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

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Overview of Invited Talks and Sessions

(lecture rooms HÜL 386, ZEU 118, ZEU 255 and WIL B321; Poster P1A and P1B)

Plenary Talk

The plenary talk related to the division DY by Prof. P. Hänggi takes place Monday, 8:30, HSZ 01.
See the plenary section for title and abstract.

Prize Talk

The prize talk (Gentner-Kastler-Prize) by Prof. T. Geisel takes place Tuesday, 13:00, HSZ 01.
See the plenary section for title and abstract.

Invited Talks

DY 1.1	Mon	10:15–10:45	HÜL 386	**Heat transfer on the nanometer scale — Near-field thermal scanning microscopy** — •Achim Kittel
DY 4.1	Mon	14:00–14:30	HÜL 386	**Mechanisms of tissue maintenance: a laboratory for statistical physics** — •Benjamin Simons
DY 7.1	Tue	9:30–10:00	HÜL 386	**Statistical Mechanics of sytems with long range interactions.** — •David Mukamel
DY 10.1	Tue	14:00–14:30	HÜL 386	**Self-Dynamics of a Slender Rod** — •Thomas Franosch
DY 14.1	Wed	9:45–10:15	HÜL 386	**Turbulent convective transport - news and challenges** — •Siegfried Grossmann
DY 14.5	Wed	12:00–12:30	HÜL 386	**Towards a quantum Church-Turing Theorem** — •Reinhard F. Werner
DY 15.1	Wed	14:00–14:30	HÜL 386	**Time-reversed waves and super-resolution** — •Mathias Fink
DY 20.1	Thu	9:30–10:00	HÜL 386	**Magnetic granular matter: from lattices to self-assembled swimmers** — •Igor Aranson, Alexey Snezhko, Maxim Belkin, Wai Kwok
DY 23.1	Thu	14:00–14:30	HÜL 386	**Work and Fluctuation Theorems for quantum systems** — •Peter Talkner

Focused Session "50 years DY: Trends in dynamics and statistical physics"

Organization: H. Kantz (MPIPKS Dresden), K. Richter (Universität Regensburg)
(Opening address at 9:30, HÜL 386.)

DY 14.1	Wed	9:45–10:15	HÜL 386	**Turbulent convective transport - news and challenges** — •Siegfried Grossmann
DY 14.2	Wed	10:15–10:45	HÜL 386	**What's up in quantum chaos?** — •Roland Ketzmerick
DY 14.3	Wed	11:00–11:30	HÜL 386	**Non-equilibrium work and fluctuation theorems** — •Andreas Engel
DY 14.4	Wed	11:30–12:00	HÜL 386	**Computational Statistical Physics** — •Wolfhard Janke
DY 14.5	Wed	12:00–12:30	HÜL 386	**Towards a quantum Church-Turing Theorem** — •Reinhard F. Werner

Focused Session "Pattern formation in colloidal and granular systems"

Organization: M. Schröter, S. Herminghaus (MPIDS Göttingen), H. Löwen (Heinrich-Heine-Universität Düsseldorf)

DY 20.1	Thu	9:30–10:00	HÜL 386	**Magnetic granular matter: from lattices to self-assembled swimmers** — •Igor Aranson, Alexey Snezhko, Maxim Belkin, Wai Kwok
DY 20.2	Thu	10:00–10:30	HÜL 386	**Non-equilibrium aggregates in confined systems of self-propelling colloidal rods** — •Rik Wensink, Hartmut Löwen
DY 20.3	Thu	10:30–11:00	HÜL 386	**Beyond Faraday's crispations: nonlinear patterns of shaken granular material** — •Christof Kruelle
DY 20.4	Thu	11:15–11:45	HÜL 386	**Archimedean-like Tilings on Decagonal Quasicrystalline Surfaces** — •Clemens Bechinger, Jules Mikhael, Laurent Helden
DY 20.5	Thu	11:45–12:15	HÜL 386	**Injection in a confined granular suspension: from the Saffman-Taylor fingering instability up to flow inside a weakly jammed granular matrix.** — Christophe Chevalier, Anke Lindner, Oeistein Johnson, •Eric Clement
DY 20.6	Thu	12:15–12:45	HÜL 386	**Pattern Formation in Colloids Induced by Shear Flow and Electric Fields.** — •Jan Dhont, Kyongok Kang, Pavlik Lettinga

Invited Talks of joint symposia with other divisions

Symposium: "Anderson localization in nonlinear and many-body-systems (SYAL)"

See SYAL for the full program of the symposium

SYAL 1.1	Mon	14:00–14:30	BAR SCHÖ	**Delocalization by nonlinearity and interactions in systems with disorder** — •Dima Shepelyansky
SYAL 1.2	Mon	14:30–15:00	BAR SCHÖ	**Absence of Diffusion in a Fröhlich-Spencer-Wayne model for nonlinear random systems** — •Serge Aubry
SYAL 1.3	Mon	15:00–15:30	BAR SCHÖ	**Anderson localization and nonlinearity in disordered photonic lattices** — •Yaron Silberberg
SYAL 1.4	Mon	15:30–16:00	BAR SCHÖ	**Many Body Localization** — •Boris Altshuler
SYAL 1.5	Mon	16:00–16:30	BAR SCHÖ	**Localized states and interaction induced delocalization in Bose gases with quenched disorder** — •Thomas Nattermann
SYAL 1.6	Mon	16:30–17:00	BAR SCHÖ	**Single-particle and many-body Anderson localizations with Bose-Einstein condensates** — •Laurent Sanchez-Palencia

Symposium: "Transport in graphene (SYTG)"

See SYTG for the full program of the symposium

SYTG 1.1	Tue	14:00–14:30	BAR SCHÖ	**The nature of localization in graphene under quantum Hall conditions** — •Jurgen Smet
SYTG 1.2	Tue	14:30–15:00	BAR SCHÖ	**Electronic Transport in Graphene Nanostructures** — •Thomas Ihn, Christoph Stampfer, Johannes Güttinger, Francoise Molitor, Stephan Schnez, Arnhild Jacobsen, Klaus Ensslin
SYTG 1.3	Tue	15:00–15:30	BAR SCHÖ	**Spins and valley-spins in graphene nanostructures** — •Inanc Adagideli
SYTG 1.4	Tue	15:30–16:00	BAR SCHÖ	**Theory of ballistic transport in graphene** — •Bjoern Trauzettel

Symposium: "Self-organizing surfaces and interfaces (SYSO)"

See SYSO for the full program of the symposium

SYSO 1.1	Wed	14:00–14:30	BAR SCHÖ	**Pattern formation in epitaxial growth and ion beam erosion** — •Thomas Michely
SYSO 1.2	Wed	14:30–15:00	BAR SCHÖ	**Patterns and Pathways in Far-from-equilibrium Nanoparticle Assemblies** — •Philip Moriarty, Andrew Stannard, Emmanuelle Pauliac-Vaujour, Matthew Blunt, Chris Martin, Ioan Vancea, Uwe Thiele
SYSO 1.3	Wed	15:00–15:30	BAR SCHÖ	**Block-Copolymer Derived Inorganic Functional Materials** — •Ullrich Steiner

SYSO 2.1	Wed	15:45–16:15	BAR SCHÖ	**Crystallisation of polymers at surfaces and in thin films** — •Günter Reiter
SYSO 2.2	Wed	16:15–16:45	BAR SCHÖ	**Active Organisation of Cell Surface Molecules by Cortical Actin** — Kripa Gowrishankar, Debanjan Goswami, Subhasri Ghosh, Abhishek Chaudhuri, Bhaswati Bhattacharya, Satyajit Mayor, •Madan Rao
SYSO 2.3	Wed	16:45–17:15	BAR SCHÖ	**Phase Behaviour and Dynamics in Lipid Mixtures** — •Peter Olmsted

Symposium: "Data analysis in complex systems (SYCS)"

See SYCS for the full program of the symposium

SYCS 1.1	Fri	10:15–11:00	BAR SCHÖ	**Eat, Drink, and Be Merry: The Spread of Health Phenomena in Complex, Longitudinally Resolved Social Networks** — •Nicholas Christakis
SYCS 1.2	Fri	11:00–11:30	BAR SCHÖ	**Transport efficiency and resilience in mycelial networks** — •Mark Fricker, Daniel Bebber, Lynne Boddy
SYCS 1.3	Fri	11:30–12:00	BAR SCHÖ	**From genetic variability between species to the inference of protein-protein interactions** — •Martin Weigt, Robert A. White, Hendrik Szurmant, James A. Hoch, Terrence Hwa
SYCS 1.4	Fri	12:00–12:30	BAR SCHÖ	**Clustering and multiscale structure of graphs** — •Boaz Nadler
SYCS 1.5	Fri	12:30–13:00	BAR SCHÖ	**Clustering, chance, and statistical mechanics** — Marta Luksza, Michael Lässig, •Johannes Berg
SYCS 1.6	Fri	13:00–13:30	BAR SCHÖ	**Physics of recommendation mechanisms** — •Yi-Cheng Zhang

Sessions

DY 1.1–1.9	Mon	10:15–13:00	HÜL 386	**Statistical physics I (general)**
DY 2.1–2.8	Mon	11:00–13:00	ZEU 255	**Statistical physics in biological systems I (joint session DY/BP)**
DY 3.1–3.8	Mon	11:00–13:00	ZEU 118	**Nonlinear dynamics, synchronization and chaos I**
DY 4.1–4.9	Mon	14:00–16:45	HÜL 386	**Statistical physics in biological systems II (joint session DY/BP)**
DY 5.1–5.8	Mon	14:45–16:45	ZEU 255	**Soft matter**
DY 6.1–6.8	Mon	14:45–16:45	ZEU 118	**Critical phenomena and phase transitions**
DY 7.1–7.12	Tue	9:30–13:00	HÜL 386	**Statistical physics II (general)**
DY 8.1–8.8	Tue	10:00–12:40	WIL B321	**Glasses I (joint session DY/DF)**
DY 9.1–9.9	Tue	10:15–12:45	ZEU 255	**Nonlinear dynamics, synchronization and chaos II**
DY 10.1–10.7	Tue	14:00–16:00	HÜL 386	**Brownian motion and transport I**
DY 11.1–11.6	Tue	14:00–16:00	WIL B321	**Glasses II (joint session DY/DF)**
DY 12.1–12.48	Tue	14:30–16:30	P1A	**Poster I**
DY 13.1–13.4	Tue	14:45–15:45	ZEU 255	**Statistical physics III (general)**
DY 14.1–14.5	Wed	9:30–12:30	HÜL 386	**Focused Session: 50 years DY: Trends in dynamics and statistical physics**
DY 15.1–15.7	Wed	14:00–16:00	HÜL 386	**Quantum chaos I**
DY 16.1–16.12	Wed	14:45–18:00	ZEU 255	**Fluid dynamics I**
DY 17.1–17.8	Wed	14:45–16:45	ZEU 118	**Reaction-diffusion systems**
DY 18.1–18.9	Wed	16:15–18:45	HÜL 386	**Granular matter / contact dynamics**
DY 19.1–19.4	Wed	17:00–18:00	ZEU 118	**Quantum dynamics, decoherence and quantum information**
DY 20.1–20.6	Thu	9:30–12:45	HÜL 386	**Focused Session: Pattern formation in colloidal and granular systems**
DY 21.1–21.10	Thu	10:15–13:00	ZEU 255	**Quantum chaos II**
DY 22.1–22.10	Thu	10:15–13:00	ZEU 118	**Brownian motion and transport II**
DY 23.1–23.7	Thu	14:00–16:00	HÜL 386	**Statistical physics far from thermal equilibrium**
DY 24.1–24.8	Thu	14:45–16:45	ZEU 255	**Pattern formation in colloidal and granular systems I**
DY 25.1–25.7	Thu	14:45–16:30	ZEU 118	**Fluid dynamics II**
DY 26.1–26.40	Thu	16:00–18:00	P1A	**Poster II**
DY 27.1–27.24	Thu	16:00–18:00	P1B	**Poster II**
DY 28.1–28.11	Fri	10:15–13:15	HÜL 386	**Pattern formation in colloidal and granular systems II**

DY 29.1–29.11	Fri	10:15–13:15	ZEU 255	**Statistical physics of complex networks**
DY 30.1–30.12	Fri	10:15–13:15	ZEU 118	**Nonlinear stochastic systems**

Annual General Meeting of the Dynamics and Statistical Physics Division

Thursday 18:30–19:30 HÜL 386

Tagesordnung:

- Bericht des Fachverbandsleiters
- Tagungsnachlese
- Wahl eines neuen Fachverbandsleiters und Stellvertreters
- Verschiedenes

DY 1: Statistical physics I (general)

Time: Monday 10:15–13:00 Location: HÜL 386

Invited Talk DY 1.1 Mon 10:15 HÜL 386

Heat transfer on the nanometer scale — Near-field thermal scanning microscopy — •Achim Kittel — Institute of Physics, University of Oldenburg, Carl-von-Ossietzky Str. 9-11, 26129 Oldenburg, Germany

Every body at a finite temperature emits heat radiation. Beside the propagating modes there exist evanescent modes which only can contribute to the heat transfer on short distances. Their contribution to the total heat transfer overcomes the one of the propagating modes at distances well below one micrometer between two bodies. Understanding the evanescent modes and the physics of the electromagnetic fluctuations at the nanometer scale will help to understand the coupling between nanoscale particles. The new possibilities of scanning probe microscopy offer experimental access to investigate these phenomena. Heat transfer mediated by the evanescent modes is detected by means of a modified scanning tunneling microscope (STM), whose tip is functionalized as a coaxial thermocouple with dimensions in the range of a few hundred nanometers. During the measurements the temperature of the sample can be reduced to about 110K or raised to 350K while the tip holder is kept at room temperature. By this means, the heat transfer between the cooled or heated sample and the tip can be measured while scanning over the surface at the tunnel distance. By retracting the tip from the surface the heat transfer in dependence on the distance can be studied. Methods of the experiment will be introduced and results of the measurements are presented and compared to model calculations.

DY 1.2 Mon 10:45 HÜL 386

Critical Casimir force for films in the crossover between various surface universality classes — •Thomas Friedrich Mohry[1,2], Anna Maciołek[1,2], and Siegfried Dietrich[1,2] — [1]Max-Planck-Institut für Metallforschung, Heisenbergstraße 3, 70569 Stuttgart, Germany — [2]Universität Stuttgart, Institut für Theoretische und Angewandte Physik, Pfaffenwaldring 57, 70569 Stuttgart, Germany

The critical Casimir force and the order-parameter profiles in thin films belonging to the Ising universality class are studied field theoretically, focusing on the crossovers between various surface universality classes. The corresponding universal scaling functions are calculated within mean-field theory. For both the crossover between the normal and the special transition and for the crossover between the normal and the ordinary transition, the scaling function of the critical Casimir force exhibits a rich structure, such as the emergence of several extrema. Depending on the choice of the surface properties, as described by surface fields or surface enhancement parameters, the critical Casimir force can change its sign once or twice by varying the temperature. A simple relation between the sign of the force and the values of the order-parameter at the surfaces and in the bulk is presented. The results are relevant for colloidal systems in the presence of a critical solvent and for wetting films near critical end points.

DY 1.3 Mon 11:00 HÜL 386

Critical Casimir Forces in Strongly Anisotropic Systems — •Matthias Burgsmüller and Hans Werner Diehl — Fachbereich Physik, Universität Duisburg-Essen, D-47048 Duisburg, Germany

Strongly anisotropic systems are considered in a d-dimensional film geometry. Such systems involve two (or more) distinct correlation lengths ξ_β and ξ_α that scale as nontrivial powers of each other: i.e. $\xi_\alpha \sim \xi_\beta^\theta$ with $\theta \neq 1$. Thus two fundamental orientations, $\perp$ and $\parallel$, for which the surface normal is oriented along an α or β direction must be distinguished. The confinement of critical fluctuations caused by the film's boundary planes is shown to induce effective forces $\mathcal{F}_C$ that decay as $\mathcal{F}_C \approx -(\partial/\partial L)\Delta_{\perp,\parallel}\, L^{-\zeta_{\perp,\parallel}}$ as a function of film thickness L, where the decay exponents $\zeta_{\perp,\parallel}$ and Casimir amplitudes $\Delta_{\perp,\parallel}$ differ for $\perp$ and $\parallel$ orientation. To corroborate these findings, n-vector models with an m-axial bulk Lifshitz point are investigated by means of RG methods below the upper critical dimension $d^*(m) = 4+m/2$ under various boundary conditions. The exponents $\zeta_{\perp,\parallel}$ are determined, and explicit results to one or zeroth loop order are presented for several Casimir amplitudes $\Delta_{\perp,\parallel}$.

DY 1.4 Mon 11:15 HÜL 386

Ultrafast Converging Path Integral Approach for Rotating Ideal Bose Gases — •Antun Balaž[1], Ivana Vidanović[1], Aleksandar Bogojević[1], and Axel Pelster[2,3] — [1]Scientific Computing Laboratory, Institute of Physics Belgrade, Serbia — [2]Fachbereich Physik, Universität Duisburg-Essen, Germany — [3]Institut für Theoretische Physik, Freie Universität Berlin, Germany

Recently, we have developed an efficient recursive approach for analytically calculating the short-time expansion of the propagator to extremely high orders for a general many-body quantum system [1]. Here we apply this technique for numerically studying the thermodynamical properties of a rotating ideal Bose gas of ^{87}Rb atoms in an anharmonic trap [2]. First, the energy spectrum of the system is obtained by diagonalizing the discretized short-time propagator. Then the condensation temperature and the time-of-flight absorption pictures are calculated for varying rotation frequencies. The obtained results improve previous semiclassical calculations [3] and agree well with Path Integral Monte Carlo simulations [4].

[1] A. Balaž, A. Bogojević, I. Vidanović, A. Pelster, `arXiv:0806.4774`
[2] V. Bretin, S. Stock, Y. Seurin, J. Dalibard, *PRL* **92**, 050403 (2004)
[3] S. Kling, A. Pelster, *PRA* **76**, 023609 (2007)
[4] D. M. Ceperley, *Rev. Mod. Phys.* **67**, 279 (1995)

15 min. break.

DY 1.5 Mon 11:45 HÜL 386

Quench Dynamics of Harmonically Trapped Free Bosons — •Oliver Gabel[1] and Axel Pelster[1,2] — [1]Institut für Theoretische Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Fachbereich Physik, Universität Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg, Germany

Within the path-integral formulation of density matrices we calculate the effect of a sudden quench of the trap frequency for N harmonically confined free bosons which are, originally, in thermal equilibrium. In order to derive the corresponding reduced one-particle density matrix, we explicitly integrate out $N-1$ irrelevant degrees of freedom in the N-particle density matrix. This yields a difference equation for the non-equilibrium contributions of the respective permutation cycles. Finally, we discuss the resulting explicit expressions in view of the emerging collective oscillations.

DY 1.6 Mon 12:00 HÜL 386

Dispersion of matter waves in gaussian disorder potentials — •Christian J. Harrer, Christopher Gaul, and Cord A. Müller — Universität Bayreuth, Germany

We wish to determine the effective dispersion relation of matter waves in disorder potentials by diagrammatic perturbation theory [1]. While conventional perturbation theory truncates the self energy at finite order, the recently developed momentum average method (MA) [2] approximates each diagram of the self energy series but retains all orders and all diagrams so that the whole asymptotic series is represented rather accurately. We use this idea for matter waves in gaussian correlated disorder [3] and, using Borel summation and related techniques, obtain an analytical result for the self energy, which allows to calculate the mean free path in good agreement with numerical results.

[1] R.C. Kuhn et al., NJP 9, 161 (2007)
[2] M. Berciu, PRL 97, 36402 (2006)
[3] M. Hartung et al., PRL 101, 020603 (2008)

DY 1.7 Mon 12:15 HÜL 386

Arbitrary rotation invariant random matrix ensembles and supersymmetry — •Mario Kieburg and Thomas Guhr — Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

The supersymmetry method is an essential tool for studies in random matrix theory and mesoscopic physics. Recently, this method was generalized from Gaussian ensembles to arbitrary rotation invariant matrix ensembles in two different approaches, the generalized Hubbard-Stratonovitch transformation [J.Phys. A39 (2006) pp. 13191] and the superbosonization formula [Commun. Math. Phys. 283 (2008) pp. 343]. In this presentation, we will demonstrate connections and differences of both approaches and their results for all symmetry classes of O(N), U(N) and USp(N) rotation invariance.

DY 1.8 Mon 12:30 HÜL 386

Variational Methods with and without Replicas for a Zero-Dimensional Disorder Model — •Markus Düttmann[1], Jürgen Dietel[1], and Axel Pelster[1,2] — [1]Institut für Theoretische Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Fachbereich Physik, Universität Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg, Germany

We analyze the stationary probability distribution of the Smoluchowski equation for an overdamped harmonic oscillator in a random potential with three analytic approximation methods. A standard method for tackling such a zero-dimensional disorder problem is the replica method [1]. However, the replica-symmetric solution breaks down for sufficiently small temperatures. Improved results are obtained by the replica symmetry breaking approach which was originally developed by Giorgio Parisi to treat spin-glass systems. Furthermore, we work out another variational approach, which does not rely on replicas and involves the temperature as a variational parameter. All three analytical approximation methods are compared with numerical results from Monte-Carlo simulations.

[1] A. Engel, Nucl. Phys. B **410**, 617 (1993)

DY 1.9 Mon 12:45 HÜL 386

Geometric Characterization of Phase Transitions in the Lipkin-Meshkov-Glick Model — •Daniel Scherer, Michael Kastner, and Cord Müller — Physikalisches Institut, Universität Bayreuth, Germany

At least two decades ago people have begun to realize that matter can be macroscopically ordered in ways that do not fit into the framework of the Ginzburg-Landau paradigm for classical degrees of freedom. Since the discoveries of high-temperature superconductivity and the quantum Hall effect, novel aspects such as quantum phase transitions and topological order have become the focus of both theoretical and experimental efforts. On the theoretical side, several quantities have been proposed to trace signatures of such exotic phase transitions and to characterize the physics within those phases. One of these approaches is given by the so called fidelity metric. This is a Riemannian metric on the state space of a quantum system, that might allow for a common description of both Ginzburg-Landau and topological order independently of knowledge, or even existence, of a local order parameter. We apply this approach to the Lipkin-Meshkov-Glick Model exhibiting conventional (Ginzburg-Landau) order at finite temperature. We obtain the fidelity metric for ordered and disordered phases in the isotropic model and show that in this case the metric can be expressed completely in terms of the free energy. Finally we point out similarities with Ruppeiner geometry.

DY 2: Statistical physics in biological systems I (joint session DY/BP)

Time: Monday 11:00–13:00 Location: ZEU 255

DY 2.1 Mon 11:00 ZEU 255

Segregation and long-range order in self-propelled particles with nematic interactions — •Markus Bär[1], Hugues Chate[2], Andreas Deutsch[3], Francesco Ginelli[2,4], and Fernando Peruani[4] — [1]Physikalisch-Technische Bundesanstalt, Berlin — [2]CEA Saclay, France — [3]ZIH, TU Dresden — [4]ICS Paris

Motivated by experiments on collective dynamics of gliding bacteria, we study collective phenomena in a two-dimensional stochastic system of self-propelled particles (SPP) interacting locally through an apolar, nematic alignment mechanism. Extensive simulations show that there are four qualitatively different regions of spatial organisation. At high noise intensity, disordered spatially homogeneous distributions are found, while at low noise intensity long-range nematic order is found. For intermediate noises and large enough system size, the system segregates into macroscopic areas with either high or very low particle density. The high density areas take the form of bands that can take on stable straight shapes or can be dynamically changing depending on the size of the system, band width and noise intensity.

DY 2.2 Mon 11:15 ZEU 255

Transport on inhomogeneous filament networks — •Philip Greulich and Ludger Santen — Fachrichtung Theoretische Physik, Universität des Saarlandes, 66041 Saarbrücken, Germany

We present a model for intracellular vesicle transport on submembranal actin networks. These networks are created by stochastic growth dynamics of actin filaments leading to an inhomogeneous structure. The dynamics of vesicles are implemented by an interplay of active transport on filaments and diffusion in the cytosol, while steric interactions of vesicles are taken into account. One observes the formation of vesicle clusters in a wide range of parameter space. We investigate the distribution of cluster sizes and compare these results to a system without filaments but attractive interactions between vesicles.

DY 2.3 Mon 11:30 ZEU 255

Stochastic models for efficient intracellular transport — •Maximilian Ebbinghaus and Ludger Santen — Department of Theoretical Physics, Saarland University, 66041 Saarbruecken

Intracellular transport along microtubules is bidirectional although single motor proteins such as kinesin or dynein perform stochastic motion in a single direction. For several diseases, the breakdown of the bidirectional transport is known to be pathologic. It is thus of great importance to understand how cells organize their transport system in an efficient way and which influences might interfere. We approach this question by numerically examining one-dimensional lattice gas models with multiple filaments in parallel on which we assume hard core exclusion. Further particle-particle interactions are introduced in order to observe lane formation, i.e. filaments that are occupied by a single type of molecular motor. In this way, we find different transport regimes with highly different transport capacities. The surrounding cytoplasm is modeled by further tracks on which particles do not interact and perform undirected diffusion. This very simplified model of the cytoplasm is compared with the results of a model with similar dynamics on the filaments but in a three-dimensional cylinder.

DY 2.4 Mon 11:45 ZEU 255

Statistical mechanics description of the process of polypeptides and proteins folding — •Alexander Yakubovich, Ilia Solov'yov, Andrey Solov'yov, and Walter Greiner — Frankfurt Institute of Advanced Studies, Goethe—Universität Frankfurt, Ruth-Moufang Straße 1, D-60438 Frankfurt am Main, Germany

The conformational transitions in finite molecular systems, i.e. the transition from a stable 3D molecular structure to a random coil state or vice versa (also known as (un)folding process) occur or can be expected in many different complex molecular systems and in nano objects, such as polypeptides, proteins, polymers, DNA, fullerenes, nanotubes. Experimental studies of the recent years reveal new detailed mechanisms of such nanoscale transitions and challenge the development of new theoretical models for the description of these complex processes. We suggest a theoretical method based on the statistical mechanics for treating the helix↔random coil transition in polypeptides. We consider this process as a first-order phase transition in a finite system and develop a theory which is free of model parameters and is based solely on fundamental physical principles. It describes essential thermodynamical properties of the system such as heat capacity, the phase transition temperature and others from the analysis of the polypeptide potential energy surface calculated as a function of two dihedral angles, responsible for the polypeptide twisting. The developed formalism is extended for the description of helix↔coil transition in solvent. We also provide a recipe for the theoretical description of the folding↔unfolding processes in proteins.

DY 2.5 Mon 12:00 ZEU 255

Protein folding dynamics in a simplified 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, Cambridge, UK

The study of all-atom protein folding dynamics is usually restricted to conformations close to the native state as it requires significant computational efforts and its force fields may not be accurate for unfolded structures. Coarse-grained models are therefore of great interest to capture essential features of the free energy landscape. We employ the tube model [1], describing a protein as a chain of uniform thickness with bending rigidity, and a bias towards the native structure to investigate protein folding dynamics from completely unfolded to folded native structure. The structural bias is based on a one-dimensional representation of the structure (structure profile) which is conceptually very different from the use of the contact map as in Gō-models. Unlike Gō-models, which favour the formation of contacts between specific residues, our approach mediates 'connectivity' of residues, that, much like hydrophobicity, describes a residue's propensity to have many contacts. We show that the 'effective connectivity' profile [2] constitutes a suitable bias towards the native structure and explore the free energy landscape and folding dynamics of this model [3].

[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 2.6 Mon 12:15 ZEU 255

Funnels in energy landscapes — •Konstantin Klemm[1], Christoph Flamm[2], and Peter Florian Stadler[1,2] — [1]Bioinformatics Group, Leipzig University, Germany — [2]Theoretical Chemistry Group, University of Vienna, Austria

Local minima and the saddle points separating them in the energy landscape are known to dominate the dynamics of biopolymer folding. Here we introduce a notion of a folding funnel that is concisely defined in terms of energy minima and saddle points, while at the same time conforming to a notion of a folding funnel as it is discussed in the protein folding literature.

DY 2.7 Mon 12:30 ZEU 255

Selectively accessible paths in fitness landscapes — •Jasper Franke and Joachim Krug — Institut für Theoretische Physik, Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany

A mutation of an organism's genome changing one nucleotide in the DNA has a higher probability of becoming fixed in the population if it increases the mutant's degree of adaptation to the environment (it's 'fitness'). A sequence of mutations that each increase the fitness of the respective mutant therefore forms a selectively accessible trajectory in the (generally very high-dimensional) space of sequences. This concept of accessible paths plays an important role in determining the possible configurations that can be reached starting from a given position in the sequence space.

Since the mapping from genotype to fitness is rather intricate and only partially understood, the fitness landscape can be modelled as a random landscape with a certain amount of correlation between the fitness values of different genotypes. The NK- Modell introduced by Kauffman was used to generate this family of fitness landscapes with tunable degree of correlation and thus tunable ruggedness.

In this talk, we present numerical results on the statistics of the selectively accessible paths in these fitness landscapes depending on the ruggedness.

DY 2.8 Mon 12:45 ZEU 255

A simple model for stress reactions in cellular regulation — •Andreas Ruttor[1], Guido Sanguinetti[2], Cedric Archambeau[3], and Manfred Opper[1] — [1]Technische Universität Berlin, Germany — [2]University of Sheffield, UK — [3]University College London, UK

Microarray experiments show that some cells can quickly respond to external stimuli, e.g. sudden environmental changes, by switching between different regulatory regimes. This stress reaction is achieved by activating a transcription factor, which changes the transcription rates of certain proteins. We present a simple model for such a bistable regulatory system. Production and degradation of mRNA and proteins are described by differential equations, as their concentrations change continuous in time. But we assume that there are only two possible states for the transcription factor, either active or inactive. Therefore its activity, which is difficult to observe in microarray experiments, is modelled as a random telegraph process. We find that this stochastic process can be reconstructed using only noisy measurements of the mRNA concentrations at discrete points in time. Our solution to this problem is based on calculating effective jump rates for the hidden activity of the transcription factor. This can be done by using the backward Chapman-Kolmogorov equation directly or an efficient approximate algorithm. Afterwards it is possible to estimate the time evolution of the posterior process and parameters of the regulatory system. Simulation results indicate that our approach works well.

DY 3: Nonlinear dynamics, synchronization and chaos I

Time: Monday 11:00–13:00 Location: ZEU 118

DY 3.1 Mon 11:00 ZEU 118

Loading the Dice — •Jan Nagler[1] and Peter H. Richter[2] — [1]MPI DS, Göttingen & Georg-August-Univ. Göttingen, Germany — [2]Universität Bremen, Germany

Dice tossing is commonly believed to be random. However, throwing a fair cube is a dissipative process well described by deterministic classic mechanics. In [Phys. Rev. E 78, 036207 (2008); see also Research Highlights, Nature 455, p. 434 (2008)] we proposed a simplified model in order to analyze the origin of the pseudorandomness: A barbell with two marked masses at its tips with only two final outcomes. In order to keep things simple, we focused on the symmetrical case of equal masses. Here, we complete the picture by considering the general asymmetric case of unequal masses. We show how, depending on initial conditions, dissipation during bounces, and mass asymmetry, the degree of unpredictability varies. Our analysis reveals for our dice throwing model the effect of dice loading.

DY 3.2 Mon 11:15 ZEU 118

Floquet stability analysis of Ott-Grebogi-Yorke and difference control — •Jens Christian Claussen — Neuro-und Bioinformatik, U zu Lübeck — Theoret. Phys. & Astrophys., CAU Kiel

For stabilization of instable periodic orbits of nonlinear dynamical systems two classes of methods exist: time-continuous control schemes based on Pyragas, and the two Poincaré-based chaos control schemes, Ott-Grebogi-Yorke (OGY) and difference control. Difference control [1] is a control scheme that is especially interesting for drifting parameter conditions [2]. In this contribution [3] a new stability analysis of these two Poincaré-based chaos control schemes is given by means of the Floquet theory. This approach allows to calculate exactly the stability restrictions occurring for small measurement delays and for an impulse length shorter than the length of the orbit. This is of practical experimental relevance; to avoid a selection of the relative impulse length by trial and error, it is advised to investigate whether the used control scheme itself shows systematic limitations on the choice of the impulse length. To investigate this point, a Floquet analysis is performed [3]. For OGY control the influence of the impulse length is marginal. As an unexpected result, difference control fails when the impulse length is taken longer than a maximal value that is approximately one half of the orbit length for small Ljapunov numbers and decreases with the Ljapunov number [3].

[1] S Bielawski D Derozier P Glorieux, Phys. Rev. A 47, 2492 (1993)
[2] JC Claussen T Mausbach A Piel HG Schuster, PRE 58, 7256 (1998)
[3] JC Claussen New Journal of Physics 10, 063006 (2008).

DY 3.3 Mon 11:30 ZEU 118

Evolutionary phase space and its impact on Fermi acceleration in the driven elliptical billiard — •Florian Lenz[1], Christoph Petri[1], Florian N. R. Koch[1], Fotis K. Diakonos[2], and Peter Schmelcher[1,3] — [1]Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg, Germany — [2]Department of Physics, University of Athens, GR-15771 Athens, Greece — [3]Theoretische Chemie, Physikalisch-Chemisches Institut, Universität Heidelberg, Im Neuenheimer Feld 229, 69120 Heidelberg, Germany

We perform the first long-time exploration of the classical dynamics of a driven billiard with a four dimensional phase space. The latter is shown to evolve with increasing velocity of the ensemble from a large chaotic sea with a rich structures of stickiness due to regular islands to a phase space consisting of thin velocity channels of diffusive motion that allow for acceleration and are bounded in the three remaining dimensions by large regular regions. As a surprising consequence, we encounter a crossover from amplitude dependent tunable subdiffusion to universal normal diffusion in momentum space. This crossover is traced back to the mentioned change of the structural composition of phase space with varying velocity. Since with increasing collision number an ensemble of particles accelerates, it effectively "sees" an evolutionary phase space which we analyze and understand in depth.

DY 3.4 Mon 11:45 ZEU 118

Compactons in Strongly Nonlinear Lattices — •Karsten Ahnert and Arkady Pikovsky — Universität Potsdam, Institut für Physik und Astronomie, Karl-Liebknecht-Strasse 24/25, 14476 Potsdam-Golm, Germany

We study localized traveling waves and chaotic states in strongly nonlinear one-dimensional Hamiltonian lattices. A specific realization of such a system might be the Hertz lattice that describes elastically interacting hard balls. We show that the solitary waves are strongly localized compactons, and present an accurate numerical method allowing to find them for an arbitrary nonlinearity index. Compactons evolve fromrather general initially localized perturbations and collide nearly elastically, nevertheless on a long time scale for finite lattices an extensive chaotic state is generally observed.

DY 3.5 Mon 12:00 ZEU 118

Spreading of wavepackets in one dimensional disordered chains - I. Different dynamical regimes — •Charalampos Skokos, Sergej Flach, and Dmitry Krimer — Max Planck Institute for the Physics of Complex Systems, Nothnitzer Str. 38, D-01187 Dresden, Germany

We present numerical results for the spatiotemporal evolution of a wavepacket in quartic Klein-Gordon (KG) and disordered nonlinear Schrödinger (DNLS) chains, having equivalent linear parts. In the absence of nonlinearity all eigenstates are spatially localized with an upper bound on the localization length (Anderson localization). In the presence of nonlinearity we find three different dynamical behaviors depending on the relation of the nonlinear frequency shift δ (which is proportional to the system's nonlinearity) with the average spacing $\overline{\Delta\lambda}$ of eigenfrequencies and the spectrum width Δ ($\overline{\Delta\lambda} < \Delta$) of the linear system. The dynamics for small nonlinearities ($\delta < \overline{\Delta\lambda}$) is characterized by localization as a transient, with subsequent subdiffusion (regime I). For intermediate values of the nonlinearity, such that $\overline{\Delta\lambda} < \delta < \Delta$ the wavepackets exhibit immediate subdiffusion (regime II). In this case, the second moment m_2 and the participation number P increase in time following the power laws $m_2 \sim t^{\alpha}$, $P \sim t^{\alpha/2}$. We find $\alpha = 1/3$. Finally, for even higher nonlinearities ($\delta > \Delta$) a large part of the wavepacket is selftrapped, while the rest subdiffuses (regime III). In this case P remains practically constant, while $m_2 \sim t^{\alpha}$.

DY 3.6 Mon 12:15 ZEU 118

Spreading of wavepackets in one dimensional disordered chains- II. Spreading mechanisms — •Dmitry Krimer, Sergej Flach, and Charalampos Skokos — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, D-01187 Dresden, Germany

As is discussed in the first part of this presentation, there are three different types of the evolution of a wavepacket in discrete disordered nonlinear Schrödinger and anharmonic oscillator chains: I) localization as a transient, with subsequent subdiffusion; II) the absence of the transient and immediate subdiffusion; III) selftrapping of a part of the packet, and subdiffusion of the remainder. Here we focus on the mechanisms that explain subdiffusive spreading of the wavepacket which is due to weak but nonzero chaotic dynamics inside the packet. Chaos is a combined result of resonances and nonintegrability. As a result the mode outside the packet is heated by the packet nonresonatly. We estimate the number of resonant modes in the packet and study the nature of resonant mode pairs by performing a statistical numerical analysis. The predicted second moment of the packet is increasing as $t^{1/3}$ which is in a good agreement with our numerical findings.

DY 3.7 Mon 12:30 ZEU 118

Nonlinear interaction in musical instruments — •Markus Abel — Universität Potsdam, Institut für Physik und Astronomie, Germany

Nonlinearities and nonlinear interactions are intrinsic to sound production let aeroacoustical let mechanical. We present very accurate experiments and corresponding theory on the sound production mechanism and the musical implications of nonlinear effects.

DY 3.8 Mon 12:45 ZEU 118

Dynamik und Struktur von Lyapunov-Vektoren in räumlich ausgedehnten chaotischen Systemen — •Ivan Georg Szendro Terán[1], Diego Pazó[2], Miguel Ángel Rodríguez[2] und Juan Manuel López[2] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [2]Instituto de Física de Cantabria, Santander, Spain

In diesem Beitrag vergleichen wir die raumzeitliche Struktur und Dynamik verschiedener Arten von LV in räumlich ausgedehnten chaotischen Systemen (racS). Zu diesem Zweck verwenden wir eine Abbildung, die das Wachstum von Perturbationen in racS in Zusammenhang bringt mit dem Wachstum von selbstähnlichen, sog. rauen, Oberflächen.

Es wird gezeigt, dass die herkömmlich zur Charakterisierung von raumzeitlichen dynamischen Systemen verwendeten 'rückwärtigen' LV, welche als Nebenprodukte bei der Berechnung von LE abfallen, artifiziele Eigenschaften haben, die Folge ihrer Definition und nicht Ausdruck der intrinsischen Phyisk des untersuchten Systems sind. Wir schließen dass, um die Physik des Systems besser zu verstehen, die sogenannten charakteristischen oder kovarianten LV betrachtet werden sollten, welche spezielle Lösungen der linearisierten Bewegungsgleichungen sind. Weiterhin zeigen wir, dass für eine große Klasse von Systemen die Struktur und Dynamik der am schnellsten wachsenden Richtungen (d.h. LV die zu LE nahe dem größten Exponenten gehören) durch die Struktur des ersten (d.h. zum größten LE gehörenden) LV determiniert ist.

DY 4: Statistical physics in biological systems II (joint session DY/BP)

Time: Monday 14:00–16:45 Location: HÜL 386

Invited Talk DY 4.1 Mon 14:00 HÜL 386

Mechanisms of tissue maintenance: a laboratory for statistical physics — •Benjamin Simons — Cavendish Laboratory, JJ Thomson Avenue, Cambridge, UK

In adult organisms, many tissues are maintained and repaired by stem cells, which divide and differentiate to generate more specialized progeny. The mechanisms that control the balance between self-renewal and differentiation promise fundamental insights into the origin and design of multi-cellular organisms. However, stem cells are often difficult to distinguish from their more differentiated progeny, and resolving these mechanisms has proved challenging. Drawing upon the results of inducible genetic labeling studies and concepts from statistical physics, we demonstrate how scaling behaviour of *clone* size distributions and spontaneous patterning phenomena reveal signatures of stochastic stem and progenitor cell fate. As well as providing insight into the molecular regulatory mechanisms controlling the maintenance, repair and regeneration of adult tissues, these results identify common organizational principles of tissue architecture.

DY 4.2 Mon 14:30 HÜL 386

A novel transition path sampling approach to assess multiple-state transition networks — •Jutta Rogal and Peter Bolhuis — Van 't Hoff Institute for Molecular Sciences, University of Amsterdam, Nieuwe Achtergracht 166, 1018 WV Amsterdam, The Netherlands

The dynamical properties of complex systems are often characterized by the existence of several (meta)stable states separated by large free energy barriers. Examples for such complex systems are omnipresent throughout nature varying from conformational changes in biological relevant molecules to phase transitions as well as many chemical reactions. The long time dynamical behavior of these systems is usually determined by transitions between the stable states. However, the sampling of such transition networks is often severely hampered by the high free energy barriers between the states making it unfeasible to use regular molecular dynamics simulations.

Transition path sampling (TPS) has been successfully applied to study such rare events, but is limited to processes between two distinct stable states. Here, we extend TPS to include multiple stable states. Combining this approach with transition interface sampling and replica exchange ideas, we not only improve sampling efficiency, but also access kinetics, mechanisms and free energies of all possible transitions within the system in one single simulation.

DY 4.3 Mon 14:45 HÜL 386

A stochastic model for tumor growth with immunization — •Thomas Bose and Steffen Trimper — Institut für Physik, Martin-Luther-Universität Halle, Germany

Much effort has been spent on revealing the mechanisms of tumor evolution. Based on these findings, we analyze tumor growth and the interaction of cancer cells with the immune system.

A deterministic component as well as a random nature is attributed to the tumor-immune interaction. More specifically, we study a stochastic model for tumor cell growth with both, a multiplicative and an additive noise term as well as cross-correlations in between. The noise includes a finite correlation time. Whereas the death rate within the logistic model is altered by a deterministic term characterizing immunization, the birth rate is assumed to be stochastically changed due to internal growth processes leading to a multiplicative internal noise. Additionally the system is subjected to an external additive noise which mimics the influence of the environment of the tumor including the stochastic elements of the immune response. The stationary probability distribution is derived to analyze the influence of finite correlation time, the immunization rate and the strength of the cross-correlation on the different steady states. Furthermore, the mean-first passage time is calculated in order to find out under which conditions the tumor can suffer extinction under the effect of correlated noise and the degree of immunization. We relate our results to a three-phase model describing tumor evolution in living organisms with an intact immune system.

DY 4.4 Mon 15:00 HÜL 386

Complex dynamics of a population submitted to changing environment — •Michel Droz[1], Ioana Bena[1], Janusz Szwabinski[1,2], and Andrzej Pękalski[2] — [1]Département de Physique Théorique, Université de Genève, quai E. Ansermet 24, 1211 Genève 4, Switzerland — [2]Institute of Theoretical Physics, University of Wrocław, pl. M. Borna 9, 50-204 Wrocław, Poland

The dynamics of a model for single-species population submitted to changing environment is studied both analytically and numerically. Different types of environment modifications are considered: periodic and abrupt (catastrophic). The delicate interplay between the different time-scale processes results in a complex dynamic for the system. The conditions for the existence of a phase transition "extinct-alive" as a function of the selection pressure and the mutation rate are discussed. Moreover, the effect of the delay in response to the changing environment on the population's survival is also investigated.

15 min. break.

DY 4.5 Mon 15:30 HÜL 386

Active Dynamics of a Particle with Energetic Shot Noise — •Jessica Strefler[1], Werner Ebeling[1], Ewa Gudowska-Nowak[2], and Lutz Schimansky-Geier[1] — [1]Institut für Physik, Humboldt-Universität Berlin — [2]Institute of Physics, Jagiellonian University, Krakow, Poland

We study the dynamics of a simple model of moving animals. We focus on the influence of stochastic energy supply modeled as shot noise on one particle in two spacial dimensions. We assume that a particle is supplied at discrete times with packets of energy which are stored in an internal energy depot. The energy of this depot is subsequently converted into kinetic energy. If enough energy is supplied the particle moves actively with a nonzero mean velocity. For this model we find two regimes which exhibit different velocity distributions and qualitatively different trajectories. We study deterministic and stochastic bifurcations of different dynamical regimes. In the adiabatic Gaussian limit we derive an analytical solution for the velocity distribution.

DY 4.6 Mon 15:45 HÜL 386

Effects of intrinsic noise on models of epidemics — •Andrew Black and Alan McKane — School of Physics and Astronomy, The University of Manchester, UK

Demographic stochasticity, i.e. intrinsic noise introduced by the random interaction of agents in indivdual-based systems, can affect their macroscopic dynamics considerably. Models which in their deterministic mean-field limit approach a fixed point, can exhibit persistent macroscopic oscillations sustained by fluctuations on the microscopic level. In the work presented here we study the effects of demographic stochasticity and external forcing on individual-based models of epidemics. We show that the fluctuations present in the unforced versions of these stochastic models can be understood in terms of noise resonating with the systems natural frequency. Analytical progress can be made by formulating the system in terms of a master equation, from which the exact power spectrum of the fluctuations is derived using a van-Kampen expansion in the inverse system size. We show that even at large amplitude of the external forcing the magnitude and frequency of the stochastic oscillations can still be determined from the unforced model.

DY 4.7 Mon 16:00 HÜL 386

Collective motion due to individual escape and pursuit response — •Pawel Romanczuk[1], Iain D. Couzin[2], and Lutz Schimansky-Geier[1] — [1]Institut für Physik, Humboldt Universität Berlin, Germany — [2]Department of Ecology and Evolutionary Biology, Princeton University, USA

Recent studies suggest that non-cooperative behavior such as cannibalism may be a driving mechanism of collective motion. Motivated by these novel results we introduce a simple model of Brownian particles interacting by biologically motivated pursuit and escape interactions. We show the onset of collective motion for both interaction types and analyze their impact on the global dynamics. We demonstrate a strong dependence of experimentally accessible macroscopic observables on the relative strength of escape and pursuit, determine the scaling of the migration speed with model parameters and present a mean field description.

DY 4.8 Mon 16:15 HÜL 386

Continuum limit of phase oscillators with delayed coupling — •Luis G. Morelli[1,2], Saúl Ares[1], Andrew C. Oates[3], and Frank Jülicher[1] — [1]Max Planck Institute for the Physics of Complex Systems — [2]Departamento de Física, Universidad de Buenos Aires, Buenos Aires, Argentina — [3]Max Planck Institute of Molecular Cell Biology and Genetics

Complex oscillatory systems can sometimes be described as coupled phase oscillators. Time delays can be present in the coupling when the signal propagation velocity is finite or the signals are produced and processed through many step processes. It has been shown that delayed coupling can have important and non-trivial effects on collective dynamics, affecting the collective frequency and leading to complex regimes in which multiple stable frequencies can coexist. In this contribution we consider an extended system of coupled phase oscillators with time delays in the coupling. We develop a continuum description of the system for arbitrary values of the delay and obtain an effective phase diffusion equation. Delayed coupling introduces a frequency and coupling strength renormalization in the phase diffusion equation describing the continuum oscillatory media. The solutions to the phase diffusion equation show that the effects of delayed coupling can be important both for the temporal organization of the system as for the emergent spatial patterns of oscillation. We expect that our results will be useful in a wide range of problems in which time delays are significant for the collective dynamics.

DY 4.9 Mon 16:30 HÜL 386

Pinwheel Crystallization in a Competitive Hebbian Model of Visual Cortical Development — •Wolfgang Keil[1,2,3,4] and Fred Wolf[1,2,3,4] — [1]MPI for Dynamics and Self-Organization, Göttingen — [2]BCCN, Göttingen — [3]Georg-August-Universität, Fakultät für Physik, Göttingen — [4]IMPRS, Göttingen

The spatially complex modular architecture of the mammalian primary visual cortex is believed to reflect the requirement to smoothly map a high dimensional space of visual stimulus features to an effectively two dimensional array of neurons. Competitive Hebbian models of cortical development have been widely used to numerically study the properties of such mappings, but no analytical results about their ground states have been obtained so far. A classical example of such dimension reducing mappings is the Elastic Network Model (EN), proposed by Durbin and Mitchison (Nature (343), pp. 644-647, 1990). Here we use a perturbative approach to compute the ground states of the dynamics of orientation preference maps within this model. We find different phases as a function of the lateral intracortical interactions and external stimulus distribution properties. However, in all parameter regimes, the grounds states of the Elastic Network Model are either stripe-like, or crystalline representation of visual features. We present

a complete phase diagram of the model, summarizing pattern selection. Analytical predictions are confirmed by direct numerical simulations. Our results question previous studies concluding that the EN correctly reproduces the spatially aperiodic arrangement of visual cortical processing modules.

DY 5: Soft matter

Time: Monday 14:45–16:45 Location: ZEU 255

DY 5.1 Mon 14:45 ZEU 255

Thickness-Dependent Secondary Structure Formation of Tubelike Polymers — •Thomas Vogel[1], Thomas Neuhaus[2], Michael Bachmann[1], and Wolfhard Janke[1] — [1]Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, D-04009 Leipzig, Germany — [2]John von Neumann Institute for Computing (NIC), Forschungszentrum Jülich, D-52425 Jülich, Germany

By means of sophisticated Monte Carlo methods, we investigate the conformational phase diagram of a simple model for flexible polymers with explicit thickness [1,2]. The thickness constraint, which is introduced geometrically via the global radius of curvature of a polymer conformation, accounts for the excluded volume of the polymer and induces cooperative effects supporting the formation of secondary structures [3]. In our detailed analysis of the temperature and thickness dependence of the conformational behavior for classes of short tubelike polymers, we find that known secondary-structure segments like helices and turns, but also ringlike conformations and stiff rods are dominant intrinsic topologies governing the phase behavior of such cooperative tubelike objects. This shows that the thickness constraint is indeed a fundamental physical parameter that allows for a classification of generic polymer classes.

[1] T. Vogel, T. Neuhaus, M. Bachmann, W.Janke, Europhys. Lett. (2009) (in print)
[2] T. Vogel, T. Neuhaus, M. Bachmann, W.Janke, to be published
[3] J.R. Banavar, A. Maritan, Rev. Mod. Phys. **75**, 23 (2003)

DY 5.2 Mon 15:00 ZEU 255

Self-assembling network and bundle structures in systems of rods and crosslinkers — Raghunath Chelakkot[1], Reinhard Lipowsky[2], and •Thomas Gruhn[3] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich, D-52428 Jülich — [2]MPI for Colloids and Interfaces, Science Park Golm, D-14424 Potsdam — [3]Johannes Gutenberg Universität Mainz, Inst. f. Anorg. u. Analyt. Chemie, D-55099 Mainz

Self-assembling structures are studied in a binary system of long and short spherocylinders. The short spherocylinders have an adhesive site on both ends with which they can bind to the long spherocylinders. In this way, they act as crosslinkers that may interconnect a pair of long rods. In a similar way, network structures are formed by crosslinked actin filaments in the cytoskeleton of living cells. With the help of Monte Carlo simulations, the structure of crosslinker-mediated rod assemblies has been studied systematically and the critical behavior at the percolation threshold has been studied. The system shows a complex phase behaviour, including the formation of bundles of parallel rods and a transition to a three-dimensional, low-densitiy network. Bundles occur both in percolated and non-percolated systems. The same observations have been made for crosslinked actin filament networks in living cell. In a certain range of rod and crosslinker concentrations, the amount of bundling rods is a non-monotonic function of the adhesive strength.

DY 5.3 Mon 15:15 ZEU 255

Phase behaviour and demixing of a two dimensional oligomer-solvent system — •Daniel Reith, Peter Virnau, Katarzyna Bucior, Leonid Yelash, and Kurt Binder — Institut für Physik, Johannes Gutenberg-Universität, 55099 Mainz

We present the complete phase diagram of a two dimensional off-lattice oligomer-solvent mixture which describes the behaviour of hexadecane in supercritical CO2 in a slit pore geometry. A detailed finite-size analysis of our grandcanonical Monte Carlo data shows that the system belongs to the two dimensional Ising universality class. Based on this analysis we study demixing by spinodal decomposition with Molecular Dynamics simulations.

DY 5.4 Mon 15:30 ZEU 255

Test particle limit for the pair structure of quenched-annealed fluid mixtures — •Matthias Schmidt — Theoretische Physik II, Universität Bayreuth, Universitätsstraße 30, D-95440 Bayreuth, Germany

A novel route to the pair structure of quenched-annealed fluid mixtures is presented. The bulk two-body partial pair correlation functions of the mixture are identified with the one-body density distributions in an external potential that models a test particle fixed at the origin. Quenched-annealed (or replica) density functional theory is used to calculate the inhomogeneous one-body density distributions. A closed theory is obtained by using an exact sum rule that equates two different expressions for the cross pair correlation function between unlike species. Results for binary quenched-annealed hard sphere mixtures demonstrate good agreement with computer simulation data, improving over results from the replica Ornstein-Zernike equations using the direct correlation functions, obtained as second functional derivatives of the quenched-annealed excess free energy functional, as input.

DY 5.5 Mon 15:45 ZEU 255

Phase behavior of a dipolar monolayer: An integral equation study — •Liang Luo[1,2] and Sabine H. L. Klapp[1] — [1]Institut für Theoretische Physik, Arnimallee 14, Freie Universität Berlin, D-14195 Berlin, Germany — [2]Institute of Theoretical Physics, Chinese Academy of Science, Beijing 100080, China

Using integral equation theory in the Reference Hypernetted Chain (RHNC) approximation we investigate the structure and phase behavior of a dipolar hard sphere (DHS) monolayer. The dipole orientations of the particles are confined to the plane, reflecting the strong tendency of three-dimensional dipoles to orient along in-plane directions. The phase behavior is studied with an instability analysis for a wide range of densities. In agreement with simulation results, we find that the cluster- and chain-formation dominates the low density region around the spinodal temperature. With the density increasing, we observe larger contact numbers, signalling longer average chain lengths and more complicated structures such as crossing chains. In the high density region, there is no obvious indication for ferroelectric long-range correlations, contrary to the behavior of three-dimensional dipolar fluids. The instability analysis rather indicates crystallization at these high densities.

DY 5.6 Mon 16:00 ZEU 255

A wedge-shaped polarizing analyzer for the TOF spectrometer FOCUS - Ray-trace MC simulations and experiments — •Ralf Ackermann[1,2], Uwe Filges[3], Michael Schneider[1], Jochen Stahn[1], Lothar Holitzner[3], Thierry Strässle[1], Jan Peter Embs[1,2], and Rolf Hempelmann[1] — [1]Saarland University, DE — [2]LNS, ETH Zurich and PSI, CH — [3]LDM, PSI, CH

For the cold neutron TOF spectrometer FOCUS at the Swiss Spallation Neutron Source, we are developing a polarization option, which can be used, e.g., for the separation of coherent and spin-incoherent scattering contributions. Our design is based on a wedge-shaped stack of horizontally bent polarizing magnetized supermirrors covering continously the entire scattering range of 120 deg. In our setup, we use remanent magnetized FeCoV/NiN supermirrors produced at PSI. The supermirrors are surrounded by a magnetic guide field of 4.5 mT at the center position. Using the neutron ray-trace Monte-Carlo simulations, we calculated polarization and transmission properties of a 4.8 deg section. We performed test measurements on an analyzer prototype consisting of a stack of 30 supermirrors covering about 2 deg. On a polarized incoming beam of 1 mm x 40 mm dimension and varying wavelength we measured polarization values up to 95% and transmission coefficients up to 75% (6 Å). To further optimize the performance of our setup, we performed finite element calculations of the magnetic guide field and checked these results with a measurement after modifying the guide around the analyzer's entry. Results of our simulations and measurements will be presented and discussed here.

DY 5.7 Mon 16:15 ZEU 255

Ordering of colloidal particles on quasicrystalline substrates with decagonal or tetradecagonal symmetry — •Michael Schmiedeberg and Holger Stark — Institut für Theoretische Physik, Technische Universität Berlin, 10632 Berlin, Germany

Quasicrystals are non-periodic solids that nevertheless have a long-range positional order. They possess rotational point symmetries, such as five, eight, ten, or twelve-fold rotational axes that are not allowed in periodic crystals. However, not for all rotational symmetries stable quasicrystals exist in nature. For example, quasicrystals with seven-fold rotational axes have not been observed so far.

By using Monte-Carlo simulations, we study charged-stabilized colloidal particles in two-dimensional decagonal or tetradecagonal potentials, which in experiments are realized by five or seven interfering laser beams, respectively. For intermediate light intensities and special particle densities, orderings corresponding to Archimedean-like tilings occur in both potentials. A closer analysis of these structures reveals substantial differences between the decagonal and the tetradecagonal potential. For example, there are large areas with almost periodic ordering in the tetradecagonal but not in the decagonal potential. We give a possible explanation of this behavior by analyzing properties of the substrate potential that depend on whether its rotational symmetry is realized in nature or has never been observed.

DY 5.8 Mon 16:30 ZEU 255

Structure and high-frequency viscosity in dispersions of charge-stabilized colloidal spheres — •Marco Heinen and Gerhard Nägele — Institut für Festkörperforschung, Teilinstitut Weiche Materie, Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

The short-time effective viscosity of suspensions of charge-stabilized colloidal spheres is calculated by means of a renormalized density fluctuation expansion. Systems at various volume fractions, particle charges and salt concentrations are considered.

The only input required for this calculation is the static structure factor which we obtain from appropriate Ornstein-Zernicke integral equation theories. In particular, we investigate a simple modification of the well-known rescaled mean spherical approximation (RMSA) suggested by Snook and Hayter, which includes a microionic background correction that tends to compensate the typical underestimation of microstructure by the RMSA. The background-corrected RMSA is in good agreement with our simulation data and the computationally more expensive Rogers-Young scheme.

DY 6: Critical phenomena and phase transitions

Time: Monday 14:45–16:45 Location: ZEU 118

DY 6.1 Mon 14:45 ZEU 118

Exact solution of an Ising model with magnetic friction — •Alfred Hucht and Dietrich E. Wolf — Theoretische Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

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 Monte Carlo simulations and analytical methods. It turns out that in the limit of high driving velocities the model can be solved exactly for various geometries.

[1] D. Kadau, A. Hucht, and D. E. Wolf, Phys. Rev. Lett. **101**, 137205 (2008)

DY 6.2 Mon 15:00 ZEU 118

Exact ground states in 6d random-field Ising magnets — •Björn Ahrens and Alexander Karl Hartmann — Universität Oldenburg, Germany

We calculate exact ground states of random-field Ising magnets (RFIM) in 6 dimensions up to lattice sizes of $L = 10$. We calculate some critical exponents and compare them with previously obtained mean-field exponents.

The RFIM is a disordered system. It consists of ferromagnetically coupled Ising spins with an additional quenched local magnetic field. Here the field is Gaussian distributed with a fixed mean = 0 and a tuneable standard deviation.

To obtain a ground state of a realisation of the disorder we map the random field to a graph with suitible chosen edge capacities [Picard and Ratliff, 1975]. For these graphs we calculate the maximum flow using a fast max-flow/min-cut algorithm, recently developed in algorithmic graph theory. The minimum cut corresponds to a ground state configuration of the system. We can measure the bond energy, the magnetisation and the susceptibility by applying a small extern field . Using finite-size scaling we can calculate t he specific heat exponent α, the order parameter exponent β, the susceptibility exponent γ and the correlation length exponent ν. They are compared with the mean-field exponents of the RFIM, because $d_u \leq 6$ is the upper critical dimension [Tasaki, 1989] from which on the mean-field exponents should hold.

DY 6.3 Mon 15:15 ZEU 118

Multicanonical Monte Carlo study of the order-parameter distribution of the two-dimensional Ising model — •Anjan Prasad Gantapara[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

The exact order parameter distributions are computed for the two dimensional Ising Model with various boundary conditions for finite lattice sizes up to 256 at temperatures above, below, and at the critical point. All the results are fully converged with respect to the number of Monte Carlo steps. For critical systems the approach to the Gaussian behavior is generally slow. For large system sizes the fat tails observed in Ref [1] are found to appear also for temperatures approaching critical point from below. The effect of the boundary conditions at criticality in the far tail regime are studied with high precision. Our results provide benchmarks for numerical and analytical studies. This study suggest that the critical order parameter distribution must be considered to be unknown at present.

[1]Hilfer R, Biswal B, Mattutis H G, and Janke W Phys. Rev. E 68,046123 (2003).

DY 6.4 Mon 15:30 ZEU 118

Cross-correlations in scaling analyses of phase transitions — •Martin Weigel[1] and Wolfhard Janke[2] — [1]Institut für Physik, KOMET 331, Johannes Gutenberg-Universität Mainz, Staudinger Weg 7, D-55099 Mainz, Germany — [2]Institut für Theoretische Physik and Centre for Theoretical Sciences (NTZ), Universität Leipzig, Postfach 100 920, D-04009 Leipzig, Germany

Thermal or finite-size scaling analyses of importance sampling Monte Carlo time series in the vicinity of phase transition points often combine different estimates for the same quantity, such as a critical exponent, with the intent to reduce statistical fluctuations. We point out that the origin of such estimates in the same time series results in often pronounced cross-correlations which are usually ignored even in high-precision studies, generically leading to significant underestimation of statistical fluctuations. We suggest to use a simple extension of the conventional analysis taking correlation effects into account, which leads to improved estimators with often substantially reduced statistical fluctuations at almost no extra cost in terms of computation time.

DY 6.5 Mon 15:45 ZEU 118

Probability density function at the 3D Anderson transition — •Louella J. Vasquez, Alberto Rodriguez, and Rudolf A. Roemer — Department of Physics and Centre for Scientific Computing, University of Warwick, CV47AL United Kingdom

The probability density function (PDF) for the wavefunction amplitudes is studied at the metal-insulator transition of the 3D Anderson model, for very large systems up to $L^3 = 240^3$. The implications of the multifractal nature of the state upon the PDF are presented in detail. A formal expression between the PDF and the singularity spectrum $f(\alpha)$ is given. The PDF can be easily used to carry out a numerical multifractal analysis and it appears as a valid alternative to the more usual approach based on the scaling law of the general inverse participation rations.

DY 6.6 Mon 16:00 ZEU 118

Monte-Carlo simulations of nucleation and phase transitions

in small systems — •Manuel Schrader, Peter Virnau, and Kurt Binder — Institut für Physik, Johannes-Gutenberg-Universität Mainz, Staudingerweg 7, 55099 Mainz, Germany

Subcritical isotherms are obtained from grandcanonical Monte Carlo simulations of small systems inside the coexistence region. We observe sharp transitions from a homogeneous state to a droplet, a cylinder, and a slablike configuration with increasing density. The droplet phase is employed to investigate the free energy of a droplet as a function of its radius. Results agree well with a simple model derived from classical nucleation theory.

DY 6.7 Mon 16:15 ZEU 118

Polymer chains in confined geometries: massive field theory approach. — •Dirk Romeis[1] and Zoryana Usatenko[2] — [1]Leibniz-Institut fur Polymerforschung Dresden e.V., Germany — [2]Institute for Condensed Matter Physics, NASU, 79011 Lviv, Ukraine

The massive field theory approach at fixed space dimensions d=3 is applied to investigation of dilute solution of long- flexible polymer chains in a good solvent between two parallel repulsive walls, two inert walls and for the mixed case of one inert and one repulsive wall. The well known correspondence between the field theoretical ϕ^4 $O(n)$-vector model in the limit $n \to 0$ and the behavior of long-flexible polymer chains in a good solvent is used to calculate the depletion interaction potential and depletion force up to one-loop order. Our investigations include modification of renormalization scheme for the case of two inert walls. The obtained results confirm that the depletion interaction potential and the resulting depletion force between two parallel repulsive walls are weaker for chains with excluded volume interaction (EVI) than for ideal chains, because the EVI effectively reduces the depletion effect near the walls. Our results for two repulsive walls are in qualitative agreement with previous theoretical investigations [1], experimental results [2] and with results of Monte Carlo simulations [3]. [1].F.Schlesener,A.Hanke,R.Klimpel,and S.Dietrich, Phys.Rev.E **63**, 041803 (2001). [2]. D.Rudhardt, C.Bechinger, and P.Leiderer, Phys.Rev.Lett. **81**,1330 (1998). [3].H.-P.Hsu and P.Grassberger, J.Chem.Phys. **120**, 2034, 2004.

DY 6.8 Mon 16:30 ZEU 118

Capillary Condensation and Hysteresis in Porous Silicon: Network Effects within Independent Pores — Sergej Naumov[1], Alexey Khokhlov[1], •Rustem Valiullin[1], Jörg Kärger[1], and Peter A. Monson[2] — [1]Department of Interface Physics, University of Leipzig, D-04103 Leipzig, Germany — [2]Department of Chemical Engineering, University of Massachusetts, Amherst, MA 01003, USA

The ability to exert a significant degree of pore structure control in porous silicon materials has made them attractive materials for the experimental investigation of the relationship between pore structure, capillary condensation and hysteresis phenomena. Using both experimental measurements and a lattice gas model in mean field theory, we have investigated the role of pore size inhomogeneities and surface roughness on capillary condensation of N2 at 77 K in porous silicon with linear pores. Our results resolve some puzzling features of earlier experimental work. We find that this material has more in common with disordered materials such as Vycor glass than the idealized smooth-walled cylindrical pores discussed in the classical adsorption literature. We provide strong evidence that this behavior comes from the complexity of the processes within independent linear pores, arising from the pore size inhomogeneities along the pore axis, rather than from cooperative effects between different pores.

DY 7: Statistical physics II (general)

Time: Tuesday 9:30–13:00 Location: HÜL 386

Invited Talk DY 7.1 Tue 9:30 HÜL 386

Statistical Mechanics of sytems with long range interactions. — •David Mukamel — The Weizmann Institute of Science, Rehovot, Israel

Systems with long range interactions, in which the two-body potential decreases at large distances, R, with a rate slower than $1/R^d$ in d dimensions are discussed. These systems are non-additive, and as a result they display unusual thermodynamic and dynamical properties which are not present in systems with short range interactions. In particular, the various statistical mechanical ensembles are not equivalent and the microcanonical specific heat may be negative. Long range interactions may also result in breaking of ergodicity, making the maximal entropy state inaccessible from some regions of phase space. In addition, in many cases long range interactions result in slow relaxation processes, with time scales which diverge in the thermodynamic limit. Various models which have been found to exhibit these features are discussed. Relevance of these studies to collective behavior of non-equilibrium driven systems is pointed out.

DY 7.2 Tue 10:00 HÜL 386

Green-Kubo formalism for solids — •Henk van Beijeren — Institute for Theoretical Physics, Utrecht University, Leuvenlaan 4, 3584 CE Utrecht, The Netherlands — Zentrum Mathematik, Bereich M5 Technische Universität München D-85747 Garching bei München (bis Juli 2009), Germany

The Green-Kubo formalism yields macroscopic transport equations on the basis of the microscopic equations of motion, by postulating the existence of a set of slowly varying microscopic phase functions, whose dynamics allow for a closed macroscopic description. These functions always include the long-wavelength Fourier components of energy, momentum and mass densities. In systems with broken symmetries the order parameters describing these have to be added. In solids these primarily are displacement fields, describing the displacements of the atoms from their equilibrium positions. The resulting macroscopic equations are the elastic equations describing propagation and damping of sound and Fourier's law of heat conduction. The Green-Kubo formalism expresses the transport coefficients and damping constants occurring in these equations in terms of time integrals of current-current time correlation functions.

I will present the general structure of these equations together with the Green-Kubo expressions for transport and damping coefficients. If time allows I will consider mode-coupling predictions for the long time behavior of the correlation functions relevant for heat diffusion. I will discuss divergences of transport coefficients and their finite-size renormalization.

DY 7.3 Tue 10:15 HÜL 386

Theory of anisotropic electric conductivity of random resistor network on a Bethe lattice — •Fyodor Semeriyanov, Marina Saphiannikova, and Gert Heinrich — Leibniz-Institut für Polymerforschung, Hohe Str. 6, 01069, Dresden, Germany

We propose a theory of anisotropic electric conductivity of composites filled by particles of anisometric shape. This theory is a generalization of the model of random resistor network proposed by Stinchcombe [1]. Using the Bethe lattice approach, we obtained an analytical solution and verified it by means of computer simulations. Namely, we performed a Monte Carlo simulation for the random resistor network on regular 2D and 3D lattice with resistors of orientation-dependent value and computed electrical conductivity in the parallel and the normal direction of applied voltage. The simulation time increased dramatically as the resistor concentration p approached the percolation threshold pc. The advantage of the analytical approach is that it allows to access this critical region by means of e-expansion, e=p-pc. We obtained the first term to be independent of direction, whereas the second was found to be anisotropic. These results are important in connection with experimental data for carbon-filled systems. Finally, we present a dynamic model for shear-induced effects based on a kinetic equation controlling resistor concentration.

This work was supported by the BMBF grant CarboNet No. 03X0504E.

[1] R.B. Stinchcombe, J. Phys. C 7, 179, 1974.

DY 7.4 Tue 10:30 HÜL 386

Pair-factorized Steady States on Arbitrary Graphs — Bartlomiej Waclaw[1], Julien Sopik[2], Wolfhard Janke[3], and •Hildegard Meyer-Ortmanns[4] — [1]Institute of Theoretical Physics, Leipzig University, 04009-Leipzig, Germany — [2]SES, Jacobs University, 28725-Bremen, Germany — [3]Institute of Theoretical Physics, Leipzig University, 04009-Leipzig, Germany — [4]SES, Jacobs University, 28725-Bremen, Germany

A variety of stochastic processes out-of-equilibrium may be summarized under the name of stochastic mass transport models. We shall consider variations of mass transport models with interactions leading to pair-factorized steady states on arbitrary graphs. Usually the hopping rates are the primary quantities that are specified to model a given transport process, and the stationary states are determined thereafter. Here we consider the reverse question. Given a pair-factorized steady state over an arbitrary (connected) graph, we ask which hopping rates could have led to this state. We give an answer in terms of hopping rate classes that include frequently studied special cases. By construction all the hopping rates within one class lead to the same stationary state, but differ in their conserved current. For special cases we then present results on the phase structure in terms of liquid versus condensed phases. Finally, we shall indicate extensions towards full factorization over k-cells on arbitrary graphs, of which pairs (i.e. 2-cells) are just a special case.

DY 7.5 Tue 10:45 HÜL 386

On the critical properties of DLA clusters — Lev Shchur[1], Anton Menshutin[1], and •Vladimir Vinokour[2] — [1]Landau Institute for Theoretical Physics, 142432 Chernogolovka, Russia — [2]Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439, USA

We introduce variable size of the probe particles to estimate harmonic measure and extract fractal dimension of DLA clusters taking two limits, of vanishingly small probe particle size and of infinitely large size of a DLA cluster. We generate 1000 DLA clusters consisting of 50 million particles each using off-lattice killing-free algorithm developed in the early work. We found that effective fractal dimension D(N,b) measured using probe particles of size b and ensemble of the clusters of size N may be collapsed onto one curve as function of the variable b/Rdep, where Rdep is the radius of deposition. Thus, using smaller radius of the probe particles we get larger effective size of cluster. We extend our program and method for the case of clusters with the local anisotropy and investigate clusters with local symmetry of order 3 through 8. Results of simulation may be interpreted in the following way: i) there is strong repulsion between cluster branches for the local symmetry larger than 5, and all generated structures belongs to the one universality class of the off-lattice DLA with fractal dimension D=1.7104(5); 2) for symmetry lower than 5 structures seems to belong to the universality class of anisotropic fractals with D=3/2; 3) the case with 5 main branches is the marginal one - even lowest level of the noise reduction moves structures to the class of anisotropic fractals.

DY 7.6 Tue 11:00 HÜL 386

Heterogeneous nucleation in the Ising model — •David Winter, Peter Virnau, and Kurt Binder — Institut für Physik, Johannes Gutenberg-Universität Mainz

Nucleation is typically enhanced by the presence of a wall because the free energy of a droplet in contact with a wall is reduced in comparison to the free energy of a droplet in the bulk. The difference between the homogeneous and the heterogeneous case can be described by Turnbull's formula which determines the free energy of a droplet as a function of the contact angle given by Young's equation. In this work, we test this simple model with Monte Carlo simulations of the 3d Ising model.

15 min. break.

DY 7.7 Tue 11:30 HÜL 386

MD simulation of the formation of pharmaceutical particles by rapid expansion of a supercritical solution — •Frank Römer and Thomas Kraska — Institute for Physical Chemistry, University Cologne, Luxemburger Str.116, 50939 Köln, Germany

Rapid Expansion from Supercritical Solution (RESS) is a method for the production of small particles down to the nanometer size for various substances including pharmaceuticals. The substance is dissolved in a supercritical solvent, typically carbon dioxide, and then expanded in a nozzle. This leads to lowering of the solubility and hence to a very high supersaturation. As a consequence the solute precipitates from the solution. We investigate this process by molecular dynamics simulation. An equilibrated supercritical solution is expanded by successive expansion of the simulation box. The parameters of the expansion are chosen to closely follow the path of an adiabatic expansion while preventing the phase separation of the solvent. The particles obtained in this way are investigated with respect to their structure and properties.

DY 7.8 Tue 11:45 HÜL 386

Ultrametricity structure in the subspace of quasi optimum configurations of packing problems — •Johannes Josef Schneider, Andre Müller, and Elmar Schömer — Department of Physics, Mathematics, and Computer Science, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

We consider the problem of finding the densest closed packing of hard discs with proposed different radii in a circular environment, such that the radius of the circumcircle is minimal. With our heuristic optimization approach based on simulated annealing, we are able to get optimum and quasi optimum configurations for this packing problem [1]. The subspace of these configurations exhibits the property of ultrametricity,

[1] André Müller, Johannes J. Schneider, Elmar Schömer, Packing a multidisperse system of hard discs in a circular environment, accepted by Phys. Rev. E, 2008.

DY 7.9 Tue 12:00 HÜL 386

GPU accelerated optimization of packing problems — •Andre Müller, Johannes Josef Schneider, and Elmar Schömer — Department of Physics, Mathematics, and Computer Science, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

We consider the problem of finding the densest closed packing of hard discs with proposed different radii in a circular environment, such that the radius of the circumcircle is minimal, and the analogous problem of hard spheres in three dimensions. Recently, the CUDA package has become a useful tool for performing simulations very fast on graphical processing units (GPUs) produced by NVidia. We will show how we implemented our optimization techniques for this problem on the GPU and we will provide results for small and medium system sizes.

DY 7.10 Tue 12:15 HÜL 386

Finite-size effects and prediction of extreme events in the BTW model — •Anja Garber[1], Holger Kantz[1], and Sarah Hallerberg[2] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [2]Instituto de Física de Cantabria, Santander, Spain

The BTW Abelian sandpile model is a prominent example of systems exhibiting self-organised criticality. Finite-size effects are studied with special emphasis on the statistics of extreme events. Not only the avalanche size probability distribution, but also the mutual independence of large avalanches is affected. Instead of a Poissonian recurrence time distribution, a temporal repulsion of extreme events is found in the finite system that depends on the avalanche size rather than on its respective probability.

Deriving a decision variable from the time series of avalanches, this effect can be used to predict the occurrence of a particularly large event in the next time step. The larger the magnitude of these target avalanches, the better is their predictability.

DY 7.11 Tue 12:30 HÜL 386

Reproduction of the collective behavior of the Hamiltonian Mean Field Model by means of a single forced oscillator — •Angelo Facchini[1,2] and Stefano Ruffo[3] — [1]Center for the Study of Complex Systems, University of Siena, Italy — [2]Department of Information Engineering, University of Siena, Italy — [3]Dipartimento di Energetica "S. Stecco", University of Florence, INFN and CSDC, Italy

We force a single oscillator with the x and y components of the magnetization computed by integrating an N particles Hamiltonian Mean Field model (*Phys. Rev. E, 52, 2361*). The equations of motion read $\ddot{x} = M_x(t)\sin(x) - M_y(t)\cos(x)$, where $M_x(t)$ and $M_y(t)$ are computed step by step and the energy is set to $U = 0.3$. We show that the motion of the particle is statistically equivalent to the motion of the N particles cluster, and that the memory effect (*Comm. Nonlin. Sc. and Num. Methods, 13, 868*) observed in the life-time of the cluster is also found in the phase of the driven particle. Furthermore, we test the consistency of the single oscillator phase with that of the cluster by driving with $M_{x,y}(t)$ a system of N uncoupled oscillators whose initial conditions correspond to those of the equilibrium state of the HMF model.

DY 7.12 Tue 12:45 HÜL 386

A New Method of Tracking Feature Points in Videos — •Mario Heidernätsch and Günter Radons — Chemnitz University of Technology, D-09126 Chemnitz, Germany

A general problem in the analysis of moving objects is to trace their path in a series of snapshots or a video. The objects are abstractly described by a set of properties/features, e.g. position, shape, color etc. To determine whether a detected feature point is the same in a series of consecutive images and to follow its path, it is necessary to find the optimal assignment by means of its features. An additional difficulty which could show up during tracking lies in the property that points stay undetected on single frames and make it inevitable to look at more than one frame at a single tracking step.

To solve this problem we propose a new tracking algorithm, which extends the idea of a connection cost matrix [1] with use of the Viterbi algorithm. On the basis of random moving fluorescent molecules we demonstrate how the algorithm works. In addition to the minimalistic a priori information of a single particle track due to the random movement, these molecules underlie the effect of photobleaching and therefore are temporary complete invisible. Thus these videos are the best "Testground" for this algorithm.

[1] I.F. Sbalzarini, P. Koumoutsakos, Journal of Structural Biology, 151, pp. 182-195, 2005

DY 8: Glasses I (joint session DY/DF)

Time: Tuesday 10:00–12:40 Location: WIL B321

DY 8.1 Tue 10:00 WIL B321

Upconversion in fluorozirconate based glass ceramics for high efficiency solar cells — •Bernd Ahrens[1,2], Bastian Henke[2], Paul T. Miclea[2,3], and Stefan Schweizer[2,3] — [1]Department of Physics, University of Paderborn, Warburger Str. 100, 33098 Paderborn, Germany — [2]Fraunhofer Center for Silicon Photovoltaics, Walter-Hülse-Str. 1, 06120 Halle (Saale), Germany — [3]Institute of Physics, Martin-Luther-University of Halle-Wittenberg, Heinrich-Damerow-Str. 4, 06120 Halle (Saale), Germany

Solar cells are unable to use the whole solar spectrum. In particular, sub bandgab photons cannot be absorbed. Materials, which convert in an upconversion process two or more sub bandgap photons into photons with an energy higher than the bandgap energy, are of great interest. Low-phonon energy glasses like fluorozirconate (FZ) glasses are desirable hosts for rare-earth ions such as Er, Ho, Nd, Pr, and Tm because they enable upconverted fluorescence that would be quenched in high-phonon energy glasses. FZ glasses additionally doped with trivalent neodymium and chlorine ions and subsequently annealed show enhanced upconverted fluorescence intensities compared to the as-made samples. The samples were annealed at temperatures up to 290°C to initiate the growth of $BaCl_2$ nanocrystals therein; the Nd^{3+} ion is incorporated in the glass as well as in the nanoparticles. The diameters of the nanocrystals are in the range from a few to several tens of nanometers. The development of glass ceramics doped with Er^{3+}, whose optical properties make it a better choice for the application as an upconversion layer on silicon solar cells, is in progress.

DY 8.2 Tue 10:20 WIL B321

Fluorescence efficiency of samarium-doped glasses and glass ceramics — •Marcel Dyrba[1], Bernd Ahrens[2,3], Paul T. Miclea[1,3], and Stefan Schweizer[1,3] — [1]Institute of Physics, Martin-Luther-University of Halle-Wittenberg, Heinrich-Damerow-Str. 4, 06120 Halle (Saale), Germany — [2]Department of Physics, University of Paderborn, Warburger Str. 100, 33098 Paderborn, Germany — [3]Fraunhofer Center for Silicon Photovoltaics, Walter-Hülse-Str. 1, 06120 Halle (Saale), Germany

Optically active glasses and glass ceramics offer a broad range of applications; the functionality can be modified by appropriate doping and thermal processing performed after the glass production. Fluorescence from samarium 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. Samarium can enter the glass matrix either in its divalent form and/or as a trivalent ion.

The most efficient fluorescent glasses are characterized by low-phonon energies, a critical parameter leading to reduced non-radiative losses and thus to increased fluorescence efficiencies. However, the phonon frequency is not only dependent on the composition of the matrix the optically-active ion is incorporated into but also by the size of the matrix; in rare-earth doped nanocrystals an increased fluorescence efficiency is found. In this work, we compare the fluorescence efficiency of Sm^{2+}/Sm^{3+} in different glass systems such as borate glasses, fluorozirconate glasses, or oxyfluoride glasses.

DY 8.3 Tue 10:40 WIL B321

Improving up-conversion efficiency of rare earth ions by metallic nanoparticles — •Stefan Wackerow[1], Marcel Dyrba[1], Stefan Schweizer[1,2], Gerhard Seifert[1], and Heinrich Graener[1] — [1]Martin Luther university Halle-Wittenberg, 06120 Halle (Saale), Germany — [2]Fraunhofer Center for Silicon Photovoltaics, 06120 Halle (Saale), Germany

A potential way to increase silicon solar cell efficiency is frequency up-conversion of infrared sunlight which can be done by rare earth ions. A novel approach to enhance the up to now rather low up-conversion rates of rare earth ions in glasses is the inclusion of metallic nanoparticles in the glass. The nanoparticles may increase up-conversion efficiencies by the local near-field enhancement and interaction of the plasmon polaritons with rare earth energy levels.

We are therefore studying the co-doping of glasses with rare earth ions and metallic nanoparticles. Generation of silver nanoparticles in glasses is a two-step process. First, silver ions are brought into the glass by field-assisted ion exchange. Second, these glasses are heated in an hydrogen atmosphere, reducing the silver ions to atoms, which then form silver nanoparticles. This nanoparticle formation has been investigated in commercial rare-earth laser glasses, borate glasses and standard soda lime glass. In order to tune the resonance between plasmon polaritons and the rare earth energy levels, we also modified the nanoparticle shapes from spherical to ellipsoidal by irradiating the samples with intense femtosecond laser pulses.

All modified samples were analyzed by fluorescence measurements.

DY 8.4 Tue 11:00 WIL B321

Correlation analysis of dielectric polarization noise in glass formers — •Jens Schindele, Andreas Reiser, and Christian Enss — Kirchhoff-Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, 69120 Heidelberg

The analysis of dielectric polarization noise is a powerful tool to investigate relaxation processes in dielectric or ionic fluids, glass-forming liquids or glasses. To determine the polarization noise, we measure voltage fluctuations between electrodes immersed in the sample. We show time series analyses of voltage fluctuations of typical glass formers in the temperature range between room temperature and the glass transition temperature. Correlations in space and time probed by a three electrode setup. This enables us to follow the random walk of an effective polarization vector in two dimensions.

DY 8.5 Tue 11:20 WIL B321

Investigation of the microscopic nature of tunnelling systems in glassy glycerol by using nuclear moments as local probes — •Masoomeh Bazrafshan, Celine Rüdiger, Gudrun Fickenscher, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, Universität Heidelberg, Germany

At low temperatures many properties of glassy materials can be described in the framework of the standard tunnelling model. It assumes the presence of 2-level systems with a broad distribution of energy splittings E, which arise from particles of mass m tunnelling between the wells of a double well potential. Up to today, the microscopic nature of these tunnelling systems, i.e. of the tunnelling particles and the tunnelling motion, is not known. We show that nuclear moments on the tunnelling particle can be used as a probe for the microscopic motion of tunnelling systems. We have performed dielectric polarisation echo experiments on a series of partially deuterated glycerol samples. The electric quadrupole moments of the deuterium nuclei interacting with local electric field gradients cause a fine splitting of the tunnelling levels, which leads to a quantum beating in small magnetic fields and a pronounced magnetic field dependence of the echo amplitude. The anisotropic interaction of the magnetic dipole moments of the hydrogen nuclei yields a similar effect on a smaller energy scale. By comparing the data to detailed numerical model calculations we were able to extract an effective tunnelling angle and can draw preliminary conclusions about the microscopic properties of the tunnelling entities.

DY 8.6 Tue 11:40 WIL B321

Mechanisms of atom dynamics on the microseconds scale during the alpha-decay in MD simulated glass forming Ni0.5Zr0.5. — •Helmar Teichler — Institut für Materialphysik, Universität Göttingen, Göttingen, Germany

In glass forming melts near TG, the alpha-decay reflects relaxation processes on meso- and macroscopic time scales. Its microscopic explanation is a challenging open question, as it needs to understand emergence of extreme slow dynamics, more than ten orders of magnitude below atomic vibrations, from the atomic motions in the melt. Here we present molecular dynamics simulation results on the microseconds scale for glass forming Ni0.5Zr0.5 at 785 K, aimed at elucidating the microscopic processes of meso-scale dynamics during the alpha-decay well below the critical temperature Tc of mode coupling theory.- From the self intermediate scattering function we find that avalanches of collectively moving atoms, local in space and time, dominate these dynamics. The avalanches are known as higher organized cooperative processes in high-viscous dynamics [H. Teichler, PRE 71, 031505 (2005); JNCS 312, 533 (2002)], and more recently as "democratic particle motion" [G.A. Appignanesi et al. PRL 96, 057801 (2006)]. From our MD data, avalanches turn out as rare events, being created at or near a preceding one with about microsecond delay. Our results are discussed with regard to the dynamical facilitation model of Garrahan and Chandler.

DY 8.7 Tue 12:00 WIL B321

Length scale effects in amorphous metals investigated by mechanical loss spectroscopy — •Dennis Bedorf, Moritz Schwabe, and Konrad Samwer — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Glassy behavior is, in a common assumption, affected by inhomogeneities in internal dynamics. Recent computer studies using molecular dynamics have revealed dynamical heterogeneities on an atomic length scale (Teichler et al. , Zink, Mayr[1] and Neudecker). During a shear process shear transformation zones with a radius of about 1.5 nm and string like fluctuations with several nm length occur. Both processes are supposed to be surrounded by an Eshelby-Stress-Field to memorize configuration via the elastic energy [2].

Mechanical spectroscopy using double-paddle-oscillator technique enables us to study mechanical loss in thin films. For this study we choose glassy PdCuSi. The dependence of the loss on temperature and film thickness delivers the activation of certain processes in particular α- and β- process (wing). Our measurements show a disappearance of the β- process below 50 nm. We discuss this finding in terms of stress fields competing with spatial confinement and surface annihilation.

This work was supported financially by DFG, SFB 602 and Leibniz Programm.

[1] M. Zink, K. Samwer, W. L. Johnson and S. G. Mayr, Phys. Rev. B 73, 172203, (2006).
[2] J. S. Harmon, M. D. Demetriou, W. L. Johnson and K. Samwer, Phys. Rev. Lett. 99, 135502, (2007).

DY 8.8 Tue 12:20 WIL B321

Influence of surfaces on dynamics in polymer thin films - a molecular dynamics study — •Christian Vree and Stefan Georg Mayr — I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

The influence of free surfaces on the mobility of model polymer chains is investigated with the help of classical molecular dynamics simulations. Below a critical temperature, T*, a strong enhancement of the mobility of chains near the surfaces is observed, as calculated from the center-of-mass displacements of the chains. This effect diminishes with increasing temperature. A similar behavior is observed in fluctuations of the radius of gyration, corresponding to conformation changes and hence to structural relaxations. Here the difference between surface and bulk decreases with increasing temperature as well as with increasing time. The temporal evolution of these fluctuations give rise to characteristic sampling times and, thus, activation energies of relaxations of the system. The activation energy for surface relaxations is found to be lower than for bulk relaxations and additionally less temperature dependent.

This work is financially supported by the DFG - SFB 602 (TP B3).

[1] C. Vree and S.G. Mayr, submitted to New Journal of Physics (2008)

DY 9: Nonlinear dynamics, synchronization and chaos II

Time: Tuesday 10:15–12:45 Location: ZEU 255

DY 9.1 Tue 10:15 ZEU 255

Noise and timing in cellular automata — •Konstantin Klemm — Bioinformatics, Leipzig University, Germany

Cellular automata (CA) form a broad class of models for discrete complex dynamics as they produce a wealth of non-trivial spatio-temporal patterns with simple rules of interaction. The complex behaviour is observed in deterministic CA with step-wise synchronous update. However, long-term and long-range correlations are suppressed when switching to random asynchronous update which acts as a source of strong noise.

Here I consider CA under weak but non-vanishing noise, implemented as small fluctuations of the time a cell needs to respond to a changing input. I find that stability under these fluctuations strongly varies across CA rules. In Conway's Game of Life, most dynamic elements such as blinkers and gliders are unstable. Also Wolfram's elementary CA rule 110 is highly unstable, while the linear rule 150 and the chaotic rule 22 are examples of stable rules. These findings restrict the candidate set of mechanisms underlying complex dynamics. In the presence of noise, only stable CA rules are eligible as models of reproducible pattern generation.

DY 9.2 Tue 10:30 ZEU 255

Canards and gluing dynamics in muscle sarcomeres. — •Stefan Günther and Karsten Kruse — Saarland University, Saarbrücken

Sarcomeres, the elementary force generating elements of muscles, are able to oscillate spontaneously [1]. In a chain of sarcomeres, these oscillations can lead to traveling waves. Here we present a microscopic model for sarcomeres that takes into account the action of molecular motors and of elastic elements. The model can generate oscillations due to a Hopf-bifurcation. In addition, we find canard explosions, which are strong deformations of a limit cycle close to a Hopf-bifurcation, which account for wave generation. Beyond we find gluing bifurcations that result from the fusion of two oscillatory solutions having its origin in a varying number of molecular motors that participate in sarcomere contraction.

[1] Yasuda, Shindo, and Ishiwata, Biophys. J. 70 (1996)

DY 9.3 Tue 10:45 ZEU 255

Pattern Formation During Deformation of a Confined Viscoelastic Layer: From a Viscous Liquid to a Soft Elastic Solid. — •Julia Nase[1,2], Anke Lindner[1], and Costantino Creton[2] — [1]PMMH-ESPCI, Paris, France — [2]PPMD-ESPCI, Paris, France

We study pattern formation during tensile deformation of confined viscoelastic layers. The use of a model system (PDMS with different degrees of crosslinking) allows us to go continuously from a viscous liquid to an elastic solid. We observe two distinct regimes of fingering instabilities: a regime called "elastic" with interfacial crack propagation where the fingering wavelength only scales with the film thickness, and a bulk regime called "viscoelastic" where the fingering instability shows a Saffman-Taylor-like behaviour. We find good quantitative agreement with theory in both cases and present a reduced parameter describing the transition between the two regimes and allowing to predict the observed patterns over the whole range of viscoelastic properties.

DY 9.4 Tue 11:00 ZEU 255

Atrial fibrillation induced by interference of regular wave fronts with fronts emanating from a spiral wave — •Claudia Hamann, Mario Einax, and Philipp Maass — Institut für Physik, Technische Universität Ilmenau, Germany

We investigate the interference of a stable spiral wave in the left atrium with regular paced waves in the right atrium as generating mechanism of atrial fibrillation on the basis of the FitzHugh-Nagumo model. We show that this interference scenario is a possible cause of fibrillation in the right atrium. A high pacing rate can yield an irregular, fibrillatory state and is seen as a key factor for the occurrence of fibrillation episodes [1].

[1] C. Hamann, diploma thesis, Technische Universität Ilmenau, 2008

DY 9.5 Tue 11:15 ZEU 255

Computing by Switching? Heteroclinic Bifurcation in Spiking Neural Networks — •Fabio Schittler-Neves, Christoph Kirst, Andreas Sorge, and Marc Timme — Network Dynamics Group, MPI for Dynamics and Self-Organization, Göttingen, Germany

Networks of spiking neurons may often exhibit saddle periodic orbits that are heteroclinically connected among each other. For fast interaction responses, these systems may show heteroclinically connected unstable attractors [1-3]. Here we show that pulse-coupled (spiking) systems exhibit an analog of heteroclinic bifurcation that has both discrete and continuous parts [4]. On this basis, we demonstrate how input signals may be encoded by spiking neural networks in a novel way.

[1] M. Timme et al., Phys. Rev. Lett. 89:154105 (2002)
[2] P. Ashwin and M. Timme, Nonlinearity 18:2035-2060 (2005)
[3] P. Ashwin and M. Timme, Nature 436:36-37 (2005)
[4] C. Kirst and M. Timme, http://arxiv.org/abs/0709.3432v1, Phys. Rev. E, Rapid Communications (accepted)

15 min. break.

DY 9.6 Tue 11:45 ZEU 255

Coupling effects of time-delayed feedback for the synchronization of neural dynamics — •Philipp Hövel[1], Sarang A. Shah[2], Markus A. Dahlem[1], and Eckehard Schöll[1] — [1]Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany — [2]Georgia Institute of Technology, Atlanta, Georgia 30332, USA

We investigate two mutually coupled neural populations modeled by two FitzHugh-Nagumo systems. The subsystems are prepared at parameter values at which no autonomous oscillations occur and each system is subject to its own source of random fluctuations realized by Gaussian white noise. For proper choices of the noise intensities and coupling strength, we find cooperative dynamics such as frequency synchronization and phase synchronization. It was shown by Hauschildt et al. that application of time-delayed feedback, which was originally suggested for deterministic chaos control, is able to influence the cooperative dynamics. We discuss various coupling schemes of the feedback method and investigate the effects of specific realizations, i.e., when the control force is generated form the activator or inhibitor and applied to either component.

DY 9.7 Tue 12:00 ZEU 255

Synchronization of coupled demographic oscillators — •Tobias Galla — Theoretical Physics, School of Physics and Astronomy, The University of Manchester, Manchester M139PL, UK

Demographic oscillators are individual-based systems exhibiting temporal cycles sustained by the stochastic dynamics of the microscopic interacting particles. We here use the example of coupled predator-prey oscillators to show that synchronization to a common frequency can occur between two such systems, even if they oscillate at different frequencies in the absence of coupling. The power spectra of the separate and the coupled systems are computed within a van Kampen expansion in the inverse system size, and it is found that they exhibit two peaks at separate frequencies at low coupling, but that only one peak is present at large enough coupling strength. We further make predictions on the time behaviour of the phases of the two oscillators, and their phase difference, and so confirm the frequency entrainment. Theoretical results are verified convincingly in numerical simulations.

[Reference: Tobias Galla, Synchronization of coupled demographic oscillators, arXiv:0811.3689]

DY 9.8 Tue 12:15 ZEU 255

Synchronization of networks of chaotic units with time-delayed couplings — •Anja Englert[1], Wolfgang Kinzel[1], and Ido Kanter[2] — [1]Institut für Theoretische Physik und Astrophysik, Universitität Würzburg, Germany — [2]Department of Physics, Bar-Ilan University, Ramat-Gan, Israel

A network of chaotic units is investigated where the units are coupled by signals with a transmission delay. It is shown that chaotic trajectories cannot be synchronized if the transmission delay is larger than the time scales of the isolated units. For several models the master stability function is calculated which determines the maximal delay time for which synchronization is possible.

See: www.physik.uni-wuerzburg.de/?id=2200

DY 9.9 Tue 12:30 ZEU 255

Partial mean conditional recurrences for the identification of indirectionality in model systems — •Yong Zou[1], Marco Thiel[2], Mamen Romano[2], and Juergen Kurths[1,3] — [1]Potsdam Institute for Climate Impact Research, P.O. Box 601203, 14412 Potsdam, Germany — [2]Department of Physics, University of Aberdeen, Aberdeen AB 24 3UE, United Kingdom — [3]Institut for Physik, Humboldt Universität zu Berlin, Newtonstr. 15, 12489 Berlin, Germany

The identification of the coupling directionality from measured time series taking place in a group of interacting components is a non-trivial problem for experimental studies. We propose a method to uncover the coupling configuration by means of recurrence properties. The approach hinges on a generalization of conditional probability of recurrence, which was originally introduced to detect and quantify the weak coupling directionality between two interacting subsystems. Here, we extend this approach to the case of multivariate time series, where the indirect interaction presents. We test our method by considering three coupled Van der Pol oscillators contaminated with normal distributed noise. Furthermore, we extract the correct time delay information contained in the three coupled Lorenz systems. Our results confirm that the proposed method could be used to identify the indirectionality, which shows relevance for experimental time series analysis.

DY 10: Brownian motion and transport I

Time: Tuesday 14:00–16:00 Location: HÜL 386

Invited Talk DY 10.1 Tue 14:00 HÜL 386

Self-Dynamics of a Slender Rod — •Thomas Franosch — Arnold Sommerfeld Center for Theoretical Physics (ASC) and Center for NanoScience (CeNS), Department of Physics, Ludwig-Maximilians-Universität München, Theresienstraße 37, D-80333 München, Germany

Rods of high aspect ratio in concentrated suspensions constitute strongly interacting systems with rich dynamics: transport slows down drastically and the anisotropy of the motion becomes arbitrarily large. A general theory for the anisotropic motion of rods in entangled suspensions is a long-standing problem, due to the intricacy of the many-body interaction. We have performed extensive computer simulations for a model system consisting of single needle exploring a disordered planar array of obstacles. For ballistic needles we find an enhancement of diffusion as the density of obstacles increases which may be explained by heuristic scaling argument.

For Brownian needles we measure the intermediate scattering function and find a peculiar power-law decay in the highly entangled regime. This behavior can be explained from the strong coupling of translational and rotational motion within a tube and. We then develop a mesoscopic description of the dynamics down to the length scale of the interparticle distance. Our theory is based on the exact solution of the Smoluchowski-Perrin equation for the unconstrained motion. Employing the measured diffusion coefficients as input parameters we find quantitative agreement with our Brownian dynamics simulations in the dense regime

DY 10.2 Tue 14:30 HÜL 386

Brownian Dynamics with Constraints: An Asymptotic-Expansion Approach — Roman Schmitz and •Burkhard Dünweg — MPI fuer Polymerforschung, Mainz, Germany

We consider the well-known problem of overdamped Brownian motion with holonomic constraints. In the "rigid" case, the constraints are viewed as present even on the underlying short ballistic time scales. Conversely, in the "stiff" case, the Brownian motion is viewed as the long-time limiting behavior of a system whose constrained degrees of freedom are in reality subject to stiff harmonic forces, and therefore "fast". Instead of postulating the limiting equation of motion for this latter case ad hoc, we derive it systematically via a multi-time scale expansion of the Fokker-Planck operator, starting from overdamped dynamics for both "slow" and "fast" degrees of freedom.

DY 10.3 Tue 14:45 HÜL 386

Brownian motion in confined geometries – the role of entropic barriers — •Gerhard Schmid, P. Sekhar Burada, and Peter Hänggi — Institut für Physik, Universität Augsburg, D-86135 Augsburg

For particles undergoing biased Brownian motion in static media enclosed by confining geometries, transport exhibits intriguing features such as (i) a decrease of nonlinear mobility with increasing temperature or, also, (ii) a broad excess peak of the effective diffusion above the free diffusion limit [1,2]. These paradoxical aspects can be understood in terms of entropic contributions resulting from the restricted dynamics in phase space. Accordingly, bottlenecks result in *entropic barriers* which, however, exhibit a distinct temperature behavior from that observed for *energetic barriers*. The use of a time-dependent driving then causes Stochastic Resonance, thus demonstrating an anomalous signal amplification in systems possessing entropic barriers [3].

[1] D. Reguera, G. Schmid, P. S. Burada, J. M. Rubi, P. Reimann, and P. Hänggi, Phys. Rev. Lett. **96**, 130603 (2006).
[2] P. S. Burada, P. Hänggi, F. Marchesoni, G. Schmid and P. Talkner, ChemPhysChem (2009), DOI: 10.1002/cphc.200800526.
[3] P. S. Burada, G. Schmid, D. Reguera, M. H. Vainstein, J. M. Rubi, and P. Hänggi, Phys. Rev. Lett. **101**, 130602 (2008).

DY 10.4 Tue 15:00 HÜL 386

Dynamics of a Brownian circle swimmer — •Sven van Teeffelen and Hartmut Löwen — Institute for Theoretical Physics II: Soft Matter, Heinrich-Heine-Universität Düsseldorf, Universitätsstraße 1, D-40225 Düsseldorf

Self-propelled particles move along circles rather than along a straight line when their driving force does not coincide with their propagation direction. Examples include confined bacteria and spermatozoa, catalytically driven nanorods, active, anisotropic colloidal particles and vibrated granulates. Using a non-Hamiltonian rate theory and computer simulations, we study the motion of a Brownian "circle swimmer" in a confining channel. A sliding mode close to the wall leads to a huge acceleration as compared to the bulk motion, which can further be enhanced by an optimal effective torque-to-force ratio.

DY 10.5 Tue 15:15 HÜL 386

Rods in the smectic phase: 1-D Brownian diffusion in a periodic potential — •Pavlik Lettinga[1] and Eric Grelet[2] — [1]Forschungszentrum Jülich, Jülich, Germany — [2]CRPP-CNRS, Pessac, France

We report the direct visualization at the scale of single particles of mass transport between smectic layers, also called permeation, in a suspension of rodlike viruses. We show that this diffusion effectively can be described by 1-D diffusion of a Brownian particle in a periodic potential. We compare this diffusion with diffusion of rods in the isotropic and nematic phase.

DY 10.6 Tue 15:30 HÜL 386

Giant diffusion of active Brownian particles — •Benjamin Lindner and Ernesto M. Nicola — Max-Planck-Institute for the Physics of Complex Systems, Dresden, Germany

We study analytically the diffusion coefficient of an active Brownian particle with a spatial asymmetry. We demonstrate the existence of a critical force or, more generally, of a critical asymmetry that separates parameter regimes of giant diffusion from those with reliable directed transport. We derive a condition for the critical asymmetry by means of an exact expression for the diffusion coefficient and by a simplified discrete picture. A critical asymmetry, as predicted by the simple model, is also found in a detailed model of coupled molecular motors displaying bidirectional motion. Refs.: Lindner & Nicola Eur. Phys. J. ST 157, 43 (2008); Lindner & Nicola Phys. Rev. Lett. 101, 190603 (2008).

DY 10.7 Tue 15:45 HÜL 386

Performance Tests for Techniques that measure long-range Persistence in Time Series — •Annette Witt[1,2] and Bruce D. Malamud[2] — [1]Max-Planck-Institute for Dynamics and Self-organization, Bernstein Center for Computational Neuroscience Göttingen, Göttingen, Germany — [2]Department of Geography, King's College London, United Kingdom

Many time series of complex systems exhibit long-range persistence, where the power spectral density scales with a power law. The corresponding scaling exponent beta characterizes the "strength" of persistence. We compare four common techniques for quantifying long-range persistence in time series: (a) Power-spectral analysis, (b) Detrended fluctuation analysis, (c) Semivariogram analysis, and (d) Rescaled-Range (R/S) analysis. To evaluate these methods, we construct synthetic fractional noises with lengths between 512 and 4096, different persistence strengths, and different distributions (Gaussian, log-normal, Levy). We empirically find: (i) Power-spectral analysis and detrended fluctuation analysis are unbiased across all beta, although anti-persistence is over-estimated for asymmetric distributed time series; (ii) Detrended Fluctuation Analysis has larger random errors than power-spectral analysis, in particular for non-Gaussian signals. (iii) Semivariograms are appropriate for signals with long-range persistence strength between 1.0 and 2.8; it has large confidence intervals and systematically underestimates beta for asymmetric distributed time series in this range; (iv) Rescaled-Range Analysis is only accurate for beta of about 0.7, and systematically under- or over-estimates for other values.

DY 11: Glasses II (joint session DY/DF)

Time: Tuesday 14:00–16:00 Location: WIL B321

DY 11.1 Tue 14:00 WIL B321

Ion conductivity of Lithium-Borate glass layers in the nanometer thickness range — •Gerd-Hendrik Greiwe, Frank Berkemeier, and Guido Schmitz — Institut für Materialphysik der Westf. Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany

Specific ion conductivities of thin layers of Lithium-Borate-glasses with the compositions $x\ Li_2O \cdot (1-x)\ B_2O_3$, with $x = 0.15$, 0.20, 0.25 and 0.35, are determined by impendance spectroscopy as a function of temperature and layer thickness. The glass layers are prepared by ion-beam-sputtering in the thickness range from 7 nm up to 1000 nm.

Previous measurements of our group demonstrated a significant increase of the specific conductivity with decreasing layer thickness. The increase is about three orders of magnitude and occurs for layers with a thickness under ≈100 nm. Recent measurements show that this finite size effect only arises for Aluminium Lithium electrodes. In the case of Aluminium electrodes no significant thickness dependence appears. Therefore diffusion of Lithium from the electrodes into the glass-layers must be assumed as reason for the effect. In the talk different models for the concentration profile of Lithium inside the glass-layers are discussed to explain the observed finite size effect.

DY 11.2 Tue 14:20 WIL B321

Understanding the nature of ion conductivity in inorganic systems — •Andreas Heuer[1] and Heiko Lammert[1,2] — [1]Institut für Physikalische Chemie, WWU Münster — [2]Center for Theoretical Biological Physics, San Diego

It is well accepted that the ion dynamics in inorganic ion conductors is

based on ionic hops between adjacent sites provided by the network. It can be shown that the number of sites is only slightly larger than the number of ions [1]. Thus, it has been speculated that the ion dynamics should be described as a vacancy rather than a particle dynamics. This approach is elucidated in this contribution. First, a quantification of the vacancy dynamics has to be achieved. Whereas this is trivial for lattice models, several complications arise for continous systems. In this way one can identify, e.g., the relevance of cooperative ion jumps, corresponding to vacancy jumps beyond the nearest neighbor shell. Second, from studying the distribution of waiting times of a specific site as well as the patterns of forward-backward jumps one finds that the vacancy dynamics can be basically described as a single-particle problem (in contrast to the ionic motion). This result justifies the use of single-particle models such as the random-energy model to describe ion dynamics. Third, it is checked that the macroscopic conductivity can be described within a single-particle approach for the vacancies.
[1] H. Lammert, M. Kunow, A. Heuer, Phys. Rev. Lett. 90, 215901 (2003).

DY 11.3 Tue 14:40 WIL B321

How important are facilitation processes for the dynamics in supercooled liquids? — •Christian Rehwald and Andreas Heuer — Institut für Physikalische Chemie, Westfälische Wilhelms-Universität Münster, 48149 Münster

We investigate a binary mixture Lennard-Jones liquid by molecular dynamics simulation with respect to finite size effects. Our focus is the q-dependent relaxation time $\tau(q)$ and the diffusion constant D calculated from particle coordinates, inherent structures and metabasins [1]. It turns out that globally defined metabasins are no longer sufficient to predict $S(q,t)$ for large systems (except for small q). In order to avoid this problem, we calculate *local* exchange time distributions, generated by averaged particle displacements [2]. The locally defined distributions show a similar behavior as that of metabasins for long waiting times without depending explicitly on N. Moreover, as a result of facilitation processes, increasing the system size leads to a reduction of the long tails of the exchange time distribution. This N-dependence is exactly the one expected from a model glass-former based on a set of coupled elementary unit systems [3], which is e.g. implemented in several facilitated spin models.

[1] A. Heuer, Phys.: Cond. Mat. **20** (2008)
[2] L. O. Hedges *et al.*, J. Chem. Phys. **127** (2007)
[3] M. Vogel *et al.*, J. Chem. Phys. **120** (2004)

DY 11.4 Tue 15:00 WIL B321

Glass-Transition Scenarios for the Square-Shoulder System — •Matthias Sperl — Institut für Materialphysik im Weltraum, DLR, Koeln

It was discovered recently that the competition of two mechanisms of glassy arrest can trigger glass-glass transitions if the two glasses are sufficiently distinct in their localization length. It was found in simulation and experiment that the interplay between hard-sphere repulsion and a short-ranged attraction can exhibit such a scenario. Here the competition between two repulsive length scales is considered. While for both very low and very high shoulders the hard-sphere limit is recovered, for specific widths and heights of the shoulder one can identify higher-order glass-transition singularities that are indicative of glass-glass transitions. In addition, multiple reentry scenarios are found: glass-liquid-glass transitions are possible both for constant density as well as for constant temperature. The results for the square-shoulder glass transition (and its generalizations) are expected to be relevant in micellar, metallic, and granular systems as well as in water.

This work is done in collaboration with E. Zaccarelli, F. Sciortino, P. Kumar, and H. E. Stanley.

DY 11.5 Tue 15:20 WIL B321

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

Considering $O(n)$ vector spin glasses, a major simplification of the free energy landscape occurs 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 11.6 Tue 15:40 WIL B321

Relaxational dynamics of a fragile plastic crystal investigated by dielectric spectroscopy — •Thomas Bauer, Melanie Köhler, Peter Lunkenheimer, and Alois Loidl — Experimental Physics V, Center for Electronic Correlations and Magnetism, University of Augsburg, 86135 Augsburg, Germany

In the present contribution, we report dielectric spectra on 60succinonitrile-40glutaronitrile (60S40GN), a binary mixture showing an orientationally disordered (OD) plastic-crystal phase with unusually high fragility [1].

Based on earlier works [2], the relaxation dynamics of OD materials generally seem to show rather strong characteristics within the strong-fragile classification scheme by Angell. However, the plastic crystalline phase of 60S40GN behaves unconventional in this respect and can be characterized as fragile [1]. This finding may be ascribed to a higher density of minima in the potential energy landscape, caused by substitutional disorder effects. Furthermore, the presented system is a good ionic conductor, showing decoupling between rotational and translational dynamics. In addition, while most other plastic crystalline phases show no or only a very weak secondary process [2], 60S40GN exhibits a well developed β relaxation.

[1] F. Mizuni, J.-P. Belieres, N. Kuwata, A. Pradel, M. Ribes, and C.A. Angell, J. Non-Cryst. Solids 352, 5147 (2006).
[2] See, e.g., R. Brand et al., Phys. Rev. Lett. 82, 1951 (1999); R. Brand et al., J. Chem. Phys. 116, 10386 (2002).

DY 12: Poster I

Time: Tuesday 14:30–16:30 Location: P1A

DY 12.1 Tue 14:30 P1A

Influence of broken rotational symmetry on granular segregation in horizontally vibrated systems — •Axel Feltrup[1], Ingo Rehberg[1], and Christof Krülle[2] — [1]Experimentalphysik V, Universität Bayreuth, D-95440 Bayreuth, Germany — [2]Maschinenbau und Mechatronik, Hochschule Karlsruhe - Technik und Wirtschaft, D-76133 Karlsruhe, Germany

A dish filled with glass beads is excited by a circular horizontal vibration. When inserting an intruder of different size or density, we can observe segregation of the intruder. Previous experiments were made in a circular dish[1,2]. By using non-circular dishes of different geometries we investigate the influence of broken rotational symmetry on the flow of the glass beads and the intruder.

[1]T. Schnautz, R. Brito, C. A. Kruelle, and I. Rehberg, A horizontal brazil-nut effect and its reverse, Physical Review Letters 95, 028001 (2005) [2]S. Aumaître, T. Schnautz, C.A. Kruelle, and I. Rehberg: Granular phase transition as a precondition for segregation, Physical Review Letters 90, 114302 (2003).

DY 12.2 Tue 14:30 P1A

Microstructure and Pattern Formation during Zone Melting of Colloidal Crystals — •Thomas Palberg[1], Enrique Villanova Vidal[1], Nina Lorenz[1], Hans-Joachim Schöpe[1], and Hartmut Löwen[2] — [1]Johannes Gutenberg Universität, Institut f. Physik, D-55128 Mainz, Germany — [2]Heinrich Heine Universität, Institut f. theoretische Physik II, D-40225 Düsseldorf, Germany

We mimic the zone melting process of metals using colloidal model systems subjected to a gradient in particle interaction. We first study the continuous melting process of a confined one-component colloidal charged sphere crystal pushed up a gradient in salt concentration by a hydrostatic pressure difference along a slit cell. Here we study the dependence of interfacial morphology on system parameters and gradient strength. a polycrystalline to columnar transition is found, persumably caused by the applied shear. In addition we study the melting behavior if the salt is applied homogeneously and no drive is applied. Here we observe a swiss cheese morphology. Finally we study (again without drive) the morphology and the segregation behavior, when a second component is added, taking the role of an impurity. Contaminated crystals melt at low salt concentration, where purified crystals are still stable and in fact reform from the melt via heterogeneous nucleation. A zoo of interesting morphologies including dendrites and phase separation is observed.

DY 12.3 Tue 14:30 P1A

Fluidization and segregation in a vertically vibrated quasi two-dimensional granulate — •Jonathan Kollmer[1], Christof A. Krülle[1,2], and Ingo Rehberg[1] — [1]Experimentalphysik V, Universität Bayreuth, 95447 Bayreuth, Germany — [2]Maschinenbau und Mechatronik, Hochschule Karlsruhe - Technik und Wirtschaft, 76133 Karlsruhe, Germany

An ensemble of hard spheres confined by two vertical glass plates forming a gap only slightly larger than the particle diameter - comparable to a Hele-Shaw cell - is vertically oscillated. To study segregation intruders are designed by gluing several spheres together. When a critical value of the forcing strength is reached, the granular bed begins to fluidize and - in the presence of intruders - segregation phenomena can be observed. By tracking of all granular particles, density and velocity fields of the system are measured. The question whether the intruders attract each other or are driven to a common location is addressed.

DY 12.4 Tue 14:30 P1A

Two dimensional wet granular matter under shear — •Kai Huang, Martin Brinkmann, Jayati Sarkar, and Stephan Herminghaus — Max Planck Institute for Dynamics and Self-organization, Bunsenstr.10, 37073 Göttingen, Germany

The two dimensional clustering of wet particles under shear flow is studied experimentally and the results are compared with both molecular dynamic (MD) and Lattice Bolzmann (LB) simulations. Particles floating on a viscous liquid are wetted by an oil film, which gives rise to a hysteretic and short ranged capillary force between adjacent particles. This attractive force dominates other particle-particle interactions. Shear induced clustering of particles is captured by a high speed camera and motions of individual particles are determined by an image processing procedure. The size distribution and fractal dimensions of clusters obtained by experiments show good agreement with MD simulation. Comparison to LB simulation indicates that hydrodynamic interaction does not play an important role. The average cluster size is shown to vary as $\propto \dot{\gamma}^{\alpha}$ with $\alpha \approx -2/3$, where $\dot{\gamma}$ is the applied shear rate. Our results can be well explained on the basis of a simple capillary model.

DY 12.5 Tue 14:30 P1A

Phase field modeling: The interaction of interfaces — •Robert Spatschek[1,2], Nan Wang[2], and Alain Karma[2] — [1]ICAMS, Ruhr-Universität Bochum — [2]Northeastern University Boston

Nowadays, phase field models are an important tool for simulating the dynamics of e.g. solidification processes. Often, these models are used in the sharp or thin interface limit, where all relevant physical length scales are large in comparison to the intrinsic interface thickness, which is then used as a purely numerical parameter that does not influence the results.

In the recent time, pattern formation on the nanoscale has attracted much interest, and there the above scale separation breaks down. Interactions between interfaces are therefore an inevitable and essential new effect, raising the question to which extend they can be modeled by conventional multi-order parameter phase field models in a reliable and well-controlled way. I will demonstrate a theoretical procedure how to analyze these phase field interactions and show the limitations of the conventional models. Also, I will present a new model which overcomes these restrictions; furthermore, the influence of alloying and mechanical stress will be investigated.

DY 12.6 Tue 14:30 P1A

Quantitative tests of local porosity theory for single phase flow in prous media — •Thomas Zauner[1], Jens Harting[1], Bibhu Biswal[1], and Rudolf Hilfer[1,2] — [1]Institut für Computerphysik, Universität Stuttgart, 70569 Stuttgart — [2]Institut für Physik, Universität Mainz, 55099 Mainz

Understanding fluid transport in natural porous media such as sandstones is important for many industrial and ecological applications. Permeability is widely used for characterization because it is one of the measured transport parameters that is strongly correlated to the microstructure. We present quantitative comparison of permeabilities estimated from the geometrical characterization of the microstructure within the framework of local porosity theory [1] with those obtained from large scale lattice Boltzmann simulations via Darcy's law. With these two methods we analyze a laboratory scale continuum model of Fontainebleau sandstone [2] discretized at increasing resolutions ranging from 80 to 2.5 μm. Furthermore, many cubic subsamples with sidelength from 0.0128 to 1.024 cm are investigated to gain information about the representative elementary volume for this kind of sandstone. The results provide information for estimating representative elementary volume and resolutions for reliable permeability calculations.

[1] R. Hilfer. Adv. Chem Phys., XCII:299, 1996.
[2] B. Biswal et al. Phys. Rev. E, 75:061303, 2007.

DY 12.7 Tue 14:30 P1A

Study of Droplet-Coalescence for Miscible Liquids — •Stefan Menzel and Michael Bestehorn — Lehrstuhl Statistische Physik/ Nichtlineare Dynamik, Brandenburgische Technische Universität Cottbus, Deutschland

Two miscible droplets flowing together are studied numerically using an extension of the thin film equation. Recent experimental observations show that sessile droplets not only fuse instantaneously after peripheral contact but also coalesce delayed for many seconds [1]. This rather unusual behavior occurred for droplets with small contact angles consisting of different liquids. After initial contact a thin gap between the droplets was observed through which liquid is exchanged from the low to the high surface tension liquid.

[1] H. Riegler, P. Lazar, Langmuir Vol. 24 (2008) 6395-6398.

DY 12.8 Tue 14:30 P1A

Dynamics of turbulent structures in a Rayleigh-Bénard-system — •Michael Peters and Michael Langner — Uni Oldenburg, Deutschland

Abstract: Langevin analysis of a time series essentially serves to work out the underlying deterministic law of the stochastic dynamical system considered. This method is applied to a measured time series of a Rayleigh-Bénard convection experiment in the turbulent region. The experimental setup consists of a water-filled cylindrical vessel heated from below. At the Rayleigh number Ra=6.8×10^9 a roll convection is observed with stochastic reorientations of the roll axis. The time series refers to the measurement of the vertical velocity component at a given point near the cylinder wall. The analysis of the corresponding one-dimensional Langevin equation reveals a deterministic double-well potential.

DY 12.9 Tue 14:30 P1A

A D3Q19 lattice Boltzmann pore-list code with flow boundary conditions for permeability calculations — •Ariel Narváez, Martin Hecht, and Jens Harting — Institut für Computerphysik, Universität Stuttgart, 70569 Stuttgart

For a broad range of applications the most important transport property of porous media is its permeability, whose definition is related to the Darcy's law.

Here we present a new implementation of the well known D3Q19 lattice-Boltzmann method (single- and multi-relaxation time) using a pore-list instead of the matrix pore-space to characterize the pore structure. The input pore-list data is characterized for the position of the fluid nodes, the connectivity with each other, and also boundary conditions. The flow is driven by using a developed flow boundary conditions at the inlet and at the oulet [1]. This boundary condition acts locally on each lattice site and it is possible to specify the velocity exactly on the boundary nodes. In addition is independent on the details of the relaxation process during collision and contains no artificial slip.

This implementation reduces the computing time required to compute the flow field in steady-state for computational domain with a low porosity.

[1] General on-site velocity boundary conditions for lattice Boltzmann. preprint arXiv: 0811.4593.

DY 12.10 Tue 14:30 P1A

Interaction of turbulent spots in pipe flow — •DEVRANJAN SAMANTA, ALBERTO DELOZAR, and BJORN HOF — MPI for dynamics and self organisation Bunsenstrasse 10 gottingen 37073 lower saxony germany

The process of transition from laminar to turbulent regime in shear driven flows is still an unresolved issue. Localized turbulent regions or spots emerge in the laminar turbulent transition regime. A good understanding of these localized structures is crucial for the comprehension of the transition to turbulence. We investigate the interaction of such turbulent spots in pipe flow for Reynolds numbers from 1900 to 2500. Turbulence is created locally by injecting a jet of water through a small hole in the pipe wall. The spacing of the turbulent spots downstream is inversely proportional to the perturbation frequency. It is observed that for distances less than approximately 20 pipe diameters turbulent spots start to interact and annihilate each other. The interaction distance is measured as a function of Reynolds number. This investigation is closely related to spatially turbulent laminar periodic patterns which were earlier observed in other shear driven flows like Taylor-Couette or plane Couette.

DY 12.11 Tue 14:30 P1A

Invariants of the velocity gradient tensor in turbulent flows — •ANTON DAITCHE, MICHAEL WILCZEK, and RUDOLF FRIEDRICH — Institut für Theoretische Physik, Wilhelm-Klemm-Str. 9, 48149 Münster

The velocity gradient tensor $A_{ij} = \partial_j u_i$ can be used to characterize the fine scale motion of a turbulent flow. For example the local topology of the velocity field is determined by the rate of strain tensor and the rate of rotation tensor, which are the symmetric and asymmetric parts of A_{ij}. We study A_{ij} along Lagrangian trajectories in homogeneous, isotropic and stationary turbulence. Due to the isotropy the pdf of A_{ij} is a function of the invariants of this tensor. A detailed analysis of the statistics of these invariants will be presented. Furthermore we estimate the drift of these invariants and evaluate the statistical properties of its fluctuations.

DY 12.12 Tue 14:30 P1A

Hysteresis in twophase flow in porous media - a numerical experiment — •FLORIAN DOSTER[1], PAUL ZEGELING[2], and RUDOLF HILFER[1,3] — [1]Institute for Computational Physics, University of Stuttgart, 70569 Stuttgart, Germany — [2]Departement of Mathematics, Utrecht University, 3584 CD Utrecht, Netherlands — [3]Institute for Physics, University of Mainz, 55099 Mainz, Germany

Existing theories for twophase flow in porous media at the scale of centimeters to hectometers show a number of deficiencies, particularly concerning hysteresis, upscaling and residual saturations. An alternative constitutive theory [1] has proposed to treat the percolating and the non-percolating fluid parts seperately. We have now closed the set of nonlinear coupled partial differential equations of this theory selfconsistently. The set of equations is then solved for the initial/boundary value problem of raising a closed column by an adaptive moving grid algorithm [2]. Its solutions show that this new constitutive theory [1] is capable of predicting some hysteretic phenomena in twophase flow in porous media.

[1] R. Hilfer, Phys. Rev. E, 016307 (2006)
[2] J.G. Blom et al., ACM Trans. in Math. Software 20, 194, (1994)

DY 12.13 Tue 14:30 P1A

New anemometers for atmospheric and laboratory turbulent flows — •JAROSLAW PUCZYLOWSK, HENDRIK HEISSELMANN, MICHAEL HÖLLING, and JOACHIM PEINKE — ForWind - Center for Wind Energy Research, University of Oldenburg, Oldenburg, Germany

We present setups and measurement results of new anemometers, the 2D-Laser-Cantilever-Anemometer and the sphere anemometer.

Compared to cup-anemometers the sphere anemometer is a robust sensor for simultaneous detection of wind speed and direction with a high spatial and temporal resolution. The drag force raised by air flow acts upon a sphere resulting in a deflection of the supporting pipe. Using the technology of atomic force microscopes deflections in micrometer range can be detected. Via calibration the corresponding flow velocity in two dimensions can be obtained.

The 2D-Laser-Cantilever-Anemometer is equipped with a cantilever measuring the dimensions of few ten micrometers. Small deflections of the cantilever due to flow can be detected by means of the laser pointer principle. In view of the bending and twisting behavior of the cantilever, longitudinal and transversal velocity components can be measured at the same time. A two-dimensional PSD element is used to determine the position of the reflecting laser spot. The 2D-Laser-Cantilever-Anemometer allows measurements with a spatial and temporal resolution comparable to x-wire-anemometry.

The working principle of both anemometers is similar. The sphere anemometer is applicable for measuring atmospherical flows, the 2D-Laser-Cantilever-Anemometer can be used for flows on smaller scales.

DY 12.14 Tue 14:30 P1A

Experimental and numerical studies of avalanche motion — •CHRISTIAN KRÖNER, BIRTE DOMNIK, and SHIVA P. PUDASAINI — Steinmann Institut, Universität Bonn

The motion of avalanches can be divided into three parts: starting zone, track and deposition area. Normally the flow along the track can be described by the Savage-Hutter model[1], a depth-integrated continuum model. Since in the beginning and the end of the motion the vertical velocity cannot be neglected, a non depth-integrated model is required. This also holds for the impact of an avalanche on obstacles, which are often mounted on avalanche paths for protection. The main challenge in modelling a real three dimensional flow, is to find an appropriate description of the stresses inside the material. Therefore, numerical simulations using different stress models[2] are compared to a model experiment.

[1] S.B. Savage, K. Hutter, J. Fluid Mech. 199,177-215 (1989)
[2] C. Fang, Y. Wang, K. Hutter, Continuum Mech. Thermodyn. 19,423-440 (2008)

DY 12.15 Tue 14:30 P1A

Flight paths of vertically fluidized wet granulates — •ZEINA KHAN[1], MARIO SCHEEL[1], MARCO DI MICHIEL[2], RALF SEEMANN[1,3], and STEPHAN HERMINGHAUS[1] — [1]MPI for Dynamics and Self-Organization, Bunsenstr. 10, D-37073 Goettingen — [2]European Synchrotron Radiation Facility, BP 220 F-38043 Grenoble Cedex — [3]Experimental Physics, Saarland University, D-66041 Saarbruecken

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 [1], however it is not yet known which flow patterns evolve in this three dimensional system . Using fast synchrotron X-ray imaging techniques we track the motion of tracer particles embedded in the bulk of the granulate flow. We report on the effects of varying the vibration amplitude and frequency on the resulting flow pattern and velocity statistics. 1. M. Scheel et al., J. Phys.: Cond Mat. 16, S4213 (2004).

DY 12.16 Tue 14:30 P1A

Continuous and discontinuous jamming transitions — •CLAUS HEUSSINGER and JEAN-LOUIS BARRAT — Laboratoire de Physique de la Matière Condensée et Nanostructures Université Lyon 1

We discuss the jamming transition of frictionless elastic particles at zero temperature. A quasistatic shear simulation is implemented that probes the yield-stress of the system. By varying the volume-fraction across the jamming point we cannot only follow the yield-stress line but also discuss the flow properties of the fluid below jamming.

Previous studies have viewed jamming as a mixed continuous-discontinuous phase transition, as it has both a diverging correlation length and a discontinuous order parameter (number of particle contacts).

In contrast, our results suggest that the number of contacts is fully continuous across the transition and only shows a cusp singularity. Furthermore, we will discuss the mean-square displacement as well as four-point correlation functions to highlight the role of dynamical effects in the process of jamming.

DY 12.17 Tue 14:30 P1A

Structure Factors of a Driven Granular Gas suffering Stokes' Drag — •ANDREA FIEGE[1], TIMO ASPELMEIER[1], and ANNETTE ZIPPELIUS[1,2] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Institute of Theoretical Physics, University of Göttingen, Germany

We study a system of dissipative granular particles, i. e. spherical particles suffering energy loss due to inelastic collisions and Stokes' drag. An energy source (volume bulk driving) provides a stationary state, such that the Langevin equation for a tagged particle becomes

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathbf{v}_i = -\gamma_S \mathbf{v}_i + \frac{\mathbf{F}_i}{m_i} + \boldsymbol{\xi}_i \qquad (1)$$

where $\mathbf{F}_i$ denotes the change in the velocities due to the systematic force representing the collisions. Adding a Stokes' drag force to a common driven granular fluid is expected to suppress the random walk of total momentum due to non-momentum-conserving driving.

We investigate the influence of momentum conservation on static structure factors using fluctuating hydrodynamics. A method to incorporate Stokes' drag into standard event driven molecular dynamic simulations is introduced allowing us to carry out extensive numerical work and compare results to our theoretical predictions.

DY 12.18 Tue 14:30 P1A

Elasticity of wet fiber networks — •Ohle Claussen, Martin Brinkmann, and Stephan Herminghaus — MPI for Dynamics and Self-Organization, Bunsenstrasse 10, D-37073 Göttingen

Networks of elastic fibers change their mechanical properties when they become wetted by a liquid. Capillary forces induce an aligning torque between overlapping fibers which causes the formation of fiber bundles. We present a 2D model of randomly distributed straight elastic rods with periodic boundary conditions representing a 3D network of entangled fibers that exhibit both stretching and bending modes. Besides permanent crosslinks we introduce sliding bonds exerting a hysteretic torque on the network in order to model the effects of capillarity. The fibers are coupled to an oscillating external field inducing a time dependent strain in the network. Depending on the amplitude of the strain different dynamic regimes can be observed. We investigate the dissipated energy and the effective shear loss modulus of the fiber network for varying excitations numerically.

DY 12.19 Tue 14:30 P1A

Pattern formation of granulates in a flat rotating container — •Frank Rietz and Ralf Stannarius — Universität Magdeburg, FNW, IEP, Abteilung Nichtlineare Phänomene

What happens inside a rotating Hele-Shaw cell that is filled with a granular mixture you'll see at this poster. Depending on the fill level we find either stripe patterns, traveling waves or convection rolls. Relations to other pattern forming systems are apparent however an explanation is still missing.

DY 12.20 Tue 14:30 P1A

The entropy of the Hard-Core Model mimiking disordered systems — •Andrea Winkler[1], Gerold Alsmeyer[1], and Andreas Heuer[2] — [1]Institut für mathematische Statistik WWU, 48149 Münster — [2]Institut für physikalische Chemie WWU, 48149 Münster

A very simple model of particle interaction is the Hard-Core Model. Here one considers n particles on a two-dimensional square-cell lattice with N sites subject to the condition that the particles can not overlap. It can be regarded as a discrete version of the hard disc system. We calculate the entropy of this model, firstly, with the analytical method according to [1] and, secondly, with numerical methods via Monte-Carlo-simulations. We find a scaling relation $S(\rho) = a(\rho) + b(\rho)\frac{\ln c(\rho)N}{N}$ for large N and the density $\rho = \frac{n}{N}$. Futhermore the deviations for small system sizes are discussed.

[1] R.B.McQuistan, J.L.Hock, Composite nearest-neighbor degeneracies for several kinds of simple particles distributed on two-dimensional, square-cell lattices (J.Math.Phys 33, August 1992)

DY 12.21 Tue 14:30 P1A

Pseudo-knots in helical structures — Fernao Vistulo de Abreu[1], Ricardo Dias[1], and •Christian von Ferber[2,3] — [1]Department of Physics, Aveiro University, Portugal — [2]Applied Mathematics Research Centre, Coventry University, UK — [3]Physikalisches Institut, Universität Freiburg

It is generally accepted that physical entanglements are essential to explain some mechanical properties of polymers, like viscoelasticity. The current view is that entanglements behave as dynamic links that are destroyed and created in time. It is less clear whether entanglements could alternatively produce local and stable links, with similar effects to chemical bonds. Here we show that local and stable entanglements, that we call physical pseudo-knots, exist and are formed with high probability in helical structures. The energies required to create and destroy physical pseudo-knots can differ by at least one order of magnitude. Together with their localized nature this makes them controllable, opening the possibility for a wide range of applications in material science, nano- and biotechnology. Physical pseudo-knots may also have implications for living systems, that may use them, or try to avoid them and hence be related to disease. [Soft Matter 4:731 (2008)]

DY 12.22 Tue 14:30 P1A

Molecular dynamics simulation of Ostwald ripening — •Thomas Kraska — Institut für Physikalische Chemie, Universtät zu Köln

Ostwald ripening is a process taking place in the late stages of a phase transition after the system has already a low or vanishing supersaturation. Small particles dissolve or evaporate due to their high solubility or high vapour pressure while the large particles grow. The particle size distribution caused by ripening has been modelled by various theories while there are few atomistic or molecular simulations of single ripening processes. Here molecular dynamics simulations of liquid argon droplets in the saturated vapour phase are performed [1] because evaporation and condensation of droplets as well as the diffusion in the vapour phase are fast processes. It allows monitoring ripening in a time frame of 100 nanoseconds simulation time. Although the examined system models a gas-liquid transition one finds many analogies with experimental results of solid-liquid ripening processes such as for the water system being important for the stability of ice cream.

[1] T. Kraska, J. Phys. Chem. B. 112, 12408 (2008)

DY 12.23 Tue 14:30 P1A

Relaxation into stationary nonequilibrium — •Jakob Mehl, Valentin Blickle, and Clemens Bechinger — 2. Physikalisches Insitut, Universität Stuttgart, Germany

By now, the physics of equilibrium states is well understood. One remarkable feature is that equilibrium states are characterized by a relaxation time, which is independent of initial conditions. In contrast, the relaxation of a nonequilibrium stationary state (NESS) is *a priori* unknown. By combining colloidal particles, rotating laser tweezers, and video microscopy, we study experimentally the transitions between two well-defined NESS. Our experiments prove, that likewise to an equilibrium state, a NESS is characterized by an intrinsic relaxation time. Furthermore, this time constant crucially depends on how far the system is driven out of thermal equilibrium. In accordance with theoretical predictions, the relaxation time monotonically increases with driving strength.

DY 12.24 Tue 14:30 P1A

Nonequilibrium phase transitions in finite arrays of globally coupled Stratonovich models: Strong coupling limit — Fabian Senf, •Philipp M. Altrock, and Ulrich Behn — Institut für Theoretische Physik, Universität Leipzig, Deutschland

A finite array of N globally coupled Stratonovich models exhibits a continuous nonequilibrium phase transition. In the limit of strong coupling there is a clear separation of time scales of center of mass and relative coordinates. The latter relax very fast to zero and the array behaves as a single entity described by the center of mass coordinate. We compute analytically the stationary probability and the moments of the center of mass coordinate. The scaling behavior of the moments near the critical value of the control parameter $a_c(N)$ is determined. We identify a crossover from linear to square root scaling with increasing distance from a_c. The crossover point approaches a_c in the limit $N \to \infty$ which reproduces previous results for infinite arrays. The results are obtained in both the Fokker-Planck and the Langevin approach and are corroborated by numerical simulations. For a general class of models we show that the transition manifold in the parameter space depends on N and is determined by the scaling behavior near a fixed point of the stochastic flow.

DY 12.25 Tue 14:30 P1A

Separation of variables in MD simulation: A criterion to estimate the quality of the approximation — •Adolfo Poma and Luigi Delle Site — Max-Planck-Institut für Polymerforschung, Ackermannweg 10, D-55128 Mainz, Germany

We propose a simple method to evaluate the approximation of separation of variables (ASV) in Molecular Dynamics (MD) and related fields. It is based on a point-by-point evaluation of the difference between the true potential and the corresponding potential where the separation of variables is applied. The major advantage of such an approach is the fact that it requires only the analytical form of the potential as provided in most of the MD codes. We provide an application of this criterion for the alkane (aliphatic) chain and compare the efficiency for two different Mapping Schemes (MS).

DY 12.26 Tue 14:30 P1A

Size Distribution of Hanging Dew Droplets — •Tobias Lapp, Johannes Blaschke, Jürgen Vollmer, and Björn Hof — MPI for Dynamics and Self-Organization, 37073 Göttingen, Germany

The formation, growth and coarsening of dew droplets on flat surfaces has widely been studied in the physics literature under the keyword "Breath Figures". Surprisingly, little attention has been devoted however to hanging dew droplets. In this case coarsening comes to rest due to dripping off of droplets from the surface, and gravity changes the relation of droplet volume and surface release in coalescence events. We present experimental data for the droplet distribution, and discuss how these gravity induced effects influence Family and Meakin's classical expressions for the size distribution of droplets.

DY 12.27 Tue 14:30 P1A

Statistical mechanical description of polarizable liquid systems in electric field — •Semjon Stepanow and Thomas Thurn-Albrecht — Institut für Physik, Universität Halle, D-06099 Halle

We formulate the statistical mechanical description of liquid systems without permanent dipoles in an electric field in the **E**-ensemble, which is the pendant to the thermodynamic description in terms of the free energy at constant potential. The contribution of the electric field to the configurational integral $\tilde{Q}_N(\mathbf{E})$ in the **E**-ensemble is given in an exact form as a factor in the integrand of $\tilde{Q}_N(\mathbf{E})$. We also calculate the contribution of the electric field to the Ornstein-Zernike formula for the scattering function in the **E**-ensemble. As an application we calculate the shift of the critical temperature for the van der Waals gas in the electric field, and show that the shift is downward in $\mathbf{E}_0$-ensemble (constant charges) and upward in **E**-ensemble.

DY 12.28 Tue 14:30 P1A

Shape Dependence of Free Energies — •Anatoly Danilevich, Thorsten Hiester, and Klaus Mecke — Institut für Theoretische Physik Universität Erlangen-Nürnberg, Staudtstrasse 7, 91058 Erlangen, Germany.

Thermodynamic potentials of a fluid bounded by a finite, arbitrarily shaped convex container $K \subset \mathbb{R}^d$ are expected to be dependent only on $d+1$ morphometric measures, the so-called Minkowski functionals $M_i(K)$, and additional terms which decrease exponentially with the size of K [1]. This conjecture has been tested analytically for lattice models and - by reducing the problem to integral geometric calculations - also for a cluster expansion of a continuous fluid model.
The results can be used in combination with density functional theory to derive an explicit expression for the Tolman length, i.e., the curvature correction to the surface tension of a spherical drop.

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

DY 12.29 Tue 14:30 P1A

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

Many physical and technical systems such as shape memory alloys, magnetic nanoparticles, or certain friction models are characterized by non-trivial hysteretic behavior. The fact that either deterministic external fields are superimposed by thermal noise or input seems to be entirely erratic itself leads to questions concerning stochastic processes under hysteresis. We mainly investigate spectral properties and autocorrelation of Preisach hysteresis models driven by stochastic input scenarios.

Since hysteresis is able to create long-term memory, it is possible to observe an algebraic decay of the output autocorrelation function and $1/f$-noise even for δ-correlated input trajectories [1]. We always observe an emphasized low frequency regime, respectively an increase in correlation times, for δ-correlated noise driven hysteresis.

Furthermore, we investigate how correlated input processes, including fractional Gaussian noise (fGN), are transformed by hysteretic operators. In contrast to uncorrelated input processes, a further increase in output correlation times is not enforced for fGN driven hysteresis. Additionally, first results are presented on how similarly correlated processes from different sources are treated under the influence of hysteresis.

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

DY 12.30 Tue 14:30 P1A

Phase transition as a mechanism of fullerene formation — •Adilah Hussien, Alexander Yakubovich, Andrey Solov'yov, and Walter Greiner — Frankfurt Institute for Advanced Studies, Goethe University, Ruth-Moufang-Str. 1, Frankfurt am Main 60438, Germany

Phase transition in fullerenes C_{60} and C_{240} are investigated by means of constant-temperature molecular dynamics simulations. In the phase transition region, the assembly (and fragmentation) of the C_{60} cage from (and to) the gaseous state is demonstrated via the dynamical coexistence of two phases. In this critical region, the fullerene system is seen to continuously oscillate between the carbon cage (the solid phase) and the state of carbon dimers and short chains (the gas phase). These oscillations correspond to consecutive disintegration and formation of the fullerene. Furthermore, the temperature-dependent heat capacity of the fullerene features a prominent peak, signifying the finite system analogue of a first-order phase transition. The simulations were conducted for 500 ns using a topologically-constrained pairwise forcefield which was developed for this work. Results of the simulations were supplemented by a statistical mechanics analysis to account for entropy and pressure corrections, corresponding to experimental conditions. These corrections lead to a phase transition temperature of 3800-4200 K for pressure 10-100 kPa, in good agreement with available experimental values.

DY 12.31 Tue 14:30 P1A

Thermodynamic effects of an endohedral atom on the phase transition of fullerenes — •Adilah Hussien[1], Andrey Lyalin[2], and Andrey Solov'yov[1] — [1]Frankfurt Institute for Advanced Studies, Goethe University, Ruth-Moufang-Str. 1, Frankfurt am Main 60438, Germany — [2]Division of Chemistry, Graduate School of Science, Hokkaido University, Sapporo 060-0810, Japan

Encapsulation of a species within a fullerene can be regarded as an impurity which modifies the thermodynamic properties of the fullerene cage. The magnitude of the induced change is dependent upon the interaction of the carbon atoms in the fullerene and the type of endohedral species. In this work, we demonstrate that an Argon encapsulated within C_{60} can be regarded as intrinsic pressure on the fullerene cage. This intrinsic pressure leads to a shift in the temperature required to fragment the fullerene cage, therefore affecting the phase transition behaviour of the fullerene from the cage structure to a gaseous state of carbon dimers. In this work, we construct a statistical mechanics model to explain this behaviour, as well as molecular dynamics simulations using the Tersoff potential. We demonstrate that the intrinsic pressure from the encapsulated species causes the fullerene system to be in one of its many isomer states. When the species is ejected out of the cage at high temperatures, the fullerene cage remains in the higher energy isomer state, therefore requiring less energy for a phase transition to its final gaseous phase of carbon dimers.

DY 12.32 Tue 14:30 P1A

Stochastic Resonance in a ring of bistable elements — •Johannes Werner and Hartmut Benner — Institut für Festkörperphysik, Technische Universität Darmstadt

A plethora of effects can be observed in unidirectionally coupled bistable systems. They include auto oscillations and enhaned sensitivity to external signals (e.g. [1]) as well as pattern formation [2]. These effects require an odd number of elements as well as an inverting, sufficiently strong coupling.

We show experimental results obtained from a ring of three negatively coupled Schmitt triggers, which are bistable electronic systems easy to realize. This ring was driven by different types of input signals. While our setup could reproduce most results from [1], it also showed several experimental constraints resulting from the finite frequency response and a small asymmetry of the elements.

In contrast to results from similar systems, e.g. [2], we were could observe stochastic resonance like phenomena, specifically, an increased cross correlation between periodic input and response of the system. The results are supported by numerical experiments.

[1] Bulsara et al. PRE 70, 036103 (2004)
[2] Palacios et al. PRE 74, 021122 (2006)

DY 12.33 Tue 14:30 P1A

Computer simulations of 2D colloidal crystals: elastic constants and effects of periodic, external fields — •Kerstin

Franzrahe and Peter Nielaba — Department of Physics, University of Konstanz, 78457 Konstanz, Germany

Minimization trends in physics and technology have caused a lot of interest in monolayers and their interactions with a substrate lately. Colloidal suspensions have proven to be ideal model systems for studies on such systems. The question of how the addition of another length scale into such a system will influence the intricate competition between adsorbate-adsorbate interaction and adsorbate-substrate interaction is addressed by studying a binary 50% hard disk mixture under the influence of a 1D spatially periodic substrate potential. The phase diagram is investigated by Monte Carlo simulations[1,3]. Furthermore we analyze the elastic properties of two dimensional colloidal crystals. The nonlocal elastic response function is crucial for understanding many properties of soft solids. It may be obtained by measuring strain-strain autocorrelation functions. We use computer simulations as well as video microscopy data of superparamagnetic colloids to obtain these correlations for two-dimensional triangular solids. Elastic constants and elastic correlation lengths are extracted by analyzing the correlation functions[2,3].

[1] K. Franzrahe, P. Nielaba, Phys. Rev. E 76, 061503 (2007); [2] K. Franzrahe, P. Keim, G. Maret, P. Nielaba and S. Sengupta, Phys. Rev. E 78, 026106 (2008); [3] K. Franzrahe et al., J. Phys.: Condens. Matter 20, 404218 (2008)

DY 12.34 Tue 14:30 P1A

A Sinai-Billiard Model for Wet Granular Matter — •Franziska Glassmeier, Jürgen Vollmer, and Martin Brinkmann — Dept. Dynamics of Complex Fluids, MPI for Dynamics & Self-Organization, 37073 Göttingen, Germany

We generalize the collision rules of the Sinai billiard to mimic collisions of two wet disks in a system with periodic boundary conditions. Within this framework we discuss the phase-space structure of invariant measures, and the entropy production involved in free cooling. Our results are compared to numerical data for the free cooling of large assemblies of wet disks.

DY 12.35 Tue 14:30 P1A

Scaling in a One-Dimensional Model of Cyclic Interactions — •Anton Winkler[1], Tobias Reichenbach[2], and Erwin Frey[1] — [1]Arnold Sommerfeld Center for Theoretical Physics and Center for NanoScience, Department of Physics, Ludwig-Maximilians-Universität München, Theresienstraße 37, 80333 München — [2]Laboratory of Sensory Neuroscience, The Rockefeller University, 1230 York Avenue, New York, NY 10065, U.S.A.

Cyclic (rock-paper-scissors-type) population models serve to mimic complex species interactions. We have studied the effect of mutations on such a paradigmatic three-species model in one dimension, utilizing simple renormalization arguments complemented with exact calculations for certain limiting cases. We have thus achieved to build up a comprehensive picture of the system's dynamics. As the final arbiter of the validity of our results, we have employed stochastic simulations, which corroborate our predictions. Our methods and findings are potentially relevant for the spatio-temporal evolution of other non-equilibrium processes.

DY 12.36 Tue 14:30 P1A

Flow equation analysis of the strong interaction Hubbard model — •Alexander Hoffmann and Stefan Kehrein — Physics Department, ASC, and CeNS, Ludwig-Maximilians-Universität, Theresienstraße 37, 80333 Munich, Germany

We employ unitary transformations to diagonalize the Hubbard model with strong Coulomb repulsion. The diagonal form permits us to investigate the equilibrium dynamics in the Mott insulating regime in a t/U-expansion. As an outlook, it can also serve as the basis for studying the non-equilibrium dynamics after a sudden interaction quench.

DY 12.37 Tue 14:30 P1A

Preferential Trapping in State Space Dynamics — •Andreas Fischer[1], Karl Heinz Hoffmann[1], and Christian Schön[2] — [1]TU Chemnitz, D-09107 Chemnitz, Germany — [2]Max-Planck-Institut für Festkörperforschung, D-70569 Stuttgart, Germany

The understanding of complex systems' dynamics is the basis for a successful modeling of a large variety of experimental results. This requires a in detailed analysis of the connectivity and the respective time scales of the transitions in the state space.

The hierarchical tree has proven to be a very useful model for a complex system's state space, as its capabilities have been frequently tested. The dynamics in such a hierarchical system is governed by the flow of probability and the tree's branching points, which is determined by different factors which need to be discussed in detail.

The research presented here analyzes the distribution of the probability when it flows towards the tree structures leafs. It is the way of this probability splitting which determines the over all time behavior. In this work the analysis is being expanded to more general approaches for the density of states.

DY 12.38 Tue 14:30 P1A

Effect of disorder on equilibrium conformations of semiflexible polymers — •Sebastian Schöbl, Klaus Kroy, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig

The structure and behaviour of biological cells is essentially affected by the biomechanical properties of semiflexible polymers. In the form of networks, such as the cytoskeleton, they build up the basic scaffold of eukaryotic cells. In order to study the mechanical properties of these highly complex systems, both interactions of the polymer with the surrounding network and further perturbing influences have to be taken into account.

We investigate the equilibrium structure of semiflexible polymers in different potential landscapes by Monte Carlo simulations. In our simulations we use two approaches, a lattice and an off-lattice model. In the first, the polymer is represented by a self-avoiding walk on a lattice with defects that represent the disorder. In the second, the semiflexible polymer is described by a Heisenberg chain, a discretized wormlike chain model. Relevant observables such as the end-to-end distribution function and the tangent-tangent correlation function are discussed. The disorder potential is modeled according to the underlying experimental biological system.

DY 12.39 Tue 14:30 P1A

Transport on inhomogeneous filament networks — •Philip Greulich and Ludger Santen — Fachrichtung Theoretische Physik, Universität des Saarlandes, 66041 Saarbrücken, Germany

We present a model for intracellular vesicle transport on submembranal actin networks. These networks are created by stochastic growth dynamics of actin filaments leading to an inhomogeneous structure. The dynamics of vesicles are implemented by an interplay of active transport on filaments and diffusion in the cytosol, while steric interactions of vesicles are taken into account. One observes the formation of vesicle clusters in a wide range of parameter space. We investigate the distribution of cluster sizes and compare these results to a system without filaments but attractive interactions between vesicles.

DY 12.40 Tue 14:30 P1A

Analysing the reflectance spectra of human skin — •Lioudmila Belenkaia[1], Philippe-A. Bourdin[1], Vera Sterzik[2], Michael Bohnert[2], and Andreas W. Liehr[1] — [1]Freiburger Materialforschungszentrum, Stefan-Meier-Str. 21, 79104 Freiburg — [2]Institut für Rechtsmedizin, Albertstr. 9, 79104 Freiburg

Analysing the measurement data of a complex system always means interpreting the data with respect to a certain model. For the interpretation of the reflectance spectra of human skin, we use a twofold model. Part one of the model relates mesoscopic quantities like concentrations of skin dyes and the scatterer size distribution to characteristic optical parameters. The second part is a simulation of the experiment, which relates the reflectance to the optical parameters and therefore enables the estimation of the mesoscopic parameters on the basis of the measured reflectance [1]. In order to apply this model to topics of legal medicine a scientific information repository has been developed, which enables the physicist to store the measured reflectance spectra and to browse the analysis performed by the physician [2]. This contribution discusses the twofold model, the scientific information repository, and the experimental verification that the discolouration of livor mortis due to cooling is caused by re-oxygenation [3].

[1] Bohnert et al.: Int J Legal Med, 2005, 119, 355-362
[2] Belenkaia et al: arXiv:cs.DB/0612123
[3] Bohnert et al: Int J Legal Med, 2008, 122, 91-96

DY 12.41 Tue 14:30 P1A

Wave localization in complex networks with high clustering — •Lukas Jahnke[1], Jan W. Kantelhardt[1], Richard Berkovitz[2], and Shlomo Havlin[2] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, 06099 Halle, Germany — [2]Minerva Center and Department of Physics, Bar-Ilan University, Ramat-Gan 52900,

Israel

We study localization phenomena in complex optical networks. We find that strong clustering of links, i.e., a high probability of triadic closure, can induce a localization-delocalization quantum phase transition (Anderson-like transition) of coherent excitations. For example, the propagation of light wave-packets between two distant nodes of an optical network (composed of fibers and beam splitters) will be absent if the fraction of closed triangles exceeds a certain threshold. We suggest that such an experiment is feasible with current optics technology. We determine the corresponding phase diagram as a function of clustering coefficient and disorder for scale-free networks with different degree distributions characterized by an exponent lambda. Without disorder, we observe no phase transition for lambda<4, a quantum transition for lambda>4 and an additional distinct classical transition for lambda>4.5. Disorder reduces the critical clustering coefficient such that phase transitions occur for smaller lambda. Ref.: Jahnke, Kantelhardt, Berkovits, and Havlin, Phys. Rev. Lett. 101, 175702 (2008)

DY 12.42 Tue 14:30 P1A

Rule 150 cellular automata on 2D and Bethe lattices — •Jens Christian Claussen — Neuro- und Bioinformatik, U zu Lübeck — Theoret. Phys. & Astrophys., CAU Kiel

The rule 150 cellular automaton is a remarkable discrete dynamical system, as it shows $1/f^\alpha$ spectra if started from a single seed [1]. Despite its simplicity, a feasible solution for its time behavior is not obvious. Its self-similarity does not follow a one-step iteration like other elementary cellular automata. In this contribution [2] it is shown how its time behavior can be solved as a two-step vectorial, or string, iteration, which can be viewed as a generalization of Fibonacci iteration generating the time series from a sequence of vectors of increasing length. This allows us to compute the total activity time series more efficiently than by simulating the whole spatiotemporal process or even by using the closed expression. The results are further extended to the generalization of rule 150 to the two-dimensional case and to Bethe lattices, where two new corresponding integer sequences [3, 4] arise.

[1] J Nagler and J. C. Claussen, Phys. Rev. E 71, 067103 (2005)
[2] Jens Christian Claussen, Rule 150 cellular automata on 2D and Bethe lattices, Journal of Mathematical Physics 49, 062701 (2008)
[3] Jens Christian Claussen, Total activity of the Rule 150 cellular automaton on a Bethe lattice with coordination number 3, Online Encyclopedia of Integer sequences A138276
[4] Jens Christian Claussen, Total activity of the Rule 150 cellular automaton on a Bethe lattice with coordination number 4, Online Encyclopedia of Integer sequences A138277

DY 12.43 Tue 14:30 P1A

Monte Carlo generation of complex random graphs with given functional weights — •Hannes Nagel, Bartlomiej Waclaw, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, 04009 Leipzig

We propose a C++ library for generating and handling random graphs with given statistical weights. The modular and extendable set of functions allows the user to easily create a program that generates complex networks with prescribed node-degree distribution, node-node correlations and assumed global structure (trees, simple graphs or degenerated graphs), with no a-priori limitation on the size of graph. The library also contains functions to perform statistical estimations on graphs or to export the graphs for further external processing.

DY 12.44 Tue 14:30 P1A

Evolution of Boolean networks with different selection criteria and different update rules — •Agnes Szejka and Barbara Drossel — Institut für Festkörperphysik, TU Darmstadt, Hochschulstrasse 6, 64289 Darmstadt, Germany

We study the evolution of Boolean networks under various selection criteria. Inspired by biological networks, we select simultaneously for robust attractors and for the ability to respond to external inputs by changing the attractor. Mutations change the connections between the nodes and the update functions. In order to investigate the influence of the type of update functions, we perform our simulations with canalizing as well as with threshold functions. We compare the properties of the fitness landscape that results for different versions of the selection criterion and the update functions, and the properties of the "solutions" found by the evolutionary process.

DY 12.45 Tue 14:30 P1A

Anisotropy of the interface tensions of the three-dimensional Ising model — •Elmar Bittner, Andreas Nussbaumer, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, D-04009 Leipzig, Germany

We determine the interface tension for the 100, 110 and 111 interface of the simple cubic Ising model with nearest-neighbour interaction using novel simulation methods. To overcome the droplet/strip transition and the droplet nucleation barrier we use a newly developed combination of the multimagnetic algorithm with the parallel tempering method. We investigate a large range of temperatures to study the anisotropy of the interface tension in detail.

DY 12.46 Tue 14:30 P1A

Plateau formation in the twist parameter of the bond alternating AF S=1/2 Heisenberg spin chain — •Rainer Bischof and Janke Wolfhard — Institut für Theoretische Physik, Universität Leipzig, Germany

The twist (order) parameter was introduced in [1] to signal a quantum phase transition between different valence bond configurations in various 1D quantum spin systems. We present quantum Monte Carlo simulations combined with quantum reweighting methods. At non-zero temperature we find the formation of a plateau in the twist (order) parameter around the (zero temperature) quantum critical point. We investigate the possibility that this plateau is related to the quantum critical region that fans out from the quantum critical point.

[1] M. Nakamura, S. Todo: Phys. Rev. Lett. 89, 077204 (2002).

DY 12.47 Tue 14:30 P1A

Bose condensation for attractive interaction? — •Michael Männel[1], Pavel Lipavský[2,3], Klaus Morawetz[4,5], and Michael Schreiber[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Institute of Physics, Academy of Sciences, Cukrovarnická 10, 16253 Prague 6, Czech Republic — [3]Faculty of Mathematics and Physics, Charles University, Ke Karlovu 3, 12116 Prague 2, Czech Republic — [4]Research-Center Dresden-Rossendorf, Bautzner Landstr. 128, 01328 Dresden, Germany — [5]International Center of Condensed Matter Physics, University of Brasilia, 70904-970, Brasilia-DF, Brazil

We investigate a Bose gas with finite range interaction using a scheme to eliminate successive collisions as well as a single-channel T-matrix approximation. For attractive interaction we find a Evans-Rashid transition from a quasi-ideal Bose gas to a BCS like phase with a gaped dispersion. The gap decreases with increasing density. At another critical point the gap vanishes, the dispersion becomes linear for small momenta and a Bose condensate appears. It is well known, that a Bose gas with contact interaction and a negative scattering length becomes instable and undergoes a gas-liquid or gas-solid transition. Looking for this instability we also calculate the pressure for the three phases.

DY 12.48 Tue 14:30 P1A

Efficient free-energy calculation based on a generalized work fluctuation theorem — •Aljoscha Maria Hahn and Holger Then — Institut für Physik, Carl-von-Ossietzky-Universität Oldenburg

Traditional methods for the calculation of free-energies often converge extremely slow making it difficult to obtain accurate results. An example is the numerical computation of chemical potentials of fluids in the high density regime. The problem is that after inserting a test particle, the underlying phase space distribution does no longer coincide with its previous form.

A generalized work fluctuation theorem which includes bijective mappings of the underlying phase spaces allows the derivation of a maximum-likelihood estimator for the free-energy. By use of an appropriate map this estimator can, in principle, be made arbitrarily fast convergent.

DY 13: Statistical physics III (general)

Time: Tuesday 14:45–15:45 Location: ZEU 255

DY 13.1 Tue 14:45 ZEU 255

Searching phase transitions in lattice triangulations — •JOHANNES REINHARD and KLAUS MECKE — Institut für Theoretische Physik Universität Erlangen-Nürnberg, Staudtstrasse 7, 91058 Erlangen, Germany

The number of unimodular triangulations of the planar grid with size $m \times n$ scales as $\sim e^{s_0 mn}$. This allows the definition of a statistical model of random planar graphs in analogy to the Ising model. Instead of spin configurations on a fixed grid we consider triangulations with random edge lengths and coordination numbers at each grid point. The Hamiltonian of a triangulation includes the sum over all edge lengths and powers of the coordination numbers. We study the geometric and topological properties of this ensemble of lattice triangulations by a Monte-Carlo simulation based on an ergodic edge-flip dynamics. A transition is observed between a disordered and an ordered state of triangulations.

DY 13.2 Tue 15:00 ZEU 255

Ground states of $2d$ $\pm J$ Ising spin glasses via stationary Fokker-Planck sampling — •OLIVER MELCHERT and ALEXANDER K. HARTMANN — Institut für Physik, Universität Oldenburg, Carl-von-Ossietzky Strasse 9-11, 26111 Oldenburg, Germany

We investigate the performance of the recently proposed stationary Fokker-Planck sampling method considering a combinatorial optimization problem from statistical physics. The algorithmic procedure relies upon the numerical solution of a linear second order differential equation that depends on a diffusion-like parameter D. We apply it to the problem of finding ground states of $2d$ Ising spin glasses for the ±J−Model. We consider square lattices with side length up to $L = 24$ with two different types of boundary conditions and compare the results to those obtained by exact methods. A particular value of D is found that yields an optimal performance of the algorithm. We compare this optimal value of D to a percolation transition, which occurs when studying the connected clusters of spins flipped by the algorithm. Nevertheless, even for moderate lattice sizes, the algorithm has more and more problems to find the exact ground states. This means that the approach, at least in its standard form, seems to be inferior to other approaches like parallel tempering.

DY 13.3 Tue 15:15 ZEU 255

GPU Accelerated Monte Carlo Simulation of the 2D and 3D Ising Model — •TOBIAS PREIS[1,2], PETER VIRNAU[1], WOLFGANG PAUL[1], and JOHANNES J. SCHNEIDER[1] — [1]Department of Physics, Mathematics and Computer Science, Johannes Gutenberg University of Mainz - Staudinger Weg 7, D-55099 Mainz, Germany — [2]Artemis Capital Asset Management GmbH - Gartenstr. 14, D-65558 Holzheim, Germany

The compute unified device architecture (CUDA) is a fundamentally new programming approach for performing scientific calculations on a graphics processing unit (GPU) as a data-parallel computing device. The programming interface allows to implement algorithms using extensions to standard C language. First, we apply this new technology to Monte Carlo simulations of the two dimensional ferromagnetic square lattice Ising model. By implementing a variant of the checkerboard algorithm, results are obtained up to 60 times faster on the GPU than on a current CPU core. An implementation of the three dimensional ferromagnetic cubic lattice Ising model on a GPU is able to generate results up to 35 times faster than on a current CPU core. As proof of concept we calculate the critical temperature of the 2D and 3D Ising model using finite size scaling techniques. Theoretical results for the 2D Ising model and previous simulation results for the 3D Ising model can be reproduced.

DY 13.4 Tue 15:30 ZEU 255

Phase space description of spin dynamics — WILLIAM COFFEY[1], YURI KALMYKOV[2], •BERNARD MULLIGAN[3], and SERGUEY TITOV[4] — [1]Trinity College, Dublin, Ireland — [2]Université de Perpignan, France — [3]Max Planck Institute for the Physics of Complex Systems, Dresden — [4]Russian Academy of Sciences, Russia

The spin system with Hamiltonian $\hat{H}_S = -\xi \hat{S}_Z - \sigma \hat{S}_Z^2$ (ξ and σ are external and internal field parameters) is treated as an 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. The relaxation time of the longitudinal component of the spin can be estimated using a quantum generalization of the classical integral relaxation time via the stationary distribution and diffusion coefficient of the master equation.

DY 14: Focused Session: 50 years DY: Trends in dynamics and statistical physics

Time: Wednesday 9:30–12:30 Location: HÜL 386

Opening address **Wed 9:30 HÜL 386**

Invited Talk DY 14.1 Wed 9:45 HÜL 386

Turbulent convective transport - news and challenges — •SIEGFRIED GROSSMANN — Fachbereich Physik, Philipps-Universität Marburg, Renthof 6, 35032 Marburg

Recent progress in our understanding of turbulent transport is reviewed, especially of heat convection in Rayleigh-Bénard geometry and of azimuthal momentum transport in Taylor-Couette geometry of concentrically rotating cylinders. The respective Nusselt numbers and convection amplitudes (Reynolds numbers) are analysed as functions of the control parameters Rayleigh and Prandtl number or Taylor number and gapwidth. Non-Oberbeck-Boussinesq effects, the flow structure and its dynamics, and the dominating role of the boundary layers are addressed. Finally a brief discussion of the most urging challenges for future research in this field is offered.

Work was done in cooperation with Detlef Lohse, Guenter Ahlers, Bruno Eckhardt, Enrico Calzavarini, Kazuyasu Sugiyama, Francisco Fontenele Araujo, Eric Brown, and Denis Funfschilling.

Topical Talk DY 14.2 Wed 10:15 HÜL 386

What's up in quantum chaos? — •ROLAND KETZMERICK — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden

Many fundamental quantum signatures of chaos have been established in recent years, partly based on a deeper understanding of classical dynamics. This talk will review some of these highlights, like the universal properties of energy spectra when the classical limit shows fully chaotic dynamics. For typical systems, where regular and chaotic phase-space regions coexist, we can say now whether or not quantum eigenstates will respect these regions and a quantitative understanding of tunneling between them is on the way. Future challenges will be addressed throughout the talk.

15 min. break.

Topical Talk DY 14.3 Wed 11:00 HÜL 386

Non-equilibrium work and fluctuation theorems — •ANDREAS ENGEL — Institut für Physik, Carl-von-Ossietzky-Universität Oldenburg

The general theoretical description of systems driven violently away from thermal equilibrium is still an open problem. Whereas equilibrium situations are comprehensively characterized by a small number of general principles, and near-equilibrium processes can be modeled within the framework of linear-response theory the extreme diversity of phenomena occuring far from equilibrium has precluded a coherent theoretical description up to now.

Nevertheless, some simple, exact and general relations have been established recently which apply to systems driven arbitrarily far from equilibrium. These relations are by now referred to as fluctuation and work theorems respectively, and are in particular relevant for small systems with typical energy changes of the order of the thermal energy $k_B T$. They offer a fresh view on some classical problems in non-equilibrium statistical mechanics, open interesting possibilities for further research, and have motivated new experimental techniques and numerical algorithms.

The talk gives a general introduction into the field of non-equilibrium work and fluctuation theorems and discusses some results and applications.

Topical Talk DY 14.4 Wed 11:30 HÜL 386

Computational Statistical Physics — •Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Postfach 100920, 04009 Leipzig

One line of computational statistical physics focuses on providing precise numerical data for testing and complementing analytical predictions for well-controlled model systems. After a brief overview of recent progress in Monte Carlo computer simulation methodologies, the current level of interplay between analytical and numerical considerations will be illustrated in more detail for one selected example application.

Invited Talk DY 14.5 Wed 12:00 HÜL 386

Towards a quantum Church-Turing Theorem — •Reinhard F. Werner — Inst. Math.Physik, TU Braunschweig, Germany

The Church-Turing Thesis states that any reasonable computational process can be simulated by a standard computational model, e.g., the Turing machine. In the quantum case this amounts to the question, whether we have actually found the most general ways to make quanta compute: can every conceivable computational model, which can be formulated within quantum mechanics, be simulated efficiently by one of the equivalent quantum computational models we know, e.g., the gate model, the one-way quantum computer, or adiabatic quantum computing?

We present some partial results, and discuss the relation to the broader question whether Nature is (quantum) computable.

DY 15: Quantum chaos I

Time: Wednesday 14:00–16:00 Location: HÜL 386

Invited Talk DY 15.1 Wed 14:00 HÜL 386

Time-reversed waves and super-resolution — •Mathias Fink — Ecole Supérieure de Physique et Chimie Industrielles de la Ville de Paris, University Denis Diderot, UMR CNRS 7587, 10 rue Vauquelin, 75005, Paris, France

Time-reversal invariance is a very powerful concept in classical and quantum mechanics. In the field of classical waves (acoustics and electromagnetism), where time reversal invariance also occurs, time-reversal mirrors (TRMs) may be made simply with arrays of transmit-receive antenna, allowing an incident broadband wave field to be sampled, recorded, time-reversed and re-emitted. TRMs refocus an incident wave field to the position of the original source regardless of the complexity of the propagation medium. TRMs have now been implemented in a variety of physical scenarios from GHz Microwaves to MHz Common to this broad range of scales is a remarkable robustness exemplified by observations at all scales that the more complex the medium (random or chaotic), the sharper the focus. A TRM acts as an antenna that uses complex environments to appear wider than it is, resulting for a broadband pulse, in a refocusing quality that does not depend of the TRM aperture. Time reversal focusing opens also completely new approaches to super-resolution. We will show that in random metamaterials, a time-reversed wave field interacts with the random medium to regenerate not only the propagating but also the evanescent waves required to refocus below the diffraction limit. Focal spots as small as $\lambda/30$ are demonstrated with microwaves. This results in a large increase of the information transfer rate.

DY 15.2 Wed 14:30 HÜL 386

Quantum corrections to the fidelity — •Daniel Waltner[1], Boris Gutkin[2], Martha Gutiérrez[1], Jack Kuipers[1], and Klaus Richter[1] — [1]Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany — [2]Fachbereich Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

We study semiclassically quantum corrections to the fidelity for a classically chaotic system. We consider in addition to the diagonal approximation [1], also the effect of very similar trajectory pairs differing in encounters [2] in different regimes of the fidelity decay. We find agreement of our results for the Fermi Golden Rule regime with predictions from Random Matrix Theory (RMT) [3]. Going beyond RMT, we also study the effect of a finite Ehrenfest time on our results for the Fermi Golden Rule regime and make predictions for nondiagonal corrections to the fidelity in the Lyapunov regime inaccessible to RMT.

Using recursion relations to count the considered diagrams, we further show the unitarity of our theory and a relation between the fidelity amplitude and the spectral form factor [4].

[1] F. M. Cucchietti, H. M. Pastawski, R. A. Jalabert, Phys. Rev. B **70**, 035311 (2004),
[2] D. Waltner, M. Gutiérrez, A. Goussev, K. Richter, Phys. Rev. Lett. **101**, 174101 (2008),
[3] H.-J. Stöckmann, R. Schäfer, New J. Phys. **6**, 199 (2004),
[4] H. Kohler, I.E. Smolyarenko, C. Pineda, T. Guhr, F. Leyvraz, T.H. Seligman, Phys. Rev. Lett. **100**, 190404 (2008).

DY 15.3 Wed 14:45 HÜL 386

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

We investigate the scattering fidelity in a microwave billiard. In former 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. We derive an exact formula using an supersymmetrical ansatz and compare it with experiments in an chaotic billiard, where the coupling of a channel was changed by means of an slit. Again an algebraic decay for large times is found and the experiment confirms this findings.

[1] R. Schäfer, H.-J. Stöckmann, T. Gorin, and T. H. Seligman, Phys. Rev. Lett. 95, 184102 (2005).
[2] R. Höhmann, U. Kuhl, and H.-J. Stöckmann. Phys. Rev. Lett. 100, 124101 (2008).

DY 15.4 Wed 15:00 HÜL 386

Study of diffraction patterns and temporal properties in open microwave billiards — •Pedro Oria Iriarte, Stefan Bittner, Barbara Dietz, Maksim Misky-Oglu, Achim Richter, and Florian Schaefer — Institut fuer Kernphysik, TU Darmstadt, Schlossgartenstr. 9, Darmstadt, Germany

The outcoming electromagnetic flush from open microwave billiards with regular and chaotic dynamics is investigated. Time decay properties and field diffraction patterns are related to periodic orbits in the billiards. Results of the famous double slit experiment are also shown and discussed.

DY 15.5 Wed 15:15 HÜL 386

Diffraction effects on transport properties of a circular cavity — •Tobias Dollinger[1], Michael Wimmer[1], Iva Brezinova[2], Joachim Burgdörfer[2], and Klaus Richter[1] — [1]Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany — [2]Institut für Theoretische Physik, Technische Universität Wien, 1040 Vienna, Austria

It is by now well established that quantum transport properties can be predicted analytically by starting from semiclassical expressions for the Greens-function. This approach proves particularly useful for systems with classical analoga revealing chaotic dynamics. Here we will use a semiclassical approach to re-examine a circular billiard, which is integrable in the classical case. We mainly focus on diffraction at the openings and analyse how it influences quantum effects, such as weak localization, for different curvatures at the points that connect leads and billiard boundary. This is motivated by an analysis of scattering matrix elements obtained from quantum simulations, in which features of the corresponding classical scattering system are observed.

DY 15.6 Wed 15:30 HÜL 386

Microwave experiments with dielectric circular billiards — •Stefan Bittner, Barbara Dietz, Maksim Miski-Oglu, Pedro Oria-Iriarte, Achim Richter, and Florian Schäfer — Institut für Kernphysik Darmstadt, Germany

Microlasers typically consist of a flat dielectric micro-cavity surrounded by media with smaller index of refraction. For the theoretical description of the three-dimensional electromagnetic fields of highly excited modes one usually uses a two-dimensional approximation based on the so-called effective index of refraction. The validity and precision of this approximation is tested experimentally with two flat circular microwave resonators of different height made of Teflon. The resonance frequencies as well as intensity distributions of several hundreds of TE- and TM-modes were measured, and the related quantum numbers were identified. These data are compared to computations based on the effective index of refraction approximation. Significant deviations between the measured and computed resonance frequencies as well as the resonance widths were found for both polarizations and especially in the long wavelength limit.

DY 15.7 Wed 15:45 HÜL 386

Extended ray dynamics for optical microcavities — •Julia Unterhinninghofen[1], Jan Wiersig[1], and Martina Hentschel[2] — [1]Institut für Theoretische Physik, Otto-von-Guericke-Universität Magdeburg, 39106 Magdeburg — [2]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden

Optical microcavities have important applications in various fields of physics; deformed optical microdisks in particular attract interest in the quantum chaos community because they can be used to study ray-wave correspondence in open systems both theoretically and experimentally. As smaller and smaller cavities can be fabricated, corrections to the ray picture become important. Unfortunately, analytical formulas for the lowest-order corrections (so-called Goos-Hänchen shift and Fresnel filtering) only exist for certain limiting cases. Here, we present a method that allows the numerical calculation of there corrections; the corrections can be applied to the full phase space, which is not possible using the analytical results. We present results for the extended ray dynamics of elliptical and Limacon-shaped microdisks and compare them to wave calculations.

DY 16: Fluid dynamics I

Time: Wednesday 14:45–18:00 Location: ZEU 255

DY 16.1 Wed 14:45 ZEU 255

Measuring the Effect of Dynamic Stall — •Jörge Schneemann, Gerrit Wolken-Möhlmann, and Joachim Peinke — Universität Oldenburg, Institut für Physik, Germany

An airfoil in laminar inflow experiences static lift and drag forces. Under turbulent conditions dynamic effects like dynamic stall take place. We present measurements of dynamic stall in a closed test section of a wind tunnel using the pressure distribution on the wind tunnel walls to calculate lift forces. Dynamic stall was induced by pitching the foil sinusoidally. Pressure sensors placed in the foil were used to study the dynamics of the separation point. Our next task is to install a strain gauge based system for measuring radial forces on the mounting of the foil that will allow to investigate dynamic stall under turbulent conditions.

DY 16.2 Wed 15:00 ZEU 255

3D flow measurement with Digital Holographic Particle Tracking Velocimetry (DHPTV) — •Tim Homeyer and Gerd Gülker — Carl von Ossietzky University Oldenburg - Institute of Physics - Hydrodynamics and Windenergy, Germany

The two-dimensional flow measurement technique PIV (Particle Image Velocimetry) is a standard method to investigate air or fluid flows. After seeding the fluid with small light scattering particles, a laser light sheet is created, and two fast consecutive images of the illuminated field are recorded. These images are correlated in a computer and resulting in a two-dimensional vector field of the flow velocity.

This technique is extended to the third dimension using holography (Holographic PIV). By recording a volume in a hologram and subsequent reconstruction, the whole three-dimensional particle field of the flow is captured.

For small volumes, one can also record the holograms with a digital camera, instead of using film material. This has the advantage that recording and reconstruction is directly performed in the computer and no chemical development and additional digitizing is needed. Due to noise the number of particles has to be reduced. That is why each particle is identified, validated and tracked through the volume (Particle Tracking Velocimetry) instead of performing a 3D correlation (PIV).

The goals of this diploma thesis are to design a DHPTV system to record small three-dimensional flows in a wind tunnel and in Rayleigh-Bénard-Cells and to compare different types of particle validation methods.

DY 16.3 Wed 15:15 ZEU 255

Statistical analysis of non-stationary atmospheric boundary layer turbulence — •Thomas Laubrich and Holger Kantz — Max-Planck-Institut fuer Physik Komplexer Systeme; Noethnitzer Str. 38, 01187 Dresden, Germany

We study the statistics of the horizontal component of atmospheric boundary layer wind speed. Motivated by its non-stationarity, we investigate which parameters remain constant or can be regarded as being piece-wise constant and explain how to estimate them. We will verify the picture of natural atmospheric boundary layer turbulence to be composed of successively occurring close to ideal turbulence with different parameters.

The first focus is put on the fluctuation of wind speed around its mean behaviour. We describe a method estimating the proportionality factor between the standard deviation of the fluctuation and the mean wind speed and analyse its time dependence. The second focus is put on the wind speed increments. We investigate the increment statistics and show that the parameters describing the distribution change with time by using superstatistics and simulated annealing optimisation.

DY 16.4 Wed 15:30 ZEU 255

Stochastic analysis of fractal-generated turbulence — •Robert Stresing[1], J. Christos Vassilicos[2], and Joachim Peinke[1] — [1]Inst. of Physics, University of Oldenburg, Germany — [2]Dep. of Aeronautics & Inst. of Math. Sciences, Imperial College, London, UK

We present a stochastic analysis of turbulence data, which provides access to the joint probability of finding velocity increments at several scales. The underlying stochastic process in form of a Fokker-Planck equation can be reconstructed from given data. Intermittency effects are included. The stochastic process is Markovian for scale separations larger than the Einstein-Markov coherence length, which is closely related to the Taylor microscale.

We extend our analysis to turbulence generated by a fractal square grid. We find that in contrast to other types of turbulence, like free-jet turbulence, the coefficients of the Fokker-Planck equation do not depend on the Reynolds number, and the n-scale statistics are universal over the entire range of Taylor based Reynolds numbers from 150 to 740. Thus we propose to have found a new class of Reynolds-number independent turbulence generated by boundary conditions of a fractal grid.

Ref.: R. Friedrich, J. Peinke, Phys. Rev. Lett 78, 863 (1997); C. Renner, J. Peinke, R. Friedrich, O. Chanal, B. Chabaud, Phys. Rev. Lett 89, 124502 (2002); R. E. Seoud, J. C. Vassilicos, Phys. Fluids 19, 105108 (2007); R. Stresing, J. Peinke, R. E. Seoud, J. C. Vassilicos, in: Progress in Turbulence III, Springer, forthcoming

DY 16.5 Wed 15:45 ZEU 255

Escape from turbulence in shear flows — •Alberto de Lozar and Björn Hof — Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen, Deutschland

The collapse of turbulence, observable in shear flows at low Reynolds numbers, raises the question if turbulence is generically of transient nature or becomes sustained at some critical point. Recent data have lead to conflicting views with the majority of studies supporting the model of turbulence turning into an attracting state. We have performed lifetime measurements of turbulence in pipe flow spanning eight orders of magnitude in time, drastically extending all previous investigations. We show that no critical point exists in this regime and that in contrast to the prevailing view the turbulent state remains transient. The behavior found here identifies turbulence in pipe flow as a type-II super-transient, which had been conjectured as a potential description of turbulence two decades ago. Additionally we investigate the lifetime behaviour for square duct and plane Poiseuille flow in order to establish in how far this transition behaviour and the collapse of turbulence are general features of shear flows.

DY 16.6 Wed 16:00 ZEU 255

Control of Intermittent Turbulence in Pipe Experiments — •Bjoern Hof, Alberto de Lozar, and Devranjan samanta — Max Planck Institut fuer Dynamik und Selbstorganisation, Goettingen, Deutschland

Despite more than a century of research the onset of turbulence in pipe flow is still not well understood. Flows can in principle remain laminar for all Reynolds numbers (Re) but in practice, unless great care is taken, transition already occurs at moderate values of Re. Typically in the transitional regime flows change intermittently between laminar and turbulence. Here we study the dynamics at the interface between the two states of the flow. An instability mechanism is identified which continuously transfers energy from the laminar to the turbulent motion. From the observed dynamical behaviour we can rationalize the intermittent dynamics and why turbulent structures remain localized in this Re regime. Furthermore, having identified the energetically most active region of the flow, we are able to apply a simple control mechanism to intercept the energy transfer. In experiments carried out at relatively low Reynolds numbers this simple control concept is sufficient to destroy the localized turbulent structures. When this procedure is applied continuously turbulence can be fully omitted downstream of the control point.

15 min. break.

DY 16.7 Wed 16:30 ZEU 255

Numerical simulations of localized turbulence in shear flows — •Marc Avila and Bjoern Hof — Max Planck Institute für Dynamik und Selbstorganisation, Bunsenstraße 10, 37073 Göttingen, Germany

Subcritical transition to turbulence in shear flows has been recently interpreted in terms of novel developments in low-dimensional dynamical systems theory. At moderate Reynolods numbers, the flows are characterized by the presence of turbulent patches which are bounded by laminar regions. On the theoretical side, these states have been linked to the presence of a chaotic saddle embedded in the infinite-dimensional phase space of the Navier-Stokes equations. Experiments and numerical simulations show that at low Reynolds number localized turbulent states are transient, their lifetimes following and exponential distribution in accordance to theoretical predictions. However, conlifcting views are held in the community as to the transient behaviour of turbulence when the Reynolds number is increased. Instead, the focus of this contribution is on the understanding of the physical mechanisms feeding localized turbulent states. Numerical simulations are conducted in order to obtain pressure and vorticity distributions, as well as propagation speeds. Particular attention is paid to the spatial resolution requirements that need to be met in order to faithfully resolve the nonlinear dynamics.

DY 16.8 Wed 16:45 ZEU 255

Basin boundary, edge of chaos and edge state in a two-dimensional model — •Jürgen Vollmer[1,2], Tobias Schneider[2], and Bruno Eckhardt[2] — [1]Dept. Dynamics of Complex Fluids, MPI for Dynamics & Self-Organization, 37073 Göttingen, Germany — [2]FB Physik, Philipps Univ. Marburg, 35032 Marburg, Germany

Basin boundaries are the boundaries between the basins of attraction of coexisting attractors. When one of the attractors breaks up and becomes a transient repelling structure also the basin boundary disappears. Nevertheless, it is possible to distinguish the two types of dynamics in phase space and to define and identify a remnant of the basin boundary, the edge of chaos. We here demonstrate the concept using a two-dimensional (2D) map, and discuss properties of the edge of chaos and its invariant subspaces, the edge states. The discussion is motivated and guided by observations on certain shear flows like pipe flow and plane Couette flow where the laminar profile and a transient turbulent dynamics coexist for certain parameters, and where the notions edge of chaos and edge states proved to be useful concepts to characterize the transition to chaos. The 2D map captures many of the features identified in laboratory experiments and direct numerical simulations of hydrodynamic flows.

DY 16.9 Wed 17:00 ZEU 255

Quantification of mixing in micro-channels using finite time Lyapunov exponents — Aniruddha Sarkar and •Jens Harting — Institute for Computational Physics, University of Stuttgart, Germany.

The staggered herring-bone mixer (SHM) is a chaotic micromixer, which was recently developed by A.Stroock et al.. We obtain mixing here by a process called "chaotic advection", which occurs due to repeated stretching and folding of the fluid interfaces, even at low Reynold's number.

The ability of the fluids to mix well depends on the rate at which chaotic advection occurs in the mixer. In order to calculate the chaotic strength of a micromixer, we analyse finite-time Lyapunov exponents(FTLE). We simulate the fluid flow using the lattice Boltzmann method(LBM), introduce massless and non interacting tracer particles and from their trajectories we calculate the Lyapunov exponents. We calculate the Lyapunov exponents and then use this method to optimize the performance of the SHM. We varried the geometrical structures of the SHM and reproduce the optimal parameters known from the literature. Further we show that the mixing properties can be increased by adding hydrophobic surfaces.

DY 16.10 Wed 17:15 ZEU 255

Determining role of Krein signature for three-dimensional Arnold tongues of oscillatory MHD dynamos — •Oleg Kirillov[1], Uwe Guenther[2], and Frank Stefani[2] — [1]Technische Universität Darmstadt, D-64289 Darmstadt, Germany — [2]Forschungszentrum Dresden-Rossendorf, P.O. Box 510119, D-01314 Dresden, Germany

Using a homotopic family of boundary eigenvalue problems for the mean-field α^2-dynamo with helical turbulence parameter $\alpha(r) = \alpha_0 + \gamma\Delta\alpha(r)$ and homotopy parameter $\beta \in [0,1]$, we show that the underlying network of diabolical points for Dirichlet (idealized, $\beta = 0$) boundary conditions substantially determines the choreography of eigenvalues and thus the character of the dynamo instability for Robin (physically realistic, $\beta = 1$) boundary conditions. In the $(\alpha_0, \beta, \gamma)-$space the Arnold tongues of oscillatory solutions at $\beta = 1$ end up at the diabolical points for $\beta = 0$. In the vicinity of the diabolical points the space orientation of the 3D tongues, which are cones in first-order approximation, is determined by the Krein signature of the modes involved in the diabolical crossings at the apexes of the cones. The Krein space induced geometry of the resonance zones explains the subtleties in finding α-profiles leading to spectral exceptional points, which are important ingredients in recent theories of polarity reversals of the geomagnetic field.

DY 16.11 Wed 17:30 ZEU 255

Observation of the Interaction of Magnetic Particles in a Rotational Magnetic Field — •Simone Herth, Alexander Weddemann, and Andreas Hütten — Fakultät für Physik, Universität Bielefeld, Germany

The manipulation of magnetic particles on chip gained interest in the field of microfluidic systems, medical physics, such as hyperthermia, or nanobiotechnology in general. Especially, the advantages of magnetic particles include their possibility to be manipulated by an external magnetic field, detected by magnetoresistive sensors, and their easy handling.

If magnetic particles are under the influence of a rotational magnetic field, their interaction strongly depends on the frequency of the rotation. Starting with a low frequency of an applied rotational magnetic field, which arranges the particles in chains, the particles will finally not be influenced by the magnetic field at all at very high frequency. However, numerical simulations show that there is a critical frequency, which leads to a repulsive force between the particles (see abstract titled "Interactions of Magnetic Particles in Non-Magnetic Liquids"). The critical frequency depends on the particle size, the saturation magnetisation as well as the applied field and can be analysed by microscopic observations.

The talk will analyse the videos taken of moving particles in a rotational magnetic field at various frequencies, compare the results with simulations, and discuss some applications.

DY 16.12 Wed 17:45 ZEU 255

Interactions of Magnetic Particles in Non-Magnetic Liquids — •Alexander Weddemann, Simone Herth, and Andreas Hütten — Bielefeld University, Universitätsstraße 25, D-33615 Bielefeld, Germany

Magnetic particles on the micro- or nanoscale, so called magnetic beads, have a growing number of different applications in many different physical, chemical or medical fields, e.g. as contrast agents or drug carriers. One of their most important features is the possibility to manipulate them in e.g. microfluidic devices by an external magnetic field. However, external fields also align the magnetic moment vectors, which leads to high forces between particles on short distances inducing very strong fluid flows. Especially, though strong magnetic forces occur in these systems, they eventually do not exceed the hydrodynamic interactions of the particles anymore. To investigate the different force contributions, the behaviour of particles in a rotational or alternating homogenous magnetic field is analysed. We discuss the dependency of particle motion with respect to field frequency as well as the particle properties, e.g. size or saturation magnetization. Furthermore, the contributions of magnetic and hydrodynamic forces are discussed.

The experimental aspects of such systems are discussed in the presentation 'Observation of the Interaction of Magnetic Particles in a Rotational Magnetic Field'.

DY 17: Reaction-diffusion systems

Time: Wednesday 14:45–16:45 Location: ZEU 118

DY 17.1 Wed 14:45 ZEU 118

Controlling the onset of traveling pulses in reactions-diffusion systems by nonlocal feedback — •MarkusA. Dahlem[1], Felix M. Schneider[1], Jens Dreier[2], and Eckehard Schöll[1] — [1]Institut für Theoretische Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany — [2]Klinik für Neurologie, Charite, Universitätsmedizin Berlin

The onset of pulse propagation is studied in a reaction-diffusion (RD) model with control by nonlocal spatial coupling and by time-delayed feedback. We show that traveling pulses occur primarily as solutions to the RD equations while nonlocal feedback changes excitability. For certain ranges of RD and feedback parameter settings, defined as weak susceptibility and moderate control, respectively, the hybrid model can be mapped to the original RD model. This results in an effective change of RD parameters that can be expressed by algebraic functions of the control gain factor as the major control parameter. A distinctly new character is, however, added to the RD patterns outside these ranges. New patterns are obtained, for example step-wise propagation due to delay-induced oscillations. Nonlocal feedback constitutes a complementary signalling system to the classical RD mechanism of pattern formation. As a hybrid model, it combines the two major signalling systems in the brain, namely volume transmission and synaptic transmission. This theoretical model is developed in conjunction with experiments on the transition between RD pulse patterns and epileptic activity at an anatomical border.

DY 17.2 Wed 15:00 ZEU 118

Moving and breathing dissipative solitons in a three-component reaction-diffusion system — •Svetlana Gurevich and Rudolf Friedrich — Institute for Theoretical Physics, WWU Münster, Wilhelm-Klemm-Str. 9, 48149 Münster, Germany

We are interested in the stability of the stationary localized structures (so-called dissipative solitons) in a three-component reaction-diffusion system with one activator and two inhibitors. Changing the time constants of inhibitors can lead to various destabilizations of the stationary dissipative soliton. In many cases the breathing mode becomes unstable first and the stationary dissipative soliton undergoes a bifurcation from a stationary to a breathing state. On the other hand a mode responding to a movement can be unstable first and a drift-bifurcation takes a place. Here we are interested in the interaction between these two unstable modes. This situation is analyzed performing a multiple scale perturbation expansion in the vicinity of the codim 2 bifurcation point and the corresponding amplitude equation is obtained. Also numerical simulations are carried out showing good agreement with the analytical predictions.

DY 17.3 Wed 15:15 ZEU 118

Validation of effective medium theory for heterogeneous reaction-diffusion systems — •Sergio Alonso[1], Raymond Kapral[2], and Markus Baer[1] — [1]Physikalisch-Technische Bundesanstalt, Berlin, Germany — [2]University of Toronto, Toronto, Canada

Fronts and travelling waves are spatiotemporal structures observed in nonlinear chemical and biological systems. Experiments in the Belousov-Zhabotinsky reaction, catalysis and in cardiac tissue show that the properties of the waves are affected by heterogeneities and deformations which hinder the stable propagation. Numerical models usually assume spatially homogeneous systems, and do not consider any type of defect. There are, however, also models of biological processes where heterogeneous reaction-diffusion equations have been employed. Here we propose and effective medium theory for reaction-diffusion systems which relate both types of approaches. We compare the predictions of the theory with numerical simulations in different types of randomly heterogeneous media.

DY 17.4 Wed 15:30 ZEU 118

Equidistant band formation in a precipitation process — •Lukas Jahnke and Jan W. Kantelhardt — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, 06099 Halle, Germany

Abstract: In bottom-up pattern formation approaches one aims at designing materials with nano- or microscopic 2d or 3d patterns for specific applications. We study theoretically the 3d Liesegang pattern formation process, which is based on diffusion and reactions with a nucleation threshold. It usually yields banded structures with increasing inter-band distances. We find that equidistantly spaced bands can evolve if a gradient of the nucleation threshold or a gradient in the nucleation threshold fluctuations (due to heterogeneities) are imposed on the sample. Using extended lattice gas simulations of the reaction-diffusion process we confirm the equidistant band formation. We propose experimental strategies for 3d grids of silver nano-particles in a glass matrix. Ref.: Jahnke and Kantelhardt, EPL 84 (2008) 48006.

DY 17.5 Wed 15:45 ZEU 118

Extended complex Ginzburg-Landau equation for globally coupled electrochemical systems — •Vladimir Garcia-Morales and Katharina Krischer — Technische Universität München, Physik Department E19, James-Franck Str. 1, D-85748 Garching bei München, Germany

Nonlocal interactions in spatially extended electrochemical oscillators arise because of the effect of inhomogeneities in the distribution of the electrostatic potential. We have derived a nonlocal complex Ginzburg-Landau equation (NCGLE) that accounts for this nonlocal coupling (NLC) at the vicinity of a supercritical Hopf bifurcation.

Experimentally, it is straightforward to add a global coupling (GC) to the nonlocally coupled electrochemical oscillators. GC occurs naturally in these systems, for example, when an external resistance is introduced or when part of the cell resistance is compensated, an often applied technique in electrochemical experiments.

In this talk we discuss how the NCGLE can be extended rigorously to account for the GC of electrochemical oscillators. We show that the experimental GC is also weak close to the supercritical Hopf bifurcation, having the same scaling properties as the NLC. Therefore, a center manifold reduction allows the NCGLE to be extended rigorously to account for the GC. We discuss how the interaction between NLC and GC widens the spectrum of coherent structures found in globally coupled oscillatory media and allows for wavelength selection of standing waves, stabilization of phase clusters without breaking phase invariance, and creation of heteroclinic networks connecting families of oscillatory states characterized by different spatial symmetries.

DY 17.6 Wed 16:00 ZEU 118

Generalized Recurrence Quantification analysis reveals road to turbulence in the 2D Ginzburg-Landau equation — •Angelo Facchini[1,2], Chiara Mocenni[1,2], and Antonio Vicino[1,2] — [1]Center for the Study of Complex Systems, University of Siena, Italy — [2]Department of Information Engineering, University of Siena, Italy

We use the Generalized Recurrence Plot (GRP) and the Generalized Recurrence Quantification Analysis (GRQA) (*Phys. Lett. A, 360, 545, 2007*) to investigate the pattern formed by the Complex Ginzburg-Landau Equation (CGLE)(*Rev. Mod. Phys., 74, 99, 2002*). The state of the dynamical system in steady state conditions is here represented by an image, and the application of the GRQA assign to each image a value for both ENT and DET (*A. Facchini et al, Physica D (2008), in press*). The signature of the dynamics of the CGLE is identified by the position of the image in the DET-ENT diagram. We focus on the portion of the parameter space in which there are both absolutely stable and unstable spiral wave solutions, separated by a bifurcation line (*Physica A 224, 348, 1996*). Our results show that images belonging to different stability zones are clustered in different regions of the DET-ENT diagram. By looking at the parameters value for which the position of the image jumps from a cluster to another we are able to reconstruct the bifurcation line in the DET-ENT diagram. Furthermore, before the onset of the turbulent state (cluster jump) we observe a transition region located along the reconstructed bifurcation line.

DY 17.7 Wed 16:15 ZEU 118

Diffusion-limited reactions and mortal random walkers in confined geometries — •Ingo Lohmar and Joachim Krug — Institute for Theoretical Physics, Cologne, Germany

Motivated by the diffusion-reaction kinetics on interstellar dust grains, we study a first-passage problem of mortal random walkers in a confined two-dimensional geometry. We provide an exact expression for the encounter probability of two walkers, which is evaluated in limiting cases and checked against extensive kinetic Monte Carlo simulations. We analyze the continuum limit which is approached very slowly, with corrections that vanish logarithmically with the lattice size. We then examine the influence of the shape of the lattice on the first-passage probability, where we focus on the aspect ratio dependence: Distorting the lattice always reduces the encounter probability of two walkers and can exhibit a crossover to the behavior of a genuinely one-dimensional random walk. The nature of this transition is also explained qualitatively.

DY 17.8 Wed 16:30 ZEU 118

Binding kinetics of DNA and protein targets to surface tethered probes studied with switchable DNA surfaces — •Makiko Maruyama, Wolfgang Kaiser, Erika Pringsheim, Gerhard Abstreiter, and Ulrich Rant — Walter Schottky Institut, Technische Universität München, 85748 Garching, Germany

We report on the binding kinetics of DNA and protein targets to surface immobilized probes, using the *switch*DNA sensor. The overall detection performance of a biosensor depends on the transport of target molecules from solution to the sensor and the reaction rate of the targets with the probes. The influence of analyte flow across the sensor surface and the sensor temperature on the binding response is studied and the results are compared to solution measurements.

The hybridization of 24nt DNA on the *switch*DNA sensor proceeds with outstanding efficiency; the rate constants obtained on the surface ($k > 10^5 M^{-1}s^{-1}$) correspond to values measured in solution. The results indicate that the sensor predominantly operates in the reaction-limited case for the DNA binding experiments, whereas diffusion-limited kinetics are found for the binding of streptavidin to surface-tethered biotinylated probes. The results can be rationalized by theoretically estimating the operation conditions of the sensor based on dimensionless fluidic numbers, in particular the Péclet and Damköhler numbers. The rapid reaction of the biotin-streptavidin couple ($k > 5 \times 10^6 M^{-1}s^{-1}$ in solution) leads to the formation of a target-concentration depletion zone above the sensor surface and results in mass-transport limited kinetics.

DY 18: Granular matter / contact dynamics

Time: Wednesday 16:15–18:45 Location: HÜL 386

DY 18.1 Wed 16:15 HÜL 386

Quasistatic rheology at random close packing — •Claus Heussinger and Jean-Louis Barrat — Laboratoire de Physique de la Matière Condensée et Nanostructures Université Lyon 1, France

We report results of quasistatic shear simulations of athermal packings of frictionless elastic particles. We focus on densities at random close packing, where the system undergoes the "jamming" transition from a fluid to a solid state.

Previous studies have either concentrated on the linear elastic properties in the solid phase (development of "soft modes" under decompression, O'Hern PRE 2003), or on the flow properties of the fluid (e.g. Olson PRL 2007).

In contrast, the quasi-static method allows us to discuss both aspects at the same time as the simulation probes the borderline between fluid and solid phase – by construction it follows the yield-stress line of the material. The emerging coexistence of flowing and jammed states allows us to gain novel insights into the nature of the jamming transition.

DY 18.2 Wed 16:30 HÜL 386

Trigger of failure in granular assemblies — •Philipp Welker[1] and Sean McNamara[2] — [1]Institut für Computerphysik, Universität Stuttgart, 70569 Stuttgart, Germany — [2]GMCM, Institut de Physique de Rennes, Université de Rennes I, 35042 Rennes cedex, France

We investigate the mechanisms that trigger the collapse of assemblies of polydisperse granular media subjected to an increasing deviatoric stress. The DEM simulations in two dimensions are evaluated by use of the stiffness matrix.

It is always possible to identify a contact status change that triggers the collapse of the packing. This contact status change almost always causes, in small assemblies, a mechanical instability, or a motion with neutral stability. In a few cases, the status change provokes an oscillation, and a second status change following shortly thereafter introduces an instability. This is when failure happens, and the kinetic energy rises exponentially. In larger assemblies, motions with neutral stability become less frequent, while vibrations frequently appear.

We will explain the different trigger mechanisms and show how they depend on system size. Furthermore, we investigate the sources of energy that drive failure.

DY 18.3 Wed 16:45 HÜL 386

Theoretical Model of Avalanche Motion — •Birte Domnik, Christian Kröner, and Shiva P. Pudasaini — Steinmann Institut,Universität Bonn, Germany

A continuum model for rapid motion of granular material is presented, which provides both the geometry (height) and the velocity field of the granular flow. The knowledge of the motion and rheology of granular materials is needed in the area of snow avalanche hazard research in order to determine the regions at risk and the impact power of avalanches on defense structures. First a depth-integrated model [1] based on the Savage-Hutter model is presented, which is useful in regions where the flow is almost plane and vertical momentum transfer can be neglected. The main challenge in modelling a complete three dimensional flow is to find an appropriate description of the stresses in the material. Therefore, different stress models are implemented into a not depth-integrated flow model. To reduce the computing time the not depth-integrated and the depth integrated model will be coupled.
[1] S. P. Pudasaini, Avalanche Dynamics, Springer-Verlag,Berlin, 2007

DY 18.4 Wed 17:00 HÜL 386

Long-Time Tails and Cage Effect in Driven Granular Fluids — •Andrea Fiege[1], Timo Aspelmeier[1], and Annette Zippelius[1,2] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Institute of Theoretical Physics, University of Göttingen, Germany

We study the velocity autocorrelation function (VACF) of a driven granular fluid in the stationary state in 3 dimensions with the help of event driven molecular dynamic simulations. As the critical volume fraction of the glass transition in the corresponding elastic fluid is approached, we observe pronounced cage effects in the VACF as well as a strong decrease of the diffusion coefficient, depending on the strength of the inelasticity. At moderate densities the VACF is shown to decay algebraically in time like $t^{-3/2}$ if momentum is conserved locally, and like t^{-1} if momentum is not conserved by the driving. A simple scaling argument supports the observed long-time tails.

DY 18.5 Wed 17:15 HÜL 386

Measurement of fluctuation-dissipation temperature in a driven dense granular suspension. — •Sonia May[1], Alexander Buck[2], Harry Swinney[2], and Matthias Schröter[1] — [1]Max-Plank-Institut für Dynamik und Selbstorganisation, Göttingen, Germany — [2]Center for Nonlinear Dynamics, UT Austin

We use a water-fluidised bed to drive a dense suspension of glass spheres. We can control the kinetic energy of the suspended grains by changing the flow rate and viscosity of the liquid used to fluidise them. A sphere covered with grains and connected to a torsional pendulum is immersed in the suspension, with which we measure the fluctuation-dissipation temperature of the suspension at very low driving rates. The slow driving enables us to measure energy scales even below the limit at which fluidisation becomes macroscopically visible. Here, we observe a divergence of a damping term, the granular equivalent of viscosity. This we attribute to a granular equivalent of the glass transition.

15 min. break.

DY 18.6 Wed 17:45 HÜL 386

The Velocity Autocorrelation Function of a Driven Granular Fluid — •W. Till Kranz, Andrea Fiege, and Annette Zippelius — Institute for Theoretical Physics, University of Göttingen and MPI for Dynamic and Self Organization, Göttingen, Germany

We extend the equilibrium mode coupling theory (MCT) of molecular fluids [1] to the steady state of a driven granular fluid. This allows us to derive an analytic expression for the velocity autocorrelation function $\psi(t) \sim \langle \mathbf{v}_s(0)\mathbf{v}_s(t)\rangle$. We will briefly outline the key assumptions that form the basis of our derivation. Subsequently we will discuss how the rich phenomenology already present in the equilibrium hard sphere gas [2] carries over to the non-equilibrium case of a granular fluid. In particular we will focus on long-time tails, backscattering and the suppression of diffusion at high densities. In order to asses the range of validity of the theoretical predictions we compare it to extensive numerical data that has recently become available [3].

[1] W. Götze, in *Liquids, Freezing and Glass Transition* (North Holland, 1991)
[2] B. J. Alder, E. Wainwright, Phys. Rev. Lett. **18**, 988 (1967)
[3] A. Fiege, T. Aspelmeier, A. Zippelius, arXiv:0809.4432 to appear in PRL

DY 18.7 Wed 18:00 HÜL 386

Granular Robots — •Zeina Khan[1], Audrey Steinberger[1], Ralf Seemann[1,2], and Stephan Herminghaus[1] — [1]MPI for Dynamics and Self-Organization, Bunsenstr. 10, D-37073 Goettingen, Germany — [2]Experimental Physics, Saarland University, D-66041 Saarbruecken, Germany

We have observed that when a bidisperse 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 travel horizontally along the axis of vibration. We report on various 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 detailed analysis of the interplay between rotation and sliding in the beads' motion.

DY 18.8 Wed 18:15 HÜL 386

Modelling particulate self-healing materials and application to uni-axial compression — •Olaf Herbst[1,2], Akke Suiker[1], and Stefan Luding[2] — [1]Aerospace Engineering, TU Delft, Kluyverweg 1, 2629 HS Delft, The Netherlands — [2]Multi Scale Mechanics, TS, CTW, UTwente, P.O. Box 217, 7500 AE Enschede, The Netherlands

Using an advanced history dependent contact model for DEM simulations, including elasto-plasticity, viscosity, adhesion, and friction, pressure-sintered tablets are formed from primary particles. These tablets are subjected to uni-axial compression until and beyond failure displaying peak strength. For fast and slow deformation we observe ductile-like and brittle softening, respectively.

We propose a model for local self-healing that allows damage to heal during the loading process such that the material strength of the sample increases and failure/softening is delayed to larger strain. Local healing is achieved by increasing the (attractive) contact adhesion forces for those particles involved in a potentially breaking contact.

We examine the dependence of the strength of the material on (a) the damage detection sensitivity, (b) the damage detection rate, and (c) the (increased) adhesion between healed contacts. The material strength is enhanced, i.e. the material fails at larger strains and reaches larger maximal stress values, when any of the parameters (a) – (c) is increased.

DY 18.9 Wed 18:30 HÜL 386

Wet Discs Running Down an Inclined Plane — •Seyed Habibollah Ebrahimnazhad Rahbari, Martin Brinkmann, Juergen Vollmer, and Stephan Herminghaus — Dept. Dynamics of Complex Fluids, MPI for Dynamics and Self-Organization, D-37073 Göttingen, Germany

We present results of MD-type simulations of wet discs running down an inclined plane. In our model, particles interact via a repulsive force, when they overlap, and via a hysteretic attractive force caused by liquid bridges. A liquid bridge forms when two adjacent wet discs touch each other, and entails to an attractive hysteretic force $F_{lb}(x)$ due to the surface tension of the liquid. That capillary bridge ruptures when the distance between two grains exceeds a critical separation S_c and dissipates energy. We use a minimal capillary model in which F_{lb} is assumed to be constant as the liquid bridge is stretched. The dissipation in our model is only due to the rupture events of the liquid bridges.

The systems are set up by sedimentation of the discs, and immobilization of discs touching the bottom wall. Subsequently, a tilted force is applied. We find a simple scaling expression for the fluidization transition as a function of the gravitational acceleration g, the inclination angle θ, and the rupture separation S_c. For most parameter values beyond the transition, the system settles down into to a stationary homogeneous fluidized state. However, there are also regimes where it becomes bistable or shows a thermal runaway.

DY 19: Quantum dynamics, decoherence and quantum information

Time: Wednesday 17:00–18:00 Location: ZEU 118

DY 19.1 Wed 17:00 ZEU 118

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

Through the advent and the implementation of quantum information technology over the past decade there is a 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. In addition, we give a generalized definition of heat and work based on the previous results and the concept of a local effective measurement basis (LEMBAS [1]).

[1] H. Weimer et al., Europhys. Lett. 83 (2008), 30008

DY 19.2 Wed 17:15 ZEU 118

Quantum dynamics in dispersive optomechanics — •Georg Heinrich and Florian Marquardt — LMU, Department für Physik, Arnold-Sommerfeld Center, CeNS, Theresienstr. 37, 80333 München

Macroscopic mechanical objects can be coupled to electromagnetic fields through radiation pressure. These optomechanical setups are supposed to reveal quantum effects and allow to explore the interaction of light and matter in a new regime at the boundary between quantum and classical physics. The realization of a macroscopic object, cooled to its quantum mechanical ground state, seems to be within experimental reach. Nevertheless, the detection of its energy eigenstates poses fundamental challenges. One of the most promising setups in the field is a dispersively coupled system where a dielectric membrane is placed in the middle between two high-finesse mirrors. Apart from the experimental advantage of separating mechanical and optical units, in principle, this approach allows Fock state detection and QND measurements. Here, we investigate cavity-photon dynamics of such a system in the regime where the timescale for photon exchange, between the two cavity halves, becomes comparable to the mechanical oscillation period. We discuss arising mechanical sidebands in the cavity spectrum that produce hybridized states which are superpositions of optical excitations in both sides of the cavity, with states that include phonons in the membrane. This will have implications on Fock state detection and might as well be relevant for other systems such as mechanical objects coupled to superconducting cavities.

DY 19.3 Wed 17:30 ZEU 118

Statistical model for the effects of dephasing on transport properties of large samples — •Matías Zilly[1], Orsolya Ujsághy[1,2], and Dietrich E. Wolf[1] — [1]Department of Physics, University of Duisburg-Essen and CeNIDE, 47048 Duisburg, Germany — [2]Department of Theoretical Physics and Condensed Matter Research Group of the Hungarian Academy of Sciences, Budapest University of Technology and Economics, Budafoki út 8., H-1521 Budapest, Hungary

We present a statistical model for the effects of dephasing on the transport properties of large devices. The physical picture is different from earlier models which assume that dephasing happens continuously throughout the sample, whereas we model the dephasing in a statistical sense, assuming a distribution of completely phase-randomizing regions between which the transport is coherent and described by the nonequilibrium Green's function method. Thus the sample is effectively divided into smaller parts making the numerical treatment more efficient. As a first application the conductances of ordered and disordered linear tight-binding chains are calculated and compared to the results of other phenomenological models in the literature.

DY 19.4 Wed 17:45 ZEU 118

Exact quantum quench dynamics of the fermionic pairing model — •Alexandre Faribault[1], Pasquale Calabrese[2], and Jean-Sébastien Caux[3] — [1]Physics Department, ASC and CeNS, Ludwig-Maximilians-Universität, Theresienstr. 37, 80333 München, Germany — [2]Dipartimento di Fisica dell'Università di Pisa and INFN, 56127 Pisa, Italy — [3]Institute for Theoretical Physics, Universiteit van Amsterdam, 1018 XE Amsterdam, The Netherlands

Understanding the non-equilibrium dynamics of extended quantum systems after the trigger of a sudden, global perturbation (quench) represents a daunting challenge, especially in the presence of interactions. The main difficulties stem from both the vanishing time scale of the quench event, which can create arbitrarily high energy modes, and its non-local nature, which precludes the utility of local excitation bases.

We here show that nonperturbative methods based on integrability can prove sufficiently powerful to completely characterize quantum quench problems: we illustrate this using a simple model of fermions with pairing interactions (Richardson's model).

The effects of quenches on the dynamics of important observables are discussed. Many of the features we find are expected to be universal to all kinds of quench situations in atomic physics and condensed matter.

DY 20: Focused Session: Pattern formation in colloidal and granular systems

Time: Thursday 9:30–12:45 Location: HÜL 386

Invited Talk DY 20.1 Thu 9:30 HÜL 386

Magnetic granular matter: from lattices to self-assembled swimmers — •Igor Aranson, Alexey Snezhko, Maxim Belkin, and Wai Kwok — Materials Science Division, Argonne National Laboratory, Argonne, IL60439

Fundamental mechanisms governing pattern formation and self-assembly in granular matter with complex interactions have been attracting enormous attention in the physics community. I will discuss novel dynamic patterns formed at magnetically driven granular matter: self-assembled magnetic surface swimmers: *magnetic snakes*. The snakes self-assemble from a dispersion of magnetic microparticles suspended on the liquid-air interface and subjected to an alternating magnetic field. The self-propulsion mechanism is related to a spontaneous symmetry breaking instability of the self-generated surface flows. We present a phenomenological model which reproduces observed features of the magnetic surface swimmers. In addition, formation of snakes is captured by hybrid molecular dynamics simulations of magnetic particles on the surface of fluid.

Topical Talk DY 20.2 Thu 10:00 HÜL 386

Non-equilibrium aggregates in confined systems of self-propelling colloidal rods — •Rik Wensink[1] and Hartmut Löwen[2] — [1]Department of Chemical Engineering, Imperial College London, South Kensington Campus, London SW7 2AZ, United Kingdom — [2]Institut für Theoretische Physik II: Weiche Materie, Heinrich-Heine-Universität-Düsseldorf, Universitätsstraße 1, D-40225 Düsseldorf, Germany

Swimming microorganisms, birds and fish often move collectively in large groups with spontaneous liquid crystalline order. Considerable research activity has been devoted in recent years to understand the origin of flocks and swarms in terms of simple models of self-propelled particles. In these models, "active" rods are driven by their own motor along the rod orientation axis and dissipate energy in the suspending medium. While the bulk behaviour of "active matter" is by now well understood, very little is known about the effects of system boundaries and confining geometries.

We have studied the non-equilibrium collective behavior of self-propelled colloidal rods moving in narrow channels by means of Brownian dynamics computer simulation and dynamical density functional theory. We observe an aggregation process in which rods self-organize into compact clusters that are transiently jammed at the channel walls. In the early stages of the aggregation process, fast-growing hedgehog-like wall clusters are formed which are virtually immobile. At later stages, most of these clusters dissolve and mobilize into nematized aggregates moving along the channel walls.

Topical Talk DY 20.3 Thu 10:30 HÜL 386

Beyond Faraday's crispations: nonlinear patterns of shaken granular material — •Christof Kruelle — Maschinenbau und Mechatronik, Hochschule Karlsruhe - Technik und Wirtschaft

When granular material is shaken both in horizontal and vertical direction simultaneously, as commonly done in vibratory conveyors that are well established in routine industrial production for controlled transport of bulk solids, the transported goods can exhibit a surprisingly large variety of surface patterns. For example, if a monolayer of glass beads is vibrated in a circularly manner in a narrow annular channel, a coexistence of a solidlike and a gaslike domain can be observed. The solid fraction decreases with increasing acceleration and shows hysteresis. The sharp boundaries between the two regions travel around the channel faster than the particles are transported. By using a molecular dynamics simulation we were able to extract the local granular temperature and number density. It was found that the number density in the solid phase is several times that in the gas, while the temperature is orders of magnitude lower.

If the number of particles is increased further, localized period-doubling waves arise. These solitary wave packets are accompanied by a locally increased particle density. The width and velocity of the granular wave pulses are measured as a function of the bed height. A continuum model for the material distribution, based on the measured granular transport velocity as a function of the bed thickness, captures the essence of the experimental findings.

15 min. break.

Topical Talk DY 20.4 Thu 11:15 HÜL 386

Archimedean-like Tilings on Decagonal Quasicrystalline Surfaces — •Clemens Bechinger, Jules Mikhael, and Laurent Helden — 2. Physikalisches Institut, Stuttgart, Germany

Monolayers on crystalline surfaces often form complex structures having physical and chemical properties strongly differing from those of their bulk phases. Such hetero-epitactic overlayers are currently used in nanotechnology and understanding their growth mechanism is important for the development of novel materials and devices. Compared to crystals, quasicrystalline surfaces exhibit much larger structural and chemical complexity leading e.g. to unusual frictional, catalytical or optical properties. Accordingly, deposition of thin films onto such substrates can lead to novel structures which may even exhibit typical quasicrystalline properties. Recent experiments indeed demonstrate 5-fold symmetries in the diffraction pattern of metallic layers adsorbed onto quasicrystals. Here we report a real-space investigation of the phase behaviour of a colloidal monolayer interacting with a quasicrystalline decagonal substrate created by interfering five laser beams. We observe a novel pseudomorphic phase which exhibits likewise crystalline and quasicrystalline structural properties. It can be described by an Archimedean-like tiling consisting of alternating rows of square and triangular tiles. The calculated diffraction pattern of this phase is in agreement with recent observations of copper adsorbed on icosahedral AlPdMn surfaces.

Topical Talk DY 20.5 Thu 11:45 HÜL 386

Injection in a confined granular suspension: from the Saffman-Taylor fingering instability up to flow inside a weakly jammed granular matrix. — Christophe Chevalier[2], Anke Lindner[1], Oeistein Johnson[1], and •Eric Clement[1] — [1]PMMH-ESPCI, Paris, France — [2]LCPC, Paris , France

The dynamics of fluid injection inside another one is a strong and debated issue in the context of many industrial and geophysical applications. When the displaced fluid is a complex fluid, the injection front is rarely stable and complex injection patterns usually form. These instabilities lead to strong and heterogeneous flows localisation and present a severe challenges to the fundamental understanding and accurate modelling, of multi-phases flow transfer. Here, we present recent experimental work on a simple experimental model of fluid injection inside a granular suspension confined in a Hele-Shaw cell. The density of the suspension can be varied continuously from low values up to the suspension jamming limit. The injected fluid can either be a non miscible fluid or a miscible one (like the suspension's surrounding fluid). This simple model allows a detailed investigation of many archetypal situations that extend the Saffman-Taylor fingering instability to the case of particulate fluids (Chevalier et al. Phys.Rev.Lett.(2007); Johnson et al. Phys.Rev.E(2008)) and address in a controlled way the case of hydro-fracturing in mechanically weak porous materials (Chevalier et al. JNNFM (2008)). Other collaborators : K-J.Maloy, E.Flekkoy, Univ.Oslo; R.Toussaint,J.Schmittbuhl, IPG Strasbourg.

Topical Talk DY 20.6 Thu 12:15 HÜL 386

Pattern Formation in Colloids Induced by Shear Flow and Electric Fields. — •Jan Dhont, Kyongok Kang, and Pavlik Lettinga — Forschungszentrum Juelich

Shear flow and electric fields are shown to induced non-patterned states in suspensions of colloidal rods (fd-virus particles). In part of the two-phase, paranematic-nematic region in the non-equilibrium phase diagram of colloidal rods under flow, regularly bands are formed that extend along the vorticity direction. Experiments indicate that the possible mechanism for the vorticity-banding instability is due to non-uniform elastic deformation of inhomogeneities that are formed during the initial stages of phase separation. This is similar to the Weissenberg effect in polymeric systems, where hoop stresses give rise to rolling flow as a result of the non-uniform deformation of polymer chains. Vorticity banidng is thus proposed to be similar to the Weissenberg effect, where the role of polymers is now played by inhomogeneities. The non-equilibrium phase/state behaviour of charged colloidal rods in electrric fields will be discussed, where the frequency is sufficiently low to polarize double layers. The polarized double layer around each of the rods interact with eachother, giving rise to a number of phases and dynamical states depending on the electric field amplitude and the frequency.

DY 21: Quantum chaos II

Time: Thursday 10:15–13:00 Location: ZEU 255

DY 21.1 Thu 10:15 ZEU 255

The x-ray edge problem in integrable quantum dots — •Georg Röder and Martina Hentschel — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, 01187 Dresden, Germany

The x-ray edge problem in metals, which constitutes a well-studied many-body problem, is a classic problem in condensed matter physics. Here we address the question how the smallness and the individual properties of mesoscopic systems such as quantum dots affect the Fermi-edge singularities in the photo absorption signal. To this end, we follow a Fermi golden rule approach and model the localized core hole left behind upon the excitation of a core electron as a localized, or rank one, perturbation [K.Ohtaka and Y.Tanabe, RMP 62, 929 (1990)]. For the transition of a s core electron into a s-like quantum dot level (K-edge), we find the threshold absorption processes to be enhanced compared to the metallic case where typically a rounded K-edge is found as a consequence of Anderson orthogonality catastrophe. The enhancement is particularly strong when the core hole appears close to the (hard-wall) boundary of quantum dots of integrable (circular and rectangular) shape. This effect holds also for parabolic quantum dots that possess soft walls. An external magnetic field further increases the peaked photo absorption signal at the K-edge. We compare our findings to results for chaotic quantum dots obtained by random matrix theory [M.Hentschel, D.Ullmo and H.Baranger, PRL 93, 176807 (2004)].

DY 21.2 Thu 10:30 ZEU 255

The semiclassical continuity equation for open chaotic systems — •Jack Kuipers, Daniel Waltner, Martha Gutiérrez, and Klaus Richter — Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany

We consider the continuity equation for open chaotic quantum systems in the semiclassical limit, where the survival probability and the current density can be approximated by expressions involving classical trajectories. Performing an expansion based on correlated trajectories it is possible to show that the continuity equation, which links the survival probability to the current density, is satisfied within the semiclassical approximation to all orders. For this we develop recursion relation arguments which connect the trajectory structures involved for the survival probability, which travel from one point in the bulk to another, to those structures involved for the current density, which travel from the bulk to the lead.

arXiv:0811.2164

DY 21.3 Thu 10:45 ZEU 255

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 $\hbar \gg \Phi$, while in the opposite case 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, namely two chaotic regions separated by one dominant partial barrier. This enables us to investigate the properties of eigenfunctions under variation of the ratio $\hbar/\Phi$ and to search for a universal scaling.

DY 21.4 Thu 11:00 ZEU 255

A semiclassical approach to the ac conductance of quantum chaotic cavities — •Cyril Petitjean, Daniel Waltner, Jack Kuipers, Inanc Adagideli, and Klaus Richter — Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany

Due to progress in the control and manipulation of mesoscopic structures driven by high frequency periodic voltages, the ac regime has recently been experimentally investigated [1] and consequently theoretical interest in it has been renewed. We consider a quantum chaotic cavity that is coupled via (tunnel) barriers and gates to a macroscopic circuit which contains ac-sources. For the transparent barrier, our semiclassical techniques permit us to include the Ehrenfest time in the weak-localization correction to the screened conductance, previously obtained by random matrix theory [2]. Then by extending recent semiclassical theory in presence of tunnel barriers [3] to the ac-transport, we investigate the effect of dephasing on the relaxation resistance of a chaotic capacitor in the linear low frequency regime. This last investigation is in principle relevant to the recent measurements of the admittance at zero magnetic flux of a mesoscopic capacitor [1,4].

[1] J. Gabelli et al., Science **313**, 499 (2006).
[2] P.W. Brouwer and M. Büttiker, Europhys. Lett. **37**, 441 (1997).
[3] R.S. Whitney, Phys. Rev. **B, 75**, 235404 (2007).
[4] S. Nigg and M. Büttiker, Phys. Rev. **B 77**, 085312 (2008).

DY 21.5 Thu 11:15 ZEU 255

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, where regular and chaotic regions 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.

15 min.break.

DY 21.6 Thu 11:45 ZEU 255

Transport of Bose-Einstein condensates through two-dimensional billiard geometries — •Timo Hartmann, Michael Hartung, Juan-Diego Urbina, and Peter Schlagheck — Institute for Theoretical Physics, University of Regensburg, D-93040 Regensburg, Germany

The tremendous progress in the experimental techniques for Bose-Einstein condensates during the last decade lead to the realization of almost arbitrarily shaped confinement and waveguide geometries for interacting matter waves [1]. This opens new experimental possibilities for probing the transport of Bose-Einstein condensates through various mesoscopic structures. We numerically investigate the quasi-stationary propagation of a condensate through two dimensional cavities within the mean-field approximation of the condensate. Our calculations rely on a nonlinear Green function method that is based on the Gross-Pitaevskii equation. We study, on the one hand, resonant transport through nearly closed cavities, where the presence of the nonlinearity results in strong nontrivial distortions of the resonance peaks. On the other hand, we are investigating the transmission of the condensate through wide open cavities with chaotic classical dynamics. Here we focus on the question how the scenario of weak localization is modified by the presence of the atom-atom interaction [2].

[1] W. Guerin et al., Phys. Rev. Lett. **97**, 200402 (2006);V. Milner et al. Phys. Rev. Lett. **86**, 1514 (2001)
[2] M. Hartung et al., Phys. Rev. Lett. **101**, 020603 (2008).

DY 21.7 Thu 12:00 ZEU 255

Wavepacket dynamics in energy space of a chaotic trimeric Bose-Hubbard system — •Moritz Hiller[1], Tsampikos Kottos[2,3], and Theo Geisel[3] — [1]Fakultät für Physik, Albert-Ludwigs-Universität Freiburg, Germany — [2]Department of Physics, Wesleyan University, Middletown CT, USA — [3]Max-Planck-Insitut für Dynamik und Selbstorganisation, Göttingen, Germany

We study the energy redistribution of interacting bosons in a ring-shaped quantum trimer as the coupling strength between neighboring sites of the corresponding Bose-Hubbard Hamiltonian undergoes a sudden change δk. In the framework of (ultra-)cold atoms on optical lattices this perturbation corresponds to a modulation of the trapping potential. Our analysis is based on a three-fold approach combining linear response theory calculations as well as semiclassical and random matrix theory considerations. The δk-borders of applicability of each of these methods are identified by direct comparison with the exact quantum mechanical results. We find that while the variance of the evolving quantum distribution shows a remarkable quantum-classical correspondence (QCC) for all δk-values, other moments exhibit this QCC only in the non-perturbative δk-regime.

DY 21.8 Thu 12:15 ZEU 255

Underdamped quantum ratchets — •Sergey Denisov, Sigmund Kohler, and Peter Hänggi — Universitat Augsburg,Universitätsstrasse 1, D-86135 Augsburg, Germany

We investigate the quantum ratchet effect under the influence of weak dissipation which we treat within a Floquet-Markov master equation approach. A ratchet current emerges when all relevant symmetries are violated. Using time-reversal symmetric driving we predict a purely dissipation-induced quantum ratchet current. This directed quantum transport results from bath-induced superpositions of non-transporting Floquet states.

DY 21.9 Thu 12:30 ZEU 255

Microwave Floquet-systems — •Timur Tudorovskiy, Ulrich Kuhl, and Hans-Jürgen Stöckmann — Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany

We present a theory of a two-dimensional quantum billiard perturbed by a non-stationary point-like coupling. The theory is based on a generalization of the approach recently published in [1]. Among others it covers the case of the periodic perturbation, i.e. a Floquet system. This special type of a Floquet-system is of a particular interest, since it could be realized in microwave experiments. The theory describes a sideband-structure obtained from the reflection/transmission measurements with microwave billiards. To calculate the sideband-structure one has to solve a set of integral equations. Similar equations were obtained in the problem of electron detachment from an ionized atom [2]. The equations are simplified significantly when only a single isolated resonance is considered. For such a system the sideband-structure can be described by a first order differential equation. It shows the main features similar to those known from the solution of a one-dimensional Schrödinger equation with two focal points. We realized a microwave setup simulating the system with a single periodically perturbed resonance. We concluded that the experimentally obtained sideband structure shows all theoretically predicted peculiarities and can be successfully described by the presented theory.

[1] T. Tudorovskiy et al. J. Phys. A, 41 (2008) 275101
[2] Yu. N. Demkov and V. N. Ostrovskiy, Plenum Press, New York, 1988.

DY 21.10 Thu 12:45 ZEU 255

Exceptional Points in Microcavity Systems — •Jeong-Bo Shim[1], Sang-Bum Lee[2], Soo-Young Lee[2], Juhee Yang[2], Sonky Moon[2], Kyungwon An[2], Jai-Hyung Lee[2], Jungwan Ryu[3], and Sang Wook Kim[3] — [1]Max-Planck Institute for the Physics of Complex Systems, Nöthnitzer Strasse 38, D-01187, Dresden, Germany — [2]School of Physics and Astronomy, Seoul National University, Seoul, 151-742, Korea — [3]Department of Physics Education, Pusan National University, Busan, 609-735, Korea

A physical system with multiple interacting modes can generally show the level-repulsion in its spectrum by adjusting a system parameter. In the case that this system is opened, the openness may play a role of the additional parameter, thereby it may show a singular topological structure around the level-repulsion, which is so-called 'the exceptional point'. In terms of openness and coupling of modes, a chaotic deformed microcavity can be a good example to study about it. In this talk, we will discuss about the observation of the exceptional point in the microcavity spectrum and some relevant phenomena.

DY 22: Brownian motion and transport II

Time: Thursday 10:15–13:00 Location: ZEU 118

DY 22.1 Thu 10:15 ZEU 118

Uphill motion in a deterministic relativistic Josephson Vortex Ratchet — •Edward Goldobin[1], Martin Knufinke[1], Kai Buckenmaier[1], Michael Siegel[2], Dieter Koelle[1], and Reinhold Kleiner[1] — [1]Physikalisches Institut and Center for Collective Quantum Phenomena, University of Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany — [2]Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe (KIT), Hertzstr. 16, D-76187 Karlsruhe, Germany

We investigate experimentally a deterministic relativistic Josephson vortex ratchet (JVR), i.e., a fluxon moving in a spatially asymmetric potential along annular long Josephson junction. The fluxon is driven by deterministic ac force with zero time average[1,2,3,4]. The rectification of an applied ac drive to a dc voltage (unidirectional fluxon motion) in such a system was demonstrated earlier in both quasi-static and non-adiabatic regimes[2,4]. Still the ratchet was not loaded. Now, being in the rectification regime, we apply an additional bias current which tilts the potential so that the fluxon moves uphill due to the ratchet effect. At some value I_{stop} of the bias current the fluxon stops. We determine I_{stop} both experimentally and numerically in a quasi-static and in a non-adiabatic regime and show the regions that are most favorable for operation of a JVR.

[1] P. Hänggi *et al.*, Ann. Phys. (Leipzig) **14**, 51 (2004)
[2] G. Carapella *et al.*, Phys. Rev. Lett. **87**, 077002 (2001).
[3] E. Goldobin *et al.*, Phys. Rev. E **63**, 031111 (2001).
[4] M. Beck *et al.*, Phys. Rev. Lett. **95**, 090603 (2005).

DY 22.2 Thu 10:30 ZEU 118

Computer simulation of ratchet transport of colloids on magnetically striped substrates — •Andrea Fortini and Matthias Schmidt — Theoretische Physik II, Universität Bayreuth, Universitätsstraße 30, D-95440 Bayreuth, Germany

We consider a two-dimensional model of paramagnetic colloidal particles on a magnetically patterned substrate. The pattern consists of stripe-like domains with opposite magnetization and wavelengths of the order of several particle diameters. The influence of an external oscillating magnetic field induces directed particle transport via a ratchet mechanism. Using computer simulations we investigate which of the collective transport phenomena observed in experiments with super-paramagnetic particles sedimented on top of a garnet film [P. Tierno et al, Phys. Rev. Lett 100, 148304 (2008)] can be realized with simple model dynamics. In particular the importance of the roles of topology and of curvature of the magnetic domains is addressed.

DY 22.3 Thu 10:45 ZEU 118

Magnetic Ratchet for transportation and separation of magnetic beads — •Alexander Auge, Alexander Weddemann, Frank Wittbracht, and Andreas Hütten — Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld, Germany

Transport phenomena in spatially periodic magnetic systems far from thermal equilibrium are considered. The emphasis is put on directed transport of magnetic beads in a so called magnetic ratchet (Brownian motor). An asymmetric magnetic potential and Brownian motion of magnetic beads are the basic concepts for a magnetic ratchet. The asymmetric magnetic potential is achieved by combining an external magnetic field with a spatial periodic array of conducting lines. In this work simulations are carried out to test and optimize this asymmetric potential. As simulation model the Smoluchowski equation with additional flux terms for the magnetic and gravitational force is used. Furthermore experiments are carried out to verify the simulation results. Possible applications like transport in microfluidic devices and separation of magnetic beads are discussed.

DY 22.4 Thu 11:00 ZEU 118

Classical and quantum spin pumps — •Fredy Leonardo Dubeibe Marin[1,2,3], Thomas Dittrich[1,2], and Klaus Richter[3] — [1]Universidad Nacional de Colombia, Departamento de Fisica, Bogota D.C., Colombia — [2]CeiBA – Complejidad, Bogota D.C., Colombia — [3]Institut für Theoretische Physik Universität Regensburg, Regensburg, Germany

Chaotic scattering with an internal degree of freedom and the possibility to generate directed transport of angular momentum in such a system is studied in a specific model, a magnetic dipole moving in periodically modulated magnetic field confined to a compact region in space. We show that this system is an irregular scatterer in large parts of its parameter space. If in addition all spatio-temporal symmetries are broken, directed transport of mass as well as angular momentum occurs. The sensitive parameter dependence of the corresponding currents includes frequent sign reversals. Zeros of either current quantity correspond to the exclusive occurrence of the other and thus give rise in particular to angular-momentum separation without mass transport as a classical analogue of spin-polarized currents. For the quantum case, we sketch the theory for spins and indicate how to extend our classical results in this context. Employing Floquet scattering theory we show that the basic mechanism responsible for the separation of spins in the classical case carries over to the quantum level, thus giving rise to a spin pump capable of generating polarized spin currents.

DY 22.5 Thu 11:15 ZEU 118

Ultrasonically driven nano-mechanical single-electron shuttle — •Daniel König, Eva Weig, and Jörg Kotthaus — Center for NanoScience and Fakultät für Physik der Ludwig-Maximilians-Universität, Geschwister-Scholl-Platz 1, 80539 München, Germany

The transport and detection of single electrons with extraordinary precision has been a long sought goal since its potential impact on metrology was recognized in the 80s. The one-by-one electron transfer with a well defined frequency for example may ultimately lead to the realisation of a quantum standard for the electrical current unit ampere - like the ones already implemented for voltage and resistance based on the Josephson and Quantum Hall effect, respectively. One possible approach to this goal is the mechanical transfer of single electrons. In the talk a nano-mechanical electron shuttle is presented which is mechanically excited by ultrasonic waves and placed within a Faraday cage to shield it from undesired electromagnetic fields. By this, electrically undisturbed mechanical electron transport at temperatures as low as 4 Kelvin is demonstrated. The results demonstrate that the nano-mechanical electron shuttles belong to the class of impacting systems, are intrinsically non-linear and display harmonic, subharmonic and chaotic behaviour. For a certain operating regime excellent agreement in the high temperature limit (20K) between the measured data and theoretical calculations is observed. Further more, the results suggest that operation in the Coulomb blockade regime, for which a well defined number of electrons is transferred during each oscillation period, is within reach for reduced sample dimensions and lower temperatures.

15 min. break.

DY 22.6 Thu 11:45 ZEU 118

Branched flow and caustics in random media with magnetic fields — •Jakob Metzger[1,2], Ragnar Fleischmann[1,2], and Theo Geisel[1,2] — [1]Max-Planck-Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Institute for Nonlinear Dynamics, Department of Physics, University of Göttingen, Germany

Classical particles as well as quantum mechanical waves exhibit complex behaviour when propagating through random media. One of the dominant features of the dynamics in correlated, weak disorder potentials is the branching of the flow. This can be observed in several physical systems, most notably in the electron flow in two-dimensional electron gases [1], and has also been used to describe the formation of freak waves [2].

We present advances in the theoretical understanding and numerical simulation of classical branched flows in magnetic fields. In particular, we study branching statistics and branch density profiles. Our results have direct consequences for experiments which measure transport properties in electronic systems [3].

[1] e.g. M. A. Topinka *et al.*, Nature **410**, 183 (2001), M. P. Jura *et al.*, Nature Physics **3**, 841 (2007)
[2] E. J. Heller, L. Kaplan and A. Dahlen, J. Geophys. Res., **113**, C09023 (2008)
[3] J. J. Metzger, R. Fleischmann and T. Geisel, *in preparation*

DY 22.7 Thu 12:00 ZEU 118

Suppression of size-quantization steps in disordered graphene

nanoribbon — •Florian Libisch, Stefan Rotter, and Joachim Burgdörfer — Inst.f.theoretische Physik, TU Wien, Österreich

We numerically study impurity scattering in graphene nanoribbons as a function of impurity density and ribbon length. For long ribbons (ribbon length up to 3 micrometers) we observe exponential (Anderson) localization of the wave function over eight orders of magnitude. To contrast the role of AB and K-K' scattering, we compare impurities that either break or conserve pseudo-spin. By calculating the scattering wave function on the A and B sublattice, we can directly visualize broken pseudo-spin conservation. Using a Fourier transformation allows us to quantitatively assess, for different impurity types, the amount of AB and K-K' scattering. For perfect ribbons, the conductance features size quantization steps due to the transverse confinement. We find that these steps are strongly suppressed in disordered ribbons for impurities that break the AB-symmetry. In contrast, short-range impurities that conserve pseudo-spin result in K-K' scattering and preserve size quantization steps. Comparison of our results with recent experimental data suggests that broken AB symmetry plays an important role in realistic graphene devices.

DY 22.8 Thu 12:15 ZEU 118

On moments and scalings in random walks — Michael Schmiedeberg, •Vasily Zaburdaev, and Holger Stark — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, D-10623 Berlin, Germany

Anomalous diffusion is commonly characterized by an exponent in the power law behavior of the mean square displacement as a function of time. In many cases this exponent does not provide any information about the scaling properties of the probability density function, not mentioning some superdiffusive regimes with a divergent second moment. However, the study of fractional moments can reveal the missing information. For the class of coupled random walks, one of them is the famous Levy walk model, we systematically analyze three methods used to analytically obtain characteristic exponents for the mean square displacement, scaling of the central part and the asymptotic profile of the probability density function. For example, we show that the scaling of the central part of the probability density can be determined using fractional moments $\langle|\mathbf{r}|^q\rangle$ with $q \ll 1$. These methods deliver distinct and complementary information about an underlying stochastic process. We show how our results can be accessed from experimental data.

DY 22.9 Thu 12:30 ZEU 118

$1/f^\beta$ Noise in Systems showing Weak Ergodicity Breaking — •Markus Niemann, Ivan Szendro, and Holger Kantz — Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany

Systems with weakly broken ergodicity are characterized by the property that the temporal average of an observable does not converge towards its mean value (the ensemble average) in the long time limit, although the phase space does not decompose into mutually inaccessible regions. This behavior is commonly found in systems with power law relaxation such that the relaxation time diverges to infinity. Here the weak ergodicity breaking expresses itself in the fact that the limit of the time average is described by a nontrivial probability distribution. Rebenshtok and Barkai introduced a stochastic model describing these features [PRL 99, 210601 (2007); J Stat Phys 133, 565 (2008)] using which they calculated the limit probability distributions of the time average.

By using a recently published method [PRE 78, 051104 (2008)] we determine the spectral properties of this model. We find analytically that the model shows $1/f^\beta$ noise, but similarly to the time average the spectrum does not converge to a fixed value but remains a probability distribution in the limit of the observation time going to infinity. Furthermore, the spectral values for different frequencies are only weakly correlated resulting in pronounced fluctuation around the $1/f^\beta$ behavior. We illustrate these analytical results by numerical simulations.

DY 22.10 Thu 12:45 ZEU 118

Disordered driven lattice gases with boundary reservoirs and Langmuir kinetics — •Philip Greulich[1] and Andreas Schadschneider[2,3] — [1]Fachrichtung Theoretische Physik, Universität des Saarlandes, Saarbrücken, Germany — [2]Institut für Theoretische Physik, Universität zu Köln, Köln, Germany — [3]Interdisziplinäres Zentrum für komplexe Systeme, Universität Bonn, Bonn, Germany

The asymmetric simple exclusion process with additional Langmuir kinetics, i.e. attachment and detachment in the bulk, is a paradigmatic model for intracellular transport. Here we examine this model in the presence of randomly distributed inhomogeneities ('defects'). Using Monte Carlo simulations, we find a multitude of coexisting high- and low-density domains. The results are generic for one-dimensional driven lattice gases with short-range interactions and can be understood in terms of a local extremal principle for the current profile. This principle is used to determine current profiles and phase diagrams as well as statistical properties of ensembles of defect samples.

DY 23: Statistical physics far from thermal equilibrium

Time: Thursday 14:00–16:00 Location: HÜL 386

Invited Talk DY 23.1 Thu 14:00 HÜL 386

Work and Fluctuation Theorems for quantum systems — •Peter Talkner — Inst. fuer Physik, Universitaet Augsburg, Germany

For small systems classical work and fluctuation theorems have proved useful to extract thermodynamic information from nonequilibrium processes. Here, we focus on specific quantum aspects of work performed on a quantum system by an external force. This work is random due to the randomness of quantum mechanics and of the initial state. The statistics of work is completely determined by its characteristic function defined as Fourier transform of the corresponding probability. This characteristic function can be expressed in terms of a correlation function of exponentiated system's Hamiltonians at the two instants of times that mark the beginning and end of the force protocol [1]. For systems that initially stay in a canonical state Jarzynski's work theorem [1] and Tasaki-Crooks' fluctuation theorem [2] follow immediately. For a microcanonical initial state a Crooks type fluctuation theorem holds [3]. The dependence of the statistics of work on the force protocol and the initial state are exemplified for a driven harmonic oscillator [4]. Generalizations of fluctuation and work theorems to open systems[5] are mentioned. [1] P. Talkner, E. Lutz, and P. Hanggi, Phys. Rev. E 75, 050102(R) (2007). [2]P. Talkner, and P. Hanggi, J. Phys. A 49, F569 (2007). [3] P. Talkner, M. Morillo, and P. Hanggi,Phys. Rev. E 77, 051131 (2008). [4] P. Talkner, P.S. Burada, and P. Hanggi, Phys. Rev. E 78, 011115 (2008). [5] P. Talkner, M. Campisi, and P. Hanggi, J. Stat. Mech. Theor. Exp. in press; arXiv:0811.0973.

DY 23.2 Thu 14:30 HÜL 386

Transport beyond the Fermi liquid picture of quasiparticles — •Klaus Morawetz — Forschungszentrum Dresden-Rossendorf, PF 51 01 19, 01314 Dresden, Germany — International Center for Condensed Matter Physics, 70904-910, Brasília-DF, Brazil

Considering the microscopic correlations of particles in a more realistic way by taking into account the nonlocal and noninstant character of collisions leads to a nonlocal quantum kinetic theory. This theory is thermodynamically consistent. The balance equations contain besides the Landau quasiparticle parts also the parts of the correlated states which can be seen as molecules. It leads to the same mean-field fluctuations in the one-particle distribution as proposed by Boltzmann-Langevin pictures. The kinetic equation combines time derivatives with finite time stepping known from the logistic mapping. This continuous delay differential equation equation is a consequence of the microscopic delay time representing the dynamics of the deterministic chaotic system.

K. Morawetz, P. Lipavský, and V. Špička, Ann. of Phys. **294**, 134 (2001)

P. Lipavský, K. Morawetz, and V. Špička, *Kinetic equation for strongly interacting dense Fermi systems*, Vol. 26,1 of *Annales de Physique* (EDP Sciences, Paris, 2001), ISBN: 2-86883-541-4.

K. Morawetz, CHAOS 13 (2003) 572

K. Morawetz, New Journal of Physics 9 (2007) 313

DY 23.3 Thu 14:45 HÜL 386

Condensation in 1d systems with pair-factorized steady states — •Bartlomiej Waclaw[1], Julien Sopik[2], Hildegard Meyer-Ortmanns[2], and Wolfhard Janke[1] — [1]Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, 04009 Leipzig, Germany — [2]School of Engineering and Science, Jacobs University, P. O. Box 750561, 28725 Bremen, Germany

Many models describing the transport of some conserved quantity have been proposed recently. The best known are the zero-range process and the asymmetric simple exclusion process. They are lattice models where particles jump between adjacent sites with given probability. Although they are far from equilibrium, they possess a steady state which takes a factorized form over the sites of an underlying lattice, which simplifies calculations. Recently, Evans et al. [1] have proposed a 1d model in which the steady state factorizes over N pairs of nodes: $\prod_i g(m_i, m_{i+1})$ where m_i is the number of particles at node i, and $g(m, n)$ is defined by the dynamics of the model. If $g(m, n)$ does not factorize, interactions between particles at neighboring nodes emerge. In this talk we examine how different choices of $g(m, n)$ influence static properties of the steady state. In particular we observe a condensation of particles above some critical density. The condensate can be either localized at a single node, or extended over $\sim N^\alpha$ nodes with $0 < \alpha < 1/2$, depending on the interaction strength. We calculate also the shape of the condensate and the distribution of particles.
[1] M. R. Evans, T. Hanney, and S. N. Majumdar, Phys. Rev. Lett. 97, 010602 (2006).

DY 23.4 Thu 15:00 HÜL 386

Lateral transport of interfacial fluctuations in driven lattice models — Thomas H. R. Smith[1], Oleg Vasilyev[2], •Anna Maciolek[2,3], and Matthias Schmidt[1,4] — [1]H.H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol BS8 1TL, United Kingdom — [2]Max-Planck-Institut für Metallforschung, Heisenbergstraße 3, D-70569 Stuttgart, Germany — [3]Institute of Physical Chemistry, Polish Academy of Sciences, Department III, Kasprzaka 44/52, PL-01-224 Warsaw, Poland — [4]Theoretische Physik II, Universität Bayreuth, Universitätsstraße 30, D-95440 Bayreuth, Germany

We investigate whether thermal fluctuations of the interface between coexisting phases can be coherently transported along the interface by the action of a suitably chosen external driving field. The Ising lattice gas is studied with kinetic Monte Carlo (MC) simulations using Kawasaki exchange dynamics. We apply a variety of different external fields, which may vary in space, in order to create a particle current in the direction parallel to the interface. Lateral motion of thermal capillary waves occurs only if the driving field is an odd function of the coordinate perpendicular to the averge interface plane. We argue that this interfacial transport is intimately related to a broken symmetry under space reflection and particle-hole inversion. The behaviour of the interfacial current in the Ising model, as well as results from MC simulations of a corresponding solid-on-solid model indicate that the effect is not advective but that it is induced by the motion solely of particles at the interface.

DY 23.5 Thu 15:15 HÜL 386

Quantum Jarzynski estimator for boundary switching processes — •Jens Teifel and Günter Mahler — Universität Stuttgart, 1. Institut für Theoretische Physik, Germany

We consider the Jarzynski relation for a single particle inside a one-dimensional quantum well. We compare two types of processes: i) changing the width of the well and thus the boundary conditions (BSP), ii) changing the width of a potential step inside a fixed quantum well (QBSP). The latter can approximate BSP to any desired accuracy. While BSP violates the Jarzynski relation, QBSP does not. Simulations of measurement series on QBSP reveal limits on the practical applicability of the Jarzynski estimator for the free energy change.

DY 23.6 Thu 15:30 HÜL 386

Fluctuation theorems in driven open quantum systems — Peter Talkner, •Michele Campisi, and Peter Hänggi — Institute of Physics, University of Augsburg, D-86135 Augsburg, Germany

The statistics of the internal energy, the exchanged heat and the work of a quantum system that weakly couples to its environment is determined in terms of the energy changes of the system and the environment due to the action of a classical, external force on the system [1,2]. If the system and environment initially are in a canonical equilibrium, the work performed on the system is shown to satisfy the Tasaki-Crooks theorem [3] and the Jarzynski equality [4].

References
[1] Talkner P, Campisi M and Hänggi P, *Fluctuation theorems in driven open quantum systems*, 2008 pre-print arXiv:0811.0973
[2] Talkner P, Hänggi P and Morillo M, *Microcanonical quantum fuctuation theorems*, 2008 Phys. Rev. E **77** 05113
[3] Talkner P and Hänggi P, *The Tasaki-Crooks quantum fuctuation theorem*, 2007 J. Phys. A: Math. Theor. **40** F569-F571
[4] Talkner P, Lutz E and Hänggi P, *Fluctuation theorems: Work is not an observable*, 2007 Phys. Rev. E **75** 050102

DY 23.7 Thu 15:45 HÜL 386

Quantum fluctuation theorem in the strong damping limit — •Sebastian Deffner and Eric Lutz — University of Augsburg, Germany

We consider a driven quantum particle in the large friction limit. We derive a generalized Crooks type fluctuation theorem using the quantum Smoluchowski equation and identify a new type of entropy production of purely quantum origin.

DY 24: Pattern formation in colloidal and granular systems I

Time: Thursday 14:45–16:45 Location: ZEU 255

DY 24.1 Thu 14:45 ZEU 255

Reversibly tunable standing strain wave pattern and soliton dynamics in a two dimensional colloidal crystal with confinement — •David Yu-Hang Chui[1], Surajit Sengupta[2], Ian K Snook[3], and Kurt Binder[1] — [1]Institut für Physik, Johannes-Gutenberg-Universitüt, Staudingerweg 7, 55099 Mainz, Germany — [2]S. N. Bose National Centre for Basic Sciences, Block JD, Sector III, Salt Lake, Kolkata 700098, India — [3]Applied Physics, School of Applied Science, RMIT University, GPO Box 2476V, Melbourne 3001, VIC, Australia

We have shown that confinement can be used to impose a controllable mesoscopic superstructure of a predominantly mechanical elastic character on a crystal [1]. The two dimensional colloidal crystal of two different sizes interacting with an inverse power law potential was simulated using Monte Carlo simulations [2]. Two structured walls, which are created by choosing two rows of particles fixed in the positions of the triangular lattice, provide the confinement to the system. Due to an interplay of the particle density of the system and the width D of a confining channel, "soliton staircases" can be created along both parallel confining boundaries, that give rise to standing strain waves in the entire crystal. This strain wave superstructure in the crystal can be reversibly tuned by varying the physical conditions. The novel soliton dynamics and elasticity are also investigated using Molecular Dynamics simulations. References [1] Y. H. Chui, S. Sengupta and K. Binder, Europhysics Letter 83, 58004 (2008). [2] A. Ricci, P. Nielaba, S. Sengupta and K. Binder, Physical Review E 75, 011405 (2007).

DY 24.2 Thu 15:00 ZEU 255

How attractive is a barchan dune? — •Christopher Groh[1], Ingo Rehberg[1], and Christof Kruelle[1,2] — [1]Experimentalphysik V, Universität Bayreuth, Germany — [2]Maschinenbau und Mechatronik, Hochschule Karlsruhe - Technik und Wirtschaft, Germany

The spatio-temporal behaviour of barchan dunes is investigated experimentally with downsized longitudinal barchan dune slices generated in a narrow water flow tube. We observe a rapid transition to a steady-state solution with constant mass, shape, and velocity. The development towards this shape attractor is shown on the basis of four different starting configurations in qualitative observation and quantitative analysis.

[1]C. Groh, A.Wierschem, N. Aksel, I. Rehberg, and C. A. Kruelle (2008). Barchan dunes in two dimensions: Experimental tests for minimal models. Phys. Rev. E 78, 021304.

[2]C. Groh, I. Rehberg, and C. A. Kruelle (2008). How attractive is a barchan dune? New Journal of Physics, submitted.
[3]C. Groh, N. Aksel, I. Rehberg, and C. A. Kruelle (2008). Grain size dependence of barchan dune dynamics. http://arxiv.org/abs/0811.4729

DY 24.3 Thu 15:15 ZEU 255

electric-field induced chiral patterns and dynamical states of fd-virus suspensions — •kyongok kang and jan dhont — forschungszentrum juelich, weiche-materie, juelich, 52425, germany

For low frequency and a low ionic strength, suspensions of fd-virus particles respond to external electric fields due to the deformation of their thick electric double layer. We are interested in pattern formation and phase transitions that results from interactions between such deformed double-layers. Depending on the electric-field amplitude and frequency, dynamical states and various phases are observed. Below a critical frequency, a non-chiral nematic transforms to a chiral nematic with a pitch that is a strong function of the field amplitude and frequency. On increasing the amplitude below a critical frequency, dynamical states are observed where small nematic domains melt and form. These dynamical states are investigated by time-lapsed image correlation function analysis. At sufficiently high frequency, a uniformly aligned phase is stable, which is characterized by means of birefringence measurements. There is a *non-equilibrium critical point* where all transition lines meet, and above which the dynamical state directly transforms to the uniform aligned phase on increasing the frequency.

References: K. Kang, and J. K. G. Dhont, *Double-layer polarization induced transitions in suspensions of colloidal rods*, EPL, 84 (2008) 14005. K. Kang, and J. K. G. Dhont, *Electric-field induced transitions in suspensions of rods (fd-virus) due to double-layer polarization*, Submitted to PRE (2008).

DY 24.4 Thu 15:30 ZEU 255

Humidity determines granular transport hysteresis — •Tobias Lang[1], Christof Krülle[1,2], and Ingo Rehberg[1] — [1]Universtität Bayreuth, Universitätsstrasse 30, D-95447 Bayreuth — [2]Maschinenbau und Mechatronik, Hochschule Karlsruhe - Technik und Wirtschaft, D-76133 Karlsruhe

Since the pioneering works of R.A Bagnold, a grown interest in dune dynamics evolved. Incipient motion of a sand bed starts, when the wind speed over the bed surpasses a critical threshold. It is known that the sand flux depends sensitively on the humidity of the air. Using a small scale closed-circuit wind tunnel with active moisture control, we studied the dependency of the granular transport process on the humidity. Via the variation of humidity, electrostatic charging of the particles can also be influenced. In particular we measure the hysteretic dependence of the sand flux on the wind speed.

DY 24.5 Thu 15:45 ZEU 255

Network formation in liquid crystal-colloidal-suspensions — •Marcel Roth, Günter K. Auernhammer, and Doris Vollmer — Max-Planck-Institut für Polymerforschung, Mainz, Germany

When cooling a mixture of thermotropic liquid crystal (5CB) and micrometer-sized colloids (PMMA) from the isotropic to the nematic state a self-supporting network is formed. Within this network the pores are filled with colloid-free nematic liquid crystal while the colloids are concentrated in the walls leading to a low frequency elastic modulus of up to 10^5Pa.[1]

In this talk we present the results of measurements with a self-made piezo-rheometer in shear mode. Since the applied strain is in the order of only 10^{-4} the network formation is not affected by the measurement and results are well reproducible. Moreover, the intrinsic frequency range spans four orders of magnitude accessing even 1kHz. With a suitable temperature control we monitor the extended viscoelastic response in dependence on temperature. We show that the low frequency elastic plateau is followed by a strongly viscoelastic region at higher frequencies. In addition the whole spectrum shows a pronounced temperature dependence as cooling deeper into the nematic region.

The rheological data is combined with microscopic images. Here special emphasis will be laid to the transition from a 2D to a 3D-structure varying cooling rates and sample thicknesses.

[1] Vollmer et al., Langmuir 21, 4921-4930 (2005)

DY 24.6 Thu 16:00 ZEU 255

Phase diagram of wet granular material under vertical vibrations — •Kai Huang, Klaus Röller, and Stephan Herminghaus — Max Planck Institute for Dynamics and Self-organization, Bunsenstr.10, 37073 Göttingen, Germany

The phase diagram of vertically vibrated wet granular matter is investigated by both experiments and simulations. We find a critical point where the coexistence (C) regime of the fluid (F) and gas (G) phases terminates. The energy driven F-C transition is found to scale with the rupture energy of a liquid bridge if the corresponding vibration amplitude(A) is less than particle diameter(d). This is in good agreement with our simulations. Close to the F-G transition line, the variation of the size of the gas bubble with vibration amplitude shows a hysteretic behavior. Within the hysteresis loop, we observe temporary gas bubbles with strong fluctuations in size. The F-G boundary is shown to have an interfacial tension and non-trivial wetting behavior at container walls. Focusing on the solid (S)- F transition line, we find that the fluidization is a surface melting process. This is demonstrated by detecting the mobility of ruby tracers utilizing ruby fluorescence. This as well agrees with our simulation results.

DY 24.7 Thu 16:15 ZEU 255

Fractionation in random symmetric A-B block copolymers — •Alice von der Heydt and Annette Zippelius — Institut für Theoretische Physik, Göttingen, Germany

Starting from a mean-field free energy based on a microscopic model, we investigate the coexistence of homogeneous and structured phases of a triblock copolymer melt with an incompatibility $\chi \propto 1/T$ between A- and B-blocks. The natural random block sequence distribution is generated by a Markov process with an overall A-probability $p = \frac{1}{2}$ and a correlation parameter λ. The latter determines the structure of the ordered phases which the initially disordered melt forms on increasing χ: lamellae with wave number $k(\lambda)$ appear for $\lambda < \lambda_c$, two homogeneous A- and B-rich phases for $\lambda > \lambda_c$ [1].

An explicit *fractionation* ansatz takes into account the exchange of individual sequences between coexisting lamellar and homogeneous phases: higher χ give rise to two additional homogenous phases for $\lambda < \lambda_c$, and to a third lamellar phase with an increased content of alternating sequences for $\lambda > \lambda_c$. The new phases emerge with zero volume fraction, but with a finite deviation from the natural sequence distribution, and, for the fractionated lamellae, with finite k. Reliable results can be obtained especially in the vicinity of the tricritical point (λ_c, χ_c), where other methods encounter difficulties.

[1] G. H. Fredrickson, S. T. Milner, and L. Leibler, *Multicritical Phenomena and Microphase Ordering in Random Block Copolymer Melts*, Macromol. **25** (1992), 6341

DY 24.8 Thu 16:30 ZEU 255

Air pressure influence on the sublimation of a granular gas in an annular conveyor — •Ralph Neubauer[1], Ingo Rehberg[1], and Christof Krülle[2] — [1]Universität Bayreuth - Experimentalphysik V, D-95440 Bayreuth — [2]Hochschule Karlsruhe - Technik und Wirtschaft, D-72133 Karlsruhe

Glass beads in a sinusoidally driven annular conveyor show the effect of solid to fluid transition. For a small range of driving frequencies the width of the gas phase is accompanied by a hysteresis. We observe this hysteresis, which is also affected by air pressure, with different amounts and sizes of the grains in the diameter range of 0.3 mm to 1.2 mm. In addition, the influence of the electrostatic charging is investigated by changing the grains from glass beads to conductive silver-coated glass beads.

DY 25: Fluid dynamics II

Time: Thursday 14:45–16:30 Location: ZEU 118

DY 25.1 Thu 14:45 ZEU 118

Endwall effects on traveling waves in Taylor-Couette flow — •Kerstin Hochstrate, Matti Heise, Jan Abshagen, and Gerd Pfister — Institute of Experimental and Applied Physics, Kiel, Germany

One of the classical hydrodynamic systems for the study of bifurcation events is the flow consisting of a viscous fluid confined in the gap between two concentric rotating cylinders. Because of the simplicity of this Taylor-Couette experiment the boundary conditions can be controlled and modified precisely. In an infinitely long system, often considered in theoretical investigations, the basic flow consists of a pure azimuthal shear flow which is invariant in the axial direction. In experimental realizations this invariance is broken, because of rigid endplates that confine the flow in the axial direction. At stationary endplates, which are often used, the velocity of the flow is zero. This changes the basic flow and leads to diverse finite-length effects.

Here we analyze experimentally the influence of rotating endplates on the basic flow and on spiral vortex flow. Spirals appear as primary instability for counter-rotating cylinders and travel in the axial direction in the infinite system. In particular, we focus on the interaction of spirals and boundary-driven vortices leading to spatial defects, which are not present in the infinite system. By rotating the endplates these defects can be eliminated and, moreover, the symmetries and the bifurcation behavior of the spirals are influenced.

DY 25.2 Thu 15:00 ZEU 118

Energetic consideration of the reflection of water jets on superhydrophobic surfaces — •Sören Kaps[1], Michael Scharnberg[2] und Rainer Adelung[1] — [1]Functional Nanomaterials, Technical Faculty, University of Kiel, Kaiserstr. 2, 24143 Kiel, Germany — [2]Chair for Multicomponent Materials, Technical Faculty, University of Kiel, Kaiserstr. 2, 24143 Kiel, Germany

After impinging onto biological and artificial superhydrophobic surfaces water jets are observed to flow across the surface for a distance equal to several jet diameters before they are reflected off the surface as coherent jets under an angle that is close to or smaller than the angle of incidence. To understand the mechanisms of water jet reflection the conversion of surface energy to kinetic energy and vice versa is considered. A simple model based on these energetic considerations was derived to fit the experimental data. The geometry of the water surface is a critical parameter in this model. Different approaches to this geometry will be discussed.

DY 25.3 Thu 15:15 ZEU 118

A phase field model for coalescence of droplets with miscible liquids — •Rodica Borcia and Michael Bestehorn — Lehrstuhl Statistische Physik/ Nichtlineare Dynamik, Brandenburgische Technische Universität Cottbus, Deutschland

We investigate the dynamics of interfaces between droplets of miscible liquids using a phase field model. This application is motivated by recent experimental observations showing that sessile droplets of completely miscible liquids do not instantaneously coalesce after peripheral contact if their contact angles are sufficiently small. Instead, after lateral contact, a microscopically thin liquid bridge connects the droplets and delays the droplet fusion. The droplets exchange liquids through this film, but they remain separated. Only after some time (up to minutes) the droplets finally merge into a single droplet and the fluid comes to rest [1]. The coalescence dynamics is obviously influenced by surface forces (Marangoni effects) and depends on the contact angle. 2D computer simulations are performed in order to understand the mixing behavior of different liquids for low and high contact angles at the solid substrate.

[1] H. Riegler, P. Lazar, Langmuir Vol. 24 (2008) 6395-6398.

DY 25.4 Thu 15:30 ZEU 118

On the parametric resonances of layered immiscible fluids — •Bernhard Heislbetz — DLR Lampoldshausen, Institut für Raumfahrtantriebe, D-74239 Hardthausen, Germany

As a generalization of the well known Faraday-Instability of a free fluid surface, we theoretically investigate the parametric resonances of stratified immiscible fluid layers under the action of an external time periodic excitation.

Considering the full viscous hydrodynamic system, we show that the dynamics of the interface between two layers of viscous fluids can be reduced to an equation of the Mathieu-type, including several temporal non-local memory integrals. Due to analytical approximations and numerical calculations we characterize the the stability behaviour of a parametrically excited interface between two fluid layers of arbitrary viscosity.

Furthermore we discuss the stability problem for the interfaces of a three-layer configuration. Within the framework of ideal fluids the temporal evolution of the interface deformations are governed by coupled Mathieu differential equations. Including fluids viscosity, we show that the interfacial dynamics is determined by a set of coupled integro-differential equations. Resonant instability domains associated to the stability of subharmonic and harmonic solutions of the problem were calculated using Floquet Theory. The characteristics of the obtained stability zones were explained by means of a multiple-time scale analysis.

DY 25.5 Thu 15:45 ZEU 118

Dynamically Adaptive Coordinate System for Binary Mixture Thin Films — •Ion Dan Borcia and Michael Bestehorn — Lehrstuhl für Theoretische Physik II, Brandenburgische Technische Universität, Cottbus, Germany

A binary mixture with deformable upper surface is numerically studied. Other numerical methods for hydrodynamics involving time-depending boundaries imply the calculation of the integration grid using spline algorithms (boundary-fitted coordinate solving method [1]). In our case the thin film equation [2] gives directly the integration grid for the 3D concentration equation. Linear and non-linear results using this method are presented.

[1] J.F. Thompson et al., J. Comput. Phys. 47, 1 (1982)
[2] A. Oron et al., Rev. Mod. Phys. 69, 931 (1997)

DY 25.6 Thu 16:00 ZEU 118

Development of a hybrid simulation approach for microfluidics — •Martin Hecht, Jens Harting, and Calin Dan — Institute for Computational Physics, University of Stuttgart, 70569 Stuttgart, Germany

We have developed a hybrid molecular dynamics (MD) and lattice Boltzmann (LB) simulation method to simulate fluid flow for applications in microfluidics. MD is capable to take detailed interactions between a fluid and a solid surface into account. However, the time and length scales relevant for experimental setups are far above those reachable by MD simulations. Therefore, several mesoscopic simulation methods (LB, DPD, MPC. . .) have been developed, which can deal with larger system sizes and larger simulation times. They use a coarse grained description in which molecular details cannot be captured. In many cases it is unclear how interactions with the surrounding solid walls can be mapped to the coarse grained description. Therefore, we compare rheological data from MD simulations with data obtained in LB simulations and calibrate the interactions in the coarse grained (LB) description. Moreover, for cases in which such a coarse graining can not be applied close to the wall, we develop a hybrid simulation method which couples an MD region close to the wall with a LB region in the bulk. The interactions with the wall are treated in full molecular detail in the MD simulation whereas the fluid flow in the bulk is described on the coarse grained level of the LB simulation. Thus, the computational effort for the bulk can be reduced considerably while maintaining the full details of the fluid-wall interactions.

DY 25.7 Thu 16:15 ZEU 118

stochastic modeling of wetting effects in fluid displacement in porous media — Rafael Rangel and •Sergio Rojas — Physics Department, Universidad Simón Bolívar, Valle de Sartenejas, Edo. Miranda, Venezuela

The displacement of a viscous fluid by another that preferentially wets a porous medium is modeled with the aim to simulate a cooperative invasion processes that has been found in experiments of immiscible wetting displacement. In our model we consider the *non-local* effects of the Laplacian pressure field and the capillary forces. This is achieved with Diffusion Limited Aggregation **DLA**-type Montecarlo computations that simulate both the hydrodynamic equations in the Darcy regime with a boundary condition for the pressure at the interface. The boundary condition contains two different types of disorder: the capillary term which constitutes an additive random disorder, and a term containing an effective random surface tension which couples to a curvature (it constitutes a multiplicative random term that carries non-local information of the whole pressure). We claim that this multiplicative random disorder together with the non-local coupling causes a short range scaling regime that reveals itself in a roughness exponent $\alpha \approx 0.80$. Additionally, we find a **DLA**-type scaling regime with a roughness exponent $\alpha \approx 0.60$ at the largest scales. These types of scaling was found by Geromichalos, Mugele and Herminghaus [Phys.Rev.lett.**89**,104503(2002)]. At intermediate scales, a regime with $\alpha \approx 0.70$ has been found that has similarities with to Invasion Percolation with Trapping.

DY 26: Poster II

Time: Thursday 16:00–18:00 Location: P1A

DY 26.1 Thu 16:00 P1A

Spin Glasses and Eigenvalue-Equations — •Katharina Janzen — Institut für Physik, Carl von Ossietzky Universtität 26111 Oldenburg, Germany

Many disordered systems show a transition to a frozen low-temperature phase. Within the replica formalism for spin glasses this transition is signalled by an instability of the replica-symmetric saddle-point. In this approach the transition to the low temperature phase can be reformulated as an eigenvalue problem.

For systems with Gaussian local fields, and therefore scalar order parameter, the corresponding eigenvalue analysis of the fluctuation matrix was performed by de Almeida and Thouless as early as 1976. In general the local field distribution is non-Gaussian - as for the case of diluted spin glasses - and there are infinitely many order parameters.

Following the replica approach of Monasson, the stability analysis for the more general case can be performed. Using the symmetry of the replica-symmetric fluctuation matrix the eigenvalue problem is reduced by techniques from representation theory of the permutation group and it is shown how generalized AT-lines may be compute

DY 26.2 Thu 16:00 P1A

Akhiezer-like sound attenuation in glasses — •Walter Schirmacher[1,2], Constantin Tomaras[2], and Bernhard Schmid[1] — [1]Institut für Physik, Universität Mainz, Staudinger Weg 7, D-55099 Mainz, Germany — [2]Physik Department E13, TU München, James-Franck-Straße 1, D-85747 Garching

We investigate a 3-dimensional continuum model for vibrational excitations in a disordered environment, based on the anharmonic generalisation of Lame's elasticity theory. The disorder is introduced into the theory via a spatially correlated fluctuating shear modulus $\mu(\mathbf{r})$. It is shown by a mean-field treatment that the low-frequency Brillouin linewidth (sound attenuation coefficient) obeys a Rayleigh law $\Gamma(\omega) \propto \omega^4$ in the case of zero anharmonicity. Including the additional anharmonic terms, we obtain an Akhiezer-like law $\Gamma(\omega) \propto T\omega^2$, which arises from a combination of disorder and anharmonicity. The same effect leads to the temperature dependent enhancement of the excess density of states $g(\omega)/g_{Debye}(\omega)$, observed in Neutron scattering experiments at frequencies below the Boson peak. The crossover from the Akhiezer to the Rayleigh regime is in agreement with light scattering experiments.

DY 26.3 Thu 16:00 P1A

Monte-Carlo-Simulations of ionic diffusion dynamics in ordered and disordered materials — •Patrick Mexner[1], André Schirmeisen[1], and Andreas Heuer[2] — [1]Institute of Physics, University of Muenster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany — [2]Institute of Physical Chemistry, University of Muenster, 48149 Muenster, Germany

Motivated by the successful measurement of ionic diffusion dynamics in nanoscopic volumes of a Lithium-Silicate-Glass by time domain electrostatic force spectroscopy (TD-EFS) [1], we simulate elementary ion hopping processes in Monte-Carlo-Simulations (MCS). The TD-EFS method measures the time evolution of the force between the tip of an atomic force microscope and the ion conducting sample after a tip voltage is applied. In our model we consider the influence of different site-energies and energy distributions in ion conductors, as well as temperature and particle concentrations on simulated relaxation processes. By variation of parameters we model both crystalline and disordered phases and compare them with experimental data. Our MCS is able to model cubic systems of 5-10nm length which is in the order of estimated effective volumes for tip-sample interaction of approx. 50 cubic nm. Hence it enables us to directly relate simulated and experimental data for a better understanding of elementary ion jumps under the influence of electric fields.

[1] Schirmeisen et al., Phys. Rev. Lett. 98 (2007) 225901

DY 26.4 Thu 16:00 P1A

Free Energy Inherent Structures in Spin Glass Models — •Mathias Aust, Elmar Bittner, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Postfach 100920, 04009 Leipzig, Germany

One important feature of the glass phase of spin glasses is its rugged energy landscape. While at zero temperature the (possibly degenerate) ground state dominates, local energy minima with higher minimum energy and the entropy of the corresponding valleys become important at higher temperatures. Especially the configurational entropy (the complexity) of the spin glass at different temperatures is of interest.

These quantities can be obtained from Monte Carlo simulations using the free energy inherent structure (FEIS) approach introduced in Coluzzi *et al., A new method to compute the configurational entropy in glassy systems,* Eur. Phys. J. B **32**, 495 (2003).

This method is applied to the Sherrington-Kirkpatrick (SK) model and the Edwards-Anderson Ising (EAI) model, both with a bimodal distribution for the couplings. The application of the multicanonical algorithm allows to simulate bigger system sizes for the SK model than before, while the EAI model has not been studied by this method before.

DY 26.5 Thu 16:00 P1A

Models for the mixed glass former effect in ion-conducting glasses — •Michael Schuch, Christian Mueller, and Philipp Maass — Institut für Physik, Technische Universität Ilmenau, Germany

A widely applied empirical method to increase ionic conductivities in ionic conducting glasses is to make use of the mixed network former effect (MNFE), which manifests itself in a minimum of the conductivity activation energy upon mixing of two network formers. We will present two theoretical models for the MNFE: In the first "mixed barrier model" [1] the resident sites of the mobile ions are considered to have comparable binding energy, while the energy barriers between the sites become lowered in heterogeneous environments containing both types of network formers. This model should apply to network formers with the same geometry of the network forming units (e.g. tetrahedral units in silicate-germanate systems). In the second "network unit trapping model" the barriers are considered to be weakly fluctuating, while the site energies associated with the network forming units differ significantly. This model should apply to network formers with different geometry of the units (e.g. trigonal und tetrahedral units in boro-phosphate systems). For both models we calculate the behavior of the dc- and ac- conductivities, as well as of the conductivity activation energy upon mixing and compare the theoretical results to the experimental findings.

[1] M. Schuch, C. Müller, P. Maass, and S. W. Martin preprint.

DY 26.6 Thu 16:00 P1A

Collective dynamics of simple liquids: A mode-coupling description — •Bernhard Schmid[1], Walter Schirmacher[1], Harald Sinn[2], and Rolf Schilling[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, Staudinger Weg 7, D-55099 Mainz, Germany — [2]Hasylab/DESY, Notkestraße 85, D-22607 Hamburg, Germany

We use the mode-coupling theory (MCT), which has been highly successful in accounting for the anomalous relaxation behaviour near the liquid-to-glass transition, for describing the dynamics of monoatomic (i.e. simple) liquids away from the glass formation regime. We find that the dynamical structure factor predicted by MCT compares well to experimental findings and results of computer simulations [1]. We have studied in particular the dynamics of Lennard-Jones Argon and compared the predicted dynamical structure factor $S(k,\omega)$ with simulation data. The memory function $M(k,t)$ exhibits a two-step decay. The existence of such a two-step decay of $M(k,t)$ has already been predicted by Levesque et al. [2] but never been explained. We can show that the long-time relaxation process which strongly depends on density can be identified as the α-relaxation associated with the cage effect. The short-time, almost density independent relaxation is of microscopic origin.

[1] W. Schirmacher, H. Sinn, J. Condens. matter **11**, 127 (2008)

[2] D. Levesque, L. Verlet, and J. Kurkijärvi, Phys. Rev. A **7**, 1690 (1973)

DY 26.7 Thu 16:00 P1A

molecular dynamics simulation of heterogeneous nucleation in Lennard-Jones colloidal system — •Hamed Maleki[1], Nadya Gribova[2], Tanja Schilling[1], and Christian Holm[2,3] — [1]institut für Physik, Johannes Gutenberg-Universität, Staudinger Weg 7, D-55099 Mainz, Germany — [2]Frankfurt Institute for Advanced Studies, Goethe-University, Ruth-Moufang-Str.1, D-60438 Frankfurt am Main, Germany — [3]Max Planck Institute for Polymer Research, Ackermannweg 10, D-55128 Mainz, Germany

Nucleation is an activated process. Therefore it is a rare event. Rare events cannot be sampled with standard MC or MD. Classical Nucleatin Theory (CNT), covers and discribes homogeneous nucleation process in three dimensions, while heterogeneous nucleation is not understood yet. We present a molecular dynamics study of the liquid to solid transition in a Lennard Jones system confined to a slit pore. This study serves as a basis for a study of heterogeneous nucleation by Forward Flux Sampling. We find strong layering of the liquid close to the wall on approach of the transition. Within the layers six-fold bond order develops, however, we do not observe a KTHNY-transition. Instead there is sufficient interaction between the layers such that crystal nucleation still proceeds in a "3d manner".

DY 26.8 Thu 16:00 P1A

Apparent changes in the molecular dynamics of thin polymer layers due to the impact of interfacial layers — •Martin Tress[1], Anatoli Serghei[1,2], and Friedrich Kremer[1] — [1]Institute for experimental physics I, University of Leipzig, Germany — [2]Department of Polymer Science and Engineering, University of Massachusetts Amherst, Amherst, MA 01003, USA

Possible mechanisms leading to an apparent faster glassy dynamics in thin polymer layers, as investigated by means of Broadband Dielectric Spectroscopy, are analyzed in detail. It is shown that manifold experimental findings can be traced back to the influence of interfacial sub-layers, where - due to the proximity to solid interfaces - the dielectric function of the polymer is altered and modifies, by that, the overall dielectric response of the polymer films. An experimental setup cloning bulk and interfacial dynamics is measured to evidence how the contribution of the interfacial layer combines with that of the bulk in order to give the total response of a thin polymer film. It is shown that the non-linear character of this combination could lead to apparently discrepant experimental results.

DY 26.9 Thu 16:00 P1A

Frustration in quasi-periodic potentials — •Christian Richter, Michael Schmiedeberg, and Holger Stark — Institut für Theoretische Physik, Technische Universität Berlin, 10632 Berlin, Germany

We study a two-dimensional colloidal suspension in a one-dimensional quasi-periodic potential. By using Brownian dynamics simulations, we observe a phase transition from a liquid phase into a frustrated solid state that is not periodic or crystalline. We determine the transition by carefully analyzing the dynamics of the system, for example the mean square displacement of the particles. One of our major goals is to search for possible quasicrystalline order and for order parameters that may describe the structure of the frustrated state. We also compare the system to other frustrated systems, e.g., glasses.

DY 26.10 Thu 16:00 P1A

Conductivity in continuous systems with disordered potential — •Steffen Röthel and Rudolf Friedrich — Westfälische Wilhelms-Universtät Münster, Institut for Theoretical Physics, Wilhelm-Klemm-Str. 9, 48149 Münster

We consider the behavior of an overdamped charged particle moving in a disordered potential in the presence of an external electric field under the influence of a Gaussian white noise. Applying periodic boundary conditions for the disordered potential a Fokker-Planck treatment of the corresponding Langevin equation allows to determine the current density. For weak disorder the case of an oscillating sinusoidal electric field leads to higher harmonic contribution to the current density. We present the frequency spectrum of the conductivity for the first two harmonics for various statistical properties of the disordered potential in one dimension. Furthermore, we calculate the conductivity in a two-dimensional disordered potential in the case of a stationary electric field for various temperatures. The experimental determination of the current-voltage relation and in particular the frequency dependence of the current can be used to identify properties of the disordered potential, and, in turn, to characterize the spatial structure of the material probe.

DY 26.11 Thu 16:00 P1A

Nonlinear Response of a Spiking Neuron to a Transient Stimulus — •Tilo Schwalger[1,3], Sven Goedeke[2], and Markus Diesmann[2,3] — [1]MPI PKS, Dresden — [2]BCCN, Albert-Ludwigs University, Freiburg — [3]RIKEN BSI, Wako, Japan

The propagation of synchronous firing activity along a feed-forward neural network has served as a model to explain precise spatio-temporal spike patterns in the cortex ("synfire chain"). The analytical description of the traveling activity pulse requires the knowledge of the single neuron response to a transient stimulus in the presence of background noise. This involves, however, a first-passage-time problem of a time-inhomogeneous stochastic process, which is difficult to solve.

Here, we present an explicit formula for the time-dependent firing rate of a leaky integrate-and-fire neuron in response to an arbitrarily strong, transient stimulus. With this formula one can accurately predict the expected response of a population of neurons to an incoming activity pulse, which permits to construct a map between the firing responses of subsequent neuron groups. This allows us to study the pulse propagation along the feed-forward network analytically. The theory is based on the Wiener-Rice series of differentiable processes.

DY 26.12 Thu 16:00 P1A

Control of unstable steady states in neutral time-delayed systems — Yuliya N. Kyrychko[1], Konstantin B. Blyuss[1], •Philipp Hövel[2], and Eckehard Schöll[2] — [1]Department of Engineering Mathematics, University of Bristol, Bristol, BS8 1TR, UK — [2]Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

We present analysis of time-delayed feedback control used to stabilize an unstable steady state of a neutral delay differential equation. A delay differential equation is called neutral if it contains a time delay in the highest derivative involved. This type of equations arises in numerous physical and engineering application, for example, hybrid testing, chaotic oscillations in transmission lines and torsional waves of a drill string. Due to the original time delay present in the system, its steady states may become unstable through a Hopf bifurcation, and adding a time-delayed feedback control will stabilize the system again

Stability of the controlled system is addressed by studying the eigenvalue spectrum of a corresponding characteristic equation with two time delays. An analytic expression for the stabilizing control strength is derived in terms of original system parameters and the time delay of the control. Theoretical and numerical results show that the interplay between the control strength and two time delays provides a number of regions in the parameter space where the time-delayed feedback control can successfully stabilize an otherwise unstable steady state.

DY 26.13 Thu 16:00 P1A

Time-delayed control of spatio-temporal chaos in the Gray-Scott model — Yuliya N. Kyrychko[1], Konstantin B. Blyuss[1], and •Eckehard Schöll[2] — [1]Department of Engineering Mathematics, University of Bristol, Bristol, BS8 1TR, UK — [2]Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

Effects of time-delayed feedback control on the dynamics of spatio-temporal patterns in the Gray-Scott reaction-diffusion system are studied numerically. Several kinds of control schemes are investigated, including single-species, diagonal and mixed control. In the case of spatio-temporal chaos, the control may stabilize uniform steady states or lead to bistability between a trivial steady state and a propagating travelling wave. When the basic state is a stable travelling pulse, the control can provide either a stationary Turing pattern, or the above-mentioned bistability. In each case, the stability boundary is found in the parameter space of the control strength and the time delay. Numerical simulations suggest that diagonal control fails to stabilize spatio-temporal chaos.

DY 26.14 Thu 16:00 P1A

Delay stabilization of rotating waves near fold bifurcation and application to all-optical control of a semiconductor laser — Bernold Fiedler[1], Serhiy Yanchuk[2], Valentin Flunkert[3], Hans-Jürgen Wünsche[4], •Philipp Hövel[3], and Eckehard Schöll[3] — [1]Institut für Mathematik I, FU Berlin, Arnimallee 2-6, D-14195 Berlin, Germany — [2]Humboldt Universität zu Berlin, Institut für Mathematik, Rudower Chaussee 25, D-12489 Berlin, Germany — [3]Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany — [4]Humboldt Universität zu Berlin, Institut für Physik, Newtonstr. 15, D-12489 Berlin, Germany

We consider the delayed feedback control method for stabilization of unstable rotating waves near a fold bifurcation. Theoretical analysis of a generic model and numerical bifurcation analysis of the rate-equations model demonstrate that such orbits can always be stabilized by a proper choice of control parameters. We confirm the recently discovered invalidity of the so-called “odd-number-limitation” of delayed feedback control. Previous results have been restricted to the vicinity of a subcritical Hopf bifurcation. We now refute such a limitation for rotating waves near a fold bifurcation. We include an application to all-optical realization of the control in three-section semiconductor lasers.

DY 26.15 Thu 16:00 P1A

Suppression of pulse propagation in excitable media through time delayed feedback — Felix M. Schneider, •Markus A. Dahlem, M. Hannelore Rittmann-Frank, and Eckehard Schöll — Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

We propose a mechanism to suppress spatio-temporal pattern formation in excitable media based on feedback control. As a generic model for excitable media the FitzHugh-Nagumo system with diffusion in the activator variable is investigated in a one dimensional domain. We show that by applying time-delayed feedback control in this system, the propagation of traveling pulses can be suppressed. The suppression can be explained by a shift of the propagation boundary in the parameter space of the model. This boundary is a bifurcation of codimension one separating the parameter regime of pulse propagation from the regime where a local disturbance dies out. The optimization of this feedback and its characteristic time scales are discussed for different control schemes and ranges of control parameters. Moreover, we discuss a mechanism for the emergence of spreading depolarization, i.e., reaction-diffusion waves occurring under neurological conditions such as migraine and stroke, by impaired neurovascular coupling that provides a natural time-delayed feedback signal.

DY 26.16 Thu 16:00 P1A

Cognitive Aging as a Loss of Criticality — •Hecke Schrobsdorff[1,2], Matthias Ihrke[1,2], Jörg Behrendt[1,3], Marcus Hasselhorn[1,3,4], and J. Michael Herrmann[1,2,5] — [1]BCCN Göttingen — [2]MPI for Dynamics and Self-Organization Göttingen — [3]Georg-Elias-Müller Institute for Psychology Göttingen — [4]German Institute for International Educational Research Frankfurt — [5]School of Informatics at the University of Edinburgh

The performance in psychological tests of fluid intelligence such as Raven’s Advanced Progressive Matrices, tends to decrease with age [1]. These results are in obvious contrast to performance improvements in everyday situations [2]. We hypothesize that the observed aging deficits are partly caused by learning.

We consider a network of integrate-and-fire neurons with dynamical synapses, where critical behavior is a generic phenomenon [3] which might provide a suitable basis for tasks like Raven’s test where the exploration of a large set of combinations of features is required. The synaptic adaptation by learning reoccurring neural-activity patterns is shown to cause a breakdown of the critical state. Networks with comparatively lower memory load achieve more stable activations of new feature combinations than ’old’ networks. This corresponds well to the results of the free-association mode in either network type where only the ’young’ networks are close to a self-organized critical state.

[1] R L Babcock. Intelligence (2002) [2] T A Salthouse. In: Handbook of the psychology of aging (1999) [3] A Levina, J M Herrmann and T Geisel. Nature Physics (2007)

DY 26.17 Thu 16:00 P1A

Significant morphological differences between experimental and simulated Turing patterns — •Christian Scholz, Stephanie Häffner, Klaus Mecke, and Gerd E. Schröder-Turk — Institut für Theoretische Physik, Universität Erlangen, Germany

Systems of deterministic reaction-diffusion equations with suitable reaction terms are widely accepted as models for chemical Turing patterns. These models reproduce the stripe and hexagonal patterns found in chemical reaction-diffusion systems with correct length scales. However, here we show that there are distinct differences in the functional form of the concentration profiles observed in numerical solutions of the reaction-diffusion models (Brusselator and Lengyel-Epstein model) and those observed in the experimental Chlorite-Iodide-Malonic Acid (CIMA) reaction. These qualitative differences of the concentration profiles are conveniently characterised by Minkowski functionals, as described in [1]. We also show that these morphological differences persist when introducing additive noise into the reaction diffusion equation.

- [1] K. Mecke, Morphological characterization of patterns in reaction-diffusion systems, Phys. Rev. E 53 53, 4794 (1996)

DY 26.18 Thu 16:00 P1A

Hysteresis in pinning and depinning of spiral waves — Vladimir Zykov[1], Grigory Bordyugov[2], Hartmut Lentz[1], and •Harald Engel[1] — [1]Institut für Theoretische Physik, TU Berlin, D-10623 Berlin, Germany — [2]Institut für Physik und Astronomie, Universität Potsdam, D-14476 Potsdam, Germany

For the FitzHugh-Nagumo model hysteresis in the transition between pinning and depinning of spiral waves rotating around a hole in a two-dimensional excitable medium has been studied both by use of the continuation software AUTO and by direct numerical integration of the reaction-diffusion equations. To clarify the role of curvature and dispersion in this phenomenon, a kinematical description is applied. It assumes the existence of a boundary layer of finite thickness ahead of the wave front and results in a nonlinear velocity-curvature relationship (eikonal equation) for the front velocity. It is found that the hysteresis phenomenon can be reproduced qualitatively in the framework of the boundary layer model even when dispersion is neglected. However, to obtain a quantitative agreement with results obtained from the reaction-diffusion model, both the nonlinear eikonal equation and the dispersion relation have to be taken into account.

DY 26.19 Thu 16:00 P1A

Velocity of Fronts in Periodic-Heterogeneous Reaction Diffusion Systems — •Jakob Löber and Harald Engel — Institut für Theoretische Physik, TU Berlin

Heterogeneities affect the pulse and front dynamics in excitable and bistable media. The velocity of travelling front solutions of the Schlögl model in a one-dimensional infinite medium has been calculated analytically for a spatially-periodic variation of the excitation threshold. The front velocity was found to display a maximum for a certain value of the spatial period. In a certain parameter range the maximum velocity exceeds the velocity in the effective homogeneous medium. Previously, a similar dependence of the pulse velocity on the size of the heterogeneity had been found in numerical simulations with a modified Oregonator model for the light-sensitive Belousov-Zhabotinskii reaction, where the local excitation threshold depends on the intensity of applied illumination [1]. The analytical results have been obtained for the Schlögl model by a second order perturbation approach that is based on the averaging method and uses the size of the heterogeneity as a small parameter [2]. These results agree qualitatively with direct numerical simulations.

[1] I. Schebesch and H. Engel, Wave propagation in heterogeneous excitable media, Phys. Rev. E **57**, 3905(1998).
[2] J.P. Keener, Propagation of Waves in an Excitable Medium with Discrete Release Sites, SIAM **61**, 317(2000).

DY 26.20 Thu 16:00 P1A

Three-dimensional wave propagation in thin layers of a photosensitive BZ-medium — •Peter A. Kolski and Harald Engel — Technische Universität Berlin

In the past, a variety of wave phenomena including target pattern, spiral waves and chemical turbulence have been studied in thin transparent layers of the BZ medium. With a few exceptions [K. Showalter et. al. PRL 77 (15), 3244 (1996)], three-dimensional effects on wave propagation were neglected in the quasi two-dimensional experimental setup because of the small layer thickness. We will present experimental results demonstrating that under certain conditions even in thin layers (0.5-0.8 mm) scroll waves can be formed. They cause unexpected phenomena as reflective wave collision, wave splitting in response to external perturbation and formation of autonomous pacemakers. Three-dimensional numerical simulations with the underlying reaction-diffusion model have confirmed the three-dimensional mechanism responsible for the experimental observations.

DY 26.21 Thu 16:00 P1A

Towards an universal description of the kinematics of rigidly rotating spiral waves — •Martin Marmulla, Vladimir Zykov, and Harald Engel — Institut für Theoretische Physik, Technische Universität Berlin, D-10623 Berlin, Germany

Spiral wave patterns represent a famous example of self-organized spatio-temporal structures in excitable media. They have been observed in many experimental systems and reproduced numerically in different reaction-diffusion models. Up to now the problem of spiral wave selection has been solved only for special limits in the model parameters. Here we like to test a recently developed free-boundary approach, which intends to represent a universal method to predict rotation frequency and the shape of a rigidly rotating spiral in a broad parameter range. The prediction is based on the measurements of the duration and the propagation velocity of an excitation impulse in a periodic wave train. Our computations are performed within broad parameter ranges of different reaction-diffusion models, where rigidly rotating or meandering spiral waves are observed. A feedback control mechanism is used to suppress meandering and to produce rigidly rotating spirals for any model parameters. The agreement between the results of our reaction-diffusion computations and the predictions obtained with the proposed free-boundary approach is discussed.

DY 26.22 Thu 16:00 P1A

Wave Transmission and Synchronisation in Inhomogenous Active Media — •Felix Müller and Lutz Schimansky-Geier — Institut für Physik, Humboldt-Universität zu Berlin

In biological systems as well as in chemical reactions the transport of ions or reactants, respectively, proceeds generally through non homogeneous media. The compartments can be excitable, oscillatory, purely diffusive or inactive. Based on simulations of moving patterns in reaction-diffusion systems we study the embedding of excitable and oscillatory regions in a diffusive medium.

We find regimes of synchronization, oscillation death or propagation failure for different diffusion coefficients and miscellaneous local arrangements.

Additionally we consider moving dissipative wave segments propagating in a medium with fluctuating excitability, where the waves can break up and and disappear or form spiral turbulence.

DY 26.23 Thu 16:00 P1A

Controllable selectivity in a microfluidic ratchet device: theory and experiment — •Christian Wess[1,2], Jan Regtmeier[1], Ralf Eichhorn[2], Peter Reimann[2], and Dario Anselmetti[1] — [1]Biophysics and Applied Nanoscience, Bielefeld University, Germany — [2]Condensed Matter Theory, Bielefeld University, Germany

Three different species of micron sized particles were separated in a microfluidic device via electrodeless dielectrophoresis with controllable selectivity.

The experimental device consists of a linear channel containing an array of triangular non-conducting posts fabricated with polydimethylsiloxane (PDMS). AC and DC voltages are applied to induce electrophoretically driven migration and dielectrophoretic trapping at the posts. Subtle combinations of AC and DC pulse shapes were simulated numerically first in order to optimize selectivity and separation of the three particles species ($1.2\mu m$, $1.9\mu m$ and $2.9\mu m$ in diameter). With the optimized parameters, we could demonstrate that we can selectively steer one arbitrary particle species in one direction, while the other two migrate into the opposite direction. The selectivity depends on particle size, charging and polarizability whereby we can trap and release specific particles from the traps which creates, under addition of the electrophoretical migration, net particle flows in the desired directions. The experimental results are in very good agreement with the numerical simulations, demonstrating the quality of the theoretical model. Next, the simulations and experiments will be extended to more particles species and possibly to cells.

DY 26.24 Thu 16:00 P1A

Chiral Separation of Molecules in Microchannels — •Sebastian Meinhardt, Ralf Eichhorn, Friederike Schmid, and Jens Smiatek — Condensed Matter Theory, Department of Physics, Bielefeld University, Universitätsstraße 25, 33615 Bielefeld, Germany

Techniques for the separation of particles by their handedness (chirality) in a microchannel can be used to make chiral analysis available for lab-on-a-chip devices. Current microscopic methods for chiral resolution require the use of an optically active agent.

We propose a method for chiral separation in straight microchannels that uses symmetry breaking properties of the flow without the need for a chiral agent. The method applies the known separation effect in shear flow to a microchannel environment and combines it with an asymmetric flow profile. This new method allows the separation of chiral particles by their migration speed along the channel and by their spatial distribution within the channel's cross-section.

Dissipative Particle Dynamics (DPD) simulations show that neither the hydrodynamic interactions with the chanel walls nor of the particles with each other disturb the separation process. The method works best for chiral particles with a low rotational diffusion coefficient, e.g. particles with a large aspect ratio.

DY 26.25 Thu 16:00 P1A

Investigation of the possibility to detect higher moments of charge noise by means of an dissipating harmonic oscillator — •Maximilian Köpke — Institut für Theoretische Physik, Ulm, Deutschland

A complete understanding of electronic transport through mesoscopic conductors necessitates the knowledge of all noise properties of the corresponding current. This is the goal of full counting statistics. After the numerous theoretical works on this subject it is now due to be experimentally scrutinized. After some successful measurements during the last few years, the notion of on-chip-detectors (possessing several decisive advantages over conventional techniques) was brought up - one possible realization would be a Josephson junction which can be modeled as harmonic oscillator. Here the properties of a harmonic oscillator in contact with a non-Gaussian (current) and a Gaussian (environment) heat-bath were investigated, showing a stationary dependence of the correlation on the third moment in position space.

DY 26.26 Thu 16:00 P1A

Partially broken time-reversal invariance investigated on chaotic scattering systems — Barbara Dietz[1], Thomas Friedrich[2], Hanns L. Harney[3], Maksim Miski-Oglu[1], Achim Richter[1], •Florian Schäfer[1], and Hans A. Weidenmüller[3] — [1]Institut für Kernphysik, Schlossgartenstraße 9, 64289 Darmstadt — [2]GSI Helmholzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt — [3]Max-Planck-Institut für Kernphysik, 69029 Heidelberg

We investigate effects of time-reversal symmetry breaking induced by a magnetized ferrite inside a flat microwave billiard. Our focus is the fluctuations of the scattering matrix in the regime of weakly overlapping resonances. We compare the data to a model based on random matrix theory. The model describes the fluctuations in the regime of partial time-reversal symmetry breaking with high precision. By help of the model, the time-reversal symmetry breaking strength is determined based on two independent methods, auto- and cross-correlation functions. In addition, elastic enhancement factors are studied. They drop below 2 at strong violation of time-reversal invariance. Thus, we present several independent tools to probe the violation of time-reversal symmetry in general chaotic scattering systems.

DY 26.27 Thu 16:00 P1A

Semiclassical Theory for Graphene Flakes — •Jürgen Wurm, Klaus Richter, and Inanc Adagideli — Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg

Motivated by the recently increased experimental activity [1-2], we study graphene quantum dot systems theoretically. In previous work, we explored the effect of boundary conditions on the transport and spectral properties of graphene quantum dots numerically [3]. In this work, we seek an analytic approach. To this end, we derive a multiple reflection expansion for the exact Green function of the effective Dirac equation for a graphene flake with a general boundary. Here we take into account contributions from both valleys, thus dealing with

4x4 (pseudo-)spin matrices. Evaluating this Green function semiclassically, we obtain a sum over classical multiple reflection paths. The advantage of this approach is the natural incorporation of the boundary conditions at the flake's edges. Using the semiclassical graphene Green function, we then investigate quantum transport, e.g. weak localization effects, as well as the semiclassical density of states in terms of a Dirac version of the Gutzwiller trace formula.

[1] L.A. Ponomarenko, F. Schedin, M.I. Katsnelson, R. Yang, E.W. Hill, K.S. Novoselov, A.k. Geim, Science 320, 356 (2008)

[2] C. Stampfer, J. Guettinger, F. Molitor, D. Graf, T. Ihn, K. Ensslin, Appl. Phys. Lett. 92, 012102 (2008)

[3] J. Wurm, Adam Rycerz, Inanc Adagideli, M. Wimmer, K. Richter, H.U. Baranger, arXiv:0808.1008 (2008)

DY 26.28 Thu 16:00 P1A

The semiclassical origin of curvature effects in universal spectral statistics — •Daniel Waltner[1], Stefan Heusler[2], Juan-Diego Urbina[1], and Klaus Richter[1] — [1]Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany — [2]Institut für Didaktik der Physik, Universität Münster, 48149 Münster, Germany

We study semiclassically the energy-averaged correlator of two spectral determinants. While in the unitary case, the diagonal approximation is consistent with Random Matrix Theory (RMT) [1], we show that loop contributions evaluated in the same way as for ratios of determinants [2] are not in agreement with RMT. A complementary analysis based on a field-theoretical approach shows, that the additional terms occuring in semiclassics are cancelled in field theory by so-called curvature effects. Finally we show the semiclassical interpretation of these additional terms originating from periodic orbits surrounding other periodic orbits many times and also investigate the consistency with former semiclassical approaches, studying double sums over periodic (pseudo)-orbits.

[1] J. P. Keating, S. Müller, Proc. R. Soc. **463**, 3241 (2007),

[2] S. Heusler, S. Müller, A. Altland, P. Braun, F. Haake, Phys. Rev. Lett. **98**, 044103 (2007)

DY 26.29 Thu 16:00 P1A

Universality of spectral correlations by superbosonization and free probability theory — •Stephan Mandt and Martin R. Zirnbauer — Institut für Theoretische Physik, Universität zu Köln, Germany

We sketch a proof of universality of local level correlation functions for non-Gaussian invariant random matrix ensembles, by using a new method based on the superbosonization formula in combination with elements of free probability theory. Superbosonization, a variant of the method of commuting and anticommuting variables, eclipses the traditional Hubbard-Stratonovich transformation in that it is not restricted to Gaussian probability distributions. Here, we consider random matrices H distributed according to a probability measure of the form exp(-N Tr V(H))dH with V being a polynomial. To apply the superbosonization formula, one needs to have control of the Fourier transform of the measure in the limit of infinite matrix size N. We show this Fourier transform to be determined by a key notion in free probability theory: the R-transform of the asymptotic level density.

DY 26.30 Thu 16:00 P1A

Occupation probabilities of Floquet states in driven systems with a mixed phase space — •Waltraut Wustmann and Roland Ketzmerick — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

We investigate time-periodic driven systems with regular and chaotic Floquet states weakly coupled to a heat bath. The stationary occupation probabilities of the two types of states follow fundamentally different distributions. Chaotic states have almost equal probabilities irrespective of their time-averaged energy. Regular states show Boltzmann-like probabilities proportional to $\exp(-E_n^*/kT^*)$ as in time-independent systems. In contrast, however, an effective temperature T^* appears that can be derived analytically and effective energies E_n^* that have to be determined from properties of the classical regular island they are localized on. Furthermore, we study other characteristic properties of eigenstates in a mixed phase space and their relation to the occupation probabilities.

DY 26.31 Thu 16:00 P1A

Effects of a cubic nonlinearity in optical microcavity systems — •Jeong-Bo Shim[1], Martina Hentschel[1], and Peter Schlagheck[2] — [1]Max-Planck Institute for the Physics of Complex Systems, Dresden D-01187, Germany — [2]Institut für Theoretische Physik,Universität Regensburg, Regensburg D-93040, Germany

As exteremly high-Q factors can be realized in optical systems thanks to whispering-gallery-type modes, it becomes possible to induce intense fields in microoptical elements. Accordingly, it becomes necessary to study nonlinear optical effects in micro-optical systems. In this work, we study the effect of the cubic Kerr-type nonlinearity in a 2D microcavity system. By means of a numerical integration of the time-dependent nonlinear wave equation including the microcavity system and a tapered fiber, we investigate the effects of the nonlinearity on the emission through the microcavity and the spectral characteristics. We furthermore discuss the relation of our results to Bose-Einstein condensates which are also described by a cubic nonlinear wave equation.

DY 26.32 Thu 16:00 P1A

Rogue waves in microwave structures — Ruven Höhmann, •Ulrich Kuhl, and Hans-Jürgen Stöckmann — Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany

Microwave transport experiments have been performed in a quasi-two-dimensional resonator with inserted scatterers mimicking a r^{-2} repulsive potential. The flow emitted from a source antenna and passing through the scattering arrangement show similar branching structures as known from scanning probe microscopy experiments in quantum point contact structures for the electron flow [1]. The branches follow the slopes of the potential but not the valleys, showing that caustics are responsible for the observed structures [2]. Particular conspicuous features observed in the stationary patterns are "hot spots" with intensities by far beyond those expected in a random wave field. Reinterpreting the flow patterns as wave patterns developing in the sea in the presence of spatially varying velocity fields freak or rogue waves occur much more often even in a linear system.

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[2] L. Kaplan, Phys. Rev. Lett. 89, 184103 (2002).

DY 26.33 Thu 16:00 P1A

Prediction of tunneling rates: micro-cavities and bouncing-ball modes — Arnd Bäcker, Roland Ketzmerick, and •Steffen Löck — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

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. Dynamical tunneling rates from regular states to the chaotic sea can be determined with an approach based on a fictitious integrable system [1,2]. We apply this approach to the annular billiard and extend it to the corresponding micro-cavity. The approach can also be used to determine the coupling of bouncing-ball modes to chaotic states. We find that this coupling decays like a power law $k^{-1/2}$ with the wave number k.

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[2] A. Bäcker, R. Ketzmerick, S. Löck, M. Robnik, G. Vidmar, R. Höhmann, U. Kuhl, and H.-J. Stöckmann, Phys. Rev. Lett. **100**, 174103 (2008).

DY 26.34 Thu 16:00 P1A

Consequences of Flooding in Open Quantum Systems — Arnd Bäcker, •Lars Bittrich, and Roland Ketzmerick — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Germany

For closed systems with a mixed phase space, it was recently shown that quantum mechanically flooding of regular islands occurs when the Heisenberg time is larger than the tunneling time from the regular region to the chaotic sea [1]. In this case the regular eigenstates disappear. For open systems we investigate the phenomenon of flooding and the disappearance of regular states, where the escape time occurs as an additional time scale.

[1] Phys. Rev. Lett. **94**, 054102 (2005)

DY 26.35 Thu 16:00 P1A

A full quantum-mechanical laser-model — •Gerald Waldherr and Günter Mahler — Institute of Theoretical Physics I, University of Stuttgart - Pfaffenwaldring 57, 70550 Stuttgart, Germany

We simulate an entirely quantum-mechanical laser-model comprised by a finite spin-network with one interfacing spin being coupled to a single field mode via Jaynes-Cummings-interaction.The spin-subsystem is intially prepared in a high energy state implying an effective negative temperature for the interfacing spin. The system evolves under pure Schrödinger-dynamics, but, nevertheless, shows relaxiation towards a state with increased field energy. The properties of the cavity-field are examined with quantum-optical methods (e.g. photon statistics).

Further investigations concern thermodynamical aspects of the system. The so called LEMBAS-scheme [1] is a method to systematically split energy exchange between a system and its environment into work and heat. We show that in the present case the energy exchange between both subsystems is heat only.

[1]H. Weimer et.al, Europhys. Lett., 83 (2008) 30008

DY 26.36 Thu 16:00 P1A

Dynamically stabilized entanglement via cyclic processes — •Thomas Jahnke and Günter Mahler — Universität Stuttgart, 1. Institut für Theoretische Physik, Pfaffenwaldring 57, 70550 Stuttgart

It is well known that the contact of a quantum system to a thermal bath has a negative effect on the entanglement within the system: Beyond a certain temperature, no static entanglement can survive at all.

Here we investigate the entanglement between two coupled spins driven through two-step-cycles. In the first step, spin (1) is driven by a time dependent Hamiltonian. In the second step, spin (2) is coupled to a "Schrödinger bath" (i.e. a finite quantum embedding) [1]. Both steps are thus described by pure Schrödinger dynamics. We find that after a few cycles the system approaches a stable limit cycle independent of its initial state. This periodic attractor provides entanglement between the spins even at bath temperatures for which no thermal entanglement could exist (cf. [2]).

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

[2] J. Cai, S. Popescu, H. J. Briegel, arXiv:0809.4906

DY 26.37 Thu 16:00 P1A

Unstable spin networks: quantum thermodynamics with varying particle numbers — •Kilian Rambach and Günter Mahler — Universität Stuttgart, 1. Institut für Theoretische Physik, Stuttgart, Deutschland

Thermodynamic behavior of embedded quantum systems, e.g. relaxation, can be explained on entirely quantum mechanical grounds [1].

So far only systems under microcanonical and canonical conditions have been studied. We try to generalize this to grand canonical conditions. Here we restrict ourselves to a spin network. The respective environment allowing for particle exchange is introduced by means of additional "irrelevant" state spaces, to which the "relevant" state space (the spin) is connected via phenomenological transfer channels. One can thus study, e.g., the influence of effective particle number fluctuations as well as the quantum analogue to evaporative cooling.

[1] J. Gemmer, M. Michel, G. Mahler: Quantum thermodynamics, Springer (2004)

DY 26.38 Thu 16:00 P1A

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

An exact stochastic representation of open quantum systems was recently introduced by Stockburger and Grabert [1], allowing straightforward numerical methods which avoid both perturbative and Markovian approximations. In Ref. [1], a unique "reference trajectory" arises from a simple normalization constraint. However, alternative definitions of the reference trajectory through any representative of a large class of causal, analytic functionals of the noise variables are possible. All of these lead to equivalent exact stochastic constructions of open-system quantum dynamics. Alternative reference trajectories suitable for computation can be obtained through iteration and filtering methods. The resulting numerical algorithms are presented here. Recent results on a related semiclassical approach [2] to open-systems dynamics are also reported.

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

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

DY 26.39 Thu 16:00 P1A

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 26.40 Thu 16:00 P1A

Semiclassical theory of switching between period two-states of parametrically forced oscillator — •Alvise Verso and Joachim Ankerhold — Institut für Theoretische Physik Universität Ulm, Germany

Switching between period two-states of an underdamped quantum oscillator parametrically forced is studied in a rotating frame. Within a systematic semiclassical formalism an extension of the classical diffusion equation is derived starting from a quantum master equation. The decay rate is obtained from the stationary non-equilibrium solution and captures the intimate interplay between thermal and quantum fluctuations above the crossover to the deep quantum regime.

DY 27: Poster II

Time: Thursday 16:00–18:00 Location: P1B

DY 27.1 Thu 16:00 P1B

Effective degrees of freedom and hyperbolicity of infinite dimensional systems — •Hongliu Yang and Guenter Radons — Institute of Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany

Our numerical studies on hyperbolicity of the one dimensional Kuramoto-Sivashinsky equation reveals a natural splitting of its tangent space, an indecomposable manifold spanned by a set of relatively unstable directions and its complement spanned by the remaining purely decaying directions. The strong hyperbolicity of this splitting indicates that dynamics on this indecomposable manifold of active nontrivial degrees of freedom is uniformly separated from the trivial dynamics of being attracted to that manifold for the remaining degrees of freedom. Moreover, the dimension of the isolated manifold shows a stepwise increase with system size, which indicates the existence of a new characteristic length scale for extensive chaos of infinite dimensional systems.

[1] H.L. Yang, K.A. Takeuchi, F. Ginelli, H. Chaté and G. Radons, "Hyperbolicity and the effective dimension of spatially-extended dissipative systems" *arXiv:0807.5073.v2.*

DY 27.2 Thu 16:00 P1B

Hamiltonian dynamics with a disordered one-dimensional kick-potential — •Ines Hartwig and Günter Radons — Technische Universität Chemnitz, Chemnitz, Germany

We substitute the cosine-potential of the well-known Chirikov-Taylor standard map with a one-dimensional analytic potential with disorder. The potential is made periodic, thus introducing a fundamental cell in phase space. Island structures in typical Poincaré surfaces of section are shown to differ from the standard map. Statistics of transport characteristics computed numerically include : fractions of particles escaping the fundamental cell, distributions of critical perturbation amplitudes for the breaking of the last KAM-tori and transport exponents in both the momentum and the coordinate direction. Transport is shown to increase with increasing period of the potential, depending on the distribution of the potential.

DY 27.3 Thu 16:00 P1B

Lyapunov spectrum of linear Delay Differential Equation with time-varying delay — •Andreas Otto and Günter Radons — Institute of Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany

Many dynamical systems for instance in engineering science, biology, chemistry, economics and physics are described by Delay Differential Equations (DDE). Hence, there is an essential interest, what happens if delay time changes in time. In this case special phenomena occur in the dynamics of the system.

Our studies on the Lyapunov spectrum of simple linear, scalar, autonomous DDE with periodically time-varying delay try to uncover these special behavior. In spite of inaccuracy in the discrete approximation of the system smaller exponents and their associated Lyapunov vectors contain important information on the dynamics.

Possible extremely small exponents indicate fluctuations of phase space dimension during integration. Furthermore, exponents equal negative infinity stand for a reduced phase space, so that parts of initial function don't affect solutions of the system. Apart from effect of time-varying delay to the dimension, also different regions of initial function may have differing influence on the solution in contrast to DDE with constant delay.

DY 27.4 Thu 16:00 P1B

Synchronization of chaotic units with time delayed bi-directional couplings — Anja Englert, •Sven Heiligenthal, and Wolfgang Kinzel — Institut für Theoretische Physik und Astrophysik, Universitität Würzburg, Germany

The synchronization of chaotic units with bi-directional coupling may have applications for public channel cryptography [1]. However, two chaotic units can only synchronize if a self-feedback is added which is carefully adjusted to the transmission time delay. We investigate two methods to overcome this severe restriction:

1. Multiple feedback delay times [2] and
2. three mutually coupled chaotic units.

Numerical and analytical model calculations show the parameter space for which complete synchronization is achievable.

References:

[1] Ido Kanter, Noam Gross, Einat Klein, Evi Kopelowitz, Pinhas Yoskovits, Lev Khaykovich, Wolfgang Kinzel, and Michael Rosenbluh. Synchronization of mutually coupled chaotic lasers in the presence of a shutter. Phys. Rev. Lett., 98(15):154101, 2007.

[2] M Zigzag, M Butkovski, A. Englert, W. Kinzel, and I. Kanter. Emergence of zero-lag synchronization in generic mutually coupled chaotic systems. to be published, see http://arxiv.org/abs/0811.4066.

See: www.physik.uni-wuerzburg.de/?id=2200

DY 27.5 Thu 16:00 P1B

Entropy calculation of Markov processes with varying order via Blackwell's measure — •Michael Bauer and Günter Radons — Chemnitz University of Technology, 09107 Chemnitz, Germany

Our objective is to calculate the entropy of discrete-time Markov processes with fluctuating order in a finite state space. Such processes may arise e.g. in the symbolic dynamics of dynamical systems with varying memory length. Due to the change of order, transition matrices with different ranks are applied to the initial state resulting in a random matrix product. For a sequence of symbols produced by such a time-variant Markov chain the Kolmogorov-Sinai entropy is calculated using Blackwell's measure [1]. Therefore, special cases of this non-stationary process such as purely random variation and periodic variation are investigated and can be calculated analytically. A comparison to previous results [2] is drawn. We also provide results for processes with Markovian variation of memory establishing a fractal distribution in Blackwell's measure.

[1] D. Blackwell, The entropy of functions of finite-state Markov chains, Transactions of the First Prague Conference on Information Theory, Statistical Decision Functions, and Random Processes, pages 13–20, 1957.

[2] M. Bauer, Dynamical characterization of Markov processes with varying order, Master Thesis, Chemnitz University of Technology, 2008.

DY 27.6 Thu 16:00 P1B

Dynamics of Hysteretic Systems with Preisach-Nonlinearity — •Andreas Zienert and Günter Radons — Chemnitz University of Technology, D-09107 Chemnitz

Hysteresis plays an important role in science and engineering. In most applications dynamical systems are coupled with hysteretic subsystems. This leads to differential equations with hysteresis operators. We investigate the model of an iron pendulum within an external magnetic field. The dynamics of the pendulum can be described with a second order ordinary differential equation. The interaction with the magnetic field is modeled by a Preisach-operator, because the Preisach-model has proven to be an application independent tool for describing hysteretic systems.

The focus of our research is on whether such a hysteretic iron pendulum shows regular or chaotic dynamics. The main problem is that the phase space is infinite-dimensional due to the memory of the Preisach-operator. We calculate power spectra, apply the 0-1-Test for chaos and estimate the largest Lyapunov exponent for some phase space projection. For the latter we also provide a method considering the full memory stored by the Preisach-operator.

DY 27.7 Thu 16:00 P1B

Local Low Dimensionality and Predictability in the Lorenz96 Model of Atmospheric Dynamics — •Stefan Siegert and Günter Radons — Chemnitz University of Technology, Chemnitz, Germany

The Lorenz96 model is a prototype model mimicking certain features of mid-latitude atmospheric dynamics. It is widely used for conceptual studies of atmospheric predictability. Bred vectors characterize finite-time dynamics of high-dimensional chaotic systems under the influence of finite-size perturbations. In the present study, Bred vectors of the Lorenz96 model are characterized in terms of localization, convergence and propagation and compared to their infinitesimal-size, infinite-time counterpart, the leading Lyapunov vectors.

In recent studies it was found, that Bred vectors in atmospheric models exhibit anomalously low dimensionality in localized regions. This finding might have important implications for predictability. In the present study, regions of low Bred vector dimensionality in the Lorenz96 model were identified. There is evidence, that short-term predictability, defined in terms of information entropy of an ensemble of solutions, is low (i. e. entropy is high) in regions of low Bred vector dimension. Presently, further connections between local low dimensionality and predictability are established.

DY 27.8 Thu 16:00 P1B

Oscillatory Zoning in binary solid solution: a non-linear analysis — Tanja Mues and •Andreas Heuer — Institut für physikalische Chemie, Universität Münster, 48149 Münster

Oscillatory Zoning (OZ) is a phenomenon common to many geologically formed crystals. A model of OZ in a binary solid solution grown from an aqueous solution can be described by a two dimensional system of nonlinear partial differential equations, which were analyzed via linear stability analysis in the past. These results were compared with a numerical simulation of the full non-linear system. The non-linear terms give rise to new features in the structure formation by suppressing non-homogeneous modes. With a numerical and analytical Fourier analysis in the nonlinear regime we want to understand this behavior.

DY 27.9 Thu 16:00 P1B

Hydrodynamic Lyapunov modes in binary 1D-Lennard-Jones fluids — •Christian Drobniewski and Günter Radons — TU-Chemnitz 09107

Corresponding to the partial structure factors of molecular hydrodynamics we defined static and dynamic correlation functions of the Lyapunov vectors ([1],[2]). By this it was made possible to identify Lyapunov modes in chaotic many particle systems with softcore interactions (Lennard-Jones fluids). Lennard-Jones fluids are a well know and widely treated class of systems which are especially investigated in view of it's relevance for the glass transition. With these correlation functions we open a new batch of investigation possibilities. We present results for a binary 1D-Lennard-Jones fluid with alternating masses. Special focus lies on the scaling behaviour of the distinct properties in dependence of the system parameters. In addition we compare the results with the results for simpler model systems such as the linear chain or coupled map lattices with alternating masses ([3]). To recognize differences in the behaviour of the particle sorts we splitted the above correlations functions for each of them.

[1] Hong-liu Yang and G. Radons, Hydrodynamic Lyapunov modes in coupled map lattices, Phys. Rev. E 73, 016202 (2006),

[2] G. Radons and H. L. Yang, Static and Dynamic Correlations in Many-Particle Lyapunov Vectors, arXiv nlin. CD/0404028

[3] H.L. Yang, G. Radons, Lyapunov Spectral Gap and Branch Split-

ting of Lyapunov Modes in a Diatomic System, Phys. Rev. Lett. 99, 164101 (2007)

DY 27.10 Thu 16:00 P1B

Complex behavior of dimensional collapse of iterated maps with fluctuating delay times — •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 use iterated map systems to investigate the influence of fluctuating delay times on the system dynamics. For simplicity, the delay time in our system can change only between two values t_1 and t_2. Two cases, periodic or random variation of the delay, were studied. The characteristic feature of the dimensional collapse including the Lyapunov spectrum, number of finite Lyapunov exponents, Kolmogorov-Sinai entropy, and Kaplan-Yorke dimension are investigated.

DY 27.11 Thu 16:00 P1B

Effect of curvature on the low-frequency fidelity of an active cochlea model — •Verena Sterr and Andreas Engel — Carl von Ossietzky Universität Oldenburg, 26111 Oldenburg

The mammalian cochlea has been studied extensively from various points of view, giving rise to a lot of different models each of which emphasizes certain aspects while neglecting others. However, the fact that the cochleae of most mammals is spiral-shaped has been ignored most of the time, the common interpretation being that coiling merely helps to put the cochlea into limited space.

Only recently has it been discovered, that the coiling causes a redistribution of the wave energy towards the outer wall, thereby enhancing radial shearing of the Basilar membrane in the low-frequency region [1, 2]. This theoretical outcome has been supported by the experimental observation that the hearing thresholds of many mammals can be related systematically to the product of Basilar membrane length and number of spiral turns [2].

Until now, this interesting phenomenon has been examined within the framework of passive linear cochlea models only. In our present work, we focus on the influence of curvature on the active nonlinear model which has been proposed by T. Duke and F. Jülicher [3].

[1] D. Manoussaki, E. K. Dimitriadis, and R. S. Chadwick, Phys. Rev. Lett. 96, 088701 (2006)

[2] D. Manoussaki et al., Proc. Nat. Acad. Sci. 105(16), 6162 (2008)

[3] T. Duke, F. Juelicher, Phys. Rev. Lett. 90(15), 158101 (2003)

DY 27.12 Thu 16:00 P1B

Cluster and splay states in networks of delay-coupled Stuart-Landau oscillators — •Chol-Ung Choe, Thomas Dahms, Philipp Hövel, and Eckehard Schöll — Institut f. Theo. Physik, Sekr. EW 7-1, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

We study one-dimensional ring and chain configurations of delay-coupled Stuart-Landau oscillators. The single elements are given by the complex normal form of supercritical Hopf bifurcation. Using the master stability function approach, we calculate the Floquet exponents of the synchronized state. Our simulations yield splay states or cluster dynamics, depending upon the chosen coupling delay.

DY 27.13 Thu 16:00 P1B

Dynamical trapping and chaotic scattering of the harmonically driven barrier — •Florian Koch[1], Florian Lenz[1], Christoph Petri[1], Fotis Diakonos[3], and Peter Schmelcher[1,2] — [1]Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg, Germany — [2]Theoretische Chemie, Institut für Physikalische Chemie, Universität Heidelberg, INF 229, 69120 Heidelberg, Germany — [3]Department of Physics, University of Athens, GR-15771 Athens, Greece

We provide a detailed analysis of the classical nonlinear dynamics of a single driven square potential barrier with harmonically oscillating position. The system exhibits dynamical trapping which is associated with the existence of a stable island in phase space. Due to the unstable periodic orbits of the KAM structure, the driven barrier is a chaotic scatterer and shows stickiness of scattering trajectories in the vicinity of the stable island. The transmission function of a suitably prepared ensemble yields results which are very similar to tunneling resonances in the quantum mechanical regime.

DY 27.14 Thu 16:00 P1B

Occurrence of normal and anomalous diffusion in the time-dependent elliptical billiard — •Christoph Petri[1], Florian Lenz[1], Florian Koch[1], Fotis Diakonos[3], and Peter Schmelcher[1,2] — [1]Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg, Germany — [2]Theoretische Chemie, Institut für Physikalische Chemie, Universität Heidelberg, INF 229, 69120 Heidelberg, Germany — [3]Department of Physics, University of Athens, GR-15771 Athens, Greece

We study the phase space topology of two dimensional driven billiards and its impact on diffusion processes. In this respect, the time-dependent ellipse is extraordinary, because it is so far the only known system, which exhibits Fermi acceleration, although the static counterpart is integrable. Depending on the driving mode we find either anomalous or normal diffusion in momentum space, which is due to the different structure of the underlying four dimensional phase space. For a certain class of modes there is actually a crossover from initially amplitude dependent sub- to asymptotically universal normal diffusion. Furthermore we can make the acceleration process saturate by introducing friction into the system.

DY 27.15 Thu 16:00 P1B

Complete synchronization of chaotic systems with time delayed coupling — •Thomas Jüngling[1], Hartmut Benner[1], Hiroyuki Shirahama[2], and Kazuhiro Fukushima[3] — [1]Institut für Festkörperphysik, TU Darmstadt, 64289 Darmstadt, Germany — [2]Faculty of Education, Ehime University, Matsuyama 790-8577, Japan — [3]Faculty of Education, Kumamoto University, Kumamoto 860-8555, Japan

Complete chaotic synchronization of two mutually coupled systems is generally unstable if there is a time delay in the coupling terms larger than a critical value. For most systems this critical time delay is very small compared to their typical time scales. We present an example of two delay-coupled Rössler circuits which show stable complete synchronization for a delay time of about three periods of the mean chaotic cycle time. We have studied this phenomenon in both numerical simulations and electronic circuit experiments on variation of the coupling scheme and internal system parameters, and have investigated the effect on the critical delay time. Our results reveal general limits for stable complete synchronization depending on the internal Lyapunov exponent and the specific coupling coefficients.

DY 27.16 Thu 16:00 P1B

Time delay and noise in the Kuramoto model of coupled oscillators — •Lucas Wetzel[1], Saul Ares[1], Andrew C. Oates[2], and Frank Julicher[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 are important in several physical, chemical, engineering, and biological phenomena. Traditionally the coupling between different oscillators was assumed to be instantaneous, neglecting the time necessary for information flow between different oscillators. Time delays in the coupling affect fundamental properties of the system, like synchronization or the collective period of oscillators. However, little is known of the joint effect of noise and time delay. The noise can come from a distribution of the intrinsic frequencies of the oscillators, from a dynamical noise affecting the oscillators, or from stochastic variations of the time delays in the coupling. The latter case can be described by a distributed delay, where time delays are no longer given by a single number, but by a distribution over past times affecting the rate of oscillation in the present.

In this contribution we study the Kuramoto model of phase oscillators as a representative of systems of coupled oscillators. We introduce time delay in the coupling and characterize its effects in the presence of noise. Together with the basic understanding of the problem, we are motivated by the study of genetic oscillations in vertebrate segmentation, where a description based on phase oscillators has shown to be a valuable tool.

DY 27.17 Thu 16:00 P1B

Dynamical phase diagrams for spiral waves attached to obstacles and suppression of spiral waves by boundary effects — •Claudia Hamann, Mario Einax, and Philipp Maass — Institut für Physik, Technische Universität Ilmenau, Germany

Based on the FitzHugh-Nagumo equations we study the pinning of spiral waves by spatial inhomogeneities associated with variations of cell properties like excitability and resting state stability. These inhomogeneities can be a pacemaker source for atrial fibrillation. Dynamical phase diagrams are constructed that classify the spatio-temporal excitation patterns in dependence of the size of the obstacle and the strength of the changes of the cell properties. With increasing modification of the cell properties a transition from functional to anatomical reentry of spiral waves is found. We further show that boundaries in the neighborhood of the obstacle can suppress spiral wave generation. This allows us to gain insight into the principle and effectiveness of catheter ablation used in medical treatment of atrial fibrillation [1].

[1] C. Hamann, diploma thesis, Technische Universität Ilmenau, 2008

DY 27.18 Thu 16:00 P1B

Network communications: Applications to epileptic seizures — •Cornelia Petrovic and Rudolf Friedrich — Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str.9, D-48149 Münster, Deutschland

Epilepsy is one of the most common neurological diseases, one percent of the world's population suffering from it. It is characterized by the sudden onset of recurrent seizures due to a collective, "hypersynchronous" activity of extended populations of neurons. Since up to now only about two thirds of the patients respond to medication, understanding of the dynamic mechanisms which drive the epileptic seizures is of great interest. It appears to be that the understanding of seizure dynamics can be decisively improved by considering epileptic seizures as network phenomena.

DY 27.19 Thu 16:00 P1B

Data assimilation as a hamiltonian boundary value problem — •Jochen Bröcker — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 34, 01187 Dresden, Germany

Time series are often assumed to arise as observations from an underlying dynamical system. To analyze or forecast such systems, it is necessary to compute trajectories which are on the one hand consistent with the model dynamics, but which on the other hand closely follow (or 'shadow') the recent history of observations. This process (referred to as data assimilation in the atmospheric sciences or smoothing in the engineering community) is revisited in this contribution.

An approach to data assimilation using concepts from nonlinear control theory will be presented. The dynamics are augmented by a control force, which is chosen so as to make the discrepancy between the trajectory and the actual observations, the tracking error, small. At the same time, large control actions are penalized as well, in order to create trajectories which are as consistent with the dynamics as possible.

Provided there is no model error, the control is expected to vanish once the dynamics is "on track". In the presence of model error though, a small but non-vanishing control will remain necessary to keep the trajectory close to the observations. It is demonstrated that this approach provides an effective means to regularize the problem and to control the trade–off between perfectly following the observations and perfectly obeying the dynamics. Furthermore, an ex–post analysis of the control forces should provide information on model imperfections.

DY 27.20 Thu 16:00 P1B

Structure of Bred Vectors in Spatiotemporal Chaos — •Sarah Hallerberg, Diego Pazó, Juan M. López, and Miguel A. Rodríguez — Instituto de Física de Cantabria (IFCA), CSIC-Universidad de Cantabria, E-39905, Spain

The spatiotemporal dynamics of characteristic Lyapunov vectors in spatially extended chaotic systems can be related to properties of scale invariant growing surfaces [1,2]. These results are based on a Hopf-Cole transformation, which reveals that the Lyapunov vectors corresponding to the largest Lyapunov exponents are "piecewise copies" of the first Lyapunov vector. We study now, whether similar scaling properties, can also be observed for bred vectors, which are used in the context of data assimilation for weather forecasting. Moreover, we propose a new method to estimate the spectrum of Lyapunov exponents corresponding to the most expanding directions using bred vectors. Both results are developed by investigating bred vectors in the model proposed by Lorenz in 1996 [4] and in a lattice of coupled logistic maps.

References: [1] D. Pazó, I. G. Szendro, J. M. López and M. A. Rodríguez, PRE 78, 016209, (2008); [2] I. G. Szendro, D. Pazó, M. A. Rodríguez and J. M. López,PRE 76, 025202(R) (2007); [3] E. Kalnay, M. Corazza and M. Cai, Pp. 173-177 in Proc. of AMS Symposium on Observations, Data Assimilation and Probabilistic Prediction, (2002); [4] E. N. Lorenz in Proc. of the Seminar on Predictability, Vol I., edited by T. Palmer, ECMWF, pp. 1-18 (1996)

DY 27.21 Thu 16:00 P1B

Detecting chaos and determining the dimensions of tori in Fermi-Pasta-Ulam lattices by the Generalized Alignment Index method — •Charalampos Skokos[1], Tassos Bountis[2], and Chris Antonopoulos[3] — [1]Max Planck Institute for the Physics of Complex Systems, Nothnitzer Str. 38, D-01187 Dresden, Germany — [2]Department of Mathematics, University of Patras, GR-26500, Patras, Greece — [3]Universite Libre de Bruxelles, Campus de la Plaine, CP 231, Boulevard du Triomphe, B-1050, Brussels, Belgium

The recently introduced Generalized Alignment Index (GALI) method of chaos detection (Skokos et al. Physica D, 2007, 231, 30) is applied to distinguish efficiently between regular and chaotic orbits of multi–dimensional Hamiltonian systems. The GALI of order k ($GALI_k$) is proportional to volume elements formed by k initially linearly independent unit deviation vectors whose magnitude is normalized to unity from time to time. For chaotic orbits, $GALI_k$ tends exponentially to zero with exponents that involve the values of several Lyapunov exponents, while in the case of regular orbits, $GALI_k$ fluctuates around nonzero values or goes to zero following particular power laws that depend on the dimension of the torus and on the order k. We apply these indices to rapidly detect chaotic oscillations, identify low–dimensional tori of Fermi-Pasta-Ulam (FPU) lattices and predict weak diffusion away from quasiperiodic motion, long before it is actually observed in the oscillations (Skokos et al. Eur. Phys. J. Special Topics, 2008, 165, 5). We also present an efficient computation scheme of the GALI's, based on the Singular Value Decomposition (SVD) algorithm.

DY 27.22 Thu 16:00 P1B

Renyi Entropies of Quasi-Periodically Forced Nonlinear Systems — •Annette Witt — Max-Planck-Institute for Dynamics and Self-organization, Göttingen, Germany

Strange non-chaotic attractors (SNAs) which are characterized by a fractal geometry, although the underlining dynamics is non-chaotic, are typical for quasi-periodically forced nonlinear systems. In order to characterize the complex dynamics of these systems, their Renyi entropies K(q) are studied. Computational results are presented for time-discrete and time-continuous dynamical systems. Two types of dynamics on SNAs are found: (a) Homogeneous dynamics that is characterized by K(q)=0 for all crwoding indices q. (b) Non-homogeneous dynamics where the corresponding Renyi entropies decrease with q. Here, Renyi entropies K(q)=0 for all crowding indexes q>1 demonstrate the nonchaotic character of the considered systems. Moreover, positive Renyi entropies, K(q)>0, for crowding indexes q<q* with q*<1 stand for a fraction of exponentially expanding initially nearby trajectories. It is shown that this critical crowding index q* quantifies the ratio between regularity and chaos.

DY 27.23 Thu 16:00 P1B

Scenarios for generalized synchronization with chaotic driving — Th. Umeshkanta Singh, •Amitabha Nandi, and Ram Ramaswamy — School of Physical Sciences, Jawaharlal Nehru University, New Delhi - 110067

In chaotically driven nonlinear dynamical systems, weak generalized synchrony can arise through distinct scenarios or routes in a manner similar to the onset of low-dimensional chaos or the creation of strange nonchaotic attractors in quasiperiodically driven systems. The limit sets of the dynamics for weak generalized synchronization are nonchaotic the Lyapunov exponent is nonpositive and are geometrically strange. Quantitative measures related to the parameter sensitivity exponent and finite-time Lyapunov exponent distributions can be defined in order to characterize generalized synchronization.

DY 27.24 Thu 16:00 P1B

Ising and Bloch fronts in parametrically forced oscillating lattices — •Ernesto M. Nicola[1] and Diego Pazo[2] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Instituto de Física de Cantabria, IFCA (CSIC-UC), Santander, Spain

We study the dynamics of fronts in lattices of coupled forced oscillators. Using as a prototypical example the discrete Ginzburg-Landau equation, we show that much information about front bifurcations can be extracted by projecting onto a cylindrical phase space. We show that the discretization induces the existence of new types of Ising and Bloch fronts. These fronts exhibit a highly non-trivial dynamic behavior. Starting from a normal form that describes the nonequilibrium Ising-Bloch bifurcation in the continuum [1] and using symmetry arguments, we derive a simple dynamical system that captures the dynamics of fronts in the lattice [2].

[1] Coullet *et al.*, Phys. Rev. Lett. **65**, 1352 (1990).

[2] Pazó and Nicola, Erophys. Lett. **81**, 10009 (2008).

DY 28: Pattern formation in colloidal and granular systems II

Time: Friday 10:15–13:15 Location: HÜL 386

DY 28.1 Fri 10:15 HÜL 386

Axial segregation in oscillatory driven colloidal binary mixtures — •Adam Wysocki and Hartmut Loewen — Institut fur Theoretische Physik II: Weiche Materie, Heinrich-Heine-Universitaet Duesseldorf, Universitaetsstrasse 1, D-40225 Duesseldorf, Germany

Using computer simulations we show that binary mixtures of colloids driven in opposite directions by an oscillating external field exhibit axial segregation in sheets perpendicular to the drive direction. The segregation effect persists also for strong hydrodynamic interactions. For increasing driving forces axial segregation ceases and is taken over by lane formation in direction of the driving field.

DY 28.2 Fri 10:30 HÜL 386

Granular segregation phenomena in rotating containers — Lama Naji, Tilo Finger, and •Ralf Stannarius — Otto-von-Guericke-Universität Magdeburg

Segregation of granular mixtures in rotating drums and the subsequent coarsening of segregation patterns are well investigated phenomena. But still, many basic questions are poorly understood, among them the mechanism of coarsening of stripe patterns in cylindrical tubes, and the role of lateral boundaries. We investigate slurries, mixtures of glass beads in liquid environment (water). These systems do not only allow the optical observation of surface patterns, but also a three-dimensional structure characterization by NMR tomography. Experiments with cylindrical and spherical mixers are reported.

DY 28.3 Fri 10:45 HÜL 386

Critical Casimir forces between colloids and chemically patterned substrates — •Matthias Tröndle[1,2], Svyatoslav Kondrat[1,2], Andrea Gambassi[1,2], Ludger Harnau[1,2], and Siegfried Dietrich[1,2] — [1]Max-Planck-Institut für Metallforschung, Heisenbergstr. 3, D-70569 Stuttgart — [2]Institut für Theoretische und Angewandte Physik Universität Stuttgart, Pfaffenwaldring 57, D-70569 Stuttgart

We study the effective critical Casimir forces acting on colloids immersed in a binary liquid mixture in the presence of a chemically structured substrate with laterally varying adsorption preference. Close to the critical point of the fluid, long-ranged correlations in the mixture cause pronounced normal and lateral critical Casimir forces between the colloids and the confining wall. The sign and the magnitude of these forces depend on the surface properties so that the colloids tend to align with the substrate pattern. This allows, for example, the formation of highly ordered colloidal monolayers. Recently, the measurement of critical Casimir interactions in such a system has been reported [F. Soyka, O. Zvyagolskaya, C. Hertlein, L. Helden, and C. Bechinger, PRL 101, 208301 (2008)]. Based on general renormalization group arguments, we calculate the universal scaling functions for the critical Casimir forces acting on a spherical colloid close to a chemically patterned substrate as well as for the corresponding interaction potential and compare our results with experimental data.

DY 28.4 Fri 11:00 HÜL 386

Random-Close Packing in Binary Mixtures in Two Dimensions — •Elmar Staerk[1], Stefan Luding[2], and Matthias Sperl[1] — [1]Institut fuer Materialphysik im Weltraum, DLR, Koeln — [2]Universiteit Twente, The Netherlands

Binary mixtures are investigated at the transition from loose to load-bearing packings. The transition is determined both in computer simulation and experimentally in assemblies of stress-birefringent particles. Both the size ratio of smaller to bigger particles as well as the concentration of smaller particles is varied systematically. The transition is determined accurately by observing a discontinuity in the number of contacts per particle. It is found that the variation of the transition density follows qualitatively recent predictions for the glass transitions in binary mixtures of colloidal particles. At the transition point – especially for asymmetric mixtures – we find non-trivial variations of contact numbers, apparent exponents, and the number of rattlers.

DY 28.5 Fri 11:15 HÜL 386

Confined colloidal crystals. — Alexander Reinmüller, Ana Barreira Fontecha, Thomas Palberg, and •Hans Joachim Schöpe — Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudinger Weg 7, 55099 Mainz, Deutschland

The packing of spheres in confined geometry is of both fundamental and practical interest for logistics, mathematics, condensed matter physics, and recently also in colloid science. We study the structural transition of colloidal crystals confined between two plates. Restricting the available space leads to an adaptation of the crystalline bulk structures (bcc, hcp, fcc) to the symmetry of the confinement and a rich variety of structures is found as a function of colloid packing fraction and confinement dimension. We extend former experimental work presenting new exotic crystalline structures having no atomic counterpart. In addition we present first results of bidisperse colloidal crystals in confinement.

DY 28.6 Fri 11:30 HÜL 386

The flow field of glass beads around a fixed obstacle — •Matthias Raithel[1], Christoph Krülle[2], and Ingo Rehberg[1] — [1]Experimentalphysik V, Universität Bayreuth, D-95440 Bayreuth, Germany — [2]Maschinenbau und Mechatronik, Hochschule Karlsruhe - Technik und Wirtschaft, D-76133 Karlsruhe,Germany

In this experiment a dish filled with glass beads is shaken horizontally, so every point on that dish moves on a circular path. Controlled by the filling fraction, the oscillation frequency and amplitude, the system shows phase transitions [1] and the change from reptation to rotation [2]. By inserting an intruder the system becomes more complex. In the case of a freely moving intruder segregation occurs. The flow field around a fixed obstacle is examined in order to understand that segregation.

[1] S. Aumâitre, T. Schnautz, C. Kruelle, I. Rehberg, Phys. Rev. Lett. 90, 114302 (2003)

[2] M. Scherer, V. Buchholtz, T. Pöschel, I. Rehberg, Phys. Rev. E 54, R4560 (1996)

15 min. break.

DY 28.7 Fri 12:00 HÜL 386

Convection in thermosensitive colloidal suspensions — •Florian Winkel[1], Stephan Messlinger[1], Wolfgang Schöpf[1], Ingo Rehberg[1], Miriam Siebenbürger[2], and Matthias Ballauff[2] — [1]Experimentalphysik V, Universität Bayreuth, D-95440 Bayreuth, Germany — [2]Physikalische Chemie I, Universität Bayreuth, D-95440 Bayreuth, Germany

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 volume fraction and therefore the viscosity of the suspension. As a consequence, a temperature gradient applied to the suspension also induces a gradient of the colloid concentration which strongly influences both the onset and the nonlinear behavior of thermal convection. In our experiment we expose a Hele-Shaw convection cell to a constant temperature difference. The thermal convection is monitored via a shadowgraph setup. We report on the formation and evolution of convection patterns in our microgel suspension.

DY 28.8 Fri 12:15 HÜL 386

A new convection scenario in granulates under geometrical restriction — •Frank Rietz and Ralf Stannarius — Universität

Magdeburg, FNW, IEP, Abteilung Nichtlineare Phänomene

An experiment is presented that extends the diversity of pattern forming phenomena found in granular media. A flat container (Hele-Shaw cell) is filled with a granular mixture and slowly rotated about its horizontal long axis. The filling fraction is crucial for the observed effects.

At partial filling of the container, the material can be fluidized during rotation and patterns of axially segregated stripes appear which undergo slow coarsening. This effect resembles stripe patterns commonly found in rotating drums.

A novel interesting phenomenon emerges under geometrical restrictions when the container is nearly filled. Although the particles are on the brink of jamming, and their mobility is almost inhibited, we observe regular convection rolls that are accompanied by, and decorated by a conspicuous serpentine segregation pattern. In contrast to the loosely moving beads at partial filling, the particles move in collective clusters. Furthermore the number of convection rolls is long-term stable and only related to the container geometry.

Even though there are some superficial similarities to well known convection rolls in vibrated granular systems, there are striking differences concerning driving forces, segregation patterns, and number of rolls. Our system complements convection phenomena found in agitated granulates and brings up new questions that are discussed in the study. *Phys. Rev. Lett.* **100**, 078002 (2008).

DY 28.9 Fri 12:30 HÜL 386

Dynamical polarization and unusual flow response in the shear flow of dipolar colloidal rod suspensions — •Sebastian Heidenreich[1], Siegfried Hess[1], and Sabine H. L. Klapp[2] — [1]Institute für Theoretische Physik, TU Berlin, 10623, Germany — [2]Institut für Theoretische Physik, FU Berlin, 14195 Berlin, Germany

The flow properties of colloidal rod suspensions are strongly affected by the dynamical behavior of the orientation. Shear banding is an example of the remarkable non-Newtonian feedback that is possible in such systems. For colloidal rods with a permanent electric (magnetic) dipole moment additional exciting effects are expected. The calculations presented here are based on a self-consistent hydrodynamic model including feedback effects between orientational motion and velocity profile [1]. The competition between shear-induced tumbling motion (observed in colloidal suspensions of rod-like fd virus [2]) and the boundary conditions imposed by plates leads to oscillatory alignment structures. These give rise to a spontaneous time-dependent polarization and to oscillating local spurts of the velocity profile [3]. Moreover, our model can be extended to polar active biomaterials by including "activity terms". Finally, some preliminary results of the local spurt effect in active polar colloidal suspensions are presented. [1] S. Grandner, S. Heidenreich, S. Hess and S. H. L. Klapp, EPJE 24, 353 (2007).; M. G. Forest, S. Heidenreich, S. Hess, X. Yang and R. Zhou JNNFM 155, 130 (2008). [2] M. P. Lettinga, Z. Dogic, H. Wang, J. Vermant, Langmuir 21, 8048 (2005). [3] S. Heidenreich, S. Hess, and S. H. L. Klapp, submitted to PRL.

DY 28.10 Fri 12:45 HÜL 386

Unstable Kolmogorov flow in granular matter — •Klaus Roeller and Stephan Herminghaus — MPI for Dynamics and Self-Organization, Bunsenstr. 10, D-37073 Göttingen, Germany

We report on simulations of an instability in granular flow, which is driven by a time-constant spatially periodic shear force. This type of forcing is known as Kolmogorov flow. We performed molecular dynamics type simulations, both time-driven and event-driven, in two and three dimensions [1,2]. For small values of the applied shear force we observe the usual shear bands. Above a critical value, however, the shear bands become unstable resulting in the formation of a dynamically stable pattern with swirls. This effect was observed in dry as well as in wet granular matter, although the morphology of the swirls strongly differs for the two cases.

[1] S. Herminghaus Advances in Physics 54, 221 (2005)
[2] A. Fingerle, et al, New J. Phys. 10, 053020 (2008)

DY 28.11 Fri 13:00 HÜL 386

Statics and dynamics of a continuous Asakura-Oosawa model near the critical point — •Peter Virnau[1], Jochen Zausch[1], Jürgen Horbach[2], and Kurt Binder[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz — [2]DLR Köln

We propose a continuous variant of the Asakura-Oosawa model which allows us to study dynamics, too. The phase behaviour of the system is determined with grandcanonical Monte Carlo simulations and found to be in good agreement with the original hardcore model. Dynamical quantities near the critical point are investigated with Molecular Dynamics simulations. While the self-diffusion of polymers increases slightly when the critical point is approached, the self-diffusion of colloids decreases. Critical slowing down of interdiffusion is observed, which is qualitatively similar to the behavior of a symmetric binary Lennard-Jones mixture near criticality.

DY 29: Statistical physics of complex networks

Time: Friday 10:15–13:15 Location: ZEU 255

DY 29.1 Fri 10:15 ZEU 255

Automated moment closure and oscillations in adaptive networks — •Thilo Gross — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany

Adaptive networks combine topological evolution OF a network with dynamics ON the network. Recently a number of new phenomena that appear in this class of systems have been reported. One methods by which adaptive networks can be studied is the moment closure approximation, which yields a low-dimensional system of differential equations. In this talk I will first explain the conventional moment closure approach and then present automated moment closure (AMC) as an extension. In AMC appropriate closure terms are computed on-demand from short bursts individual-based simulation. Despite these micro-level simulations the system is analyzed directly on a macro-level, i.e., as a low-dimensional system of ordinary differential equations describing emergent system-level properties. This approach is used to find regions of oscillatory dynamics in an epidemiological susceptible-infected-susceptible model. Unlike oscillations on static network, the oscillatory dynamics on the adaptive network involves topological as well as local degrees of freedom.

DY 29.2 Fri 10:30 ZEU 255

The hierarchical system of PDE and a diffusive anomalous spread in media with multiscale connections — •Eugene Postnikov — Kursk State University, Kursk, Russia

Recently, there exists a large variety of real-world problems, which require mathematical methods for the modeling of diffusion in a strongly disordered complex environment. For example, description of human and animal mobility [González et al, 2008] as well as spread of information and diseases [Brockmann et al, 2006].

It has been shown [Naether, Postnikov, Sokolov, 2008] that realistic asymmetric Kendall waves of an SIR epidemic spread along a population with small mobility can be described with the PDE system, which contains the specific combination of infected individuals density and its Laplacian multiplied by the characteristic habitat size.

In the present contribution, the further development of this approach is presented. To model a spread in a hierarchical metapopulation, the unique "size coefficient" for diffusion term is replaced with the progressive set of values.

It has been shown that such an approach allows to reproduce the anomalous relaxation in the small world networks (with comparison with the direct simulation [Sokolov et al, 2000]) and some properties of anomalous human mobility patterns citied above.

DY 29.3 Fri 10:45 ZEU 255

Ergodic diffusion in network configuration space — •Sebastian Weber and Markus Porto — Institut für Festkörperphysik, Technische Universität Darmstadt, Germany

Virtually all real-world networks have evolved over time by stepwise alternation into their present structure. The patterns by which structural changes occur can be assumed to allow, in principle, for a free diffusion in the network configuration space. However, an ergodic exploration of the network configuration space by means of a generic process beyond single edge addition or removal is a subtle task as

modification patterns are often bound to a particular class of networks [1]. We present an ansatz which uses only information of the current network in order to alter the network structure and evaluate the proposed schemes by driving, for instance, Erdős-Rényi type to two-point correlated scale-free type networks and back.
[1] S. Weber, and M. Porto, submitted

DY 29.4 Fri 11:00 ZEU 255

Critical Boolean networks with scale-free in-degree distribution — •Florian Greil — Institut für Festkörperphysik, Technische Universität Darmstadt, Germany

We investigate analytically and numerically critical Boolean networks with power-law in-degree distributions. When the exponent of the in-degree distribution is larger than 3, we obtain the same results as for networks with fixed in-degree, e.g., that the number of the non-frozen nodes scales as $N^{2/3}$ with the system size N. When the exponent of the distribution is between 2 and 3, the number of the non-frozen nodes increases as N^x, with x being between 0 and 2/3 and depending on the exponent and on the cutoff of the in-degree distribution. Our results explain various results obtained earlier by computer simulations.

DY 29.5 Fri 11:15 ZEU 255

The impact of clustering on the transport capacity of scale-free communication networks. — •Jan Scholz[1] and Martin Greiner[2] — [1]Frankfurt Institute for Advanced Studies, Goethe Universität Frankfurt, Ruth-Moufang-Str. 1, 60438 Frankfurt am Main, Germany — [2]Corporate Technology, Information & Communications, Siemens AG, 80200 München, Germany

The efficiency of communication networks can very effectively be enhanced by optimizing the routing metrics [1]. However, there is apparent discrepancy between the performance of null models (random scale-free networks) and measured Internet topology.

A key difference between these classes of networks is clustering, which is very abundant in the Internet data, while being suppressed in random scale-free networks.

Here we investigate the influence of clustering on the increase of communication performance by adaptive routing metrics and on the robustness of the resulting weighted networks.

[1] Jan Scholz, Wolfram Krause, and Martin Greiner. Decorrelation of networked communication flow via load-dependent routing weights. *Physica A — Statistical Mechanics and its Applications*, 387:2987–3000 (2008)

DY 29.6 Fri 11:30 ZEU 255

Complex dynamics on dissortative scale-free networks — •Jörg Menche, Angelo Valleriani, and Reinhard Lipowsky — Max-Planck-Institute of Colloids and Interfaces, Science Park Golm, 14424 Potsdam, Germany

Many biological and technological networks have been found to exhibit scale-free degree distributions together with dissortative mixing by degree. We study the properties of local majority rule dynamics on such networks. Networks without degree correlations only show two stable fixed points that correspond to the completely ordered states. In contrast, networks with degree correlations are found to exhibit a large number of additional attractors. Surprisingly, the number of attractors does not increase monotonously as a function of network size, but reaches a maximum for intermediate sizes. This can be explained by the reduction in the maximal dissortativity that can be achieved for scale-free networks in the limit of large network sizes.

15 min. break.

DY 29.7 Fri 12:00 ZEU 255

Fluctuating power flows in a future European power transmission network with a high share of wind and solar power production — •Dominik Heide[1], Clemens Hoffmann[2], Martin Greiner[2], Lüder von Bremen[3], Kaspar Knorr[3], Markus Speckmann[3], and Stefan Bofinger[3] — [1]Frankfurt Institute for Advanced Studies FIAS, Ruth-Moufang-Straße 1, 60438 Frankfurt am Main, Germany — [2]Siemens AG, Corporate Research and Technology, 81730 München, Germany — [3]Institut für Solare Energieversorgungstechnik ISET, Königstor 59, 34119 Kassel, Germany

We envision a future European transmission power network, which has only power production from renewable sources. With an 8-years-long numerical weather data set of 1h time resolution, the regional wind and solar power production across Europe is determined. This renewable power generation is confronted with the regional consumer loads and determines the fluctuating source/sink strengths of each region. The balancing of the sources and sinks determines the power flow. The latter is calculated within the DC flow approximation, which employs the Laplace matrix of the underlying geometric network, where node-like regions are connected by links. Due to the fluctuating source and sink strengths, the power flows across the links show strong fluctuations. Their characterization allows to roughly estimate the future investment needs into the European transmission power network.

In the second part of the presentation an abstracted network model will be presented, which is able to generically reproduce the results obtained from the weather-driven first part.

DY 29.8 Fri 12:15 ZEU 255

Counting Complex Disordered States by Efficient Pattern Matching: Chromatic Polynomials and Potts Partition Functions — •Marc Timme[1], Frank van Bussel[1], Denny Fliegner[2], Sebastian Stolzenberg[3], and Christoph Ehrlich[4] — [1]Network Dynamics Group, MPIDS Göttingen — [2]Dept. of Nonlinear Dynamics, MPIDS Göttingen — [3]Dept. of Physics, Cornell University, USA — [4]Dept. of Physics, TU Dresden

Counting problems, determining the number of possible states of a large system under certain constraints, play an important role in many areas of science. They naturally arise for complex disordered systems in physics and chemistry, in mathematical graph theory, and in computer science. Counting problems, however, are among the hardest problems to access computationally. Here we suggest a novel method to access a benchmark counting problem, finding chromatic polynomials of graphs. We develop a vertex-oriented symbolic pattern matching algorithm that exploits the equivalence between the chromatic polynomial and the zero-temperature partition function of the Potts antiferromagnet on the same graph. Implementing this bottom-up algorithm using appropriate computer algebra, the new method outperforms standard top-down methods by several orders of magnitude, already for moderately sized graphs. As a first application we compute chromatic polynomials of samples of the simple cubic lattice, for the first time computationally accessing three-dimensional lattices of physical relevance. The method offers straightforward generalizations to several other counting problems.

DY 29.9 Fri 12:30 ZEU 255

Deformed Gaussian Orthogonal Ensemble description of Small-World networks — •Josue Xavier de Carvalho[1], Sarika Jalan[1], and Mahir Saleh Hussein[1,2] — [1]MPIPKS, Dresden, Germany — [2]USP, Sao Paulo, Brazil

The study of spectral behaviour of networks has gained enthusiasm over the last few years. In particular, Random Matrix Theory concepts have proven to be useful. In discussing transitions from regular behaviour to fully chaotic behaviour it has been found that an extrapolation formula of the Brody type can be used. In the present paper we analyse the regular to chaotic behaviour of Small World networks using an extention of Wigner's Gaussian Orthogonal Ensemble. This RMT, coined the Deformed Gaussian Orthognal Ensemble, supplies a natural foundation of Brody's formula. The analysis performed in this paper proves the utility of the DGOE in network physics, as much as it has been useful in other physical systems.

DY 29.10 Fri 12:45 ZEU 255

Applying statistical complexity measures to networks — •Eckehard Olbrich, Thomas Kahle, Nils Bertschinger, and Jürgen Jost — Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany

Statistical complexity measures such as the excess entropy are well established in the context of time series and were recently generalized to quantify the complexity of joint probability distributions in general. We discuss, how statistical complexity measures can be applied to quantify structural properties of graphs.

In particular, we propose the interaction complexity – a recently introduced vector valued complexity measure, whose components quantify the complexity in terms of k-th order statistical dependencies that cannot be explained by interactions between $k-1$ units – as a general and systematic framework for analyzing the subgraph (motif) statistics of complex networks.

DY 29.11 Fri 13:00 ZEU 255

Public transport networks under random failure and directed

attack — Bertrand Berche[1], •Christian von Ferber[2,3], Taras Holovatch[1,2], and Yurij Holovatch[4,5] — [1]Laboratoire de Physique des Materiaux, Université Nancy, France — [2]Applied Mathematics Research Centre, Coventry University, UK — [3]Physikalisches Institut, Universität Freiburg — [4]ICPM National Academy of Sciences of Ukraine, Lviv — [5]Institut für Theoretische Physik, Universität Linz, Österreich

The behavior of complex networks under failure or attack depends strongly on the specific scenario. Of special interest are scale-free networks, which are usually seen as robust under random failure but appear to be especially vulnerable to targeted attacks. In a recent study of public transport networks of 14 major cities of the world we have shown that these systems when represented by appropriate graphs may exhibit scale-free behaviour [Physica A 380, 585 (2007)]. Our present analysis, focuses on the effects that defunct or removed nodes have on the properties of public transport networks. We confirm that the impact of random failure is weak and that for a moderate share of defunct nodes there is little to no change in the network behaviour. Simulating different directed attack strategies however, we derive vulnerability criteria that result in minimal strategies with high impact on these systems.

DY 30: Nonlinear stochastic systems

Time: Friday 10:15–13:15 Location: ZEU 118

DY 30.1 Fri 10:15 ZEU 118

Strong interactions in diffusive random lasers — •Hakan E. Tureci[1], Douglas Stone[2], Li Ge[2], and Stefan Rotter[2,3] — [1]Institute for Quantum Electronics, ETH Zurich, 8093 Zurich, Switzerland — [2]Department of Applied Physics, Yale University, New Haven, CT 06520, USA — [3]Institute for Theoretical Physics, Vienna University of Technology, A-1040 Vienna, Austria

Novel laser designs have emerged recently due to modern nanofabrication capabilities. Striking among these are diffusive random lasers (DRLs) which have no resonator to trap light and no high-Q resonances to support lasing. Due to this lack of sharp resonances the DRL has presented a challenge to conventional laser theory, leading to controversy over their correct description. We recently presented a theory able to treat the DRL rigorously, and provided results on the lasing spectra, internal fields and output intensities of DRLs (Science 320, 643, 2008). DRLs are always multimode lasers, i.e. they emit light at a range of wavelengths. I will show that the modal interactions through the gain medium in such lasers are extremely strong and lead to a uniformly spaced frequency spectrum, in agreement with recent experimental observations. Non-hermitian character of the system is correctly captured, resulting in lasing modes which have an average spatial growth towards the loss-boundary.

DY 30.2 Fri 10:30 ZEU 118

Properties of the Langevin equation driven by noises with heavy and super-heavy tailed distributions of the increments — •Stanislav Denisov[1], Peter Hänggi[2], and Holger Kantz[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, D-01187 Dresden, Germany — [2]Institut für Physik, Universität Augsburg, D-86135 Augsburg, Germany

We present our results on the statistical properties of the solutions of the overdamped Langevin equation driven by noises whose increments are distributed with heavy and super-heavy tails. Starting from an arbitrary distribution of the increments, we derive the generalized Fokker-Planck equation that in a concise and natural way captures all known particular cases including the fractional Fokker-Planck equation associated with the Langevin equation driven by a Lévy stable noise [1]. We demonstrate that the fractional Fokker-Planck equation is valid also for all noises whose increments have heavy-tailed distributions and calculate its parameters in terms of the asymptotic characteristics of these distributions [2]. In the case of super-heavy tailed distributions of the noise increments, i.e., distributions that do not possess finite moments of any fractional order, the generalized Fokker-Planck equation is solved exactly and the role of these noises is analyzed.

[1] S.I. Denisov, W. Horsthemke, and P. Hänggi, Phys. Rev. E 77, 061112 (2008).

[2] S.I. Denisov, P. Hänggi, and H. Kantz, arXiv:0811.1162.

DY 30.3 Fri 10:45 ZEU 118

Surmounting collectively oscillating bottlenecks — •Dirk Hennig[1], Lutz Schimansky-Geier[1], and Peter Hänggi[2] — [1]Institut für Physik, Humboldt Universität zu Berlin, Newtonstr. 15, 12489 Berlin — [2]Institut für Physik, Universität Augsburg, Universitätsstr. 1, 86135 Augsburg

We study the collective escape dynamics of a chain of coupled, weakly damped nonlinear oscillators from a metastable state over a barrier when driven by a thermal heat bath in combination with a weak, globally acting periodic perturbation. Optimal parameter choices are identified that lead to a drastic enhancement of escape rates as compared to a pure noise-assisted situation. We elucidate the speed-up of escape in the driven Langevin dynamics by showing that the time-periodic external field in combination with the thermal fluctuations triggers an instability mechanism of the stationary homogeneous lattice state of the system. Perturbations of the latter provided by incoherent thermal fluctuations grow because of a parametric resonance, leading to the formation of spatially localized modes (LMs). Remarkably, the LMs persist in spite of continuously impacting thermal noise. The average escape time assumes a distinct minimum by either tuning the coupling strength and/or the driving frequency. This weak ac-driven assisted escape in turn implies a giant speed of the activation rate of such thermally driven coupled nonlinear oscillator chains.

DY 30.4 Fri 11:00 ZEU 118

Estimation of an effective potential for a collective variable of globally coupled bistable systems — •Christoph Honisch — Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster

We derive an effective Langevin equation for the mean field of N globally coupled bistable systems subject to a periodic driving force and Gaussian white noise. For this purpose we simulate the system and at first give evidence that the behaviour of the mean field can be described as a Markov process. Then we use a numerical algorithm to estimate the Kramers Moyal coefficients $D^{(1)}$ and $D^{(2)}$ of the corresponding Fokker-Planck equation. This estimation is used to reconstruct the behaviour of the mean field via a one dimensional effective Langevin equation. Finally the result is compared to the mean field of the original N dimensional system.

DY 30.5 Fri 11:15 ZEU 118

Transport of a dimer subject to localized forces over a periodic potential — •Steffen Martens, Dirk Hennig, and Lutz Schimansky-Geier — Institut für Physik, Humboldt-Universität zu Berlin

The overdamped Brownian motion of a dimer confined onto a periodic potential is studied. The two particles are coupled by non-linear interaction potentials, i.e., a Toda-like potential and the Morse potential. As extension of previous work [1,2] a localized dc force is applied to a one of the particles. The non-vanishing net current, instigated by thermal fluctuations and the localized point force, is quantitatively assessed by the value of the mobility of the center of mass. The latter is investigated both analytically and numerically. It turns out that the mobility of the dimer exhibits distinct properties in comparison with a monomer. In particular, the mobility as a function of the competing length scales of the system, that is 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. Further the net current is found to be a non-monotonous function of the localized driving force.

[1] D. Hennig, S. Martens, and S.Fugmann,Phys. Rev. E, 78, 011104, 2008.

[2] S. Martens, D. Hennig, S. Fugmann, and L. Schimansky-Geier, Phys. Rev. E, 78, 041121, 2008.

DY 30.6 Fri 11:30 ZEU 118

Entropic Stochastic Resonance — •P. Sekhar Burada, Gerhard Schmid, and Peter Hänggi — Institut für Physik, Universität Augsburg, D-86135 Augsburg

We present a novel scheme [1] for the appearance of Stochastic Resonance [2] when the motion of a Brownian particle takes place in a confined medium. The presence of curved boundaries, giving rise to a nonlinear entropic contribution to the potential, may upon application of a periodic driving force result in an increase of the spectral amplification at an optimum value of the ambient noise level [1]. The Entropic Stochastic Resonance (ESR), characteristic of small-scale systems, may constitute a useful mechanism for the manipulation and control of single molecules and nanodevices.

[1] P.S. Burada, G. Schmid, D. Reguera, M.H. Vainstein, J.M. Rubi, and P. Hänggi, Phys. Rev. Lett. **101**, 130602 (2008)
[2] L. Gammaitoni, P. Hänggi, P. Jung, and F. Marchesoni, Rev. Mod. Phys. **70**, 223 (1998)

DY 30.7 Fri 11:45 ZEU 118

Scaling of the rupture dynamics of polymer chains — •Simon Fugmann and Igor M. Sokolov — Institut für Physik, Humboldt-Universität Berlin, Newtonstrasse 15, 12489 Berlin, Germany

We consider the rupture dynamics of a homopolymer chain pulled at one end at a constant loading rate. Compared to single bond breaking, the existence of the chain introduces two new aspects into rupture dynamics: the non-Markovian aspect in the barrier crossing and the finite speed of force propagation along the chain. The relative impact of both these processes is investigated, and the second one is found to be the most important one. For not too long chains the most probable rupture force is found to decrease with the number of bonds. In the limit of large chain lengths the rupture forces saturate. Depending on the loading rate there exists a critical chain length minimizing the most probable rupture force. All our analytical findings are confirmed by extensive numerical simulations.

DY 30.8 Fri 12:00 ZEU 118

Correlation and phase-diffusion properties of coupled chemical oscillators. — •Amitabha Nandi and Benjamin Lindner — Max-Planck-Institut für Physik Komplexer Systeme, Nöthnitzer Str. 38 01187 Dresden, Germany.

We study two diffusively coupled Brusselator models by stochastic simulation and the corresponding chemical Langevin Equations. We investigate the diffusion of the phase difference between the two oscillators and also their correlation statistics. Diffusive coupling of the chemical oscillators introduces an elastic interaction term and a common noise term in the Langevin Equation for the coupled system. We investigate and compare the roles of these two distinct contributions to the correlation statistics of the oscillators.

Reference

[1] A. Nandi, Santhosh G., R. K. Brojen Singh and R. Ramaswamy, Phys. Rev. E.**76**, 041136, (2007).

DY 30.9 Fri 12:15 ZEU 118

The nonlinear ion transport mechanism in disordered systems — •Lars Lühning and Andreas Heuer — Institute of Physical Chemistry, University of Münster, Germany

The conduction mechanism which leads to nonlinear transport effects in disordered nonmetallic solids like ionic conductive glasses is still poorly understood but widely accepted to be due to hopping dynamics. Comparison of theoretical analysis and experimental data indicates that the random-energy model can serve as a realistic model to understand nonlinear ion transport. In this model the hopping of ions which occurs between localized sites in the glass matrix is projected on a square lattice with a characteristic hopping distance representing the typical distance between adjacent ionic sites. We analyze the evolution of the conductivity with increasing field strength. The strength of the nonlinear effects is strongly correlated with the properties of the sites with the lowest energies. First, the presence of very low-energy sites on average gives rise to stronger non-linear effects. Second, even for a fixed set of energies variation of the spatial arrangement gives rise to significant variations of the degree of non-linearity. Thus, also topological information is contained in the non-linear response. Bond-percolation current pathways are laid on the top of node-percolation energy cluster and the percolation calculations are extended to a more general cluster analysis. Surprisingly, there is no strict overlap of the current- with the energy percolation cluster. But the current cluster which carries up to 95% of the whole system current spans quasi-homogeneous the disordered energy landscape.

DY 30.10 Fri 12:30 ZEU 118

Interspike Interval Correlations of a Nonrenewal Integrate-and-Fire Neuron — •Tilo Schwalger, Rafael Dias Vilela, and Benjamin Lindner — MPI PKS, Dresden

Spike trains of neurons are often characterized by the interspike interval (ISI) density or even simpler by its first two moments (corresponding to firing rate and coefficient of variation). This first-order statistics is sufficient if the spike train constitutes a renewal point process, i.e. if all ISI's are statistically independent. It has been found, however, that ISI's of cortical neurons are correlated and hence nonrenewal, and it has been argued that such higher-order statistics of spike trains could be tightly related to biological functions, as e.g. spike frequency adaptation. In an integrate-and-fire neuron model such ISI correlations could be the result of a temporally correlated driving (synaptic input) or a threshold dynamics.

In this work we present an analytical technique to calculate the serial correlation coefficient (SCC) for an excitable integrate-and-fire neuron that is driven by a telegraph process (dichotomous noise) and white noise. The method is based on a discrete kinetic description and within this framework all results are exact. For slow driving we find a large, positive SCC, which has a maximum at a finite driving amplitude. As special cases the theoretical framework also includes simple threshold dynamics and residence time correlations of driven bistable systems.

Reference: T. Schwalger and B. Lindner, Phys. Rev. E 78, 021121, 2008

DY 30.11 Fri 12:45 ZEU 118

More and more weather records - Is global warming to blame? — •Gregor Wergen and Joachim Krug — Institut für Theoretische Physik Köln, Zülpicherstr. 77, 50937 Köln

If one believes in current media coverage it seems very simple: Due to the significant, largely anthropogenic, warming of the world's average temperature, more and more weather extremes occur. Every time we have a record breaking daily maximum temperature, or an immense amount of precipitation in a certain timespan, this is intuitively blamed on global warming. However mathematically the relation between an increasing mean value and the occurrence of records is far from trivial and not completely understood. This relation and its relevance to the analysis of weather data is the subject of this talk. Given an underlying distribution, we consider the probability that an event in a succession of events is a record, when the distribution itself is shifting, or altering its form. We found some approximations that are useful for the comparison with historical climate recordings. We obtained data for the daily maximum and daily minimum temperature and the daily precipitation amount from thousands of weather stations in Europe and the United States and analyzed them with regard to record events. The results are largely in accordance with what we predict from our calculations, but also reveal some interesting deviations.

DY 30.12 Fri 13:00 ZEU 118

Noise driven solitary waves — •Oskar Hallatschek — Max Planck Institut für Dynamik und Selbstorganisation, Bunsenstr. 10, 37073 Göttingen

While the deterministic behavior of solitary waves is well-understood, their noisy counterparts are still somewhat enigmatic. The current consensus is that number fluctuations due to discreteness substantially reduce the velocity of a traveling solitary wave. Here, we show that the very same fluctuations can sometimes increase the wave speed. In fact, we describe a new class of solitary waves whose velocity goes to zero as the noise vanishes (i.e., in the deterministic limit). The fluctuations due to discreteness drive these waves, and give them a finite velocity. We calculate the wave velocity analytically as a function of noise strength, and compare with simulations. The presented class of solitary waves naturally occurs in the context of genetics. They describe, for instance, the spread of a mutation that increases the carrying capacity. We discuss the biological implications of our results.