parameters a bifurcation from a homogeneous transfer to regular stripe patterns arranged parallel to the contact line is investigated in one and two dimensions. Moreover, in the two-dimensional case a secondary bifurcation to perpendicular stripes is observed in a certain control parameter range.

DY 29.5 Thu 15:00 H46

Magnetic stripe-forcing of an experiment with broken up-down symmetry — •Thomas Friedrich, Ingo Rehberg, and Reinhard Richter — Experimentalphysik 5, Universität Bayreuth

Historically, a spatial forcing was first studied experimentally in electroconvection [1]. More recently, [2] measured inclined layer convection under the influence of lamellar surface corrugations. In both experiments, the first convection pattern beyond a threshold are stripes. What has not been measured so far, is the impact of stripe-forcing on a system with a primary instability to hexagons. The Rosensweig instability in a layer of ferrofluid, is a system with broken up-down symmetry [3] [4]. Consequently its first pattern is a hexagonal one. We apply

for the first time a static magnetic stripe-forcing to the Rosensweig instability, and record the response by means of X-rays. The outcome is compared to results, obtained by amplitude equations[5].

[1] M. Lowe, J. Gollub, and T. Lubensky, Phys. Rev. Lett., **51**(9):786–789, 1983
[2] G. Seiden, S. Weiss, J. H. McCoy, W. Pesch, and E. Bodenschatz, Phys. Rev. Lett., **101**(21):214503, 2008.
[3] M. D. Cowley and R. E. Rosensweig, J. Fluid Mech.,**30**:671, 1967.
[4] R. Richter, Physik Journal, **7**:39–44, 2008.
[5] R. Peter, et al., Phys. Rev. E, **71**(4):046212, 2005.

DY 29.6 Thu 15:15 H46

Delocalization and spreading in a nonlinear Stark ladder — •Dmitry Krimer[1], Sergej Flach[1], and Ramaz Khomeriki[1,2] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden — [2]Physics Department, Tbilisi State University, Chavchavadze 3, 0128 Tbilisi, Georgia

We study the evolution of a wave packet in a nonlinear Stark ladder [1]. In the absence of nonlinearity all normal modes are spatially localized giving rise to an equidistant eigenvalue spectrum and Bloch oscillations. Nonlinearity induces frequency shifts and mode-mode interactions. For large strength of nonlinearity we observe a long lived trapped regime with an explosive transition to Bloch oscillations, followed by a subdiffusive spreading at large time scales. For moderate nonlinearities an immediate subdiffusion takes place. Finally, for small nonlinearities we find linear Stark localization as a transient, with subsequent subdiffusion. For single mode excitations and weak nonlinearities stability intervals are predicted and observed upon variation of the dc bias strength, which affect the short and long time dynamics. In all cases, we observe that nonlinearity destroys integrability, introduces chaos, and ultimately leads to a destruction of localization.

[1] D.O. Krimer, R. Khomeriki and S. Flach, Phys. Rev. E 80, 036201 (2009)

DY 29.7 Thu 15:30 H46

Self organizing networks of Belousov-Zhabotinsky oscillator droplets — •Shashi Thutupalli[1], Ralf Seemann[1,2], and Stephan Herminghaus[1] — [1]Max Planck Institute for Dynamics and Self Organization, D-37073, Göttingen, Germany — [2]Experimental Physics, Saarland University, 66041 Saarbrücken

Coupling via chemical communication is widespread in nature, such as in heart dynamics, neuronal networks, bacterial colonies, formation of tissues etc. In such systems, collective behavior emerges due to suitable interactions between the constituent individual elements. Here, we report on self organizing networks of water-in-oil emulsion droplets which exhibit coupled behavior using the non-linear Belousov Zhabotinsky (B-Z) reaction. Using microfluidic techniques, we form surfactant stabilized aqueous droplets (diameter: 50-200 microns) containing the B-Z reaction mixture in a surrounding oil phase. Due to diffusive mixing within the droplets, each individual droplet then acts as an oscillator with a time period (on the order of 10 - 100 seconds) determined by the chemical concentrations. Reaction induced motion of the droplets causes the initially spatially separated droplets to find each other and then aggregate to form droplet networks. The networks are held together by self forming surfactant bilayers between the droplets, which also seemingly act as conduits for chemical connections via ionic transfer. We report on the various phenomena in these droplet networks, such as phase coupled oscillations, bursting modes and coupled trigger waves and elucidate their possible mechanisms.

DY 29.8 Thu 15:45 H46

Directed transport in phase-modulated driven lattices — •Christoph Petri[1], Florian Lenz[1], Fotis Diakonos[2], and Peter Schmelcgher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg — [2]Department of Physics, University of Athens

An analysis of the dynamics of non-interacting particles in a phase-modulated one-dimensional lattice formed by laterally oscillating square potentials is presented. Depending on the properties of the modulation a desymmetrization of phase space occurs, which is based on breaking locally time- reverse and space-invert symmetries. This yields a directed current of particles, whose direction and magnitude is tunable by varying the parameters of the system. Furthermore, the particles show different localization behavior depending on their spatial position if the global height of the potential is chosen appropriately.

DY 30: Posters II

Time: Thursday 16:00–18:00 Location: Poster C

DY 30.1 Thu 16:00 Poster C

Asymptotics of work distributions in nonequilibrium systems — •Daniel Nickelsen and Andreas Engel — Universität Oldenburg, Germany

The asymptotic behaviour of work distributions in driven nonequilibrium systems, described by the Langevin equation with a potential $V(x,t)$, is determined using the method of optimal fluctuations. For that purpose, the corresponding Euler-Lagrange equation together with the appropriate boundary conditions and differential equations regarding the leading pre-exponential factor are derived for an arbitrary $V(x,t)$. The method is applied to an analytically solvable example, for more complicated examples the numeric implementation is demonstrated.

DY 30.2 Thu 16:00 Poster C

Shear simulations in the 2d-Ising model — •David Winter[1], Peter Virnau[1], Jürgen Horbach[2], and Kurt Binder[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz — [2]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Köln

We study the critical behavior of the two dimensional Ising model under shear with Monte Carlo simulations. The system shows a strong anisotropy and one observes two different correlation lengths. By applying anisotropic finite-size scaling techniques we find that the critical point is shifted towards higher temperatures as a function of the shear rate.

DY 30.3 Thu 16:00 Poster C

Spread of information in complex networks — •Mirko Kämpf[1], Jan W. Kantelhardt[1], and Lev Muchnik[2] — [1]Institut fur Physik, Fachgruppe Theoretische Physik, Martin-Luther- Universitat Halle-Wittenberg, 06099 Halle (Saale), Germany — [2]Leonard N. Stern School of business, New York University, New York, USA

We study the process of collecting, processing, validating, and distributing information in self-organized complex social systems based on data from, e.g., the online encyclopedia Wikipedia. We correlate page access statistics, page edit statistics, and article network structure (defined by links) to characterize the lifecycle of relevant pieces of information. Results are also compared regarding regional contexts and different languages. Focusing on extreme events we analyze scaling behavior and investigate current limitations that could be eliminated by optimizing of the communication processes.

DY 30.4 Thu 16:00 Poster C

Using an evolutionary algorithm to obtain Boolean networks with reliable and robust trajectories — •Christoph Schmal[1,2], Tiago Peixoto[1], and Barbara Drossel[1] — [1]Institut für Festkörperphysik, TU-Darmstadt — [2]Fakultät für Physik, Universität Bielefeld

We investigate Boolean networks that follow a given reliable trajectory in state space, which is insensitive with respect to the updating schedules, as recently introduced in [1]. These trajectories have the property that two successive states differ only by the value of one node. We evaluate the robustness of these networks under small perturbations of the dynamics. Here, robustness is defined as the probability that the dynamics return to the reliable trajectory after a perturbation of the state of a single node. In order to achieve higher robustness, we explore the space of possible update functions by using an evolutionary algorithm. With this procedure, we obtain networks that are robust against noise in the update schedule as well as against perturbations of the Boolean values. We compare properties such as the probability distribution of the different types of update functions, the size of the basin of attraction of the reliable trajectory, the transient times and the attractor lengths, for networks before and after running the

evolutionary optimization process.

References:

[1] Tiago P. Peixoto and Barbara Drossel, Phys. Rev. E 80, 056102 (2009)

DY 30.5 Thu 16:00 Poster C

Detecting transitions in paleoclimatological time-series using recurrence networks — •Jonathan Friedemann Donges[1,2], Norbert Marwan[1], Reik Donner[1,3,4], Yong Zou[1], and Jürgen Kurths[1,2] — [1]Potsdam Institute for Climate Impact Research, P.O. Box 601203, 14412 Potsdam, Germany — [2]Department of Physics, Humboldt University Berlin, Newtonstr. 15, 12489 Berlin, Germany — [3]Max Planck Institute for Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany — [4]Institute for Transport and Economics, Dresden University of Technology, Würzburger Str. 35, 01187 Dresden, Germany

We propose a novel, robust and effective approach for analysing time series using complex network theory. We identify the recurrence matrix calculated from time series with the adjacency matrix of a complex network, and apply measures for the characterisation of complex networks to the recurrence matrix. By using the logistic map, we illustrate the potentials of these complex network measures for detecting dynamical transitions. Finally we apply the proposed approach to speleothem palaeo-climate records and identify subtle changes of the past climate regime.

DY 30.6 Thu 16:00 Poster C

Singular spectrum analysis for a comparison of the climate data between the equatorial zone and the Arctic land — •Naoki Itoh[1] and Jürgen Kurths[2] — [1]Interdisciplinary Center for Dynamics of Complex Systems, Potsdam, Germany — [2]Potsdam-Institut für Klimafolgenforschung e.V., Potsdam, Germany

As one of the classical time series analysis, singular spectrum analysis (SSA) is applied to time series. This method gives us achievements in many fields. In our study monthly precipitation in climate data in the equatorial area (Kenya) and the Arctic land (71.25^{o}N and 179.75^{o}E) recently focused on, are analyzed in order to compare the properties of the information such as trends, periodic- and quasi periodic components extracted by the SSA. From the results climate interpretations are discussed.

DY 30.7 Thu 16:00 Poster C

Morphogenesis by coupled regulatory networks: Reliable control of positional information and proportion regulation — •Thimo Rohlf[1,2] and Stefan Bornholdt[3] — [1]Programme d'Epigenomique, Genopole Campus 1 - Genavenir 6, 5 rue Henri Desbruères, F-91030 Évry, France — [2]MPI -MIS, Inselstrasse 22, D-04013 Leipzig, Germany — [3]Institute for Theoretical Physics, University of Bremen, Otto-Hahn-Allee, D-28334 Bremen, Germany

Based on a non-equilibrium mechanism for spatial pattern formation we study how position information can be controlled by locally coupled discrete dynamical networks, similar to gene regulation networks of cells in a developing multicellular organism [1]. As an example we study the developmental problems of domain formation and proportion regulation in the presence of noise, as well as in the presence of cell flow. We find that networks that solve this task exhibit a hierarchical structure of information processing and are of similar complexity as developmental circuits of living cells. Proportion regulation is scalable with system size and leads to sharp, precisely localized boundaries of gene expression domains, even for large numbers of cells. A detailed analysis of noise-induced dynamics, using a mean-field approximation, shows that noise in gene expression states stabilizes (rather than disrupts) the spatial pattern in the presence of cell movements, both for stationary as well as growing systems. Finally, we discuss how this mechanism could be realized in the highly dynamic environment of growing tissues.

[1] T.R. and S.B., J. Theor. Biol., 2009, 261, 176-193

DY 30.8 Thu 16:00 Poster C

Accelerating glassy dynamics on graphics processing units — Peter H. Colberg[1,2] and •Felix Höfling[1,3] — [1]Arnold-Sommerfeld-Zentrum für Theoretische Physik und Center for NanoScience, LMU München, München — [2]Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Köln — [3]Rudolf Peierls Centre for Theoretical Physics, University of Oxford, Oxford, United Kingdom

Modern graphics hardware offers peak performances close to 1 Tflop/s, and NVIDIA's CUDA provides a flexible and convenient programming interface to exploit these immense computing resources. Here, we demonstrate the ability of GPUs to perform high-precision MD simulations for up to 1 million particles running stable over weeks. The performance of our molecular dynamics simulation package on a single graphics processing unit compares with the LAMMPS package on 64 distributed processor cores.

As a demanding test case, we have reproduced the slow dynamics of a binary Lennard-Jones mixture close to the glass transition. We put particular emphasis on the numerical long-time stability in terms of energy and momentum conservation. Floating point precision is a crucial issue here, and sufficient precision can be maintained by single-double emulation of the floating point arithmetic. As a result of improved numerical accuracy, we were able to follow the slow relaxation dynamics over 4 non-trivial decades in time. Further, our data provide evidence for a negative power-law decay of the velocity autocorrelation function with exponent 5/2 in the close vicinity of the transition.

DY 30.9 Thu 16:00 Poster C

Harnessing the power of modern GPUs with LAMMPS — •Lars Winterfeld[1], Christian Robert Müller[1], and Philipp Maass[1,2] — [1]Institut für Physik, Technische Universität Ilmenau, Germany — [2]Fachbereich Physik, Universität Osnabrück, Germany

We present an extension to the widely used Molecular Dynamics Package LAMMPS, which allows the usage of graphic processing units (GPUs) to accelerate simulations. In contrast to other efforts of extending molecular dynamics codes, we not only rewrote the computational extensive parts of LAMMPS, such as the force calculations, but also most of the other functions invoked in the course of the simulation. This has the advantage that frequent data transfers between the GPU and the host processor are avoided. As a result a much higher performance is not only achieved for simulations of complex systems but also for simple systems such as Lennard Jones fluids. Features of our implementation include Coulomb forces using Ewald summation and the Particle-Particle Particle-Mesh (PPPM) method, temperature control through different thermostats, direct manipulation of atoms as well as mixed precision calculations. We report on benchmarks of typical usages, focusing on systems with Coulomb and Lennard Jones interactions. With a single NVIDIA GTX 280 speedups by a factor of 20 to 80 are obtained compared to a single processor calculation on an Intel Q6600 CPU. We furthermore investigate the accuracy with respect to different precision settings, and contrast it with other precision limiting factors such as cut-off radii of force fields and the grid size in the PPPM algorithm.

DY 30.10 Thu 16:00 Poster C

Varying Coulomb Trapping of Network Forming Units and the Mixed Glass Former Effect — •Michael Schuch[1,2], Christian Robert Müller[2], and Philipp Maass[1,2] — [1]Fachbereich Physik, Universität Onsabrück, 49069 Osnabrück, Germany — [2]Institut für Physik, Technische Universität Ilmenau, 98684 Ilmenau, Germany

Mixing of two types of glass formers in ion conducting glasses can lead to strong enhancements of ionic conductivities, a phenomenon commonly referred to as the Mixed Glass Former Effect (MGFE). A theory for the MGFE is presented which allows one to describe the change of concentrations of network forming units upon mixing and associated changes in Coulomb trapping energies. Using this structural information the change of the conductivity activation energies is calculated by means of percolation theory and Monte Carlo simulations. Fits of the theory to experiments on a borophosphate system yield good agreement with the measured data both for the concentration variation of the units and the variation of the activation energy.

DY 30.11 Thu 16:00 Poster C

Non-Contact Measurement of the Specific Heat of Insulating Glasses at Low Temperatures — •Angela Halfar, Masoomeh Bazrafshan, Andreas Fleischmann, and Christian Enss — Heidelberg University, Kirchoff Institute for Physics

Parasitic heat inputs through wires are a general problem in measurements at low and ultra low temperatures. To avoid such unwanted effects new contact-free techniques for investigating the thermal properties of glasses have been developed in recent years. Particularly challenging in this respect is the measurement of the specific heat of dielectric glasses at temperatures below about 25 mK. With a new technique based on the amplitude of coherent polarisation echoes as

intrinsic temperature information and an optical heating method we hope to extend the temperature range, in which the specific heat of glasses can be measured reliably, to well below 10 mK. In this experiment the glass sample is located in a microwave cavity attached to the mixing chamber of a dilution refrigerator and is heated via an optical fibre by a pulsed LED mounted at the 1K pot. The properties of glasses at such temperatures are governed by atomic tunnelling systems. These degrees of freedom allow for the generation of polarisation echoes whose temperature dependent amplitude is used as a thermometer in the specific heat experiments. First heating sequences have been recorded using a BK7 glass as sample. We discuss this new technique and preliminary results obtained with it.

DY 30.12 Thu 16:00 Poster C

Thermodynamics of the Levy spin glass — •Katharina Janzen[1], Andreas Engel[1], and Marc Mezard[2] — [1]Uni Oldenburg — [2]Universite Paris Sud, France

We investigate the freezing transition in a mean-field spin glass with Levy-distributed couplings. A regularized model where the coupling constants smaller than some cutoff ϵ are subsumed into a Gaussian random variable can be studied by the replica symmetric (RS) cavity method for diluted spin glasses. Within the RS ansatz we determine the thermodynamic functions of the model and the deAlmeida-Thouless line signaling the breakdown of the RS assumption. Contrary to previous findings, in zero external field we do not find any stable replica-symmetric spin glass phase: the spin glass phase is always a replica-symmetry-broken phase.

DY 30.13 Thu 16:00 Poster C

Investigation of the low frequency dielectric constant of glasses at very low temperatures — •David Dähn, Michel Kinzer, Mihai Petrovici, Masoomeh Bazrafshan, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, Heidelberg, Germany

At temperatures below 1 K the properties of glasses are governed by atomic tunneling systems. Recently Strehlow et al. reported an unexpected magnetic field dependence of the dielectric constant of the non-magnetic glass a-BaO-Al_2O_3-SiO_2 below 5 mK. Furthermore, they observed a discontinuity of the dielectric constant at a temperature of $T = 5.84$ mK. Later, dielectric two-pulse polarisation echo experiments revealed that nuclear quadrupole moments are responsible for the magnetic field dependence of the echo amplitude of non-magnetic glasses.

We investigated the influence of nuclear electric quadrupoles on the low frequency dielectric constant in the limit of very large quadrupole moments. A sample of the glass N-KZFS11, containing 25 mass percent of $^{181}Ta_2O_3$, which carries a very large quadrupole moment, was measured down to $T = 8$ mK using an interdigital capacitor microfabricated on one surface of the planar glass sample. This type of setup combines a large capacitance with a rather small thermal mass and good thermal coupling. In addition, echo experiments were carried out on this sample which surprisingly did not show any magnetic field dependence up to $B = 150$ mT. We discuss whether or not these observations are in conflict with present theories that include the nuclear moments in the standard tunneling model.

DY 30.14 Thu 16:00 Poster C

Measurements of the low-frequency elastic properties of a metallic glass with double paddle oscillators and SQUID based readout — •Marius Hempel, Andreas Reiser, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, Im Neuenheimer Feld 227, 69120 Heidelberg

We investigated the elastic properties of the bulk metallic glass $Zr_{55}Cu_{30}Al_{10}Ni_5$ in the superconducting state.

A double paddle oscillator entirely made of one piece of this bulk metallic glass was fabricated. With this oscillator geometry background damping due to clamping is very small compared to the vibrating reed method. The sample is capacitively driven. A niobium pickup coil micro-fabricated on a silicon chip and connected to the input coil of a SQUID serves as a highly sensitive inductive displacement detector.

We measured the sound velocity and the internal friction at frequencies between 0.5 and 7.5 kHz down to a temperature of 5 mK. We present the experimental results and compare them to theoretical predictions. In particular, the observed temperature dependency of the internal friction is significantly weaker than suggested by the standard tunnelling model, but agrees reasonably well with the behaviour of thin ribbon samples of metallic glasses reported by other authors.

DY 30.15 Thu 16:00 Poster C

What can nuclear magnetic moments reveal about the microscopic nature of tunnelling systems in glasses? — •Masoomeh Bazrafshan, Gudrun Fickenscher, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut Für Physik, Heidelberg

More than thirty years ago anomalies in glasses at low temperatures were successfully explained by introducing atomic tunnelling systems (TS), described by the phenomenological standard tunnelling model. However, the universal behaviour of glasses prevented the experimental investigation of the microscopic nature of these TSs. Recently, unexpected magnetic field effects of the dielectric constant and of the two pulse polarisation echo amplitude, observed in non-magnetic glasses, turned out to be a proper experimental tool to investigate the microscopics of TSs. The echo experiments, done on glycerol and deuterated glycerol, prove that the interaction of nuclear quadrupole moments with local electric field gradients as well as interacting nuclear magnetic dipoles cause the observed magnetic field effects. Interestingly, the magnitude of the echo amplitude variations in magnetic fields is governed by the motion of the TSs. We present the measured effects together with numerical calculations based on the mentioned interactions which enable us to derive details of the TS's microscopic motions in glycerol. These calculations were done without considering dissipative processes acting at finite temperatures and, therefore, are strictly valid only at T=0. An analysis of the measured echo decay at different temperatures suggests that this quantum behaviour is observed, on the time scale of our measurements, at temperatures below 5mK.

DY 30.16 Thu 16:00 Poster C

Thermal conductivity of superconducting bulk metallic glasses at very low temperatures — •Daniel Rotfhuss[1], Uta Kühn[2], Andreas Fleischmann[1], and Christian Enss[1] — [1]Kirchhoff-Institute for Physics, University of Heidelberg, Im Neuenheimer Feld 227, D-69120 Heidelberg, Germany — [2]IFW Dresden, Institute for Complex Materials, P.O. Box 270116, D-01171 Dresden, Germany

Based on new production processes in the technique of casting amorphous metallic alloys a wide range of bulk metallic glasses with various electric and magnetic properties can be produced. Hereby especially superconducting bulk metallic glasses offer several advantages. Particularly with this kind of vitreous material it is possible to probe not only the interaction between tunnelling systems and phonons, but also with electrons by switching between the normal and superconducting state with an external magnetic field. But until now only little is known about the physical properties of these amorphous systems down to millikelvin temperatures.

We present the thermal conductivity of bulk amorphous $Zr_{52.5}Ti_5Cu_{17.9}Ni_{14.6}Al_{10}$ in the superconducting state down to 6mK. Measurements were performed with a SQUID-based contact free technique. Our results show that the thermal conductivity of the sample scales nearly quadratically with temperature. This suggests that far below T_c, the thermal conductivity of this bulk metallic glass can be described well by the thermal diffusion of phonons and their resonant scattering at tunnelling systems.

DY 30.17 Thu 16:00 Poster C

Master Stability Function for time-delayed chaotic networks — •Anja Englert[1], Sven Heiligenthal[1], Wolfgang Kinzel[1], Maria Butkovski[2], Meital Zigzag[2], and Ido Kanter[2] — [1]Institut für Theoretische Physik, Universität Würzburg, 97074 Würzburg — [2]Departement of Physics, Bar-Ilan-University, Ramat-Gan, Israel

Chaos synchronization in a network with time delayed couplings and self-feedbacks plays an important role in secure communication, neural models or chaotic laser systems. The Master Stability Function (MSF) is a well known method to analyse the stability of the synchronization of such a network. We analyse the MSF for Bernoulli networks by using the Schur-Cohn theorem and derive symmetry arguments for the possible appearance of zero lag synchronization. We apply these results to chaotic semiconductor laser systems in simulations using the Lang-Kobayashi equations and present experimental results.

DY 30.18 Thu 16:00 Poster C

Hopf-pitchfork bifurcation as symmetry breaking transition in coupled nonlinear circuits — Martin Heinrich[1], •Thomas Dahms[1], Valentin Flunkert[1], Eckehard Schöll[1], and Stephen W. Teitsworth[2] — [1]Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany — [2]Department of Physics, Duke University, Box 90305, Durham,

North Carolina 27708-0305, USA

We investigate the dynamics of two coupled nonlinear circuit elements with a region of negative differential conductance (NDC), for example tunneling diodes. The NDC-elements are connected in series such that a mean-field coupling is observed. Varying the bifurcation parameter leads to a symmetry breaking transition, where a pitchfork bifurcation splits the symmetric branch of fixed points into a branch within the synchronization manifold and two branches outside of the synchronization manifold. Each branch of the pitchfork bifurcation is surrounded by limit cycles, which are generated by a Hopf bifurcation occurring simultaneously with the pitchfork bifurcation. This codimension-two bifurcation can be destroyed by introducing heterogeneity to the system.

DY 30.19 Thu 16:00 Poster C

Spreading of wave packets in nonlinear disordered chains — •Tetyana Laptyeva[1,2], Charalampos Skokos[1], Dmitry Krimer[1], Joshua Bodyfelt[1], and Sergej Flach[1] — [1]Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, D-01187 Dresden, Germany — [2]Donetsk Institute for Physics and Engineering NASU, R. Luxemburg Str. 72, 83114 Donetsk-114, Ukraine

We consider the spatiotemporal evolution of wave packets in anharmonic disordered chains, in particular, for a wide range of disorder strengths. Previous studies show that Anderson localization is destroyed, and for asymptotically large times the second moment m_2 grows as $m_2 \sim t^{1/3}$ [1, 2]. Extending our analytical approach, we expect that the second moment will spread on intermediate time scales even faster, namely as $m_2 \sim t^{1/2}$, with a crossover to the asymptotic $t^{1/3}$ law at larger times. In order to observe the intermediate fast subdiffusive process, we perform extensive numerical simulations with systematic variations of the disorder strengths, initial wave packet widths, and initial wave packet amplitudes.

[1] S Flach DO Krimer Ch Skokos, Phys. Rev. Lett. **102**, 024101 (2009)

[2] Ch Skokos DO Krimer S Komineas S Flach, Phys. Rev. E **79**, 056211 (2009)

DY 30.20 Thu 16:00 Poster C

Investigating Lyapunov spectra of spatially extended symplectic systems in the continuum limit by means of Langevin-type equations — •Ivan G. Szendro and Holger Kantz — Max-Planck-Institut für Physik Komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany

We study Lyapunov spectra of spatially extended systems with symplectic symmetry in the spatial continuum limit, $\Delta x \to 0$, by means of Langevin-type equations with colored noise. We find that, while the exponents corresponding to the most expanding and contracting directions converge to some finite values, the additional exponents are introduced into the spectrum around zero exponent. This leads to the appearance of an accumulation in the spectral density near zero that diverges in the continuum limit. The results are compared with data obtained for of the forced nonlinear Schrödinger equation.

DY 30.21 Thu 16:00 Poster C

Pattern Formation in Langmuir-Blodgett Transfer Systems — •Michael H. Köpf, Svetlana V. Gurevich, and Rudolf Friedrich — Institute for Theoretical Physics, University of Münster, Wilhelm-Klemm-Straße 9, D-48149 Münster

We present a theoretical investigation of self-organized pattern formation that has been observed during Langmuir-Blodgett transfer of phospholipids onto solid substrates. Two coupled differential equations describing the surfactant density and the height profile of the water subphase are derived within the long-wavelength approximation. If the transfer is carried out in the vicinity of the so-called main transition, the first-order phase transition between the liquid-expanded and the liquid-condensed phase, the interaction with the substrate plays a key role. We model this effect via a height dependent external field in the surfactant free-energy functional. Using transfer velocity and lateral pressure as control parameters a bifurcation from a homogeneous transfer to regular stripe patterns arranged parallel to the contact line is investigated in one and two dimensions. Moreover, in the two-dimensional case a secondary bifurcation to perpendicular stripes is observed in a certain control parameter range.

DY 30.22 Thu 16:00 Poster C

Dynamical multistability in a multimode optomechanical system — •Huaizhi Wu[1,2], Georg Heinrich[1], and Florian Marquardt[1] — [1]LMU, Department of Physics, ASC, CeNS, 80333 München, Germany — [2]Department of Physics, Fuzhou University, 350002 Fuzhou, Fujian, P. R. China

Optomechanical systems couple mechanical motion of macroscopic objects to electromagnetic fields. The standard setup comprises a laser-driven cavity with a movable end-mirror whose motion changes the optical resonance frequency and thus acts back on the light field. Studies of the complex nonlinear dynamics for this system revealed several dynamical attractors due to phase locking between the mechanical oscillations of the mirror and the ringing of the light intensity. Here we study such dynamical multistability for a novel setup where a moveable membrane is placed in the middle between two high-finesse mirrors. The membrane couples two optical modes residing in the left and right half of the cavity, respectively. Its motion is determined by the coupled light-field dynamics that was recently studied elsewhere and shows two-level dynamics such as Autler-Townes splittings and Landau-Zener-Stueckelberg oscillations. Here we discuss the result of these effects on the nonlinear dynamics in terms of the attractor diagram for different parameter regimes. This is the first study of dynamical multistability in one of the exciting new setups with multiple coupled optical (and vibrational) modes that have been developed recently.

DY 30.23 Thu 16:00 Poster C

Modelling brain activity during absence seizures in the framework of neural field equations — •Cornelia Petrovic and Rudolf Friedrich — Inst. für Theoret. Physik, WWU Münster

During different functional states of the brain, neurons in the thalamus fulfill two different important tasks. During periods of wakefulness, they generate tonic series of spiking, thereby enabling the transfer of incoming sensory signals from the periphery to the cerebral cortex. During periods of sleep, however, the same neurons generate rhythmic-oscillatory burst discharges which are synchronized in the thalamocortical network and lead to a dramatic reduction of responsiveness to sensory income. In the electroencephalogram these synchronous discharges are represented by typical sleep waves. Pathological alterations of these mechanisms can lead to epileptic seizures which are associated with reduced consciousness, so-called absence seizures. In the last years several major underlying mechanisms at the molecular level have been identified. In the presented theoretical model we try to bring together those recent molecular experimental (microscopic) results with aspects of well-established (mesoscopic/macroscopic) neural field theories in order to achieve a deeper understanding of the relevance of the different spatio-temporal scales of the brain during the processes of epileptogenesis and seizure generation.

DY 30.24 Thu 16:00 Poster C

Identifying shrimp structures in continuous dynamical systems using recurrence-based methods — Yong Zou[1], •Reik V. Donner[1,2,3], Jonathan F. Donges[1,4], Norbert Marwan[1], and Jürgen Kurths[1,4] — [1]Potsdam Institute for Climate Impact Research, Potsdam, Germany — [2]Max Planck Institute for Physics of Complex Systems, Dresden, Germany — [3]Institute for Transport and Economics, Dresden University of Technology, Germany — [4]Department of Physics, Humboldt University of Berlin, Germany

The identification of some specific periodic islands (so-called shrimps) in the two-dimensional parameter space of certain complex systems has recently attracted considerable interest. While for discrete systems, a discrimination between periodic and chaotic windows can be easily made based on the maximum Lyapunov exponent of the system, this is a challenging task for continuous systems, especially if only short time series are available (e.g., in case of experimental data). In this work, we demonstrate that nonlinear measures based on recurrence plots obtained from such trajectories provide a practicable alternative for numerically detecting shrimps. Traditional diagonal line-based measures of recurrence quantification analysis (RQA) as well as measures from complex network theory are shown to allow a reasonable classification of periodic and chaotic behavior in parameter space. Average path length and clustering coefficient of the resulting recurrence networks are found to be particularly powerful discriminatory statistics for the identification of shrimps in the Rössler system.

DY 30.25 Thu 16:00 Poster C

Using extreme value theory to determine transport statistics of a disordered Hamiltonian system — •Ines Hartwig and Günter Radons — TU Chemnitz, Germany

We combine the treatment of deterministic chaos in Hamiltonian systems with aspects of the theory of disordered systems for a simple two-dimensional twist map.

Motivated by applications from plasma turbulence, we replace the cosine potential of the well-known Chirikov-Taylor standard map by random one-dimensional analytic potentials with spatial disorder but periodic boundaries.

Structures in phase space include nested island hierarchies, chaotic seas and invariant tori. But while each disorder realization has its specific KAM behavior, the ensemble of systems has to be treated statistically. A fundamental domain of controllable size in phase space enables us to investigate the limit of a disordered system of infinite size using extreme value theory. We obtain distributions of critical perturbation amplitudes, which in turn allow us to conclude about transport exponents and fractions of particles actually contributing to unbounded motion.

DY 30.26 Thu 16:00 Poster C

Detecting synchronization in coupled stochastic ecosystem networks — •Nikolaos Kouvaris[1,2], Astero Provata[1], and Dimitris Kugiumtzis[2] — [1]National Center for Scientific Research "Demokritos", 15310 Athens, Greece — [2]Department of Mathematical, Physical and Computational Science, Faculty of Engineering, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

The network under investigation is a spatial 2D lattice which serves as a substrate for Lotka - Volterra dynamics with 3rd order nonlinearities. At the mean field level this system exhibits conservative oscillations. Kinetic Monte Carlo simulations demonstrate that the system spontaneously organizes into a number of asynchronous local oscillators, when only nearest neighbor interactions are considered. In contrast, collective behavior such as global oscillations and synchronization can emerge when introducing different interactivity rules (diffusive or reactive) for nearby and distant species. Instantaneous phase difference, synchronization index and mutual information are considered in order to detect synchronization phenomena that emerge for different levels of diffusive and reactive activity in the stochastic network. The quantitative measures of synchronization show that long distance diffusion coupling induces complete synchronization after a well defined transition, while long distance reaction coupling induces smeared phase synchronization.

DY 30.27 Thu 16:00 Poster C

Stability of delay-coupled Stuart-Landau oscillators — Bernold Fiedler[1], Valentin Flunkert[2], •Philipp Hövel[2], and Eckehard Schöll[2] — [1]Institut für Mathematik I, Freie Universität Berlin, Arnimallee 2-6, D-14195 Berlin, Germany — [2]Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

We study diffusively coupled Stuart-Landau oscillators (Hopf normal forms). By introducing a noninvasive delay coupling we are able to stabilize the inherently unstable anti-phase orbits. For the super- and subcritical case we state a condition on the oscillator's nonlinearity which is necessary and sufficient to find coupling parameters for successful stabilization. We prove these conditions and review previous results on the stabilization of odd-number orbits by time-delayed feedback. Finally, we illustrate the results with numerical simulations.

DY 30.28 Thu 16:00 Poster C

Transient times for Pyragas control of steady states and periodic orbits — •Philipp Hövel, Robert Hinz, and Eckehard Schöll — Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

We investigate the transient behavior for the control of both steady states and periodic orbits by time-delayed feedback. By analytical arguments we relate the transient time to the real part of the leading eigenvalue and Floquet exponent in the case of a fixed point of focus type and supercritical Hopf bifurcation, respectively. We derive an algebraic scaling of the transient time and confirm our findings by numerical simulations in dependence on the control parameters feedback gain and time delay.

DY 30.29 Thu 16:00 Poster C

Optical Feedback Tolerance of Quantum-Dot Compared to Quantum-Well Lasers — •Christian Otto, Kathy Lüdge, and Eckehard Schöll — Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

In experiments quantum-dot (QD) lasers display lower feedback sensitivity than quantum-well (QW) lasers. This advantageous dynamical behaviour is ascribed to their smaller phase-amplitude coupling that is expressed in small linewidth enhancement factors α. In this work we investigate the complex dynamics of both laser types subjected to external optical feedback from a distant mirror. To model the QW laser we use a conventional Lang-Kobayashi model with one equation for the complex field and one equation for the carrier inversion. The QD laser is modeled with a modified Lang-Kobayashi equation for the electric field combined with microscopically based rate equations for the carriers in the quantum dots and the surrounding wetting layer.

By varying the feedback strength we obtain complex bifurcation scenarios. For large $\alpha > 3$ we find bifurcation cascades leading to chaotic regions alternating with short regions of stable continuous wave (cw) operation. However, for low $\alpha < 1$ the model exhibits a reduced feedback sensitivity and performs stable cw operation over a wide range of increasing feedback strength.

By comparison of QW and QD diagrams we find that QD lasers are indeed more tolerant to optical feedback. Furthermore for the same value of α the routes to chaos are different for QD and QW lasers.

DY 30.30 Thu 16:00 Poster C

Floquet Stability Analysis of Memory Difference Control — •David Conal Higgins and Jens Christian Claussen — Institut für Neuro- und Bioinformatik, Universität zu Lübeck

A time discrete version of Pyragas control [1], difference control, was introduced by Bielawski, Derozier and Glorieux [2] and acts in the Poincaré section. It allows stabilization of orbits with Ljapunov number between -3 and -1. Outside of this range, the scheme can be extended by an additional term (MDC, memory difference control) as introduced in [3]. In general, Poincaré-based control schemes may show limitations in the length of the control impulse, which is relevant in the case of difference control [4]. The stability can be analyzed by Floquet theory, giving rise to a special class of delay differential equations. Here we analyze the stability properties of MDC by means of a Floquet stability analysis.

[1] K. Pyragas, Phys. Lett. A 170, 421 (1992)
[2] S. Bielawski, D. Derozier and P. Glorieux, Phys. Rev. A 42, 2492 (1993)
[3] J. C. Claussen, T. Mausbach, A. Piel, H. G. Schuster, Phys. Rev. E 58, 7256 (1998)
[4] J. C. Claussen, New J. Phys. 10, 063003 (2008)

DY 30.31 Thu 16:00 Poster C

Dimensional dependence of delay in simple system with varying delay — •Jian Wang, Hong-Liu Yang, and Günter Radons — Institute of Physics, Chemnitz University of Technology, 09107 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. Due to the fluctuation of the delay time the dimension of the system dynamics collapses. This implies infinite contraction rates thereby leading to diverging Lyapunov exponents. In this study we begin with simple iterated map systems to investigate the influence of fluctuating delay times on the system dimension. For simplicity, the delay time in our system switches between two values t_1 and t_2 periodically. The evolution of the capacity dimension and the relationship between dimension and Lyapunov spectrum are explored. Simple approximations of continuum limits are also investigated and the dimensional dependence is studied.

DY 30.32 Thu 16:00 Poster C

Hysteresis and visible unstable periodic solutions in coupled logistic maps with periodic fluctuating delay — •Jian Wang, Hong-Liu Yang, and Günter Radons — Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany

Delay systems used to model retarded actions are relevant in many fields such as optics, mechanical machining, biology, ecology or physiology. A frequently encountered situation is that the length of the delay time changes with time. With the introduction of varying delay the system dynamic is more complex and new phenomena are obtained. To investigate the influence of varying delay on the dynamics of spatiotemporal system we compare in this study coupled logistic map with periodic fluctuating delay with coupled logistic maps and coupled logistic maps with constant delay. For simplicity, the delay time in our system takes only t_1 and t_2 discrete steps. Some interesting phenom-

ena including hysteresis, defect and visible unstable stationary states are obtained.

DY 30.33 Thu 16:00 Poster C

Modeling the morphogenesis of brine channels in sea ice — Bernd Kutschan[1], •Klaus Morawetz[2,3], and Sibylle Gemming[4] — [1]Ident Technologies GmbH, Rudower Chaussee 29, 12489 Berlin, Germany — [2]University of Applied Science Münster, Stegerwaldstrasse 39, 48565 Steinfurt, Germany — [3]International Center for Condensed Matter Physics, Universidade de Brasília, 70904-910, Brasília-DF, Brazil — [4]Forschungszentrum Dresden-Rossendorf, PF 51 01 19, 01314 Dresden, Germany

Brine channels are formed in sea ice under certain constraints and represent a habitat of different microorganisms. The complex system depends on a number of various quantities as salinity, density, pH-value or temperature. Each quantity governs the process of brine channel formation. There exists a strong link between bulk salinity and the presence of brine drainage channels in growing ice with respect to both the horizontal and vertical planes. We develop a suitable phenomenological model for the formation of brine channels both referring to the Ginzburg-Landau-theory of phase transitions as well as to the chemical basis of morphogenesis according to Turing. It is possible to conclude from the critical wavenumber on the size of the structure and the critical parameters. The theoretically deduced transition rates have the same magnitude as the experimental values. The model creates channels of similar size as observed experimentally. An extension of the model towards channels with different sizes is possible. The microstructure of ice determines the albedo feedback and plays therefore an important role for large-scale global circulation models (GCMs).

DY 30.34 Thu 16:00 Poster C

Generating mechanism for fibrillatory states — •Claudia Lenk[1], Mario Einax[1], J. Michael Koehler[1], and Philipp Maass[1,2] — [1]Institut für Physik, Technische Universität Ilmenau, 98684 Ilmenau, Germany. — [2]Fachbereich Physik, Universität Osnabrück, 49069 Osnabrück, Germany.

Atrial fibrillation is the most common arrhythmia of the heart in the industrial countries. Although it is known since the early 1920s, its underlying mechanisms are still under discussion. We present a theoretical model for the generation of fibrillatory excitation patterns based on the mutual disturbance of two spatially separated pacemakers in the FitzHugh-Nagumo equations. The wavefronts emanating from these pacemakers propagate in regions connected by a small bridge. We find that the structure of the excitation patterns depends significantly on the pacemaker frequencies and the size and shape of the bridge. Irregular fibrillatory states can occur and the degree of irregularity is determined by two independent methods. We furthermore performed new experiments of the Belousov-Zhabotinsky reaction in a silica gel with spatially inhomogeneous catalyst distribution to compare parts of our numerical results with measurements on a real system.

DY 30.35 Thu 16:00 Poster C

A Statistical Model for Turing Patterns in Chemical Reaction Diffusion Systems — •Christian Scholz[1], Klaus Mecke[2], and Gerd E. Schröder-Turk[2] — [1]2. Physikalisches Institut, Universität Stuttgart, Germany — [2]Institut für Theoretische Physik, Universität Erlangen, Germany

The Lengyel-Epstein (LE) model is a system of reaction-diffusion equations, which is widely accepted to reproduce the stationary stripe and hexagonal Turing Patterns observed in the Chlorite-Iodide-Malonic Acid (CIMA) reaction with correct length scales. However the turbulent patterns identified in the CIMA reaction are not reproduced by the LE model. Additionally a morphological analysis via Minkowski functionals, as described in [1], reveals qualitative differences in the functional form of the concentration profiles observed in numerical solutions of the LE model and those observed in the CIMA reaction. Here we present an extended model based on the statistical superposition of basic LE patterns, which reproduces the morphology of stationary and for the first time also turbulent patterns. [1] K. Mecke, Morphological characterization of patterns in reaction-diffusion systems, Phys. Rev. E 53, 4794 (1996)

DY 30.36 Thu 16:00 Poster C

Synchronization of co-rotating scroll waves — •Dennis Kupitz and Marcus Hauser — Otto-von-Guericke-Universität Magdeburg, Abteilung Biophysik, Institut für Experimentelle Physik, Universitätsplatz 2, 39106 Magdeburg, Germany

Scroll waves are the three-dimensional counterparts of spiral waves occurring in excitable media. Single scroll waves may undergo a series of instabilities that play an important role in the formation of cardiac arrhythmias, like ventricular tachycardia. While the dynamics of single scroll waves have attracted some experimental effort, the interaction of scroll waves has so far received much less attention.

We present an experimental study of the interaction of two corotating, meandering scroll waves. They were created in a Belousov-Zhabotinsky reaction medium and observed by optical tomography with a parallel beam technique. The organizing centres of the scrolls, the so-called filaments, were originally straight, and with time deformed to a zig-zag shape. The two filaments interact leading to a synchronization of the dynamics of the scroll waves, which is accompanied by the development of a pronounced twist along the scroll waves. The synchronization yields a stabilized collective motion of the two scroll waves.

DY 30.37 Thu 16:00 Poster C

Soret driven convection in a thermosensitive microgel suspension — •Jürgen Schmied[1], Stephan Messlinger[1], Wolfgang Schöpf[1], Ingo Rehberg[1], Miriam Siebenbürger[2], and Matthias Ballauf[2] — [1]Experimentalphysik V, Universität Bayreuth, 95440 Bayreuth — [2]Institut für Physik, Humboldt-Universität zu Berlin, Unter den Linden 6, 10099 Berlin

We investigate thermal convection in a microgel suspension that consists of core-shell colloids which change their size with temperature. The swelling and shrinking of the particles dramatically modifies the effective volume of the gel fraction and therefore the viscosity of the suspension. In our experiment, we expose a Hele-Shaw convection cell to a constant temperature difference. Due to the relatively large Soret effect of the suspension, a gradient of the colloid concentration is induced, which strongly influences both the onset and the nonlinear behaviour of the thermal convection. The convection patterns are monitored via a shadowgraph setup and also via tracking of single fluorescent tracer particles. We report on the formation and evolution of convection patterns in this thermosensitive suspension.

DY 30.38 Thu 16:00 Poster C

Convection in colloidal suspensions — •Martin Gläßl, Markus Hilt, and Walter Zimmermann — Theoretische Physik I, University of Bayreuth, 95440 Bayreuth, GERMANY

Thermal convection in colloidal suspensions is described by a generalized continuum model for binary fluid mixtures, considering additional terms unaccounted in Boussinesq approximation.

Via the Soret effect an external temperature gradient induces a gradient of the density of particles. Depending on the suspended particles this concentration gradient may lead to spatial variations of the shear viscosity as well as of the thermal conductivity of the mixture. Linear stability analysis shows that both dependencies change the onset of convection. A concentration dependent thermal conductivity may lead, for instance, in a certain range of material parameters to a restabilization of the nonlinear conductive state.

Thermosensitive colloidal particles change their size during the convective motion from warmer to colder volumes in the cell. We describe this behavior by introducing a temperature dependent Lewis number and discuss the resulting effects on convection.

DY 30.39 Thu 16:00 Poster C

Conditional velocity increment statistics in Lagrangian turbulence — •Daniel Schulz, Holger Homann, and Rainer Grauer — Institut für Theoretische Physik I, Ruhr-Universität Bochum, 44780 Bochum

The probability density functions(PDFs) and structure functions of velocity increments, conditioned to the local rate of energy dissipation, are analyzed via direct numerical simulations in the Eulerian frame of reference. As already observed in experiments, the conditioned PDFs are nearly Gaussian, thus intermittency is suppressed.

We transfer this ansatz to the Lagrangian framework and propose a new quantity for conditioning, since here the rate of energy dissipation seems not to be a suitable quantity.

DY 30.40 Thu 16:00 Poster C

A Lagrangian model for the evolution of turbulent magnetic and passive scalar fields — •Thorsten Hater, Holger Homann, and Rainer Grauer — Institut für Theor. Physik I, Ruhr-Universität Bochum

We present an extension of the *Recent Fluid Deformation (RFD)* closure introduced by Chevillard and Meneveau (2006) which was depeloped for modelling the time evolution of Lagrangian fluctuations in incompressible Navier-Stokes turbulence. We apply the RFD closure to study the evolution of magnetic and passive scalar field fluctuations. This comparison is especially interesting since the stretching term for the magnetic field and the passive scalar are similar but differ by a sign such that the effect of stretching and compression by the turbulent velocity field is reversed.

Probability density functions (PDFs) of magnetic and passive scalar field fluctuations using the RFD closure are compared against PDFs obtained from direct numerical simulations.

DY 30.41 Thu 16:00 Poster C

Spiral patterns in wet granular matter under vertical vibrations — Kai Huang, •Frank Gollwitzer, and Ingo Rehberg — Experimentalphysik V, Universitaet Bayreuth, 95440 Bayreuth, Germany

From the evolution of galaxy to hurricane, from the inner structure of sea shell to the cochlea of our inner ears, spirals are widely existing in nature. In the past decades, spiral patterns have been discovered and extensively studied in model systems such as Rayleigh-Bérnard convection, Belousov-Zhabotinksy reactions and various biological systems. Here we report spiral patterns observed in a thin layer of wet granular matter driven by vertical vibrations. In the phase diagram of driven wet granular matter, spirals appear close to a fluid-gas coexistence phase and show hysteresis. The trajectory and rotation velocity of the three-armed spirals are studied as a function of the driving parameters and compared with other model systems.

DY 30.42 Thu 16:00 Poster C

Sublimation of two dimensional wet granular matter under swirling motion — Kai Huang and •Ingo Rehberg — Experimentalphysik V, Universitaet Bayreuth, 95440 Bayreuth, Germany

The dynamical behaviors of two dimensional wet granular matter under swirling motion is studied by experiments. Different from dry granular matter, the cohesion induced by capillary bridges formed between particles tends to keep the wet granular clusters rigid against swirling motion. However, the rigid clusters are not stable: random sublimation and deposition transitions are observed. The transition dynamics and morphological changes of rigid clusters are studied by particle tracking techniques. The mechanism driving the transitions will also be discussed.

DY 30.43 Thu 16:00 Poster C

Mechanical Properties of Wet Granulates — •Somnath Karmakar[1], Martin Brinkmann[2], Stephan Herminghaus[2], Marco Di Michiel[3], Mario Scheel[3], Michael Sipahi[1], and Ralf Seemann[1,2] — [1]Universität des Saarlandes, Saarbrücken, Germany — [2]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [3]ESRF, Grenoble, France

If a wetting liquid is added to dry granulates, the granulate turns into moldable material. This arises due to the formation of liquid capillary bridges and larger liquid clusters between adjacent grains, exerting an attractive force between granules. We study the mechanical properties (i.e. yield stress, critical fluidization and tensile strength) of wet granular materials with different size and for variable liquid contents and wettability. Our experimental results show that the mechanical properties of granulates wetted with a low contact angle liquid are largely independent on the liquid content over a wide range for all the applied mechanical tests. However, in case of a large contact angle liquid, the mechanical properties vary for the various mechanical tests and with the amount of liquid. To understand the mechanical behavior in more detail, we also image the sheared granulates by high speed X-ray micro-tomography.

DY 30.44 Thu 16:00 Poster C

Dynamics of vertically fluidized wet granulates — •Zeina Khan[1], Mario Scheel[2], Marco Di Michiel[2], Ralf Seemann[1,3], and Stephan Herminghaus[1] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]European Synchrotron Radiation Facility, Grenoble Cedex, France — [3]Experimental Physics, Saarland University, Saarbrücken, Germany

When dry granulates are shaken vertically and the peak acceleration exceeds the force of gravity, the grains move irregularly like the molecular motion of a fluid while they remain densely packed. It has been shown that when a fluid is added to the granulate, the critical acceleration at which fluidization occurs increases acutely when compared with the dry case; the material becomes stiffer [1]. Using fast synchrotron X-ray bulk imaging techniques we track the motion of tracer particles embedded in the granular flow and report on the effects of varying the vibration amplitude and wetting content on the resulting velocity statistics and caging dynamics. We also present results from a novel x-ray imaging technique used to determine the three-dimensional motion of tracer particles in a fluidized granulate.

[1]: M. Scheel et al., Nature Materials 7, 189 (2008) .

DY 30.45 Thu 16:00 Poster C

Turbulent fluctuations in the saltation process. Dust emission. — •Marc Lämmel and Klaus Kroy — Institut für Theoretische Physik, Universität Leipzig, PF 100920, 04009 Leipzig, Germany

Transport of granular material in turbulent flows is ubiquitous in nature, e.g. in aeolian sand transport, or dust emissions from arid regions. While the former is crucial for the development of ripples and dunes, the latter plays an important role for our global climate. Based on the efficient and successfull sand transport model by Sauermann et al. [1], we investigate the influence of turbulent fluctuations of the wind on the sand flux. By integrating out these fast turbulent wind velocity fluctuations, we obtain coarse-grained sand transport equations supposed to be more directly applicable to the average quantities typically determined in field and laboratory measurements. The model is further generalized to the sand-induced emission of dust.

[1] G. Sauermann, K. Kroy and H.J. Herrmann, Phys. Rev. E 64, 031305 (2001)

DY 30.46 Thu 16:00 Poster C

Compaction of tetrahedral particles — •Max Neudecker, Stephan Herminghaus, and Matthias Schröter — Max-Planck-Institute for Dynamics and Self-Organisation, Bunsenstr. 10, 37073 Göttingen

Research in granular matter has covered packing problems of spheres extensively, but interest in non-spherical particles (ellipsoids, polyhedra) has risen only recently [1].

In this presentation, we show results of experimentally generated packings of tetrahedral particles, which are prepared by shaking. The range of mechanically stable packings is explored, from the random loose to the random close packing. We use X-Ray-tomography to analyse samples with different packing fractions and present results on their structure.

[1] Torquato, S. , Jiao, Y. Dense packings of the Platonic and Archimedean solids, Nature 460 (2009)

DY 30.47 Thu 16:00 Poster C

Diffusive and subdiffusive axial transport of granular material in rotating mixers — •David Fischer[1], Tilo Finger[1], Frank Angenstein[2], and Ralf Stannarius[1] — [1]Otto-von-Guericke-University Magdeburg — [2]Leibniz Institute for Neurobiology Magdeburg

Binary granular mixtures tend to segregate by size when tumbled in a partially filled, horizontally rotating drum. After a few drum revolutions, the smaller component sinks below the flowing granular surface, forming a submersed radial core. After several dozen revolutions of the drum, the core can split into axial bands. Abnormal diffusion of the grains has been proposed to play an important role in that process [1]. On the other hand, DEM simulations indicate a normal Fickian diffusion in this system [2]. We measure axial diffusion of grains in binary mixtures, completely embedded in water, by means of Nuclear Magnetic Resonance Imaging (MRI). It is found that a narrow pulse of small size particles in a bed of large particles undergoes normal (Fickian) axial diffusion, whereas an initial narrow pulse of large particles in a bed of small particles shows subdiffusive behaviour [3].

[1] Z.S. Khan and S.W. Morris, PRL 94, 048002 (2005)
[2] N. Taberlet and P. Richard, PRE 73, 041301 (2006)
[3] in press PRE

DY 30.48 Thu 16:00 Poster C

Coarsening in granular segregation, an entropic approach — •Tilo Finger[1], Matthias Schröter[2], and Ralf Stannarius[1] — [1]Otto-von-Guericke-University-Magdeburg — [2]MPI for Dynamics and Self-organization Göttingen

Binary mixtures of different sizes or densities tend to segregate under

several conditions of agitation. Segregation by size in a partially filled horizontal rotating drum has become a classical experiment in granular physics. Three types of segregation may occur in a rotating drum. An immediate radial segregation of the large and small particles (within few revolutions) is often followed by an axial segregation into a stripe pattern, on a slower time scale (several hundred revolutions). Subsequently, a coarsening process leads to the dissolution and merging of individual stripes, towards a complete axial demixing of the two particle species [1]. Here we present an X-ray tomography study which indicates that the driving mechanism of this coarsening process might be the increase of configurational entropy [2].

[1] T. Finger et al., PRE 74, 031312 (2006)
[2] S.F. Edwards & R.B.S. Oakeshott, Physica A 157, 1080 (1989)

DY 30.49 Thu 16:00 Poster C

Tailoring the frictional properties of granular media — •Philipp Aurin[1], Sonia Utermann[1,2], and Matthias Schröter[2] — [1]Georg August Universität Göttingen — [2]Max-Planck-Institut für Dynamik und Selbstorganisation

Where the theorist often neglects friction, this most intriguing of granular interactions, the experimentalist cannot, and instead must embrace it. Here, we go a step further and develop a protocol which allows us to use friction between grains as an experimental control parameter. We present two simple chemical etching procedures which alter the rugosity of soda-lime glass spheres: a procedure to smoothen the surface and one to roughen it. The rugosity has an influence on the frictional properties of the grains because it alters the topology and size of the microscopic contacts between grains. We characterise the spheres using atomic force microscopy. Additional underwater angle-of-repose measurements on our etched samples give us a measure of frictional properties in the bulk.

DY 30.50 Thu 16:00 Poster C

The mean free path of photons in granular media — •Sonia Utermann[1,2], Jonathan Kohler[2,3], and Matthias Schröter[2] — [1]Georg August Universität Göttingen — [2]Max-Planck-Institut für Dynamik und Selbstorganisation — [3]Vanderbilt University

Light transport is a powerful tool for probing the dynamics of dense, multiply scattering media. We use it to measure the kinetic granular temperature of a water-fluidised bed of glass spheres. This contribution shows our quest for the necessary light transport length scale: the photon mean free path, l^*. We measure l^* using both transmission and incoherent backscattering and present our results as a function of (a) the packing density of the grains; (b) the size of the grains; (c) their refractive index; and (d) their surface roughness.

DY 30.51 Thu 16:00 Poster C

Granular dam-break inside an inclined rectangular channel — •Christian Kröner, Birte Domnik, and Shiva P. Pudasaini — Steinmann Institut, Universität Bonn

We aim to understand the granular incidents during a dam-break. Therefore the collapse of a granular column inside an inclined rectangular channel was recorded by a high speed camera to calculate the velocity field inside the granular medium. For this purpose, two different methods were utilized: a granular PIV for fine grains and a particle tracking method for coarse grains. We are currently analysing the recorded velocity field to determine the boundary between the resting and the flowing fraction. The temporal evolution of this boundary, together with the velocity profile of the flowing material, will be used to gain a deeper understanding of the rheological behaviour of granular media. In addition to that, the experimental observations will serve as a test case to determine visco-elastic-plastic parameters for numerical simulations.

DY 30.52 Thu 16:00 Poster C

Volume correlations in disk packings — •SongChuan Zhao, Stephan Herminghaus, and Matthias Schröter — Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen,Germany

Particles in packings influence their nearest neighbors e.g by force chains.[1] An open question is how far reaching these interactions are. Here we present an experiment of bi-disperse disks driven by periodical air pulse. Images of packings are taken by a CCD camera. Then we compute the distribution of Voronoi volume and probe for a length scale using the Central Limit Theorem.[2]

[1] T.S. Majmudar, and R.P. Behringer, Nature (2005) **435** 1079
[2] F. Lechenault, F. da Cruz, O. Dauchot, and E. Bertin, J. Stat. Mech. (2006) P07009

DY 30.53 Thu 16:00 Poster C

Nonextensive statistics with application to financial processes from nonlinear stochastic differential equations — Vygintas Gontis, Julius Ruseckas, Aleksejus Kononovicius, Miglius Alaburda, and •Bronislovas Kaulakys — Institute of Theoretical Physics and Astronomy, Vilnius University, A. Gostauto 12, LT-01108 Vilnius, Lithuania

Starting from the multiplicative point process and nonlinear stochastic models of $1/f$ noise and power-law distributions [1] we present nonlinear stochastic differential equations generating processes with the q-exponential and q-Gaussian distributions of the observables with the long-range power-law autocorrelations and $1/f^{\beta}$ noise [2]. Further we analyze properties of solutions of these equations in relation with the superstatistical approach [3] and relevance of the generalized and adapted equations for modeling of the financial processes [4].

[1] B. Kaulakys and M. Alaburda, J. Stat. Mech. P02051 (2009).
[2] V. Gontis, B. Kaulakys, and J. Ruseckas, AIP Conf. Proc. **1129**, 563 (2009).
[3] B. Kaulakys, M. Alaburda, V. Gontis, and J. Ruseckas, Brazilian J. Phys. **39**, 456 (2009).
[4] V. Gontis, J. Ruseckas, and A. Kononovicius, Physica A **389**, 100 (2010).

DY 31: Statistical Physics far from Equilibrium

Time: Friday 10:15–13:00 Location: H38

Topical Talk DY 31.1 Fri 10:15 H38

Real-time transport and dynamics in strongly interacting one-dimensional systems — •Fabian Heidrich-Meisner — LMU Munich, Germany

The question of ballistic and diffusive dynamics in one-dimensional systems has a long history, both for classical and quantum systems. In the quantum case, there exist several examples such as heat transport in Heisenberg chains where integrability renders transport anomalous giving rise to ballistic behavior even at finite temperatures. While most studies have focussed on the linear response regime [1], in this talk, I will address similar questions for systems driven out of equilibrium. Using the time-dependent DMRG technique, a particular set-up is used, namely the expansion of wave-packets in either a zero [2] or finite background density [3]. The former is relevant for transport experiments on bulk materials such as low-dimensional quantum magnets whereas the latter can be directly studied with ultracold atoms in optical lattices. I will argue that this set-up allows us to identify ballistic and diffusive time regimes, depending on model parameters and initial conditions [3]. The models under scrutiny comprise spin chains and the 1D Hubbard model as well as perturbations around these two integrable limits. I shall further emphasize emergent non-equilibrium phenomena and discuss the behavior of the entanglement entropy [2].

[1] Heidrich-Meisner et al., EPJ Spec. Topics 151, 135 (2007)
[2] Heidrich-Meisner et al., Phys. Rev. A 80, 041603(R) (2009)
[3] Langer et al., Phys. Rev. B 79, 214409 (2009)

DY 31.2 Fri 10:45 H38

Generalized Clausius inequality for non-quasistatic quantum processes — •Sebastian Deffner and Eric Lutz — Universität Augsburg, D-86135 Augsburg, Germany

We sharpen the Clausius inequality for the irreversible entropy production of a quantum system arbitrarily far from equilibrium by introducing a positive, process dependent lower bound. We express the latter in terms of the Bures distance, a quantum information theoretic measure of distinguishability, between the nonequilibrium and the corresponding equilibrium density operators of the system. As an illustration, we evaluate the entropy production and the Bures distance for an analytically solvable model, namely the time-dependent

harmonic oscillator.

DY 31.3 Fri 11:00 H38

Revealing deviations from the fluctuation theorem — •Aljoscha Hahn[1] and Holger Then[2] — [1]Institut für theoretische Physik, Technische Universität Berlin, 10623 Berlin, Germany — [2]Institut für Physik, Carl von Ossietzky Universität, 26111 Oldenburg, Germany

Together with the Jarzynski relation, Crook's Fluctuation Theorem (CFT) is one of the main new theoretical results of statistical physics of irreversible processes, relating the probability of work necessary to realize a certain nonequilibrium process with that of the time-reversed process. Although it is in principle possible to test the CFT experimentally by measuring an amount of of work-values in either direction, the "verification" of the CFT becomes quite hard if the process is far from equilibrium, and the interpretation of the experiments with respect to the CFT using standard arguments (e.g. based on histograms) may remain suspicious.

Within the talk, we present a new and precise tool for testing the CFT on a given amount of experimental data which is strongly related to free-energy calculation. As key features, the method tells us simultaneously whether the amount of data collected is sufficient to make a statement on the CFT at all and whether the hypotheses that the CFT holds has to be rejected. On the other hand, if we a priori know that the CFT holds, which can be the case e.g. in computer experiments, the method can be used to detect systematic errors of the experimental setup.

DY 31.4 Fri 11:15 H38

Suppression of thermally activated escape by heating — •Sebastian Getfert and Peter Reimann — Universität Bielefeld, Fakultät für Physik, 33615 Bielefeld, Germany

The problem of thermally activated escape over a potential barrier is solved by means of path integrals for one-dimensional reaction dynamics with very general time-dependences. For a suitably chosen, but still quite simple static potential landscape, the net escape rate may be substantially reduced by temporally increasing the temperature above its unperturbed, constant level [1].

[1] S. Getfert and P. Reimann, Phys. Rev. E 80, 030101(R) (2009)

DY 31.5 Fri 11:30 H38

Anisotropic Phase Transition in a two-dimensional Ising model with friction — •Sebastian Angst, Alfed Hucht, and Dietrich E. Wolf — Fakultät für Physik, Universität Duisburg-Essen, D-47057 Duisburg

Magnetic friction is a field of raising interests. Magiera et al. [1] modeled a moving tip above a substrate consisting of Heisenberg spins. Magnetic friction in an Ising model has recently been introduced by Kadau et al.[2], and Hucht [3] investigated thermodynamic properties of this system.

Here two layers of Ising spins, displaced by one lattice constant, are moved relative to each other along an axis. Due to the directed motion the correlations behave differently in direction parallel and perpendicular to the motion. Using Monte Carlo methods it is shown, that the system becomes strongly anisotropic and thus the correlation length diverges with different exponents when reaching criticality. For infinite velocity we determine the correlation length exponents and demonstrate, that the system behaves mean field-like.

[1] M.P. Magiera et al., EPL 87, 26002 (2009)
[2] D. Kadau et al., Phys. Rev. Lett. 101, 137205 (2008)
[3] A. Hucht, Phys. Rev. E 80 (in press), arXiv:0909.0533

DY 31.6 Fri 11:45 H38

Interfacial tension in a fluid-gas coexistence of wet granular matter — •Klaus Röller and Stephan Herminghaus — MPI for Dynamics and Self-Organization, Bunsenstr. 10, D-37073 Göttingen, Germany

We report on simulations of fluid-gas coexistence in agitated wet granular matter [1,2]. Event-driven molecular dynamics type simulations were performed in three dimensions to study the dependence of the excess energy of the fluid-gas interface ('surface tension') upon the external driving. The surface tension was determined by applying a time-constant but spatially periodic shear force in the direction normal to the interface, and measuring the corresponding elongation of the initially flat interface [3]. The knowledge of the surface tension was then used to estimate an effective granular viscosity using a deterministic version of the Edwards-Wilkinson equation. An initial sinusoidally elongated configuration of the fluid interface was therefore dynamically relaxing back to its (flat) stationary state with minimal interfacial area. We found that both the surface tension and the granular viscosity are decreasing as the driving energy [2] of the external drive is increased. This result can be viewed as the non-equilibrium analogue to the known dependence of these two physical quantities to temperature in equilibrium statistical physics.

[1] S. Herminghaus Advances in Physics **5**4, 221 (2005)
[2] A. Fingerle, et al., New J. Phys. **1**0, 053020 (2008)
[3] K. Roeller, et al., Chaos **1**9, 041106 (2009)

DY 31.7 Fri 12:00 H38

Molecular dynamics simulation of excitation and relaxation kinetics of ionic subsystem in swift heavy ion's track — •Vladimir Lipp[1] and Alexander Volkov[2] — [1]Fachbereich Physik, Universität Kaiserslautern, Erwin-Schrödinger-Straße, D-67663 Kaiserslautern, Germany — [2]Russian Research Centre Kurchatov Institute, Kurchatov Sq. 1, Moscow, 123182, Russia

Computer simulation of solid argon was performed to check the validity of the classical temperature diffusion approach for short-time kinetics in swift heavy ions (SHI) tracks. Cylindrical symmetry of the SHI track was assumed. The excitation was propagating from the center to surroundings of the system. The time which the system needs to reach local equilibrium was estimated by analyzing entropy behavior and by the comparison of local kinetic temperature and configuration temperature [1] at certain distances from the center of the SHI track. In addition, spatial-temporal propagation of the excitation was compared with that predicted by classical parabolic heat conduction equation.

[1] Powles, J. G., Rickayzen, G. and Heyes, D. M.(2005)'Temperatures: old, new and middle aged', Molecular, Physics,103:10,1361-1373.

DY 31.8 Fri 12:15 H38

Dynamic crack propagation of icosahedral quasicrystals — •Tian You Fan — Department of Physics, Beijing Institute of Technology

Based on the Landau-Anderson symmetry-breaking princple on condensed matter, theory of elasticity of quasicrystals is developed, in which the two elementary excitations–phonon and phason play a central role. Elasticity and other mechanical behaviour of quasicrystals are connected close to the defects, among them dislocations and cracks are observed. The study of dynamic crack propagation is interesting in particular. The present work uses the elato-/hydro-dynamic model of quasicrystals and discusses the response of crack to the impact force and the crack fast propagation of icosahedral Al-Pd-Mn quasicrystals, the comparison of the results to those of decagonal Al-Ni-Co quasicrystals is given. The results show the effects of phason and phason-phonon coupling to the resonse and propagation, the effects are more important than that in static cases.

Invited Talk DY 31.9 Fri 12:30 H38

Noise controlled transport in constrained geometries — •Fabio Marchesoni — Dipartimento di Fisica, Universita' di Camerino, I-62032 Camerino, Italy

Diffusive transport of particles or, more generally, small objects, is a ubiquitous feature of physical and chemical reaction systems [1]. In configurations containing confining walls or constrictions, transport is controlled both by the fluctuation statistics of the jittering objects and the phase space available to their dynamics. Consequently, the study of transport at the macro- and nanoscales must address both Brownian motion and entropic effects [2].

We report on recent advances in the theoretical and numerical investigation of stochastic transport occurring either in microsized geometries of varying cross sections or in narrow channels wherein the diffusing particles are hindered from passing each other (single-file diffusion). For particles undergoing biased diffusion in static suspension media enclosed by confining geometries, transport exhibits intriguing features such as 1) a decrease in nonlinear mobility with increasing temperature and 2) a broad excess peak of the effective diffusion above the free diffusion limit [1]. If, in addition, the suspension medium is subjected to external, time-dependent forcing, rectification of the diffusing Brownian particles sets on, at times with anomalous negative mobility.

[1] P. Hänggi and F. Marchesoni, Rev. Mod. Phys. 81, 387 (2009)
[2] P. S. Burada, P Hänggi, F.Marchesoni, G.Schmid, P. Talkner, ChemPhysChem 10, 45 (2009)

DY 32: Fluid Dynamics

Time: Friday 10:15–12:30 Location: H47

DY 32.1 Fri 10:15 H47

Supersonic Air Flow due to Solid Object Impact — •Stephan Gekle[1], Ivo Peters[1], Jose Manuel Gordillo[2], Devaraj van der Meer[1], and Detlef Lohse[1] — [1]Physics of Fluids, University of Twente, The Netherlands — [2]Mecanica de Fluidos, Universidad de Sevilla, Spain

A solid object impacting on liquid creates a liquid jet due to the collapse of the impact cavity. Using visualization experiments with smoke particles and multiscale simulations we show that in addition a high-speed air-jet is pushed out of the cavity. Despite an impact velocity of only 1 m/s, this air-jet attains *supersonic* speeds already when the cavity is slightly larger than 1 mm in diameter. The structure of the air flow resembles closely that of compressible flow through a nozzle – with the key difference that here the "nozzle" is a *liquid* cavity shrinking rapidly in time.

DY 32.2 Fri 10:30 H47

Maximizing torque transmission in magneto-rheological clutches — •Hanna Lagger, Claas Bierwisch, and Michael Moseler — Fraunhofer Institut für Werkstoffmechanik IWM, Freiburg, Germany

Typical magneto-rheological fluids (MRF) consist of micron-sized magnetically permeable particles (mostly iron) dispersed in carrier oil. MRF are increasingly being considered in variety of devices such as shock absorbers, vibration insulators, brakes or clutches. The activation of an external magnetic field causes a fast and dramatic change in the apparent viscosity of the MRF contained in the clutch. Chains of magnetized particles are formed between the two inner surfaces of the clutch within a few milliseconds. The flow properties of the MRF change from liquid to solid and, thus, render large torque transmission possible.

In this study, numerical simulations based on the discrete element method (DEM) are used to model magneto-rheological clutches. Magnetic and mechanical interactions among particles and between the particles and the surface of the clutch are implemented.

For different volume fractions of the suspension, we investigate the influence of inter-particle-friction, particle-surface-friction and the external magnetic field on the torque transmission. Mechanisms that may lead to the breaking of the chains of the magnetic particles under high shear stresses are discussed.

DY 32.3 Fri 10:45 H47

Characteristics of water jet reflection on superhydrophobic surfaces in experiment and theory — •Sören Kaps[1], Rainer Adelung[1], Srdjan Milenkovic[2], and Achim Walter Hassel[2] — [1]Functional Nanomaterials, Technical Faculty, University of Kiel, Kaiserstr. 2, 24143 Kiel, Germany — [2]Institute for Chemical Technology of Inorganic Materials, Johannes Kepler University, Altenbergerstr. 69, 4040 Linz, Austria

After impinging onto superhydrophobic surfaces water jets are observed to flow along for a distance equal to several jet diameters before they are jumping off the surface under an angle that is close to or smaller than the angle of incidence. To understand this effect the reflection of water jets on different surfaces with varying jet parameters was investigated. The reflection mechanism can be described by a mathematical model which assumes the total energy of the system as constant. The speed of the conversion of kinetic energy to surface energy and vice versa can be calculated for different wetting condition parameters. Parameters included in this theory are the surface roughness, interfacial energies as well as diameter, speed, and angle of the incident water jet. Variation of these parameters shows how the characteristics of the reflection changes and where the limits of water jet reflection are.

DY 32.4 Fri 11:00 H47

Convection and Mixing in a nanometer-thin membrane — •Markus Abel[1], Michael Winkler[1], Guggi Kofod[1], Rumen Krstev[2], and Silke Stöckle[3] — [1]Universität Potsdam, Institut für Physik und Astronomie — [2]NMI Naturwissenschaftliches und Medizinisches Institut an der Universität Tübingen — [3]Max-Planck-Institut für Kolloid- und Grenzflächenforschung

We investigate experimentally the convection and resulting mixing properties in a very thin membrane positioned vertically. Due to local heating or cooling a convection pattern can be created. The convection can be followed by optical tracking of the film thickness by means of interference finges. We consider the mixing properties of the motion and the related transport of the relevant physicla quantities.

DY 32.5 Fri 11:15 H47

Oscillation dynamics of soap bubbles — Ulrike Kornek[1], Kirsten Harth[1], •Ralf Stannarius[1], Andreas Hahn[2], and Lutz Tobiska[2] — [1]Otto-von-Guericke-Universität Magdeburg, Institut für Experimentalphysik — [2]Institut für Analysis und Numerik

Oscillations of fluid spheres in fluid environment have been extensively studied since the 19^{th} century. By high-speed video imaging, we investigate oscillations of soap bubbles with radii of 1 cm and more. The gases inside and outside the bubbles contribute to the oscillations, whereas the inertia of the membrane can be neglected. Initial states are prepared by fusion of two spherical bubbles. During the experiment the bubbles float on a layer of butane. The surface tension of the soap films drives damped oscillations from the initial states into the equilibrium sphere shape.

Shapes in each image are expanded in cylinder symmetric spherical harmonics, considered as the eigenmodes of the linearised system [1]. From time dependent amplitudes of these modes we analyse the frequencies and damping constants, as well as anharmonic behavior of the modes and test the predictions of various analytical and numerical models. In addition, we solve the Navier-Stokes equations by means of a finite elements algorithm with moving boundaries and compare the results with experimental data.

[1] Sir H. Lamb, *Hydrodynamics*, Cambridge University Press (1932), p. 473 *ff.*

DY 32.6 Fri 11:30 H47

A phase field description of Rayleigh-Taylor instability with evaporation — •Rodica Borcia and Michael Bestehorn — Lehrstuhl Statistische Physik/ Nichtlineare Dynamik, Brandenburgische Technische Universität Cottbus, Germany

We investigate numerically a thin liquid film under gravity effects on the underside of a cooled horizontal plate. Initially, the flat liquid film is in equilibrium with its own vapor in the gas phase below. If the free surface of the thin film is deflected around the values where the two phases are in equilibrium, thicker parts evaporate and thinner parts condensate. In this way, evaporation/condensation could be used to stabilize the Rayleigh-Taylor instability and to obtain regular structuring of the film surface [1]. Our aim is to study the Rayleigh-Taylor instability using the phase field model. 2D computer simulations are performed in order to visualize the streamlines in each bulk phase and to achieve a better understanding of the stabilization role of evaporation.

[1] M. Bestehorn, D. Merkt, Phys. Rev. Lett. **97** (2006) 127802.

DY 32.7 Fri 11:45 H47

Contact Angle Evaluation in Phase Field Simulations — •Ion Dan Borcia, Rodica Borcia, and Michael Bestehorn — Lehrstuhl für Theoretische Physik II, Brandenburgische Technische Universität Cottbus, Germany

The phase field method is a good tool for investigating fluid systems when complicated interfaces are present. For the point of view of numerical implementation a great advantage of the method is to avoid complicated boundary conditions when the interfaces are allowed to deform. In order to describe the interfaces, gradient terms of the phase field are included in the free energy functional. A study of static and dynamic contact angles is possible by including the solid-liquid interactions into the boundary conditions on the solid substrate. Due to the fact that the phase field model works with diffuse interfaces, determination of static or dynamic contact angles is not obvious. Some solutions for this problem and preliminary results will be presented.

DY 32.8 Fri 12:00 H47

Global Solutions and Dynamics for a modified Navier-Stokes Equation — •Tobias Grafke and Rainer Grauer — Theoretische Physik I, Ruhr-Universität Bochum

One of the outstanding open problems in classical fluid dynamics is

the possible existence of finite time singularities in the incompressible Navier-Stokes or Euler equations. To get further insight into the difficulties of the problem, a hydrodynamical model closely related to the Navier-Stokes equation but with a slightly modified pressure term will be presented. Existence, uniqueness and regularity of its solutions are shown. In addition to these findings numerical simulations of its turbulent behaviour were performed to confirm that this new model has dynamic properties lying inbetween Navier-Stokes and Burgers turbulence and can be described with a She-Leveque like model.

DY 32.9 Fri 12:15 H47

Stability and disintegration of liquid sheets — •Bernhard Heislbetz — DLR Lampoldshausen, Institut für Raumfahrtantriebe, D-74239 Hardthausen, Germany

The primary mechanism of liquid sheet disintegration is the growth of small disturbances on the initial flat surface of a free liquid sheet. These disturbances generate wavy structures i.e. symmetric or antisymmetric wave modes on the surfaces of the liquid sheet which increase and cause a periodical separation of ligament structures. The disintegration mechanism itself depends on various miscellaneous hydrodynamic and geometric control parameters. Thus theoretical investigations are necessary to narrow the parameter space and give a better understanding of the influence of these parameters on the fragmentation process of the liquid sheet. Therefore we present a stability analysis for liquid sheets moving with a constant velocity through a gaseous atmosphere. The analysis includes the derivation of dispersion relations for highly viscous Newtonian and non-Newtonian fluids. The non-Newtonian fluids were modelled as power-law fluids to incorporate the rheological properties and viscosity characteristic of shear-thinning liquids. We show numerical solutions related to the wave modes and determine the most unstable growth rates and the corresponding critical wave lengths as well as the sheet breakup length of both kinds of fluids.

DY 33: Nonlinear Dynamics II

Time: Friday 10:45–12:30 Location: H46

DY 33.1 Fri 10:45 H46

Control of phase separation in binary mixtures — •Alexei Krekhov, Vanessa Weith, and Walter Zimmermann — Physikalisches Institut, Universität Bayreuth, D-95440 Bayreuth, Germany

The results on new effective mechanisms to create periodic stripe patterns during the phase separation process in binary mixture will be presented. Pattern selection mechanism operating in the process of phase separation under directional quenching will be discussed. It will be demonstrated that the wavelength of periodic stripe patterns is uniquely selected by the velocity of quench interface. Theoretical analysis of phase separation in the presence of spatially periodic forcing will be presented. In this case stripe patterns with the periodicity slaved to the externally imposed one can be stabilized against coarsening above some critical modulation amplitude. The results will be compared with the experiments on thermal patterning in polymer blends. Another possibility to create regular structures in the phase-separating binary mixture by adding Janus particles will be discussed. It will be shown that due to a novel type of dynamic interparticle interaction equally oriented Janus particles form a periodic array of interfaces. The results might promote the development of tools to fabricate regular structures in material science and gain better insight into the basic mechanisms to control the spontaneous pattern formation processes in other nonequilibrium systems.

DY 33.2 Fri 11:00 H46

Correlations in complex nonlinear systems and quantum information theory — •Otfried Gühne[1] and Tobias Galla[2] — [1]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, A-6020 Innsbruck, Austria — [2]School of Physics and Astronomy, The University of Manchester, Manchester M13 9PL, UK

The dynamical evolution of classical complex systems such as coupled logistic maps or simple models of lattice gases and cellular automata can result in correlations between distant parts of the system. For the understanding of these systems, it is crucial to develop methods to characterize and quantify these multi-party correlations.

On the other hand, the study of correlations between distant particles is also a central problem in the field of quantum information theory. There, correlations are often viewed as a resource and many tools have been developed for their characterization. In this talk, we will explore the extent to which the tools from quantum information can be applied to study classical complex systems and whether they allow to study complex systems from a different perspective.

DY 33.3 Fri 11:15 H46

Directing Brownian Motion on a Periodic Surface by Spontaneous Symmetry Breaking — •David Speer[1], Ralf Eichhorn[2], and Peter Reimann[1] — [1]Universität Bielefeld, Fakultät für Physik, 33615 Bielefeld, Germany — [2]NORDITA, Roslagstullsbacken 23, 10691 Stockholm, Sweden

We consider an overdamped Brownian particle, exposed to a two-dimensional, square lattice potential and a rectangular ac drive. Depending on the driving amplitude, the linear response to a weak dc force along a lattice symmetry axis consist in a mobility in basically any direction. In particular, motion exactly opposite to the applied dc force may arise. Upon changing the angle of the dc force relatively to the square lattice, the particle motion remains predominantly opposite to the dc force. The basic physical mechanism consists in a spontaneous symmetry breaking of the unbiased deterministic particle dynamics [1].

[1] D. Speer et al, Phys. Rev. Lett. 102, 124101 (2009)

DY 33.4 Fri 11:30 H46

Diagrammatic semiclassical laser theory — •Oleg Zaitsev[1] and Lev Deych[2] — [1]Physikalisches Institut der Universität Bonn, Nußallee 12, 53115 Bonn, Germany — [2]Physics Department, Queens College of City University of New York, Flushing, NY 11367, U.S.A.

We derive semiclassical laser equations valid in all orders of nonlinearity. With the help of a diagrammatic representation, the perturbation series in powers of electric field can be resummed in terms of a certain class of diagrams. The resummation makes it possible to take into account a weak effect of population-inversion pulsations in a controlled way, while treating the nonlinearity exactly. The proposed laser theory reproduces the all-order nonlinear equations in the approximation of constant population inversion and the third-order equations with population-pulsation terms, as special cases. The theory can be applied to arbitrarily open and irregular lasers, such as random lasers.

DY 33.5 Fri 11:45 H46

Dynamics of Janus particles in a phase-separating binary mixture — •Vanessa Weith, Alexei Krekhov, and Walter Zimmermann — Theoretische Physik I, Universität Bayreuth, 95440 Bayreuth, Germany

Adding particles to a binary mixture induces an interesting dynamic coupling between the wetting of the particles and the phase separation of the mixture. Recently a new class of colloidal particles, so-called Janus particles, have been synthesized in large quantities [1]. Janus particles, named after the Roman god Janus, represent colloids with a different chemical composition of the surface of the two halves of a particle. Accordingly each half of a particle may be wetted preferentially by one component of the mixture.

We present the results of numerical simulations of the dynamics of Janus particles immersed in a phase-separating binary mixture based on a mean-field approach. When the two constituents of a binary mixture wet the two sides of a Janus particle differently, the particle induces a spatial variation of the concentration in their neighborhood. Accordingly, Janus particles in phase separating mixtures are trapped to interfaces, which leads to a complex dynamics.

Due to the strong localization of an interface, the diffusion of Janus particles is much more pronounced compared with isotropic particles. As a result of this fast diffusion the Janus particles placed initially at large distances may effectively approach each other and they can remain coupled in the case of an appropriate orientation.

[1] A. Walther and A. H. E. Müller, Soft Matter 4, 663-668 (2008)

DY 33.6 Fri 12:00 H46

Mobility enhances synchronization — Fernando Peruani[1], Ernesto M. Nicola[2], and •Luis G. Morelli[3,4] — [1]CEA-Service de Physique de l'Etat Condense', Centre d'Etudes de Saclay, 91191 Gif-sur-Yvette, France — [2]IFISC (CSIC-UIB), Campus Universitat Illes Balears, E-07122 Palma de Mallorca, Spain — [3]Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany — [4]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

When coupled oscillators hold fixed positions in space, local interactions can drive the organization of spatial and temporal patterns, as for instance in the cardiac tissue. A different situation occurs when the oscillators are not fixed in space but are able to move around. We study synchronization of locally coupled noisy phase oscillators which move diffusively in a one-dimensional ring. We show that together with the disordered and the globally synchronized states, the system also exhibits several wave-like states which display local order. We use a statistical description valid for a large number of oscillators to show that for any finite system there is a critical spatial diffusion above which all wave-like solutions become unstable. Through Langevin simulations, we show that the transition to global synchronization is mediated by the relative size of attractor basins associated to wave-like states. By disrupting these states, spatial diffusion paves the way for the system to attain global synchronization. Our theoretical framework allows for an interpretation of recent experiments with small porous particles that behave as individual chemical oscillators.

DY 33.7 Fri 12:15 H46

Phase space focusing in dissipative driven elliptical billiards — Christoph Petri[1], •Florian Lenz[1], Fotis Diakonos[2], and Peter Schmelcher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg — [2]Department of Physics, University of Athens, GR-15771 Athens, Greece

It is known that the driven elliptical billiard exhibits Fermi acceleration. Here, we demonstrate that due to the introduction of dissipation the acceleration of an ensemble of particles is present during a transient regime only, asymptotically, the energy will saturate, even for very small dissipation rates. The saturation value can be tuned by adjusting the parameters of the system, like the dissipation rate, the driving amplitude or frequency, appropriately. The presence of dissipation causes the emergence of attractors and limit cycles on which the particles get focused in their evolution. By introducing surface roughness at certain regions of the elliptical boundary, specific attractors and limit cycles can be destroyed, thus allowing to populate for example just a single attractor of interest.