DY 33: Poster II

Poster contributions from Session Stat. physics far from equilibrium; soft matter, pattern formation, Stat physics general; granular matter; Quantum chaos; Critical phenomena; Fluid Dyn / Rayleigh Benard; Anomalous diffusion; Brownian motion.

Time: Thursday 17:00–19:00 Location: Poster C

DY 33.1 Thu 17:00 Poster C

Efficiency of a Brownian information machine — •Michael Bauer, David Abreu, and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart, Germany

The second law of thermodynamics forbids cyclic engines that extract work from a single heat bath when there is no other interaction with the surrounding medium. By making a gedankenexperiment with a Maxwell demon it became clear that with additional information on the system one can indeed extract work.

We investigate two types of an engine modelled by a Brownian particle in a time dependent harmonic trap [1]. In every cycle we perform a measurement with finite precision before we apply a feedback scheme which depends on the measurement outcome. Since the machine operates at finite time the distribution will not be in equilibrium after the measurement. Hence in every cycle the work will depend on all measurements before. We calculate analytically the average work in the steady state for a large number of cycles. To define a efficiency we calculate the information extracted from on the system by the measurements. In the first type of this engine only the center of the potential moves. Here, one extracts $1/2\ k_BT$ in a quasistatic case with perfect measurements. The maximal power is $1/2$ for short cycle periods but then the efficiency goes to zero. In the second variant, additionally the strength of the potential changes which leads to efficiency 1 for precise measurements in finite time.

[1] M. Bauer, D. Abreu and U. Seifert. J. Phys. A: Math. Theor. 45, 162001 (2012).

DY 33.2 Thu 17:00 Poster C

Brownian dynamics simulations of colloidal assemblies on structured substrates — •Aleksandar Mijailović and Michael Schmiedeberg — Institut für Theoretische Physik 2, Heinrich-Heine-Universität Düsseldorf, Germany

We perform Brownian dynamics simulation in order to investigate colloidal structure formation on incommensurate substrates. We study the growth process of colloidal rims and islands that can be observed on stretched substrates. Furthermore, we want to explore the dynamics of rearrangements that occur in readily grown structures when the geometry of the substrate is changed.

DY 33.3 Thu 17:00 Poster C

Diffusion in inhomogeneous environments — Johannes Müller[1,2] and •Markus Rauscher[1,2] — [1]Max-Planck-Institut für Intelligente Systeme, Stuttgart — [2]Institut für Theoretische Physik IV, Universität Stuttgart

In the vicinity of walls the mobility of colloidal particles depends on the distance from the wall. As a consequence, the noise in the Langevin equation describing the overdamped Brownian dynamics is multiplicative and therefore ill defined. The correct stochastic calculus is determined by equilibrium statistical physics: it is the Klimontovich calculus. However, the underdamped Brownian dynamics is well defined. We investigate the overdamped limit in the framework of adiabatic elemination and we present a formal solution of the underdamped Langevin equation which allows to perform the overdamped limit on the level of the Kramers-Moyal coefficients.

DY 33.4 Thu 17:00 Poster C

Ratchet effects in magnetic colloidal suspensions — •Teresa Reinhard and Sabine H. L. Klapp — Institut für Theoretische Physik, TU Berlin, Hardenbergstraße 36, D-10623 Berlin, Germany

We consider a system of dipolar colloids driven by an oscillating magnetic field. Specifically, the regarded field is lacking net rotating components and puts the system in an out-of-equilibrium state. In such a nonequilibrium system the microscopic Brownian motion can result in directed rotational macroscopic motions [1]. This process, which is called the ratchet effect, is analysed on the basis of the dynamical density functional theory. Specifically, we investigate the impact of a dipole-dipole interaction and compare our results with those from a mean-field Fokker-Planck approach [2] and from particle-based computer simulations [3].

[1] A. Engel and P. Reimann, Phys. Rev. Let. 91, 060602 (2003).
[2] V. Becker and A. Engel Phys. Rev. E 75, 031118 (2007).
[3] S. Jäger and S. H. L. Klapp, submitted, arXiv:1210.3479 (2012).

DY 33.5 Thu 17:00 Poster C

Weak ergodicity breaking and ageing in subdiffusive continuous time random walks analyzed with the distribution of generalized diffusivities — •Tony Albers and Günter Radons — Chemnitz University of Technology, Germany

We investigate the continuous time random walk (CTRW) model with an algebraically decaying waiting time distribution which does not have a finite first moment. This subdiffusive process is known to show interesting phenomena such as weak ergodicity breaking and ageing. As a consequence, ensemble- and time-averaged quantities do not coincide, time averages become random variables, and statistical quantities depend on the elapsed time between the start of the process and the start of the measurement. In this contribution we are going to introduce a new analysis tool for anomalous diffusion, the distribution of generalized diffusivities, which describes the fluctuations during the diffusion process around the generalized diffusion coefficient that can be obtained from the asymptotic behavior of the conventionally investigated mean squared displacement. How this analysis can be used to identify subdiffusive CTRWs in the experiment and how it leads to a deeper understanding of weak ergodicity breaking and ageing will be shown.

DY 33.6 Thu 17:00 Poster C

Selforganization of magnetic particles and biotechnological applications — Claus Fütterer[1,2] and •Florian Rämisch[1] — [1]Fakultät für Physik und Geowissenschaften, In- stitut für Experimentelle Physik I, Universität Leipzig, 04103 Leipzig, Germany — [2]Translationszentrum für Regenerative Medizin (TRM), Universität Leipzig

Superparamagnetic nanoparticles are widely applied in separation technologies, however, their collective behaviour in magnetic fields is poorly understood. We fill this gap by investigating the pattern formation due to magnetic non-linear interactions between spherical particles in static and dynamic homogeneous fields. The interplay between thermal fluctuations, magnetic attraction and repulsion as well as hydrodynamic friction yield a wealth of surprizing and interesting patterns. Our work is mainly experimental but we propose some theoretical ideas as well. Last but not least we explain some biotechnological applications of our results.

DY 33.7 Thu 17:00 Poster C

Orientational order in confined Janus fluid — •Vinothkumar Mohanakrishnan[1] and Martin Schoen[1,2] — [1]Stranski-Laboratorium für Physikalische und Theoretische Chemie, Technische Universität Berlin, Straβe des 17. Juni 135, D-10623 Berlin, Germany — [2]Department of Chemical and Biomolecular Engineering, North Carolina State University, 911 Partners Way, Raleigh, North Carolina 27695, USA

In this study we report, Monte Carlo simulation of Janus fluid confined to a nanoscopic slit pore with an anchoring function planar to the slit pore, where the walls of the slit pore are structureless and non-conducting. The confined system is simulated in the specialized (N,L_z,$P_{||}$,T) isostress-isostrain ensemble. We analyzed the special case of wall separation $L_z = 8\sigma$ in detail where the confined system exhibit spontaneous phase transition from isotropic to polar phase in the pressure range of $1.2 \sim 1.4$. We have computed the density profiles, local dipolar order parameter, in-plane correlation functions at different pressures corresponding to isotropic and polar phases respectively. From the analysis of density profiles, the polar phase is characterized by an additional layer formation (8 layers) as compared to that of the isotropic phase(7 layers). The in-plane correlation function reveals fluid-like behaviour for all the pressure/densities considered. Comparison with the bulk system has been made to study the effect of

confinement.

DY 33.8 Thu 17:00 Poster C

Delaying motion in an one-dimensional colloidal system by feedback control — •Sarah Loos, Robert Gernert, and Sabine H. L. Klapp — Institut für Theoretische Physik, TU Berlin, Hardenbergstraße 36, D-10623 Berlin, Germany

Using feedback control we manipulate the Brownian motion of a colloid in an external tilted sinusoidal potential in one dimension. The mean-squared-displacement (MSD) of the overdamped particle shows a plateau [1], [2]. To stretch this plateau we introduce a feedback control force, where the first moment of the probability density serves as the control target. Preliminary results suggest that this causes a second plateau. We investigate the system by numerically solving the Fokker-Planck-Equation. We further develop a time delayed feedback control as another method to stretch the MSD.

[1] Cecile Dalle-Ferrier, Matthias Krüger, Richard D. L. Hanes, Stefan Walta, Matthew C. Jenkins and Stefan U. Egelhaaf, Soft Matter 7, 2064 (2011)

[2] Clive Emary, Robert Gernert, Sabine H. L. Klapp, arXiv:1209.1504 [cond-mat.stat-mech] (2012)

DY 33.9 Thu 17:00 Poster C

Pore scale modelling of porous media — •Andreas Lemmer and Rudolf Hilfer — Institut für Computerphysik, Universität Stuttgart,70569 Stuttgart, Deutschland

Flow and transport through geological, biological and industrial porous media typically involve multiple length and/or time scales. However, experimental approaches for structural analysis like microcomputertomography are limited in problem size or resolution. Based on a continuum model for porous media[1], we discretize three-dimensional laboratory sized images of porous stones at multiple resolutions[2]. Calculating and analyzing resolution dependent geometric and transport parameters allows quantitative validation of different theoretical approaches and comparison with experiment.

[1] B. Biswal, P.E. Øren, R. Held, S. Bakke, R. Hilfer: Stochastic Multiscale Model for Carbonate Rocks, Phys.Rev.E, 75, 061303 (2007)

[2] R. Hilfer, T. Zauner: High-precision synthetic computed tomography of reconstructed porous media, Phys.Rev.E, 84, 062301 (2011)

DY 33.10 Thu 17:00 Poster C

Generalized theory for multiphase flow in porous media — Oliver Hönig, •Rouven Steinle, and Rudolf Hilfer — Institut für Computerphysik, Universität Stuttgart, 70569 Stuttgart, Deutschland

We study multiphase flow processes, including imbibition and drainage processes, in porous media on macroscopic scales to resolve the shortcomings of the traditional theory. The equations of the fluid percolation model [1] are transformed into a dynamical system with immobile nonpercolating fluid phases. This dynamical system is investigated analytically and numerically. Various classes of travelling wave solutions have been found [2].

[1] R. Hilfer, *Macroscopic capillarity without a constitutive capillary pressure function*, Physica A, vol. 371, pp. 209, (2006)

[2] O. Hönig, F. Doster, R. Hilfer, *Travelling wave solutions in a generalized theory for macroscopic capillarity*, in preparation

DY 33.11 Thu 17:00 Poster C

Residual saturation dynamics and hysteresis in two-phase flow — •Rouven Steinle and Rudolf Hilfer — Institut für Computerphysik, Universität Stuttgart, 70569 Stuttgart, Deutschland

The concepts of relative permeability and capillary pressure are crucial for the accepted traditional theory of two phase flow in porous media. A generalization of the traditional theory does not require these concepts as input [1]. The presentation will describe this novel approach. It allows to predict residual saturations and local spatiotemporal changes between imbibition and drainage during two phase immiscible displacement. The Riemann problem for the hyperbolic limit is solved analytically in one dimension by the method of characteristics [2]. Shock fronts and rarefaction waves in both directions in the percolating and the nonpercolating fluids are found, which can be compared directly to experiment [2].

[1] R. Hilfer, *Macroscopic capillarity without a constitutive capillary pressure function*, Physica A, vol. 371, pp. 209, (2006)

[2] F. Doster and R. Hilfer, *Generalized Buckley-Leverett theory for two-phase flow in porous media*, New Journal of Physics, vol. 13, pp. 123030, (2011)

DY 33.12 Thu 17:00 Poster C

Dynamic scaling of a critical binary mixture — Dipanjan Chakraborty, •Felix Höfling, and Siegfried Dietrich — Max Planck Institute for Intelligent Systems, Stuttgart, andInstitute for Theoretical Physics IV, Universität Stuttgart, Germany

A binary mixture near its consolute point exhibits critical fluctuations of the local composition. The static properties of the mixture are well described by the Ising universality class in three dimensions [1], the dynamic properties involving conservation of particles, energy, and momentum are classified as "model H". So far, theoretical work on the critical dynamics has focused mainly on transport coefficients, while studies of the relaxation dynamics of the spatially resolved order parameter have remained elusive.

We present numerical results for the dynamic structure factor of a symmetric binary Lennard-Jones mixture near its demixing transition. To this end, we have performed extensive molecular dynamics simulations in the microcanonical ensemble, employing the immense computing resources of high-end graphics processors [2]. Our simulations cover large systems of 70,000 particles and more than 4 non-trivial orders of magnitude in time. We explore the crossover of the wavenumber-dependent relaxation time from diffusion-like to critical behaviour and find nice agreement with theoretical predictions. Further, dynamic scaling of the full time dependence of the critical relaxation is tested and dynamic scaling functions are deduced.

[1] S. K. Das *et al.*, J. Chem. Phys. **125**, 024506 (2006)

[2] P. Colberg and F. Höfling, Comp. Phys. Comm. **182**, 1120 (2011)

DY 33.13 Thu 17:00 Poster C

Shear banding in drying colloidal dispersions — •Pree-cha Kiatkirakajorn and Lucas Goehring — Max Planck Institute for Dynamics and Self-Organization, Bunsenstrasse 10, D-37075 Göttingen, Germany

During drying, colloidal dispersions undergo complex transformations such as solidification, buckling, cracking and the draining of liquid from pores. These interesting observations suggest how defects and shear localization can arise during the drying of colloidal dispersions. During this process, series of bands appear rapidly behind the solidification front and propagate away from the drying front +/-45°. The emergence of bands have never been explained, although we suggest that these may be the result of shear banding. Here we experimentally show that, during drying, particles of polystyrene dispersion are forced closer to each other so that it crystallizes into a weak solid at some critical volume fraction. Furthermore, solidification is caused by electrostatic charge and Van der Waals force. As this weak solid is further compressed, it responds to the stress during solidification by forming a herringbone pattern of parallel light and dark stripes which can be observed and measured under a microscope. We have measured the film thickness, drying rate, and the band spacing under different drying conditions and salt concentrations, which affect the magnitude of the electrostatic interaction.

DY 33.14 Thu 17:00 Poster C

Colloidal Structures on Quasicrystalline Substrates — •Matthias Sandbrink and Michael Schmiedeberg — Institut für Theoretische Physik 2: Weiche Materie, Heinrich-Heine-Universität, Düsseldorf

Quasicrystals are structures with long-range order but no periodicity. Therefore, quasicrystals may possess rotational symmetries and other physical properties that cannot occur in conventional periodic crystals. We explore how three-dimensional quasicrystals consisting of monodisperse colloidal particles grow on a substrate. The geometry of the substrate is designed with quasicrystalline symmetry from aperiodic tilings, interference patterns, or Fourier expansions and may contain point defects. By using Monte-Carlo simulations, we study the colloidal structures on the quasicrystalline substrates and investigate the influence of defects on the growth process.

DY 33.15 Thu 17:00 Poster C

Crystallization of Charged Macromolecules using FRESHS — •Kai Kratzer[1], Joshua T. Berryman[2], Rosalind J. Allen[3], and Axel Arnold[1] — [1]Institute for Computational Physics, University of Stuttgart — [2]Theory of Soft Condensed Matter, University of Luxembourg — [3]SUPA, School of Physics, University of Edinburgh

The crystallization of charged macromolecules has a number of important applications in fields such as biology, pharmacology or materials design. For example, proteins are crystallized for purification or structure determination and colloidal crystals are promising candidates for photonic crystals. However, the crystallization of proteins or colloids is still more an art rather than a technique due to the poor understanding of the underlying physical mechanisms. Experimental investigation of nucleation is extremely difficult, which can be facilitated by computer simulations. Since the nucleation of charged macromolecules is a rare event, it is inaccessible to brute force computer simulations and requires special simulation techniques, such as Forward Flux Sampling (FFS). We present our highly efficient FFS implementation FRESHS, the flexible rare event sampling harness system, which allows for massively parallel rare event sampling using conventional Molecular Dynamics codes such as ESPResSo or GROMACS. It features a novel automatic interface placement optimization, so that efficient FFS simulations no longer require expert knowledge. As an example application, we present first results on the nucleation in systems of charged macromolecules with screened Coulomb interactions, a system, that without using FRESHS would have been very challenging to investigate.

DY 33.16 Thu 17:00 Poster C

Form factors of comb polymers — •Christian von Ferber[1], Marvin Bishop[2], Thomas Forzaglia[2], and Cooper Reid[2] — [1]Applied Mathematics Research Centre, Coventry University, UK — [2]Manhattan College, Riverdale, New York, USA

We employ analytical methods and the Monte Carlo Pivot algorithm to investigate continuum, tangent hard-sphere comb polymers both in the ideal and excluded volume regimes.

The mean square radius of gyration, the g-ratio, and the form factors are evaluated. We find that the extrapolated MC g-ratios are in excellent agreement with the theory in the ideal regime. The MC data agree well with the exact form factors. The form factors reveal the influence of the polymer structure at short distances.

DY 33.17 Thu 17:00 Poster C

Excess entropy scaling of viscosity and diffusivity of model polymeric systems — •Evangelos Voyiatzis, Florian Müller-Plathe, and Michael Böhm — Eduard-Zintl-Institut für Anorganische und Physikalische Chemie, Technische Universität Darmstadt, Petersenstrasse 22, D-64287 Darmstadt, Germany

The range of validity of empirical excess entropy scalings for diffusivity and viscosity as proposed independently by Rosenfeld and Dzugutov is tested for a model system of monodisperse Lennard-Jones chains. They are long enough to be considered as entangled. Thus, the effect of entanglements on such types of scaling can be quantified. Different ways of estimating the excess entropy based on either conformational or thermodynamic information are explored. The excess entropy is calculated directly by thermodynamic integration. The excess entropy can be approximated via a thermodynamic modeling by employing the self-associating fluid theory. The detected correlations between the various conformational and thermodynamical estimations of the excess entropy are thoroughly investigated. The conformational route for a system with short-range interactions appears to be the more suitable way.The dependence of all parameters appearing in the excess entropy scaling relationships on the chain length is thoroughly examined. The relation of the scaling parameters of the viscosity and diffusion coefficient are in line with the prediction of the Stokes-Einstein law.

DY 33.18 Thu 17:00 Poster C

Bifurcation to cross-stream migration in Poiseuille flow — •Matthias Laumann, Steffen Schreiber, Johannes Greber, and Walter Zimmermann — Universität Bayreuth, Theoretische Physik, 95440 Bayreuth, Germany

The dynamics of asymmetric dumbbells and semiflexible polymers in Poiseuille flow is investigated. We find that asymmetric dumbbells and semiflexible polymers may migrate towards or away from the center of a Poiseuille flow, depending on the asymmetry of a dumbbell or on the bending stiffness of a semiflexible polymer as well as on the flow parameters. In the case they migrate away from the center of a Poiseuille flow, there are parameter ranges, where they migrate even in the absence of the effects of bounding walls only up to some distance away from the flow center. The distance of the final position of a dumbbell (semiflexible polymer) depends on the flow parameters as well as on the asymmetry and elasticity of the dumbbell (bending stiffness of a semiflexible polymer).

DY 33.19 Thu 17:00 Poster C

The Mechanical Responses of Wet Granulates under Cyclic Shear Deformation — •Somnath Karmakar[1], Marc Schaber[1], Anna-Lena Hippler[1], Marco Di Michiel[2], Mario Scheel[2], Stephan Herminghaus[3], and Ralf Seemann[1,3] — [1]Experimental Physics, Saarland University, Saarbrücken, Germany — [2]ESRF, Grenoble, France — [3]MPI-DS, Göttingen, Germany

Adding small amount of wetting liquid to an assembly of dry granulates typically leads to the stiffening of granulates which arises due to the capillary bridge forces. We experimentally study the mechanical properties of wet granulates, composed of monodisperse spherical glass or basalt beads. The glass microspheres are almost perfectly wetted by water whereas the basalt microspheres have a rather large contact angles with water. We investigate the yield strength, measured under cyclic shear deformation for various system parameters like liquid content, bead radius, shear speed, shear amplitude, and absolute pressure. The yield strength of the wettable glass beads is observed to depend on the applied shear rate, leading to a 'shear-thinning-effect'; whereas the yield strength of the non-wetting basalt beads is independent of the applied shear rate. For large absolute pressures the stiffening of a wet compared to a dry granular assembly might be inversed and the liquid might act as a 'lubricant' lowering the yield strength. With time resolved X-ray micro-tomography, we could shed some light on the underlying microscopic mechanisms. We explore the variations in packing geometry during the shear process and the liquid exchange process, occurring between the individual liquid morphologies.

DY 33.20 Thu 17:00 Poster C

Rheology of Frictional Particles — •Matthias Grob[1], Claus Heussinger[1], and Annette Zippelius[1,2] — [1]Institut für Theoretische Physik, Göttingen, Deutschland — [2]Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen, Deutschland

Granular materials are complex fluids with the ability to jam into a solid state. The properties of the jamming transition depend in addition to packing fraction and shear rate on the presence or absence of inter-particle friction. Here, jamming of frictional particles under simple shear is investigated numerically. Various regimes and transitions are observed and discussed. These transitions are influenced by the three control parameters. We find shear banding for dense systems within a certain range of shear rates and coexistence between solid and fluid like states.

DY 33.21 Thu 17:00 Poster C

Compactivity of 2D granular assemblies comprised of polygonal particles — •Volker Becker and Klaus Kassner — Institut für Theoretische Physik, Otto-von-Guericke-Universität Magdeburg, Germany

The theoretical description of granular matter is a subject of current research and scientific discussion [1]. A possible approach was proposed by S.F. Edwards [2]. The central hypothesis in Edwards' approach is that all stable states of a granulate which occupy a specified volume are equally probable. Therefore, the volume of the granulate plays the role of the energy in conventional statistical mechanics. In this framework, an intensive parameter χ called the compactivity, is the analogue to temperature in conventional thermodynamics. One way to determine the compactivity is determining the dependency of the volume fluctuations σ_ϕ on the volume fraction ϕ of the assembly and using a granular version of the fluctuation dissipation theorem[3]. On the other side one can determine χ from the distribution of free volume per particle[4]. Both is following Edwards theory.We will present results of computer simulations for 2D assemblies comprised of polygonal particles and prepared by different protocols(tapping and flow pulses) [3,5]. We compare the resulting compactivities determined by using both methods.

[1] M. P. Ciamarra et. al. *Soft Matter*, **8**, 9731 (2012) [2] Edwards et. al., *Physica A* **157**, 1080 (1989) [3] R. Nowak et al., *Phys. Rev. E* **57**, 1971 (1998) [4] T. Aste et. al., *Eur. Phys. J. B* **64**, 511-517 (2008); F. Lechenault et. al., *J- stat. Mech.*, **P07009** (2006) [5] M. Schröter et. al., *Phys. Rev. E,* **71**, 030301 (2005)

DY 33.22 Thu 17:00 Poster C

Fluctuations and yield stress in sheared granular media — •Seyyede Robabeh Moosavi[1,2], Jeliazko Jeliazkov[3], Michael LeBlanc[3], Karin Dahmen[3], and Matthias Schröter[1] — [1]Max-Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Institute for Advanced Studies in Basic Sciences, Zanjan, Iran — [3]University of Illinois at Urbana Champaign, Illinois, USA

Slowly sheared granular materials show micro-yielding events before a global fracture. These events develop via slip avalanches with a broad range of sizes. We present experiments on the distribution of avalanche sizes in granular media of different packing fractions. We discussed our results in the context of a recently proposed theoretical model of power law for these statistics [1].

1. K. A. Dahmen, Y. Ben-Zion, J. T. Uhl, Nature Physics, 7, 554-557 (2011).

DY 33.23 Thu 17:00 Poster C

Liquid-solid-like transition in two dimensional wet granular matter — •Michael Wild, Christopher May, Ingo Rehberg, and Kai Huang — Experimentalphysik V, Universität Bayreuth, 95440 Bayreuth, Germany

The phase transition of a monolayer of wet granular spheres under horizontally swirling motion is investigated experimentally. Due to the cohesion arising from the formation of capillary bridges between adjacent particles, the particles initially form a crystalline structure at moderate driving. By both increasing and decreasing the swirling frequency, we characterize the transitions between a crystal-like state and a liquid-like state with both local packing density and bond orientational order parameters. The hysteresis between the melting and crystallization threshold will be discussed. Moreover, the dependence of this transition on global fill fraction will be presented. In the limiting case of small crystalline structures, the critical driving frequency to mobilize those structures is found to depend strongly on the the cluster sizes, suggesting a size dependent effective static friction between the wet granular layer and the substance.

DY 33.24 Thu 17:00 Poster C

Tomographic Analysis of Jammed Ellipsoid Packings — •Fabian Schaller[1,2], Max Neudecker[2], Mohammad Saadatfar[3], Klaus Mecke[1], Gerd Schröder-Turk[1], and Matthias Schröter[2] — [1]Institut für theoretische Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany — [2]Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen, Germany — [3]Applied Maths, RSPhysSE, The Australian National University, Australia

Disordered packings of ellipsoidal particles are a generalization of disordered sphere packings that can shed light on geometric features of random close packings and structural transitions in granular matter. Here we report the structure of ellipsoid packings in terms of contact numbers and Voronoi cell shapes, for several aspect ratios. Discrete approximations of generalized Voronoi diagrams are extracted from a large number of tomographic data of ellipsoid configurations, obtained by vertical shaking. Their shape is quantified by isotropy indices $\beta_\nu^{r,s}$ based on Minkowski tensors [1]. Contact numbers are discussed in the context of the jamming paradigm [2]. We find that our frictional particles are hyperstatic.

[1] G.E. Schröder-Turk *et al.*, Minkowski Tensor Shape Analysis of Cellular, Granular and Porous Structures, Adv. Mater. **23**, 2535 (2011)
[2] Martin van Hecke, J. Phys.: Condens. Matter (2010)

DY 33.25 Thu 17:00 Poster C

Measuring granular force chains in 3D — •Junaid M. Laskar[1], Stephan Herminghaus[1], Matthias Schröter[1], and Karen E. Daniels[2] — [1]Dynamics of Complex Fluids, Max Planck Institute for Dynamics and Self Organization, Goettingen, Germany — [2]Department of Physics, North Carolina State University, Raleigh, USA

One of the outstanding issues within the area of statistical physics of granular matter is to have better understanding of the statistical properties of forces and force chains. Due to the link to jamming, strain induced yielding and mechanical response; this issue has also technological relevance in civil engineering and geophysics [1, 2]. There have been pioneering efforts towards experimentally measuring the force chains and their spatial distributions, though these are limited to two dimensions (2D) [1, 2]. For 3D granular systems, till now there are no experimental determinations of the forces on interior grains.

In this regard, an experimental method, based on two photon fluorescence spectroscopy to measure forces in the interior of ensemble of Ruby spheres, is developed. This novel method, which is the extension of the one demonstrated for a single ruby sphere to 3D, will be discussed in detail [3]. The results obtained from the shift in fluorescence peak in response to external compression will be discussed.

References:

[1] T. S. Majumdar and R. P. Behringer, Nature 453, 1079 (2005) [2] Karen E. Daniels and Nicholas W. Hayman, J. of Geophys. Res. 113, B11411 (2008) [3] Y. Chen et al., J. Appl. Phys. 101, 084908 (2007)

DY 33.26 Thu 17:00 Poster C

Pattern formation in agitated wet granular matter — Lorenz Butzhammer, Ingo Rehberg, and •Kai Huang — Experimentalphysik V, Universität Bayreuth, 95440 Bayreuth, Germany

Pattern formation of a thin layer of vertically agitated wet granular matter is investigated experimentally. Due to the strong cohesion arising from the capillary bridges formed between adjacent particles, agitated wet granular matter exhibits a different scenario compared with cohesionless dry particles. Rotating spirals with three arms, which correspond to the kinks between regions with different colliding phases with the vibrating plate, have been found to be the dominating pattern. This preferred number of arms arise from period tripling of the agitated granular layer, which breaks the symmetry and drives the rotation of spiral arms. From both top view snapshots and the laser profilometry method, the rotation frequency of the spiral arms is characterized with image processing procedures. Both methods reveal a finite rotation frequency at a threshold excitation acceleration, which increases linearly with the peak vibration acceleration with a slope strongly dependent on the vibration frequency. As the vibration frequency decreases, a transition from period tripling to doubling bifurcation is observed, which gives rise to 'frozen' spiral arms. The phase diagram of the patterns will be presented and its dependence on various parameters will be discussed.

DY 33.27 Thu 17:00 Poster C

Dynamics of fluid-liquid crystalline interfaces and heterogeneous growth using the Phase Field Crystal Model for Liquid Crystals — •Cristian Vasile Achim and Hartmut Loewen — Institut für Theoretische Physik II - Soft Matter, Heinrich-Heine-Universität Düsseldorf

Phase Field Crystal Model for Liquid Crystals is formulated with respect with three position-dependent order parameters, the reduced translational density, the local nematic order parameter, and the mean local direction of the orientations. The free-energy involves local powers of the order parameters up to the fourth order, gradients of the order parameters up to the fourth order, and different couplings among the order parameters. The phase diagram was investigated in Phys. Rev. E 83, 06172 (2011). Among stable phases liquid crystalline states are isotropic, nematic, columnar, smectic-A, and plastic crystalline phases. In this report we present results regarding the dynamics of fluid-liquid crystalline interface and heterogeneous growth obtained by solving numerically the couple equation of motions of the order parameters as presented in J. Phys.: Condens. Matter 22 (2010) 364105.

DY 33.28 Thu 17:00 Poster C

The Origin of Crack Surface Instabilities in silicon crystal — Liron Ben Bashat and •Dov Sherman — Technion, Haifa, Israel

Previous investigations showed micron scale height corrugations instabilities on the fracture surface of the (111) low energy cleavage plane of silicon, when the crack was propagated in the [11] direction at speed below 1100 m/sec. These corrugations were evident in three point bending and tensile experiments, and resemble fluctuations on the (111) and (110) low energy cleavage planes, propagating along the intersection line of both planes.

Recently, the density of these surface corrugations on the same crack system under bending was investigated in specimens having two distinct boron concentrations. Experiments showed that the corrugations density reduced significantly in specimens with low boron concentration. Experiments under ultra-high vacuum were conducted in STM microscope revealed that nano scaled surface instabilities initiate the larger surface corrugations. These instabilities are in the form of atomic steps. Quantum mechanical hybrid multi scale calculations with and without a single boron interstitial verified the latter experimental results in addition to a crack velocity loss at low crack speeds.

The fundamental query is whether the corrugations instabilities are formed due to interactions of the crack front with crystalline defects or is crack surface of defects free crystal always stable. We will present the experimental finding and the origin of the low speed crack surface instabilities and discuss the effect of these perturbations on crack speed.

DY 33.29 Thu 17:00 Poster C

Turing instability in one-component reaction-diffusion systems with fluctuating delay — •Jian Wang 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. With the presence of fluctuating delay the system dynamics becomes more complex, and sometimes some new phenomena can be obtained. In this study the delay is introduced into the reaction term of the KPP-Fisher-equation. It will be shown, that with a fluctuating delay the Turing instability, which in general is present in more-components systems, can also be obtained in one-component reaction-diffusion systems. The Lyapunov exponents in dependence on spatial perturbations is calculated. The structure and the related spectrum are characterized to prove this phenomenon.

DY 33.30 Thu 17:00 Poster C

Pattern formation in Swift-Hohenberg equation with delayed feedback — •Alexander Kraft and Svetlana Gurevich — Institut for Theoretical Physics, Wilhelm-Klemm-Str. 9, 48149 Münster

We are interested in the stability of periodic patterns in a real Swift-Hohenberg equation subjected to a delayed feedback. We classify different stability regimes of homogeneous solution and discuss how the delayed feedback modifies the stability of periodic patterns. In particular, we show that the delayed feedback induces a spontaneous motion of periodic patterns and leads to the formation of complex structures, including, e.g., traveling zigzag patterns and hexagons.

DY 33.31 Thu 17:00 Poster C

Orientational pattern selection by traveling modulations — •Lisa Rapp, Vanessa Weith, Alexei Krekhov, and Walter Zimmermann — Universität Bayreuth, Theoretische Physik, 95440 Bayreuth, Germany

The process of pattern formation in two-dimensional isotropic systems has been investigated intensively during the last decades. Challenging tasks in these systems are for instance the suppression defects in stripe patterns and the control of the overall orientation of the evolving structures.

We suggest an effective approach to control the pattern morphology by applying a traveling long-wave periodic modulation of the control parameter of the pattern forming system. The model systems we investigate include the Swift-Hohenberg equation (describing e.g. Rayleigh-Bénard convection) and the evolution equation for microphase separation in symmetric diblock copolymers. Studying the onset of the stripe phase we find, that depending on the traveling velocity v different orientations of the stripes with respect to the modulation may be favoured near threshold. In the case of a stationary modulation the wave vector of the stripes is preferentially perpendicular to the wave vector of the forcing. This also holds for velocities smaller than a velocity v_1. For velocities larger than a velocity v_2 a parallel orientation of the wave vectors has the lowest threshold. In the intermediate range $v_1 < v < v_2$ both wave vectors adjust themselves at an angle between 0 and $\pi/2$.

This velocity-dependent (re)orientation effect is confirmed by numerical simulations as well as the fact that the stripe patterns exhibit much less defects than in the unmodulated case.

DY 33.32 Thu 17:00 Poster C

Defect patterns in a model of wrinkles — •Achim Guckenberger, Alexei Krekhov, and Walter Zimmermann — Universität Bayreuth, Theoretische Physik, 95440 Bayreuth, Germany

Anisotropic pattern forming systems may exhibit new scenarios of pattern formation, when the system properties change perpendicularly or obliquely to the direction of the wave vector of the pattern. This is demonstrated for a two-dimensional model of wrinkles, whereby wrinkles may form on top of an elastomer, in which the elastic properties are varied in space. Within the model the critical wavenumber changes its value as a function of space in order to mimic the wrinkle formation on top of an inhomogeneous elastomer.

We show, that beyond a certain amplitude of the spatial variation of the critical waven umber the so-called Eckhaus stability-band of the possible wave number of wrinkles vanishes immediately above threshold and defect patterns may occur. Phase diagrams of this transition are presented and discussed.

DY 33.33 Thu 17:00 Poster C

Stochastic POD applied to the Wake of a Wind Turbine — •David Bastine, Matthias Wächter, and Joachim Peinke — ForWind, Institute of Physics, University of Oldenburg, Germany

Since wind turbines operating in the wake of other turbines experience a strongly altered inflow, a good understanding of the wake is crucial for the planing and optimization of large wind farms. In this work the proper orthogonal decomposition (POD) is combined with a Langevin-analysis approach to yield a low order description of spatio-temporal data. The method is applied to large eddy simulation data of a wind turbine wake. In the case of analyzing the data in a plane perpendicular to the mean flow the POD yields clearly structured eigenmodes similar to Fourier modes in the azimuthal direction. The temporal evolution of the modes can be described by time dependent coefficients given by the projection of the velocity field on the eigenmodes. We interpret these coefficients as random variables whose statistics can be modeled by Langevin equations and try to estimate the corresponding drift and diffusion coefficients.

DY 33.34 Thu 17:00 Poster C

Correlation between active grid excitation and generated wind field — •Gerrit Kampers, Nico Reinke, Joachim Peinke, and Michael Hölling — ForWind - Center for Wind Energy Research, Institute of Physics, University of Oldenburg, Germany

Turbulence plays an important role in the field of wind energy conversion. Lift forces and their fluctuations, for example, are strongly influenced by the statistics of the ambient wind field. For realistic wind tunnel investigations, an active grid was build, which allows the generation of wind fields with comparable characteristics to those in the atmospheric boundary layer (ABL). The active grid consists of seven horizontal and nine vertical axes with fixed 7.4×7.4 cm^2 square flaps. Each of these axes can be controlled individually by a step motor.
A challenging part in the work with the active grid is to find the right excitation protocols to control the position in time of the axes, and therefore the stochastical properties of the resulting turbulent flow field. The goal is to create realistic flow fields, e.g. fields with heavy intermittency, which is one of the major properties of the ABL.
To achieve that, the interaction between the active grid excitation and the resulting flow field was investigated experimentally. In the experiments, the angle of attack and the rotation speed of the flaps were successively changed for different wind speeds. The resulting flow field was measured with hot-wires at several downstream positions. Based on the experiments, a model for the excitation - flow field interaction was developed. The model allows for a more systematic creation of excitation protocols for different flow properties.

DY 33.35 Thu 17:00 Poster C

Measurements of LSC dynamics in Rayleigh-Bénard convection with an ultrasonic anemometer — •Katharina Witte and Joachim Peinke — TWiST-Turbulence, Windenergy and Stochastics, University of Oldenburg, Germany

The dynamics of large-scale circulation (LSC) in Rayleigh-Bénard convection are investigated experimentally, particularly with regard to rotations and cessations. The measurements are conducted over the range of the Rayleigh-number from $1 * 10^9$ to $6 * 10^9$. For this a cylindrical cell of aspect ratio $\Gamma = 1$ is used, which is heated from below and cooled from top. Utilization of water enriched with particles as working fluid offers the possibility to applicate an ultrasonic anemometer, which is based on the Doppler effect. With this anemometer velocity profiles of the particles which correspond to those of the fluid are taken. This contact less method is carried out inside the cell by sensors which are recessed into the cell wall.

DY 33.36 Thu 17:00 Poster C

Convection onset in a transient diffusive boundary layer at high Rayleigh numbers — •Stephan Messlinger, Christoph Kramer, Wolfgang Schöpf, and Ingo Rehberg — Experimentalphysik V, Universität Bayreuth, 95440 Bayreuth

We observe the onset of Soret driven convection in a colloidal suspension of thermosensitive microgel particles in water. The suspension exhibits a strong positive Soret-effect, resulting in large solutal Rayleigh numbers even for low temperature gradients. When heated from below in a classical convection cell, the convective instability does not set in uniformly over the system height, but starts in the steep concentration profiles established at the cell boundaries. We report on the latency time of the convection onset and the transient behaviour of the fluid motion shortly thereafter.

DY 33.37 Thu 17:00 Poster C

Transitions in double-diffusive finger convection — •Matthias Kellner and Thomas Müller — Institut für Geophysik der Georg-August Universität, Göttingen, Deutschland

An electrodeposition cell is used to sustain a destabilizing concentration difference of copper ions in aqueous solution and a stabilizing temperature gradient between the top and bottom boundaries of the cell. The thermal Rayleigh number was varied for a set destabilizing chemical Rayleigh number. Finger convection is observed, although the overall density gradient is destabilizing ($|\lambda| < 1$). A transition from finger regime to Rayleigh-Benard convection is observed for a fixed ratios of the Rayleigh numbers. This is marked by a change from an anisotropic to an isotropic velocity field. The Sherwood number increases with decreasing Rayleigh number towards its maximum at the transition, after which it will drop again in the convective zone. Numerical simulations concerning this scenario are done.

DY 33.38 Thu 17:00 Poster C

Statistical Physics of Quadrics in Finite Projective Spaces — •Benedikt Krüger, Nils Alex, Felix Winterhalter, Johannes F. Knauf, and Klaus Mecke — Institut für Theoretische Physik, FAU Erlangen-Nürnberg, Staudtstr. 7, D-91058 Erlangen, Germany

Projective Geometry is an interesting alternative to the usual affine geometry that is typically used in physics. Certain symmetries (e.g. between points and lines in projective planes) lead to a more elegant mathematical description of geometric structures by avoiding case-by-case analysis. A projective space can be seen as an extension of the usual affine space where all parallel hyperplanes intersect on an added "hyperplane at infinity". The analogon to affine conic sections (ellipses, parabolas and hyperbolas) are projective quadrics. This definition holds for projective spaces over finite fields, as well. The emerging properties of these finite quadrics are examined with methods from statistical physics.

DY 33.39 Thu 17:00 Poster C

Quantitative characterisation of capillary rise in nanoscale systems — •Christian Thome and Heiko Rieger — Theoretische Physik, Universität des Saarlandes, Campus E2 6, D66123 Saarbrücken

Considering fluids in confined nanoscale geometries one finds a strong influence of surface effects. Therefore a closer look at the rise of liquid-air interfaces, also called menisci, in nanometer scale capillaries shows the need of modifications of the macroscopic laws like Lucas Washburn. In addition some experiments on the spontaneous imbibition of water in nano-porous vycor glass showed a broadening of the imbibition front. This phenomenon encouraged us to investigate the capillary rise of a simple Lennard-Jones fluid in nano-pores, nano-pore-junctions and nano-pore-intersections using molecular dynamics simulations. Our main interest is the quantitative characterisation of the influence of the interaction strength between the wall particles and the fluid particles. We present results for the fluid propagation, the interface morphology and fluid density profiles.

DY 33.40 Thu 17:00 Poster C

Scaling properties of a parallel implementation of the multicanonical algorithm — •Johannes Zierenberg, Martin Marenz, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Germany

The multicanonical method has been proven powerful for statistical investigations of lattice and off-lattice systems throughout the last two decades. We discuss an intuitive but very efficient parallel implementation of this algorithm and analyze its scaling properties for discrete energy systems, namely the Ising model and the 8-state Potts model. The simple parallelization relies on independent equilibrium simulations in each iteration with identical multicanonical weights, merging their statistics in order to obtain estimates for the successive weights. With good care, this allows faster investigations of large systems, because it distributes the time-consuming weight-iteration procedure and allows parallel production runs. We show that the parallel implementation scales very well for the simple Ising model, while the performance of the 8-state Potts model, which exhibits a first-order phase transition, is limited due to emerging barriers and the resulting large integrated autocorrelation times. The quality of estimates in parallel production runs remains of the same order at same statistical cost.

DY 33.41 Thu 17:00 Poster C

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

Pattern formation in reaction-diffusion (RD) systems is important in many areas as, e.g., the embryonic development, catalytic activity or population dynamics. These systems are mostly constituted of many coupled subunits, like the cells of the embryo or catalyst nanoparticles. To get insight into the influence of these modular structure onto the emerging excitation patterns we conduct experiments of the Bhelousov-Zhabotinsky reaction (BZR) in a Nafion membran with a catalyst distribution in form of a micro spots pattern and compare the BZR waves with numerical calculations of the FitzHugh-Nagumo equations.

The influence of the catalyst spot size, their distance and shape on the coupling strength was investigated. We observe a bifurcation into two different patterns, i.e. a spiral wave and a target pattern, in dependence of the distance of catalyst spots. Thereby the initial conditions control which pattern occurs. In further studies, we will investigate the possibility to predict which pattern occurs if only the initial conditions are known.

DY 33.42 Thu 17:00 Poster C

Contemplating coincidences: Rigorous testing for synchrony between time series of discrete events — Jonathan F. Donges[1,2], •Reik V. Donner[1], Katharina Kohl[1,3], and Jürgen Kurths[1,2] — [1]Potsdam Institute for Climate Impact Research, Germany — [2]Department of Physics, Humboldt University, Berlin, Germany — [3]Department of Mathematics, Heinrich Heine University of Düsseldorf, Germany

We present a novel approach to rigorous statistical testing for synchrony between two time series of discrete events. For uncorrelated events, the distribution of the test statistics can be analytically derived under the assumption of rare events. The limits of this analytical approximation are explored by numerical simulations. Subsequently, necessary corrections for correlated events are numerically derived for both short- and long-term correlations. Relationships with existing concepts such as event synchronization are discussed. Finally, the proposed approach is applied to some real-world geoscientific example in order to distinguish signatures of synchrony from insignificant coincidences.

DY 33.43 Thu 17:00 Poster C

Characterization of diffusion processes with non-exponential dwell time distributions by the distribution of diffusivities — •Michael Bauer and Günter Radons — Chemnitz University of Technology, Germany

Many transport phenomena in physical and biological systems can be described by heterogeneous diffusion processes where the diffusive behavior changes during the motion. For instance, diffusion in ultra-thin liquid films is governed by layer-dependent diffusion coefficients and jumps between the liquid layers. Such processes are often characterized by observing individual tracers in single-particle tracking (SPT) experiments. To account for inhomogeneities, we suggested to investigate the distribution of diffusivities and its dependence on the time lag between snapshots [1]. We further studied the relation to ensemble-based measurements obtained from pulsed field gradient nuclear magnetic resonance (PFG NMR) and applied it to the two-compartment exchange (Kärger) model [2]. In our contribution, we extend the investigations to heterogeneous systems where the Kärger model is not applicable. In such systems the dwell time distribution does not decay exponentially but depends on the spatial potential related to, e.g., structured surfaces. We analyze such systems by the time-lag dependence of the distribution of diffusivities and its moments, which characterizes the diffusivity as a fluctuating quantity along a trajectory.

[1] M. Bauer et al., Diffus. Fundam. 11, 104 (2009)
[2] M. Bauer et al., J. Chem. Phys. 135, 144118 (2011)

DY 33.44 Thu 17:00 Poster C

Strong bounds on Onsager coefficients and efficiency for three terminal thermoelectric transport in a magnetic field — •Kay Brandner[1], Keiji Saito[2], and Udo Seifert[1] — [1]II. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart, Germany — [2]Department of Physics, Keio University, 3-14-1 Hiyoshi, Kohoku-ku, Yokohama, Japan 223-8522

For thermoelectric transport in the presence of a magnetic field that

breaks time-reversal symmetry, a strong bound on the Onsager coefficients is derived within a general set-up using three terminals. Asymmetric Onsager coefficients lead to a maximum efficiency substantially smaller than the Carnot efficiency reaching only $\eta_C/4$ in the limit of strong asymmetry. Related bounds are derived for efficiency at maximum power, which can become larger than the Curzon-Ahlborn value $\eta_C/2$, and for a cooling device. Our approach reveals that in the presence of reversible currents the standard analysis based on the positivity of entropy production is incomplete without considering the role of current conservation explicitly.

DY 33.45 Thu 17:00 Poster C

Resonant tunnelling and complex paths : 1-d integrable models using normal forms — •Jérémy Le Deunff — MPIPKS, Dresden, Germany

Dynamical tunnelling, defined as a quantum phenomena which is classically forbidden (i.e. which cannot be described by the real classical solutions of the Hamilton's equations), may manifest itself through transition between different regions dynamically disconnected in the classical phase space. It is well-known that the classical nonlinear resonant chains observed in non integrable Hamiltonian systems affect by many order of magnitude the quantum observables describing tunnelling (splittings or decay rates). Here, we introduce a class of 1-d integrable Hamiltonians which reproduce main islands surrounded by (r:s) resonant chains in the phase space. We then propose a semiclassical formula for tunnelling splittings using a complex paths approach. We show that this approach leads to a good agreement with the exact numerical results and we compare with the resonance-assisted-tunnelling theory in different regimes.

DY 33.46 Thu 17:00 Poster C

Multicanonical analysis of the gonihedric Ising model — •Marco Müller[1], Desmond A. Johnston[2], and Wolfhard Janke[1] — [1]Institut für Theoretische Physik, Universität Leipzig, Germany — [2]Math. Dept., Heriot-Watt University, Edinburgh, United Kingdom

The gonihedric Ising model originates from catching basic properties of fluctuating random surfaces in a bosonic string theory. Formulated as a lattice model of interacting classical spins it can be investigated by means of the multicanonical Monte Carlo algorithm to resolve open questions on the first-order phase transition. The transition temperature has been determined for the model and a dual representation; also the interface tension has been measured for both models and appears to be quite strong.

DY 33.47 Thu 17:00 Poster C

Self-avoiding walks on critical percolation clusters in two to seven dimensions — •Niklas Fricke and Wolfhard Janke — Institut für Theoretische Physik and Centre for Theoretical Sciences (NTZ),
Universität Leipzig, Postfach 100920, D–04009 Leipzig, Germany

Self-avoiding walks (SAWs) on critical percolation clusters are a basic model for polymers in crowded disordered media. The fractal nature of the substrate gives rise to interesting scaling behavior, which, despite considerable efforts in the past, is still poorly understood . We used a recently developed exact enumeration technique [1], which can handle walks of several thousand steps. This enabled us to determine the SAW scaling exponents very accurately. Varying the lattice dimension to the upper critical limit ($D = 6$) allows us to closely check the predictions from field theory and to investigate the influence of the various fractal dimensions of the critical cluster.

[1] N. Fricke and W. Janke, Europhys. Lett. **99**, 56005 (2012).

DY 33.48 Thu 17:00 Poster C

Incommensurate Nematic Fluctuations in 2d Metals — •Tobias Holder and Walter Metzner — Max-Planck-Institute for Solid State Research, D-70569 Stuttgart

In a homogeneous nematic state an orientational symmetry of the system is spontaneously broken, without breaking the translation invariance. However, in 2010 Metlitski and Sachdev (New J. Phys. **12**, 105007) found a tendency toward formation of a *modulated* nematic state in a two-dimensional metal with strong antiferromagnetic spin-density wave fluctuations.

We investigate the possibility of a modulated nematic state from a model of tight-binding electrons on a square lattice with an interaction that has an attractive d-wave component for forward scattering in the charge channel. Within a random phase approximation (RPA), we find that the wave vector of the nematic quantum fluctuations is generically nonzero at $T = 0$. At finite temperatures the nematic fluctuations are reduced considerably due to their singular momentum dependence, restricting sizable effects of incommensurate fluctuations to very low temperatures.

Ref.: T. Holder and W. Metzner, Phys. Rev. B **85**, 165130 (2012).

DY 33.49 Thu 17:00 Poster C

MERA-networks as holographic duals for the random Heisenberg spin-chain — •Johannes Oberreuter and Stefan Kehrein — Georg-August-Universität Göttingen, Germany

The holographic duality relates a field theory to a theory of (quantum) gravity in one dimension more. A strongly coupled field theory is dual to weakly coupled, classical gravity. This allows to do a calculation of correlation functions for a strongly coupled theory in the weakly coupled counterpart perturbatively. Thereby, the extra (radial) dimension represents the scale of the RG transformation in the field theory. Real space renormalization procedures like the multi-scale-renormalization-ansatz (MERA) can be used to determine the ground state of the field theory. It has been conjectured, that the tensor networks which arise during this procedure are a discretized version of Anti-de Sitter space, which is the background of the gravity theory, for which the duality is established best (AdS/CFT-correspondence). It was so far impossible to construct such a network explicitely. We consider the dual network of a random Heisenberg spin-chain, for which real-space renormalization can be performed analytically. After establishing the form of the network at finite temperature, we examine quenches in the spin-chain to study the relation between the MERA-network and the Heisenberg chain far from equilibrium.

DY 33.50 Thu 17:00 Poster C

Numerical survey of the condensate shape and scaling laws in pair-factorized steady states — Eugen Ehrenpreis, •Hannes Nagel, and Wolfhard Janke — Institut für theoretische Physik, Universität Leipzig, Leipzig, Deutschland

We numerically survey the shapes and scaling laws of extended particle condensates that emerge as a result of spontaneous symmetry breaking in pair-factorized steady states of a stochastic transport process. The specific model based on the zero-range process consists of indistinguishable particles that stochastically hop between sites controlled by a tunable interaction composed of a zero-range and a local-range part. We identify the different condensate shapes within their respective regimes of interaction strengths as well as precisely determine the condensate width scaling. We find good agreement with theoretic predictions [1].

[1] B. Wacław, J. Sopik, W. Janke and H. Meyer-Ortmanns, **Phys. Rev. Lett.** 103, 080602 (2009).

[2] E. Ehrenpreis, H. Nagel and W. Janke, Lepzig preprint (2012).

DY 33.51 Thu 17:00 Poster C

Scaling properties and synchronisation in chaotic networks with multiple delays — •Otti D'Huys[1], Steffen Zeeb[1], Sven Heiligenthal[1], Thomas Juengling[1], Wolfgang Kinzel[1], and Serhiy Yanchuk[2] — [1]Institute of Theoretical Physics, University of Wuerzburg, 97074 Wuerzburg, Germany — [2]Institute of Mathematics, Humboldt University of Berlin, 10099 Berlin, Germany

Delayed complex systems have received much interest in recent years, as delays play an important role in systems as diverse as population dynamics, traffic, communication networks, genetic circuits, and the brain. In general the different interaction delays in a network are not equal, or may even differ by several orders of magnitude.

We consider a hierarchical network of chaotic units: the coupling delay within a subnetwork is much shorter than the delay between the subnetworks. We show that the spectrum of Lyapunov exponents has a typical structure, with different parts of the spectrum scaling with the different delays. We can relate the scaling properties of the maximal Lyapunov exponent to the synchronisation properties of the network: units within a subnetwork can synchronise if the maximal exponent scales with the shorter delay while long range synchronisation between different subnetworks is only possible if the maximal exponent scales with the long delay.

DY 33.52 Thu 17:00 Poster C

Noise enhances information transfer in hierarchical networks — •Agnieszka Czaplicka[1], Janusz A. Hołyst[1], and Peter M.A. Sloot[2,3,4] — [1]Faculty of Physics, Center of Excellence for Complex Systems Research, Warsaw University of Technology, Koszykowa 75, PL-00-662 Warsaw, Poland. — [2]Computational Science, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands. — [3]National Research University of Information Technologies, Mechanics and Optics (ITMO), Kronverkskiy 49, 197101 Saint Petersburg, Russia. — [4]Nanyang Technological University, 50 Nanyang Avenue, 639798 Singapore.

We study the influence of noise on information transmission in a form of packages shipped between nodes of hierarchical networks. Numerical simulations are performed for artificial tree networks, scale-free Ravasz-Barabási networks as well for a real network formed by email addresses of former Enron employees. Two types of noise are considered. One is related to packet dynamics and is responsible for a random part of packets paths. The second one originates from random changes in initial network topology. We find that the information transfer can be enhanced by the noise. The system possesses optimal performance when both kinds of noise are tuned to specific values, this corresponds to the Stochastic Resonance phenomenon. There is a nontrivial synergy present for both noisy components. We found also that hierarchical networks built of nodes of various degrees are more efficient in information transfer than trees with a fixed branching factor.

DY 33.53 Thu 17:00 Poster C

Individual Fractal Weyl Laws in Systems with a Mixed Phase Space — •Martin Körber[1,2], Matthias Michler[1], Arnd Bäcker[1,2], and Roland Ketzmerick[1,2] — [1]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden, Germany

In open chaotic systems the number of long-lived states is expected to obey a fractal Weyl law, with the exponent being associated to the fractal dimension of the repeller. For generic open systems with a mixed phase space we demonstrate that there is not just one fractal Weyl law but individual ones. They correspond to states localizing on different regions of the hierarchical phase space. This is illustrated for a designed Markov chain model and the standard map.

DY 33.54 Thu 17:00 Poster C

Integrable Approximation of Regular Islands: The Iterative Canonical Transformation Method — Clemens Löbner[1,2], Steffen Löck[1,3], •Arnd Bäcker[1,2], and Roland Ketzmerick[1,2] — [1]Technische Universität Dresden, Institut für Theoretische Physik, 01062 Dresden — [2]MPI für Physik komplexer Systeme, 01187 Dresden — [3]Technische Universität Dresden, OncoRay - National Center for Radiation Research in Oncology, 01307 Dresden

Our aim is to approximate the dynamics of a regular island in a non-integrable Hamiltonian H by an integrable Hamiltonian H_{reg}. We present a new method which allows to find H_{reg} for arbitrarily many degrees of freedom. The method is based on the construction of an integrable approximation in action representation which is then improved in phase-space representation by iterative applications of canonical transformations. These transformations are optimized such that the regular dynamics of H and H_{reg} agree as closely as possible.

We apply this iterative canonical transformation method to the standard map and the cosine billiard. In the second case the resulting integrable Hamiltonian describes a billiard with the same boundary, but a nontrivial time evolution. This provides a basis for the future determination of regular-to-chaotic tunneling rates for generic billiards with the fictitious integrable system approach.

DY 33.55 Thu 17:00 Poster C

Complex paths for regular-to-chaotic tunneling rates — Normann Mertig[1,2], •Steffen Löck[1,2,3], Arnd Bäcker[1,2], Roland Ketzmerick[1,2], and Akira Shudo[2,4] — [1]Institut für Theoretische Physik, Technische UniversitätDresden, 01062 Dresden — [2]MPI für Physik komplexer Systeme, 01187 Dresden — [3]OncoRay, Technische Universität Dresden, 01307 Dresden — [4]Department of Physics, Tokyo Metropolitan University, Minami-Osawa, Hachioji, Tokyo 192-0397, Japan

For generic non-integrable systems we show that a semiclassical prediction of tunneling rates between regular and chaotic phase-space regions is possible. Our prediction is based on complex paths which can be constructed despite the obstacle of natural boundaries. The semiclassically obtained tunneling rates are in excellent agreement with numerical tunneling rates for the standard map where few complex paths dominate. This gives a semiclassical foundation of the long-conjectured and often-observed exponential scaling with Planck's constant of regular-to-chaotic tunneling rates.

DY 33.56 Thu 17:00 Poster C

Criticality in transport through the quantum Ising chain — •Malte Vogl, Gernot Schaller, and Tobias Brandes — Institut für Theoretische Physik, TU Berlin

We consider thermal transport between two reservoirs coupled by a quantum Ising chain as a model for non-equilibrium physics induced in quantum-critical many-body systems. By deriving rate equations based on exact expressions for the quasi-particle pairs generated during the transport, we observe signatures of the underlying quantum phase transition in the steady-state energy current already at finite and different reservoir temperatures.

Ref.: M.V., G. Schaller, and T. Brandes: arXiv[cond-mat]:1208.5989, to be published in PRL

DY 33.57 Thu 17:00 Poster C

Nonequilibrium dynamics of few–electron systems—A comparison of Green functions and reduced density operator theory — •Sebastian Hermanns and Michael Bonitz — ITAP, Christian–Albrechts–Universität Kiel, Leibnizstr. 15, 24098 Kiel

The dynamics of few–electron systems out of equilibrium are among the most interesting but likewise most challenging problems in theoretical physics for the last 50 years. The complexity lies in the fact that, on the one hand, for more than a few particles, direct numerical solutions of the exact equations of motion are mostly not possible due to the exponentially scaling of the problem size. On the other hand, methods relying on statistical averaging can only be applied successfully for much larger particle numbers. In between these two limiting cases, the approximate methods of nonequilibrium Green functions (NEGFs) and the reduced density operator (NEDO) theory have been widely used. To obtain a closed equation of motion for the main quantities, the single-particle NEGFs and NEDOs, one has to find a suitable truncation of respective hierarchies, the Martin–Schwinger– and the BBGKY–hierarchy.

In this contribution, we compare different strategies of truncation, both for NEGFs and NEDOs, with respect to the representability of different time–dependent processes and the compliance with important conservation laws. A main focus lies on the relation between similar approximations for NEGFs and NEDOs[1].

[1] S. Hermanns, and M. Bonitz, submitted to Jour. Phys. Conf. Ser., arXiv: 1211.6959

DY 33.58 Thu 17:00 Poster C

Green functions approach to the nonequilibrium dynamics of 3D Hubbard nano–clusters — •Sebastian Hermanns[1], Karsten Balzer[2], and Michael Bonitz[1] — [1]ITAP, Christian–Albrechts–Universität Kiel, Leibnizstr. 15, 24098 Kiel, Germany — [2]Max Planck Research Department for Structural Dynamics Hamburg, Building 99 (CFEL), Luruper Chaussee 149, 22761 Hamburg, Germany

The three–dimensional Hubbard model is widely used for the description of narrow–band solid state systems in terms of sites, on which the electrons interact, and hopping amplitudes between these sites. Despite these drastic simplifications, it exhibits many physically relevant phenomena, including phase transitions from Mott–insulator to conductor or the time–dependent dynamics of strongly correlated electrons after an excitation. To describe these classes of processes, the theoretical framework of Nonequilibrium Green functions is very well suited[1], since it provides a controlled way of approximations, is non–perturbative in the exciting field and has shown good results for 1D Hubbard chains[2]. In this contribution, we show results for the response of $2 \times 2 \times 2$ up to $5 \times 5 \times 5$ cubic 3D Hubbard nano–clusters with on–site interaction and nearest–neighbor hopping, after different kinds and strength of excitations and compare with exact as well as other approximate methods.

[1] K. Balzer, and M. Bonitz, *Nonequilibrium Green's Functions Approach to Inhomogeneous Systems*, in press (2012)
[2] K. Balzer, S. Hermanns, and M. Bonitz, submitted to J. Phys. Conf. Ser., arXiv: 1211.3036

DY 33.59 Thu 17:00 Poster C

Simulations of the structure formation of Alkyl-Adenine monolayers on graphene — •Oliver Rubner, Markus Bam-

ler, Pritam Kumar Jana, and Andreas Heuer — Institut für Physikalische Chemie, Universität Münster

Recent experiments showed that N9-Alkyl-Adenine molecules can form two different domains when deposited on a graphene surface. These domains consist of networks with different arrangements of head (Adenine) and tail (Alkyl) groups. The formation of the domains and their relative abundance depends in a non trivial way on parameters like temperature or deposition flux. The exact molecular structure of the domains is, however, still unknown. In order to explain the experimental results we first performed quantum-chemical calculations to elucidate the possible network structure and the corresponding energetics. Given these parameters we used Monte-Carlo simulations to investigate the dependence of the structure formation on external parameters. We will present here a model that is consistent with the experimental findings and can be used to tune further experiments to control the network structure on a graphene surface.

DY 33.60 Thu 17:00 Poster C

Ground states of 1D long-range random-field Ising magnets — •Timo Dewenter and Alexander K. Hartmann — Institut für Physik, Carl von Ossietzky Universität Oldenburg

In random-field Ising magnets (RFIMs) Ising spins interact ferromagnetically with each other. Disorder is introduced by local random fields which act on each spin and whose values are drawn from a Gaussian distribution. At zero temperature, at a critical random-field strength h_c the system undergoes a phase transition.

Here, we consider an one-dimensional RFIM with long-range interactions that are only present between spins with a probability that decays like a power-law in the geometric distance between the interacting spins. The parameter σ in the power-law exponent enables us to tune the effective dimension of the model.

Different values of σ are used to investigate numerically [1] the three parameter regions, which are the mean-field, non-mean-field region and the region without a phase transition ($h_c = 0$). Ground states are calculated [2] with graph theoretical algorithms by mapping the system to a directed graph. The critical random-field strength h_c and the critical exponents are obtained by finite-size scaling and then compared to analytical predictions and to results of a hierarchical model [3].

[1] A.K. Hartmann: *Practical Guide to Computer Simulations*, World-Scientific, 2009
[2] A. K. Hartmann and H. Rieger: *Optimization Algorithms in Physics*, Wiley-VCH, 2002
[3] C. Monthus and T. Garel, J. Stat. Mech., P07010, 2011

DY 33.61 Thu 17:00 Poster C

Multifractal analysis of electronic states in corner-sharing tetrahedral lattices — Martin Puschmann, •Philipp Cain, and Michael Schreiber — Institut für Physik, Technische Universität Chemnitz, D-09107 Chemnitz

The corner-sharing tetrahedral lattices appear as a sublattice in different materials, e.g. spinels and pyrochlore. We consider the transport of non-interacting electrons and investigate their electronic states in the vicinity of the localization-delocalization (LD) transitions by analyzing the multifractal properties of the wave functions. The multifractal analysis (MFA) is used to explore the phase diagram, which is then compared to the results obtained by other methods [1]. Furthermore the MFA yields detailed insight into the critical behavior at the LD transition, i.e. the divergence of the correlation length, which is characterized by the value of the universal critical exponent.

[1] F. Fazileh, X. Chen, R. J. Gooding, and K. Tabunshchyk, Phys. Rev. B **73**, 035124 (2006)

DY 33.62 Thu 17:00 Poster C

A State Dependent Potts Model — •Gabriell Máté[1], Ronald Dickman[2], and Dieter W. Heermann[1] — [1]Institute for Theoretical Physics, Heidelberg University, Heidelberg, Germany — [2]Departamento de Física, ICEx, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil

Although the resolution of conventional confocal microscopy is limited, the images provided by this technique carry a tremendous amount of information. One of the most straightforward approaches to describe these images is to model them with a Potts model. However, in many cases the detected configurations correspond to a system characterized by a temperature close to the critical point, making it almost impossible to control this model. In this work we present a modified version of the Potts model which might be useful in such situations. The modification consists in introducing arbitrary couplings between different states. We argue that in the simplest case the modified model is equivalent to the original Potts model. We investigate it numerically with respect to criticality and observe a shift of the critical point as we vary the parameters. We also show that the model is capable of exhibiting more exotic behavior.

DY 33.63 Thu 17:00 Poster C

Energy Transfer and Optical Properties of Molecular Aggregates: Application of Non-Markovian Quantum State Diffusion — •Gerhard Ritschel[1], Jan Roden[1,3], Walter T. Strunz[2], and Alexander Eisfeld[1,4] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [2]Technische Universität Dresden, Germany — [3]University of California, Berkeley, USA — [4]Harvard University, Cambridge, USA

The general non-Markovian quantum state diffusion method is used to calculate excitation energy transfer and optical spectra of molecular aggregates for various temperatures. With that approach it is possible to account for structured spectral densities explicitly containing internal vibrational modes of the molecules as well as phonons of an environment. Because the method is very efficient, systematic investigations with respect to parameter variations are possible. We apply the method to the photosynthetic Fenna-Matthews-Olson complex focussing particularly on the role of the recently discovered eighth chromophore, which is believed to play an important role in receiving excitation from the main light harvesting antenna, for excitation energy transfer through the aggregate. It is shown that the energy transfer changes qualitatively when site 8 is excited initially. Instead of the relatively fast transfer that is usually observed when the initial excitation is localized on site 1 or 6, an exponential-like decay of the excitation is found when initialization at site 8 is considered.