DY 26: Poster II

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

DY 26.1 Thu 16:00 P1A

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

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

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

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

DY 26.2 Thu 16:00 P1A

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

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

DY 26.3 Thu 16:00 P1A

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

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

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

DY 26.4 Thu 16:00 P1A

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

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

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

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

DY 26.5 Thu 16:00 P1A

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

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

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

DY 26.6 Thu 16:00 P1A

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

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

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

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

DY 26.7 Thu 16:00 P1A

molecular dynamics simulation of heterogeneous nucleation in Lennard-Jones colloidal system — •Hamed Maleki[1], Nadya

Gribova[2], Tanja Schilling[1], and Christian Holm[2,3] — [1]institut für Physik, Johannes Gutenberg-Universität, Staudinger Weg 7, D-55099 Mainz, Germany — [2]Frankfurt Institute for Advanced Studies, Goethe-University, Ruth-Moufang-Str.1, D-60438 Frankfurt am Main, Germany — [3]Max Planck Institute for Polymer Research, Ackermannweg 10, D-55128 Mainz, Germany

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

DY 26.8 Thu 16:00 P1A

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

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

DY 26.9 Thu 16:00 P1A

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

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

DY 26.10 Thu 16:00 P1A

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

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

DY 26.11 Thu 16:00 P1A

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

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

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

DY 26.12 Thu 16:00 P1A

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

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

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

DY 26.13 Thu 16:00 P1A

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

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

DY 26.14 Thu 16:00 P1A

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

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

DY 26.15 Thu 16:00 P1A

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

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

DY 26.16 Thu 16:00 P1A

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

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

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

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

DY 26.17 Thu 16:00 P1A

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

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

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

DY 26.18 Thu 16:00 P1A

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

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

DY 26.19 Thu 16:00 P1A

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

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

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

DY 26.20 Thu 16:00 P1A

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

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

DY 26.21 Thu 16:00 P1A

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

Spiral wave patterns represent a famous example of self-organized

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

DY 26.22 Thu 16:00 P1A

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

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

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

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

DY 26.23 Thu 16:00 P1A

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

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

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

DY 26.24 Thu 16:00 P1A

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

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

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

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

DY 26.25 Thu 16:00 P1A

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

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

DY 26.26 Thu 16:00 P1A

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

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

DY 26.27 Thu 16:00 P1A

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

Motivated by the recently increased experimental activity [1-2], we study graphene quantum dot systems theoretically. In previous work, we explored the effect of boundary conditions on the transport and spectral properties of graphene quantum dots numerically [3]. In this work, we seek an analytic approach. To this end, we derive a multiple reflection expansion for the exact Green function of the effective Dirac equation for a graphene flake with a general boundary. Here we take into account contributions from both valleys, thus dealing with 4x4 (pseudo-)spin matrices. Evaluating this Green function semiclassically, we obtain a sum over classical multiple reflection paths. The advantage of this approach is the natural incorporation of the boundary conditions at the flake's edges. Using the semiclassical graphene Green function, we then investigate quantum transport, e.g. weak localization effects, as well as the semiclassical density of states in terms of a Dirac version of the Gutzwiller trace formula.

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

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

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

DY 26.28 Thu 16:00 P1A

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

Münster, Germany

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

[1] J. P. Keating, S. Müller, Proc. R. Soc. **463**, 3241 (2007),
[2] S. Heusler, S. Müller, A. Altland, P. Braun, F. Haake, Phys. Rev. Lett. **98**, 044103 (2007)

DY 26.29 Thu 16:00 P1A

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

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

DY 26.30 Thu 16:00 P1A

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

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

DY 26.31 Thu 16:00 P1A

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

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

DY 26.32 Thu 16:00 P1A

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

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

[1] M. A. Topinka, et al., Nature 410, 183 (2001).
[2] L. Kaplan, Phys. Rev. Lett. 89, 184103 (2002).

DY 26.33 Thu 16:00 P1A

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

In systems with a mixed phase space regular islands are dynamically separated from the chaotic sea, while quantum mechanically these phase-space regions are connected by dynamical tunneling. Dynamical tunneling rates from regular states to the chaotic sea can be determined with an approach based on a fictitious integrable system [1,2]. We apply this approach to the annular billiard and extend it to the corresponding micro-cavity. The approach can also be used to determine the coupling of bouncing-ball modes to chaotic states. We find that this coupling decays like a power law $k^{-1/2}$ with the wave number k.

[1] A. Bäcker, R. Ketzmerick, S. Löck, and L. Schilling, Phys. Rev. Lett. **100**, 104101 (2008).
[2] A. Bäcker, R. Ketzmerick, S. Löck, M. Robnik, G. Vidmar, R. Höhmann, U. Kuhl, and H.-J. Stöckmann, Phys. Rev. Lett. **100**, 174103 (2008).

DY 26.34 Thu 16:00 P1A

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

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

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

DY 26.35 Thu 16:00 P1A

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

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

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

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

DY 26.36 Thu 16:00 P1A

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

It is well known that the contact of a quantum system to a thermal bath has a negative effect on the entanglement within the system: Be-

yond a certain temperature, no static entanglement can survive at all.

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

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

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

DY 26.37 Thu 16:00 P1A

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

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

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

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

DY 26.38 Thu 16:00 P1A

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

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

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

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

DY 26.39 Thu 16:00 P1A

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

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

DY 26.40 Thu 16:00 P1A

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

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