DY 40: Poster - Quantum Systems/ Stat. Phys./ Diffusive Process

In this poster session there are contribution to the topics
- Quantum Systems
- Statistical Physics
- Diffusive Processes

Time: Thursday 17:00–19:00 Location: P3

DY 40.1 Thu 17:00 P3

Global structure of regular tori in a generic 4D symplectic map — Steffen Lange[1,2], Martin Richter[1,2], •Franziska Onken[1], Arnd Bäcker[1,2], and Roland Ketzmerick[1,2] — [1]Institut für Theoretische Physik, TechnischeUniversität Dresden, 01062 Dresden, Germany — [2]Max-Planck-Institut für Physik komplexer Systeme, 01187 Dresden, Germany

We progress towards an understanding of the phase-space structures of higher-dimensional systems similar to the well-known case of Hamiltonian systems with two degrees of freedom. Using 3D phase-space slices and frequency analysis we investigate the global organization of regular tori of a generic 4D symplectic map with a mixed phase space. We visualize how all of the regular 2-tori are organized around a skeleton of elliptic 1-tori in the 4D phase space. The 1-tori occur in two types of one-parameter families: The first type are Lyapunov families attached to elliptic-elliptic periodic orbits. These families are observed to exist even far away from their periodic orbit and beyond major resonance gaps. We explain how the second type originates from rank-1 resonances. At resonance gaps of both families either (i) periodic orbits exist, similiar to the Poincaré-Birkhoff theorem for 2D maps, or (ii) the family forms large bends. In combination these results allow for describing the self-similiar hierarchy of regular tori in the 4D phase space.

DY 40.2 Thu 17:00 P3

Trapping of chaotic orbits in 4D symplectic maps — •Steffen Lange[1,2], Martin Richter[1,2], 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, 01187 Dresden, Germany

Generic Hamiltonian systems with more than two degrees of freedom lead to chaotic zones in phase space which are all interconnected by the Arnol'd web. We study 4D symplectic maps with a regular region embedded in a large chaotic sea, i.e., far away from the near-integrable regime. Chaotic orbits are trapped in the vicinity of the regular region and show a power-law decay of survival times. We search for the trapping mechanism by visualizing the trapped orbits in 3D phase-space slices of the 4D phase space and analyzing their time-dependent frequencies. We find that the underlying mechanism is clearly different from trapping in 2D maps and not related to the Arnol'd web. Instead, an anisotropic diffusion near the surface of the regular region is observed. In this surface region the chaotic orbits are frequently trapped at different resonances.

DY 40.3 Thu 17:00 P3

Perturbative analysis of whispering-gallery modes in the Limaçon microcavity — •Marcus Kraft and Jan Wiersig — Otto-von-Guericke-Universität Magdeburg, 39016 Magdeburg

In recent experiments it has been demonstrated that wavelength-scale microdisk lasers with the shape of a Limaçon can support high-quality whispering-gallery modes despite the chaotic internal ray dynamics. Here, we show that these modes can be accurately described by a perturbation theory for slightly deformed microdisk cavities. Our results reveal that the performance of the perturbation theory can be considerably improved by a suitable choice of the origin around which the perturbation series is expanded.

DY 40.4 Thu 17:00 P3

Experiments with Superconducting Microwave Billiards — •Barbara Dietz, Maksim Miski-Oglu, Tobias Klaus, Christopher Cuno, and Achim Richter — Institut für Kernphysik, TU-Darmstadt, Schlossgartenstr. 9, D-64298 Darmstadt

We present experimental results on spectral properties of Dirac billiards simulating graphene billiards. They consist of a photonic crystal enclosed in a microwave billiard. Here we use the analogy between the associated scalar Helmholtz equation and the Schrödinger equation and the fact that the peculiar properties of graphene are solely due to the symmetry properties of its hexagonal lattice structure. We will present results on the spectral properties and length spectra of periodic orbits that were obtained in high precision experiments with superconducting Dirac billiards. Furthermore we determined the density of states with an unprecedented accuracy and investigated the effect of edge states on its features. It exhibits two sharp peaks at the frequencies of the van Hove singularities. There, a topological transition from the relativistic Dirac regime to the non-relativistc Schrödinger regime takes place which can be identified with a neck-disrupting Lifshitz and with an excited state quantum phase transition. The theoretical considerations are corroborated by experimental results on the features of the density of states.

*Supported by the Deutsche Forschungsgemeinschaft (DFG) within the Collaborative Research Center SFB634.

DY 40.5 Thu 17:00 P3

Aufbau und Spektrale Eigenschaften einen Mikrowellenanalogon des Fulleren Moleküls — •Tobias Klaus, Barbara Dietz und Achim Richter — Institut für Kernphysik, TU-Darmstadt

Wir präsentieren die Realisierung einen Mikrowellenanalogon der C60 Fullerene Molekül.

DY 40.6 Thu 17:00 P3

Modelliernug von einem C_{60} Fullerenmolekül durch einen supraleitenden Mikrowellenresonator — Barbara Dietz, •Tobias Klaus, Maksim Miski-Oglu, Achim Richter, Tetyana Skipa und Marcus Wunderle — TU Darmstadt, Schlossgartenstr. 9, 64289 Darmstadt

Wir präsentieren unsere Untersuchung zu den spektralen Eigenschaften eines C_{60} Fullerenmoleküls mit einem supraleitenden Mikrowellenresonator, einem sogenannten Fullerenbillard. Dies ist ein Mikrowellenresonator, dessen Hohlraum die Form eines C_{60} Fullerenmoleküls hat. Hierzu wurden in eine Vollkugel 60 Kreisresonatoren und 90 Wellenleiter, die diese miteinander verbinden, eingefräst. Das Index Theorem wurde mit Hilfe des Fullerenbillards experimentell untersucht. Dieses verbindet die Anzahl der Eigenzustände mit Eigenwert Null mit der Topologie der Oberfäche von C_{60}. Um ein vollständiges Eigenfrequenzspektrum zu erhalten, wurde ein supraleitendes Mikrowellenbillard verwendet, dessen Güten Werte von $Q > 10^5$ erreichen.

Gefördert durch die DFG im Rahmen des SFB 634.

DY 40.7 Thu 17:00 P3

Spektrale Eigenschaften eines Chaotischen Mikrowellen Africa Diracbillard — Barbara Dietz, Tobias Klaus, Maksim Miski-Oglu, Achim Richter, Tetyana Skipa und •Marcus Wunderle — TU-Darmstadt,Schlossgartenstr. 9, 64289 Darmstadt

Wir präsentieren die experimentelle Untersuchung der spektralen Eigenschaften eines supraleitenden Mikrowellen Diracbillards. Die Form des Billards entspricht den Umrissen des Kontinents Afrika und wird deshalb Afrika Diracbillard genannt. Das Mikrowellenbillard enthält Metallzylindern, die einen photonischen Kristall mit der Struktur eines Dreiecksgitters bilden. In der Nähe einer bestimmten Frequenz, der sogenannten Diracfrequenz, ist die Dispersionsrelation der elektromagnetische Wellen ähnlich der von masselosen, relativistischen Fermionen und wird durch die Diracgleichung beschrieben. Der Einsatz von supraleitenden Billards ermöglicht die experimentelle Bestimmung eines vollständigen Spektrums von Eigenfrequenzen. Die Fluktuationseigenschaften folgen der Vorhersage der Zufallsmatrizen Theorie für ein GOE Ensemble.

Gefördert durch die DFG im Rahmen des SFB 634.

DY 40.8 Thu 17:00 P3

Two-level dynamics in presence of a band-gapped material

— •Martin Pietsch, Denis Kast, and Joachim Ankerhold — Institut für Theoretische Physik, Universität Ulm, Albert-Einstein-Allee 11, 89069 Ulm

We studied the dynamics of a single spin that interacts with a bosonic broadband reservoir (spin boson model). The spectrum is Ohmic, but with a gap near a certain frequency. Our numerically exact Path Integral Monte Carlo simulations, including recent extensions [1,2], reveal that the spectral hole imprints its frequency onto the dynamics, thereby prohibiting the fixation of a well-defined coherent-incoherent transition point for increasing system-reservoir coupling. This investigation is motivated by impressive progress in designing photonic bandgap materials during the last years.

[1] D. Kast and J. Ankerhold, Phys. Rev. Lett. 110, 010402 (2013).
[2] D. Kast and J. Ankerhold, Phys. Rev. B 87, 134301 (2013).

DY 40.9 Thu 17:00 P3

All-electric qubit control in heavy hole quantum dots via non-Abelian geometric phases — •Dietrich Rothe[1], Jan Budich[3], Hartmut Buhmann[2], Ewelina Hankiewciz[1], and Björn Trauzettel[1] — [1]Instit. für theoret. Physik, Universität Würzburg — [2]Physikal. Institut, Universität Würzburg — [3]Department of Physics, Stockholm University, Sweden

We demonstrate how non-Abelian geometric phases can be used to universally process a spin qubit in heavy hole quantum dots in the absence of magnetic fields. A time dependent electric quadrupole field is used to perform any desired single qubit operation by virtue of non-Abelian holonomy. During the proposed operations, the degeneracy of the time dependent two level system representing the qubit is not split. Since time reversal symmetry is preserved and hyperfine coupling is known to be weak in spin qubits based on heavy holes, we expect very long coherence times in the proposed setup.

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DY 40.10 Thu 17:00 P3

Coherent dynamics of a quantum spin coupled to a fermionic bath — •Lars-Hendrik Frahm, Benjamin Baxevanis, and Daniela Pfannkuche — I. Institut für Theoretische Physik, Universität Hamburg, Germany

We investigate the dynamics of a quantum spin system weakly coupled to its environment. The environment is modeled by a bath of fermions coupled by exchange interaction to the spin system. Partial polarization of the fermionic bath affects the spin dynamics and we investigate its impact on the precession and coherence of the spin system. In order to determine the coherent dynamics of the spin system coupled to the bath, we calculate the time evolution of coherent states, i.e. off-diagonal density matrix elements. This is achieved by employing the time-convolutionless projection operator technique which allows for the computation of the coherent, non-Markovian spin dynamics.

DY 40.11 Thu 17:00 P3

Efficient Implementation and Application of the Artificial Bee Colony Algorithm to Low-Dimensional Optimization Problems — •Guido Falk von Rudorff[1], Christoph Wehmeyer[1], and Daniel Sebastiani[1,2] — [1]Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Institute of Chemistry, Martin-Luther-Universität Halle-Wittenberg, von-Danckelmann-Platz 4, 06120 Halle, Germany

We adapt a swarm-intelligence-based optimization method (the artificial bee colony algorithm, ABC) for the prediction of global minima on potential energy surfaces of molecular geometries to enhance its parallel scaling properties and to improve the escaping behavior from deep local minima. Specifically, we apply the approach to the geometry optimization of Lennard-Jones clusters. We illustrate the performance and the scaling properties of the parallelization scheme for several system sizes (5-20 particles) and different atomic interaction potentials. Deriving optimal parameters for the algorithm is a highly non-trivial problem. We present a strategy for finding ranges of the parameters of the ABC algorithm which yield maximal performance for Lennard-Jones clusters and Morse clusters. We evaluate small carbon clusters using the Tersoff potential to illustrate which kind of potential energy surfaces can be searched with this algorithm in a timely manner. The suggested parameter ranges turn out to be very similar for these different interaction potentials; thus, we believe that our reported values are fairly general for the ABC algorithm applied to chemical optimization problems.

DY 40.12 Thu 17:00 P3

Spontaneous imbibition in microfluidic pores — •Zeinab Sadjadi[1], Michael Jung[2], Heiko Rieger[1], and Ralf Seemann[2] — [1]Theoretical Physics Department, Saarland University, Saarbrucken, Germany — [2]Experimental Physics Department, Saarland University, Saarbrucken, Germany

Recently, spontaneous imbibition of wetting liquids in porous media consisting of elongated pores, has been studied theoretically [1,2]. The numerical simulation as well as analytical model predict that at a pore junction, meniscus propagation can come to a 'halt' for a certain amount of time. These 'arrest events' lead to a fast broadening of the imbibition front in the porous medium. Here we study this phenomenon in a single junction of three microfluidic pores and present experimental evidence for 'halt' of meniscus for the first time.

[1] S. Gruener, Z.Sadjadi, H.E. Hermes, A. V. Kityk, K. Knorr, S. U.Egelhaaf, H. Rieger and P. Huber, Proc. Natl. Acad. Sci. U. S. A. 109, 10245 (2012)
[2] Z. Sadjadi and H. Rieger, Phys. Rev. Lett.110, 144502 (2013)

DY 40.13 Thu 17:00 P3

Stiff Directed Lines in Random Media — •Horst-Holger Boltz and Jan Kierfeld — TU Dortmund, Dortmund, Deutschland

We investigate the localization of stiff directed lines with bending energy by a short-range random potential. Using perturbative arguments, Flory arguments, and a replica calculation, we show that a stiff directed line in 1+d dimensions undergoes a localization transition with increasing disorder for d>2/3. We demonstrate that this transition is accessible by numerical transfer matrix calculations in 1+1 dimensions and analyze the properties of the disorder-dominated phase. On the basis of the two-replica problem, we propose a relation between the localization of stiff directed lines in 1+d dimensions and of directed lines under tension in 1+3d dimensions, which is strongly supported by identical free energy distributions. This shows that pair interactions in the replicated Hamiltonian determine the nature of directed line localization transitions with consequences for the critical behavior of the Kardar-Parisi-Zhang (KPZ) equation. Furthermore, we quantify how the persistence length of the stiff directed line is reduced by disorder.

DY 40.14 Thu 17:00 P3

Polymer Adsorption onto a Stripe-Patterned Surface — •Momchil Ivanov[1], Monika Möddel[2], and Wolfhard Janke[1] — [1]Institut für Theoretische Physik, Universität Leipzig — [2]Basycon Unternehmensberatung, München

Previous theoretical studies have provided phase diagrams that lay the foundations for a better understanding of the basic mechanisms of polymer adsorption. This particular study focuses on a single polymer chain in a confined volume and its adsorption onto a stripe-patterned surface.

A minimalistic simple-cubic lattice model was used where the chain is represented by an interacting self-avoiding walk (ISAW) and was confined between an attractive patterned wall and a steric wall with no interaction whatsoever. The pattern consisted of parallel stripes of defined width and separation. Besides the pattern parameters, three energy scales determine the phase diagram of the system: chain-surface attraction, chain-pattern attraction and chain self-attraction.

Chains of lengths up to $N = 19$ monomers were studied using the method of exact enumeration. The influence of the energy scales and pattern parameters on the system was analysed with the help of temperature vs. chain-pattern attraction phase diagrams. These diagrams were constructed by means of both canonical and microcanonical analysis of the enumeration data.

DY 40.15 Thu 17:00 P3

Steady-State Droplet Size Distributions for Breath Figures with Dripping — •Jakob de Maeyer[1,2], Johannes Blaschke[1,2], and Jürgen Vollmer[1,2] — [1]Max-Planck-Institut für Dynamik und Selbstorganisation (MPIDS), 37077 Göttingen, Germany — [2]Fakultät für Physik, Georg-August-Universität Göttingen, 37077 Göttingen, Germany

The concept of condensing droplets on a surface (breath figures) plays a crucial role in microfabrication and high-efficiency heat transfer.

Recent studies have shown that existing scaling theories fail to explain experimental data on the droplet size distribution. A faithful description must explicitly deal with growth mechanisms of the smallest droplets and their fractal packing. The fractal droplet arrangement

introduces non-trivial and non-universal scaling exponents.

Here, we show that the arising of the non-universal exponents is related to the breakdown of a common approximation in Smoluchowski models of droplet aggregation: there is no simple decomposition of the coalescence kernel into single-particle distribution functions.

We revisit these findings in the light of new experimental data on steady states where droplets are constantly removed from the surface through gravity-induced dripping.

DY 40.16 Thu 17:00 P3

Mesoscopic Model for Topological Defect in Nematic Liquid Crystals — •Kuang-Wu Lee and Marco G. Mazza — MPI für Dynamik und Selbstorganisation, 37077 Göttingen, Deutschland

Topological line defects in nemetic liquid crystals under flow has been investigated in microfluidic channels [Sengupta et al. 2013]. To study the dynamical nature of this topological defect and its shear flow/nematic elasticity interactions under different flow regimes, we develop a mesoscopic scheme based on the stochastic rotational dynamics (SRD) method. We adapt the SRD method to particles with orientational degree of freedom. The model is tested for the liquid crystal phase transition under different temperatures. The viscosity and rotational diffusion coefficients, usually assigned in fluid approach, are self-generated in this model, hence this mesoscopic model enables us to study the local transport due to flow.

DY 40.17 Thu 17:00 P3

Rate of Mutual Information Between Coarse-Grained Non-Markovian Variables — •David Hartich, Andre C. Barato, and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart, Germany

Mutual information, a central quantity in information theory, quantifies correlations between two random variables. We focus on bipartite systems with two coarse-grained processes that together specify a continuous time Markov process. In this case no analytical formula for the rate of mutual information is known. However, we calculate an upper bound on the rate of mutual information that becomes exact in some special cases with time scale separation. Additionally, we develop a numerical method to calculate the rate of mutual information in continuous time. We illustrate our main results with simple four state models, which provide insight into the relation between the rate of mutual information and the thermodynamic entropy production.

[1] A. C. Barato, D. Hartich, and U. Seifert, J. Stat. Phys. **153**, 460 (2013)

[2] A. C. Barato, D. Hartich, and U. Seifert, Phys. Rev. E **87**, 042104 (2013)

DY 40.18 Thu 17:00 P3

Fluctuation Spectra and Coarse Graining in Stochastic Dynamics — •Artur Wachtel[1,2], Bernhard Altaner[1,2], and Jürgen Vollmer[1,2] — [1]Max-Planck-Institut für Dynamik und Selbstorganisation (MPI DS), Göttingen — [2]Fakultät für Physik, Georg-August-Universität, Göttingen

Fluctuations in small biological systems can be crucial for their function. Large-deviation theory characterizes such rare events from the perspective of stochastic processes.

In most cases it is very difficult to directly determine the large-deviation functions. Circumventing this necessity, I present a method to quantify the fluctuation spectra for arbitrary Markovian models with finite state space. Under non-equilibrium conditions, current-like observables are of special interest. The space of all current-like observables has a natural decomposition into orthogonal complements. Remarkably, the fluctuation spectrum of any observable is entirely determined by only one of these components.

The method is applied to study differences of fluctuations in setups sampling the same dynamics at different resolutions. Coarse graining relates these models and can be done in a way that preserves expectation values of observables. However, the effects of the coarse graining on the fluctuations are not obvious. These differences are explicitly worked out for simple model systems.

DY 40.19 Thu 17:00 P3

Generalized Bose condensation into multiple states and heat transport in tight-binding lattices far from equilibrium — •Alexander Schnell[1,2], Daniel Vorberg[1,2], Waltraut Wustmann[1,2], Roland Ketzmerick[1,2], and André Eckardt[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany — [2]Technische Universität Dresden, Institut für Theoretische Physik, 01062 Dresden, Germany

If an ideal Bose gas is driven into a steady state far from equilibrium, then a generalized form of Bose condensation can occur [1]. Namely the single-particle states unambiguously separate into two groups: one, that we call Bose selected, whose occupations increase linearly when the total particle number is increased at fixed system size, and another one whose occupations saturate. We study this effect in a tight-binding lattice, where the non-equilibrium regime is achieved either by coupling the system to two heat baths, one of positive and another one of negative temperature, or by a combination of periodic forcing and the coupling to a heat bath. We investigate which and how many single-particle states are selected in such lattice systems. We, moreover, address how system properties like the heat conductivity are controlled by the various parameters of the model, like lattice size, dimensionality, or the coupling to the heat bath(s).

[1] D. Vorberg, W. Wustmann, R. Ketzmerick and A. Eckardt, Phys. Rev. Lett. (to be published), arXiv:1308.2776

DY 40.20 Thu 17:00 P3

Generalized Bose-Einstein condensation into multiple states in driven-dissipative systems — •Daniel Vorberg[1,2], Waltraut Wustmann[1,2], Roland Ketzmerick[1,2], and André Eckardt[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany — [2]Technische Universität Dresden, Institut für Theoretische Physik, 01062 Dresden, Germany

Bose-Einstein condensation, the macroscopic occupation of a single quantum state, appears in equilibrium quantum statistical mechanics and persists also in the hydrodynamic regime close to equilibrium. Here we show that even when a degenerate Bose gas is driven into a steady state far from equilibrium, where the notion of a single-particle ground state becomes meaningless, Bose-Einstein condensation survives in a generalized form: the unambiguous selection of an odd number of states acquiring large occupations. Within mean-field theory, we derive a criterion for when a single and when multiple states are *Bose selected* in a non-interacting gas. We study the effect in several driven-dissipative model systems, and propose a quantum switch for heat conductivity based on shifting between one and three selected states.

DY 40.21 Thu 17:00 P3

Nonthermal Fixed Points and Superfluid Turbulence in Ultracold Bose Gases — Sebastian Erne[1,2], •Markus Karl[1,2], Steven Mathey[1,2], Boris Nowak[1,2], Andreas Samberg[1,2], Jan Schole[1,2], Carlo Ewerz[1,2], and Thomas Gasenzer[1,2] — [1]Institut für Theoretische Physik, Ruprecht-Karls-Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany

Turbulence appears in situations where, e.g., an energy flux goes from large to small scales where finally the energy is dissipated. As a result the distribution of occupation numbers of excitations follows a power law with a universal critical exponent. The situation can be described as a nonthermal fixed point of the dynamical equations. Single-particle momentum spectra for a dynamically evolving Bose gas are analysed using semi-classical simulations and quantum-field theoretic methods based on effective-action techniques. These give information about possible universal scaling behaviour. The connection of this scaling with the appearance of topological excitations such as solitons and vortices in one-component gases and domain walls and spin textures in multi-component systems is discussed. In addition, this results are discussed from the point of view of holographic superfluids. The results open a view on solitary wave dynamics from the point of view of critical phenomena far from thermal equilibrium and on a possibility to study non-thermal fixed points and superfluid turbulence in experiment without the necessity of detecting solitons and vortices in situ.

DY 40.22 Thu 17:00 P3

Nonlinear Response in the Driven Lattice Lorentz Gas — •Sebastian Leitmann[1,2] and Thomas Franosch[1,2] — [1]Institut für Theoretische Physik, Leopold-Franzens-Universität Innsbruck, Technikerstraße 25/2, A-6020 Innsbruck, Austria — [2]Institut für Theoretische Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg, Staudtstraße 7, 91058 Erlangen, Germany

We determine the nonlinear time-dependent response of a tracer on a

lattice with randomly distributed hard obstacles as a force is switched on [1]. The calculation is exact to first order in the obstacle density and holds for arbitrarily large forces. Whereas, on the impurity-free lattice, the nonlinear drift velocity in the stationary state is analytic in the driving force, interactions with impurities introduce logarithmic contributions beyond the linear regime. The long-time decay of the velocity toward the steady state is exponentially fast for any finite value of the force, in striking contrast to the power-law relaxation predicted within linear response. We discuss the range of validity of our analytic results by comparison to stochastic simulations.

[1] Sebastian Leitmann and Thomas Franosch, Phys. Rev. Lett. 111, 190603 (2013).

DY 40.23 Thu 17:00 P3

Diffusion of nanorods on quasicrystalline substrates with phasonic drift — •Felix Rühle[1], Michael Schmiedeberg[2], and Holger Stark[1] — [1]Institut für Theoretische Physik, Technische Universität Berlin, D-10623 Berlin — [2]Institut für Theoretische Physik II, Heinrich-Heine-Universität Düsseldorf, D-40225 Düsseldorf

In order to understand ordering and growth on quasicrystalline substrates, experiments and theory have investigated colloidal ordering in a two-dimensional decagonal potential that is realizable by laser interference patterns [1,2]. In particular, spheres and rods show interesting phase behaviour and colloidal dynamics [2,3].

Phasons are hydrodynamic modes that occur in quasiperiodic crystals only and represent local rearrangements of atoms. In this contribution, we apply a phasonic drift with a constant drift velocity to the decagonal potential [4]. We place single nanorods of two different lengths in the potential and investigate their diffusive motion for different phasonic drift velocities. The results are obtained using kinetic Monte-Carlo simulations. We observe that single rods pass through a superdiffusive regime before reaching normal diffusion in the long-time limit. Depending on the length of the rods and the direction of the phasonic drift, they may align themselves with a preferential direction in real space.

[1] J. Mikhael et al., *Nature*, **454**, 501 (2008).
[2] M. Schmiedeberg and H.Stark, *PRL*, **101**, 218302 (2008).
[3] P. Kählitz, M. Schoen, and H. Stark, *JCP*, **137**, 224705 (2012).
[4] J.A. Kromer et al., *EPJE*, **36**, 25 (2013).

DY 40.24 Thu 17:00 P3

Computersimulation of colloidal particles in channel geometries — •Ullrich Siems, Birte Heinze, and Peter Nielaba — University of Konstanz

We present the results of Brownian Dynamics Simulation of colloidal particles confined to two- and three-dimensional micro-channels under the influence of external forces. Counter-flow in three dimensions and the influence of a periodic substrate potential in two dimensions are under investigation. Confinement into channels can have a great influence on diffusion and transport properties in such systems.

DY 40.25 Thu 17:00 P3

The impact of interactions on the rotational ratchet effect in magnetic colloidal suspensions — •Teresa Reinhard and Sabine H. L. Klapp — Institut für Theoretische Physik, TU Berlin, Hardenbergstraße 36, D-10623 Berlin, Germany

The extraction of directed motion from undirected random motion is a well-known problem with many different applications, such as the efficiency of heat engines, biological transport or nano-motors.
To analyze such effects, we consider a system of dipolar colloids with dipole-dipole interactions that are driven out-of-equilibrium by an oscillating magnetic field. Due to microscopic Brownian motion, these systems can exhibit directed rotational motions without an externally applied net torque [1]. This so-called ratchet effect is analysed on basis of the dynamical density functional theory [2].
Specifically, we investigate the impact of the frequency of the external field, as well as the dependence on the distance vector between the particles.
We compare our results with those from a mean-field Fokker-planck approach [3] and from particle-based computer simulations [4].

[1] A. Engel and P. Reimann, Phys. Rev. Let. 91, 060602 (2003).
[2] M. Rex, H. H. Wensink and H. Löwen, Phys Rev E 76, 021403 (2007)
[3] V. Becker and A. Engel Phys. Rev. E 75, 031118 (2007).
[4] S. Jäger and S. H. L. Klapp, Phys. Rev. E 86, 061402 (2012).

DY 40.26 Thu 17:00 P3

Ageing and nonergodicity in the Standard map — •Tony Albers and Günter Radons — Technische Universität Chemnitz, Germany

We investigate diffusion processes occurring in the phase space of the well-known Standard map, which is a paradigmatic example for low-dimensional non-integrable Hamiltonian chaos. These diffusion processes deviate from the laws of normal diffusion and especially have non-stationary increments. As a consequence, statistical quantities depend on the elapsed time (ageing time) between the beginning of the process and the beginning of the measurement. Furthermore, ergodicity of these processes can be broken in the sense that ensemble and time averages do not coincide and time averages become random variables. We study the ageing and nonergodicity of the observed anomalous diffusion in terms of the mean squared displacement and the distribution of generalized diffusivities [1], which describes the fluctuations during the diffusion process around the generalized diffusion coefficient that is obtained from the asymptotic time dependence of the mean-squared displacement.

[1] T. Albers and G. Radons, EPL 102, 40006 (2013)

DY 40.27 Thu 17:00 P3

Universality of Anomalous Transport in Model Crowded Media — •Markus Spanner[1], Felix Höfling[2], Gerd Schröder-Turk[1], and Thomas Franosch[1,3] — [1]Institut für Theoretische Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany — [2]MPI für komplexe Systeme, Stuttgart, and IV. Institut für Theoretische Physik, Universität Stuttgart, Germany — [3]Institut für Theoretische Physik, Leopold-Franzens-Universität Innsbruck, Austria

The Lorentz model is a simple model for transport in porous materials, where a point-like tracer moves through an array of random overlapping spheres. At the point where the void space between the frozen-in obstacles undergoes a percolation transition, sub-diffusive transport $\delta r^2(t) \sim t^{2/d_w}$, $d_w = 4.81$ can be observed. In this regime transport is dominated by narrow channels in the host structure, where the tracer can barely squeeze through.

With our simulations, we want to test the influence of these narrow channels, a) by introducing correlations in the obstacle positions, thereby changing the statistics of channel widths, and b) by comparing ballistic and Brownian tracer dynamics, i.e. changing the way channels are probed by the tracer.

While in the first case, the system is stable and d_w stays unchanged, in the second case, a splitting in two universality classes can by observed.

DY 40.28 Thu 17:00 P3

Anomalous transport of self-propelled particles in biological environments — Mohammadreza Shaebani, •Zeinab Sadjadi, Heiko Rieger, and Ludger Santen — Theoretical Physics Department, Saarland University, Saarbrucken, Germany

We study the influence of structural characteristics of random filamentous networks – or equivalently the stepping strategy in continuous space – on the transport properties of a random walker. A general master equation formalism is developed to investigate the persistent motion of self-propelled particles, which enables us to identify the key parameters and disentangle their contributions to the transport properties. Depending on the persistency of the walker and the anisotropy and heterogeneity of the structure, the particles exhibit an anomalous diffusive dynamics. We establish the existence of up to three different regimes of motion, and determine the phase diagrams of the behavior. We verify that the crossover times between different regimes as well as the long-term diffusion coefficient can be enhanced by a few orders of magnitude within the biologically relevant range of control parameters. The analytical predictions are in excellent agreement with simulation results.

DY 40.29 Thu 17:00 P3

Collective behaviour of self-propelled particles with nematic alignment in three dimensions — •Rebekka Heyn and Marco G. Mazza — Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen, Germany

In the field of active swimmers, numerical models with simple, local interaction rules are a powerful instrument to study collective phenomena of any type of self-propelled particles.

Here, we fill the gap of such a model in three dimensions with local nematic alignment and study the collective behaviour in large sys-

tems (up to 10^6 particles in reasonable computational time). The system shows interesting collective states such as global nematic order, isotropic phase, coexistence of different phases, and density waves. We investigate these waves in detail, as they show a surprising symmetry breaking of the nematic interaction. Moreover, we examine the effects of spatial disorder by adding obstacles to the system. We study their influence on the collective behaviour of the self-propelled particles and, specifically, on the waves.

DY 40.30 Thu 17:00 P3

Statistical analysis of trajectories of sedimenting beads in a active fluid — •Levke Ortlieb, Matthias Mussler, Christian Wagner, and Thomas John — Universität des Saarlandes, Experimentalphysik 7.2, 66123 Saarbrücken, Germany

Aqueous suspensions of life-forms have existed on earth since the very beginning of life. All cellular life is characterized by metabolism and requires a continuous assimilation of food or light as its energy source. Locomotion favors the admission of these materials and raises survival probability.

Here we present details on an experimental setup to investigate the locomotion of the green alga chlamydomonas reinhardtii and in particular the sedimentation of micro-spheres of different diameters in a Hele-Shaw-flow environment. The alga has two flagella, a diameter of 10 μm and swims as a puller with approximately 50 μm/s. We present extracted statistical properties of the suspended, passive bead positions, e.g. the mean square displacement or the probability density function of positions. We will compare our results from the microswimmer suspensions with the Brownian motion characteristics of sedimenting particles in very dilute systems and the characteristics in passive sedimenting particles at higher volume concentrations. In our microswimmer suspensions as well as in the sedimentation at higher volume concentrations, the hydrodynamic interaction becomes important and a non-Brownian behavior can be observed.

DY 40.31 Thu 17:00 P3

Investigating Chlamydomonas reinhardtii's gears of motion by means of holographic optical tweezers and micropipettes — •Christian Ruloff, Thomas John, and Christian Wagner — Dynamics of Fluids, Wagner Group, Saarland University

Chlamydomonas reinhardtii (CR) is an approximately twelve micron sized unicellular green algae which uses two beating flagella for locomotion. The light-sensing eyespot is used to detect the incident light and stears its motion to control the distance between the algae itself and the light source for ideal photosynthesis: At low light intensities the algae is swimming towards the light source while at strong illumination CR increases its distance to it. Both flagella are not beating in the same plane leading to a superposition of foreward movement with a slight rotation mandatory for phototaxis. Besides the wild type there exist many mutants like blind or deflagellated ones. Therefore, CR is used as a model organism for research on basic questions like "How do cells move?" or "How do cells respond to light?". Using holographic optical tweezers (HOT) we generate two counterrotating optical vortices at the same spatial position which form a cogwheel potential whose radius is chosen to match the algae's body size. With this technique it is possible to partially suppress out-of-plane movement of the CR to reduce the problem to two dimensions. This is necessary because with our setup it is only possible to observe movements in the focal plane of the microscope objective. Furthermore, we want to compare our results for an almost free-swimming CR with measurements of CR in a totally body-fixed state when held by a micropipette.

DY 40.32 Thu 17:00 P3

Phase field modelling of oxide scale growth — •Fabian Twiste[1], Claas Hüter[1], Robert Spatschek[1], Jörg Neugebauer[1], and Michael Finnis[2] — [1]Max-Planck Institut für Eisenforschung, Düsseldorf — [2]Imperial College, London

We present recent steps towards a phase field description of oxide scale growth for the modelling of corrosion processes and the formation of protective layers in high-temperature applications. In the model we consider chemical reactions which are taking place both at the scale-air surface as well as at the scale-metal interface. Charged defects therefore play a central role, and their equilibrium distributions and diffusion through the oxide layer is influenced by external and self-generated electrostatic fields. The phase field framework for the description of the film growth is therefore supplemented by reaction-diffusion equations and consideration of the local electrical potential. The predictions are compared against sharp interface considerations.

DY 40.33 Thu 17:00 P3

Light sensitivity of Belousov-Zhabotinsky reaction with 1,4-cyclohexanedione as the organic substrate — Andreas Bindler and •Stefan C. Müller — Institute of Experimental Physics, Otto-von-Guericke-Universität Magdeburg

The study of spatio-temporal patterns in chemically reactive systems is one of the central problems of modern reaction kinetics. A well-known experimental model system is the Belousov-Zhabotinsky (BZ) reaction, which exhibits oscillations and chemical waves. In a photosensitive Ru-catalyzed version of this reaction light can act as an external control of various features of such patterns. Recent work is focused on the light-sensitivity of 1,4-cyclohexadione (CHD) as a new substrate, which has particular advantages and specific properties of interest. We study the influence of CHD and its intermediates on the kinetics of the BZ-reaction and on other chemical reagents like the catalyst or bromide. The response to illumination of the BZ-reaction with CHD is much more complex, compared with the previously investigated light-sensitive reaction including Ruthenium and malonic acid as the substrate. Thus, we have investigated the pattern evolution in the presence of CHD and different catalysts. A major goal is to determine, how the interaction between CHD and Ruthenium under irradiation in the visible spectrum can be minimized.