DY 7: Poster I

This Poster Session has contributions from the Topics DY 1 and DY 3 Quantum dynamics; DY 2 Statistical physics in biological systems; DY 5 Reaction diffusion systems; DY 11 Statistics and dynamics of /on networks; DY 12 Nonlinear dynamics, synchronization and Chaos;

Time: Monday 17:30–19:30 Location: Poster C

DY 7.1 Mon 17:30 Poster C

Zeno effect for repeated projective and finite-time measurements — •Andreas Prinz-Zwick[1], Gert-Ludwig Ingold[1], Peter Talkner[1], and Juyeon Yi[2] — [1]Institut für Physik, Univ. Augsburg, Germany — [2]Dept. of Physics, Pusan National University, Korea

The decay of an unstable state can be slowed down by frequently repeated measurements and even be stopped completely under continuous observation. This so-called quantum Zeno effect has been studied for a single particle on a one-dimensional chain subject to repeated projective measurements on the first lattice site [1]. In contrast to previous work, we keep track of all possible measurement outcomes. While the Zeno effect is obtained for short times, asymptotically the system approaches a uniform state. As an extension, we have considered non-projective measurements where the system is coupled to a measurement apparatus as introduced in [2]. The Zeno effect is studied as a function of the duration of the measurement τ_m and the time between measurements τ_a. An optimal measurement is achieved by appropriately choosing the coupling strength as a function of τ_m. It is found that for not too large duration of the measurement, the Zeno effect becomes more pronounced when τ_m is increased [3].

[1] J. Yi, P. Talkner, G.-L. Ingold, Phys. Rev. A **84**, 032121 (2011)
[2] W. Zurek, Ann. Phys. (N.Y.) **9**, 855 (2000)
[3] A. Prinz-Zwick, Master thesis (Universität Augsburg, 2012)

DY 7.2 Mon 17:30 Poster C

Quantum-classical correspondence in the dynamics of the Dicke model — •Lutz Bakemeier, Andreas Alvermann, and Holger Fehske — Institut für Physik, Ernst-Moritz-Arndt Universität Greifswald, Deutschland

The Dicke model describes an ensemble of two-level systems coupled to a quantum oscillator. It shows several interesting properties in its classical limits. While the ground state features a quantum phase transition, the classical dynamics shows a transition from regular to chaotic motion.

We consider the question how the signatures of the classical model evolve in the quantum model when the classical limit is approached. Based on Chebyshev expansion and kernel polynomial numerical methods we give an overview of the quantum-classical correspondence observable in the dynamical spectral functions, the time evolution of individual states, and the global dynamics in phase space. We analyze the excitations in the dynamical spectral function which correspond to the collective modes of the classical model characterizing the quantum phase transition. For the global dynamics we discuss a quantum equivalent to the classical Poincaré surface of section on phase space. This quantity shows how the systems eigenstates localize on different parts of the energy shell and thus adequately describes the transition from regular to chaotic motion.

DY 7.3 Mon 17:30 Poster C

Strong driving in open quantum systems: Beyond Markovian dynamics — •Christine Brix and Jürgen T. Stockburger — Institut für Theoretische Physik, Universität Ulm, Albert-Einstein-Allee 11, 89069 Ulm, Germany

Strong driving of an open quantum system typically leads to a breakdown of the commonly used strategy of Born, Markov, and RWA approximations. Hence, the typical quantum optical master equation (Lindblad type) becomes unreliable. Here we present a non-RWA equation of motion which preserves the initially given separable structure of the interaction, keeping the dissipative terms "agnostic" of the system Hamiltonian which may contain driving of arbitrary strength and time dependence. In contrast to previous work the resulting stochastic equation of motion can now be cast in a form that does not involve a sign problem. This gain in efficiency allows new applications in both quantum information and chemical physics.

DY 7.4 Mon 17:30 Poster C

Controlled engineering of extended states in disordered systems — •Alberto Rodriguez[1], Arunava Chakrabarti[2], and Rudolf A Römer[3] — [1]Physikalisches Institut, Albert-Ludwigs Universität Freiburg, Hermann-Herder Strasse 3, D-79104, Freiburg, Germany — [2]Department of Physics, University of Kalyani, Kalyani, West Bengal-741 235, India — [3]Department of Physics and Centre for Scientific Computing, University of Warwick, Coventry, CV4 7AL, United Kingdom

We describe how to engineer wavefunction delocalization in disordered systems modelled by tight-binding Hamiltonians in $d > 1$ dimensions [1]. We show analytically that a simple product structure for the random onsite potential energies, together with suitably chosen hopping strengths, allows a resonant scattering process leading to ballistic transport along one direction, and a controlled coexistence of extended Bloch states and anisotropically localized states in the spectrum. We demonstrate that these features persist in the thermodynamic limit for a continuous range of the system parameters. Numerical results support these findings and highlight the robustness of the extended regime with respect to deviations from the exact resonance condition for finite systems. The localization and transport properties of the system can be engineered almost at will and independently in each direction. This study gives rise to the possibility of designing disordered potentials that work as switching devices and band-pass filters for quantum waves, such as matter waves in optical lattices.

[1] Phys. Rev. B 86, 085119-12 (2012)

DY 7.5 Mon 17:30 Poster C

Energy Transfer and Decoherence in Phase Space — •Per Lieberman[1,2] and Oliver Mülken[2] — [1]Universität des Saarlandes, Saarbrücken, Germany — [2]Albert-Ludwigs-Universität Freiburg, Germany

Phase space methods can be used to describe both classical and quantum mechancal transport processes, such as, for instance, the energy transfer in photosynthetic light harvesting complexes. To gain a deeper insight into the phase space dynamics of the Continuous-Time Quantum Walk on a discrete network, a discrete Wigner function represents the quantum state of the system. Environmental effects such as decoherence are implemented in the framework of the Lindblad Master Equation. In this context, the Quantum Stochastic Walk contains the Random Walk and the Quantum Walk as special cases for both strong and weak coupling strengths. Furthermore a source and a drain are added to the trimer's network, leading to a simplified model for the excitation transport within the Fenna-Matthews-Olsen complex.

DY 7.6 Mon 17:30 Poster C

Simulation of a particle in a one-dimensional double-well potential using stochastic mechanics — •Jeanette Köppe and Wolfgang Paul — Institute of Physics, Martin-Luther-Universität Halle-Wittenberg, Germany

It was shown that the well-known Schrödinger equation is equivalent to a conservative Brownian motion [1]. This concept enables to investigate the duration of quantum-mechanical processes, hence there is the opportunity to directly study particle dynamics.

Using Nelson's interpretation of quantum mechanics, we simulate the tunneling process of a particle in a one-dimensional double-well potential to demonstrate its predictive power. In particular, we determine the mean first passage time needed to cross the barrier, which is equal to the tunneling time in quantum mechanics, and study its dependence on the width and the height of the barrier. The respective results are compared to those calculated by "normal" quantum mechanics.

[1] E. Nelson, Phys. Rev. 150, 1079-1085 (1966)

DY 7.7 Mon 17:30 Poster C

Depletion of Superfluidity in a disordered non-equilibrium Quantum Condensate — •Alexander Janot[1], Timo Hyart[2], Bernd Rosenow[1], and Paul Eastham[3] — [1]Institut für Theoretische Physik, Universität Leipzig, 04009 Leipzig, Germany — [2]Institute of Physics, Leiden University, Niels Bohrweg 2, 2333 CA Leiden, Netherlands — [3]School of Physics, Trinity College, Dublin 2, Ireland

Observations of quantum coherence in driven systems, e.g. polariton condensates, have strongly stimulated experimental as well as theoretical efforts during the last decade. We analyze the superfluid stiffness of a non-equilibrium quantum-condensate in a disordered environment taking gain and loss of particles into account. To this end a modified effective Gross-Pitaevskii equation is employed. We find that the disorder-driven depletion of superfluidity is strongly enhanced due to the gain-loss mechanism. It turns out that the condensate remains stiff at finite length scales only.

DY 7.8 Mon 17:30 Poster C

Structure optimization for models of protein folding by means of "local heat pulse"-quench cycles — •Florian Günther[1], Arnulf Möbius[2], and Michael Schreiber[1] — [1]Institute of Physics, Chemnitz University of Technology, Chemnitz, Germany — [2]Institute for Theoretical Solid State Physics, IFW, Dresden, Germany

Protein folding is a very challenging task because the energy landscape exhibits a huge number of local minima. For such simulations, efficient heuristic algorithms are of high value. We investigate, whether and how the "local heat pulse"-quench cycling (LHPQC) approach [1], which has proved to be highly efficient for traveling salesman and Coulomb glass problems, can be applied to protein folding tasks. For that, we consider the hydrophobic-polar lattice model [2] and the continuous "3-color, 46-bead" model [3]. In evaluating the efficiency of the LHPQC approach, we compare with standard procedures as simulated annealing.

[1] A. Möbius, A. Neklioudov, A. Diaz-Sanchez, K.H. Hoffmann, A. Fachat, and M. Schreiber, *Phys. Rev. Lett.* **79** (1997) 4297.
[2] K. F. Lau, and K. A. Dill, *Macromolecules* **22** (1989) 3986.
[3] J. D. Honeycutt, and D. Thirumalai, *Proc. Natl. Acad. Sci. USA* **87** (1990) 3526.

DY 7.9 Mon 17:30 Poster C

Improved modelling of forced Kramers escape — •Jakob Tómas Bullerjahn, Sebastian Sturm, and Klaus Kroy — Universität Leipzig, Faculty of Physics & Earth Sciences, Institute for Theoretical Physics, Brüderstr. 16, 04103 Leipzig, Germany

The forcible separation of non-covalent bonds, such as in protein unfolding and ligand dissociation, can be regarded as a transition between a bound and an unbound state [1]. This two-state system can be modelled by a test particle moving in an effective free energy landscape, trying to overcome an energy barrier separating the two states. Due to external loading the unbound state is favoured, which makes the escape practically irreversible. However, established models of such forced rupture [1,2] are restricted to the adiabatic limit of small loading rates, thus making it impossible to apply them to all-atom simulations.

Starting from the test particle's equation of motion, we describe its irreversible escape from a potential well, driven by a time-dependent external force protocol. Our model is analytically tractable and yields an expression for the rupture force distribution measured in dynamic force spectroscopy experiments [3], which holds for small and large loading rates alike. It can be extended to non-Markovian processes with arbitrary memory kernels and reduces to the main result of [2] in the limit of small loading rates.

[1] E. Evans & K. Ritchie, Biophys.J. 72, 1541 (1997) [2] O. K. Dudko, G. Hummer & A. Szabo, Phys. Rev. Lett. 96, 108101 (2006) [3] M. Carrion-Vazquez, et al., Proc. Natl. Acad. Sci. 96, 3694 (1999)

DY 7.10 Mon 17:30 Poster C

Self-organized criticality in adaptive neural network models — •Matthias Rybarsch and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Hochschulring 18, D-28359 Bremen

It has long been argued that neural networks have to establish and maintain a certain intermediate level of activity in order to keep away from the regimes of chaos and silence. Strong evidence for criticality has been observed in terms of spatio-temporal activity avalanches in cortical cultures first in ref. [1] and subsequently in many more experimental setups. These findings sparked intense research on theoretical models for criticality and avalanche dynamics in neural networks, where usually some dynamical order parameter is fed back onto the network topology by adapting the synaptic couplings. We here review and categorize two classes of models and also discuss a novel correlation-dependent mechanism for self-organized connectivity evolution, leading to a realistic distribution of avalanche sizes in agreement with the experimental findings [2].

[1] J.M. Beggs and D. Plenz: Neuronal Avalanches in Neocortical Circuits, J. Neurosci. 2003, 23(35):11167
[2] M. Rybarsch and S. Bornholdt: A minimal model for self-organization to criticality in binary neural networks, arXiv:1206.0166

DY 7.11 Mon 17:30 Poster C

Generative network models based on triadic substructures — •Marco Winkler and Jörg Reichardt — Institut für Theoretische Physik, Julius-Maximilians-Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

Often pairwise relationships between nodes are considered to be the fundamental building blocks of complex networks. However, over the last decade the overabundance of certain sub-network configurations, so called motifs, have attracted high attention. However, there is still a lack of generative models needed for testing the functional role of such subgraphs. Furthermore, supposed higher order link structures contribute to the probability of a link to emerge, models accounting for those should perform better in predicting hitherto unknown links. Motivated by these two aspects, we employ the framework of exponential random graph models (ERGMs) to define novel models based on triadic substructures. The fact that only a small portion of triads can actually be set freely poses a challenge for the formulation of such models. To overcome this obstacle we use decompositions of our networks into Steiner Triple Systems (STS). The latter are partitions of sets of nodes into pair-disjoint triads, which thus can be specified independently from each other. Combining the concepts of ERGMs and STS, we suggest novel generative network models. We present the benefits of our approach compared to models based on dyadic independence of links.

DY 7.12 Mon 17:30 Poster C

Boolean and continuous networks with checkpoint states — •Danijel Komljenović[1], Tiago Peixoto[2], Eva Ackermann[1], and Barbara Drossel[1] — [1]Institut für Festkörperphysik, TU Darmstadt — [2]Institut für theoretische Physik, Universität Bremen

Gene regulatory networks must function robustly in the presence of a stochastic environment and unreliable regulatory components. An observed mechanism employed by real organisms to fulfill this task is the enforcement of so-called "checkpoint states". This corresponds to a partial ordering of the dynamics where the trajectories cannot proceed from one checkpoint to the next until all requirements from the first checkpoint have been met. This guarantees a certain amount of predictability, while it leaves at the same time room for variation when the system moves between checkpoints. We show how such checkpoint dynamics can be explicitly constructed in a Boolean representation of gene regulatory dynamics. In this representation, a checkpoint is a state through which the dynamics must always go even when a fully stochastic update scheme is applied. Given a predefined set of checkpoints, we construct possible intermediary trajectories, and finally the ensemble of networks which fulfill it. We proceed by comparing the Boolean models with their continuous counterparts composed of differential equations describing in more detail the concentrations of proteins and mRNA. This allows us to identify the central criteria enabling the faithful reproduction of the Boolean dynamics in the continuous description, depending on the Hill coefficients of the continuous functions and the sequence of checkpoint states on the trajectory.

DY 7.13 Mon 17:30 Poster C

Inferring topology of biological networks from dynamics — •Haleh Ebadi and Konstantin Klemm — Bioinformatics Group, Institute or Computer Science, Leipzig University, Germany

An observation of a state transition provides partial information on the interactions constituting a high-dimensional deterministic system. Here we strive to quantify how the number of observed single state transitions and/or short trajectories reduces the number of interaction matrices consistent with the set of observations. As a test-bed, we use several established Boolean (threshold unit) models of cell cycle control in living organisms. The numerical study also uses ensembles of randomly reshuffled matrices as a null model. We find that the ability to reconstruct networks from measurements strongly depends on the types of threshold functions assumed by the underlying model.

DY 7.14 Mon 17:30 Poster C

Hierarchy in directed networks — •Krzysztof Suchecki and Janusz Hołyst — Faculty of Physics, Center of Excellence for Complex Systems Research, Warsaw University of Technology, ul. Koszykowa 75, Warszawa, Poland

We introduce a definition of observable hierarchy in directed networks, related to the possible information or command flows in such networks and derived purely from the network topology. For trees, it is a simple average distance of leaf vertices from the root plus one. We generalize it for any directed network. In case of presence of directed loops, we assign all the vertices in a loop to the same hierarchy, which effectively means treating loops as single complex vertices. We analyze the average hierarchy value for different types of networks and in case of network models investigate its dependence on network parameters, as well as explain the obtained results. For directed Erdos-Renyi random graphs, we observe maximum hierarchy value depending on the graph density, that coincides with the percolation threshold.

DY 7.15 Mon 17:30 Poster C

Evolutionary optimisation of dynamical networks — •Steffen Karalus — Institut für Theoretische Physik, Universität zu Köln, Germany

A large class of empirical networks structurally evolve in the course of time adapting their topology to better fit the functional requirements. This functionality in most cases is associated with dynamical processes based on the network in the sense that the topology defines the local interaction pattern between the individual dynamical units. Thus, in the evolutionary process mutations act on the network topology whereas selection acts on a 'fitness' provided by dynamical properties. In many empirical situations the speed of the evolutionary dynamics is much slower than the process dynamics so that the two time scales can be considered as well separated. Exploiting these ideas it has been shown that network structures can be successfully evolved such that non-trivial dynamical behaviour emerges [1].

I will present further developments for improving the efficiency of the evolutionary dynamics as well as for providing deeper insight into the mechanisms of network evolution and the relation between network structure and dynamics in general. By this, not only more complicated dynamical problems and larger system sizes will become tractable but also a better understanding of the complexity of network evolution and how different evolutionary strategies perform can be achieved.

[1] S. Karalus and M. Porto, EPL 99, 38002 (2012).

DY 7.16 Mon 17:30 Poster C

Voter Model with Surface Tension — •Bruno Pace and Konstantin Klemm — Leipzig University

Spin systems are very central in the context of Statistical Physics for their simplicity and generality. But also, any process out of the realm of physics that shares some intrinsic properties and symmetries with these models will inherit some of their characteristics like the phase transitions or scaling properties.

There is a well-known comparison between the Voter model and the Ising model at zero temperature. In the latter, however, curvature-driven surface tension orders the system. Here we propose a different microscopic mechanism inspired in the classic Voter dynamics for the emergence of a surface tension. It consists of making the agents actively persuasive: after choosing one node of the network, it will try to interact only with different state neighbours. Some characteristics of the out of equilibrium dynamics are explored.

DY 7.17 Mon 17:30 Poster C

A Parameter Estimation Method for Ordinary Differential Equations — •Oliver Strebel — Launitzstr. 21, 60594 Frankfurt

Estimating parameters for ordinary differential equations (ODE) is an active field of research. Prominent methods are least square and Kalman methods [1]. While the former suffer from various convergence problems [2], the latter face frequently the "loss of lock" problem of nonlinear filtering [3].

In this contribution a method is presented, which first determines the tangent slope and coordinate for given data of the solution of the ODE. With these values the ODE is transformed into a system of equations, which is linear for linear appearance of the parameters in the ODE. In this case no initial guess of the parameters is necessary. For nonlinear parameter dependence of the ODE nonlinear equations must be solved, using parameter guesses as initial values for the Newton iteration. In both cases the equations are solved repeatedly using randomly selected data points and the averaged results yield the estimates. For numerically generated data of the Lorenz attractor good estimates are obtained even at large noise levels.

[1] B. P. Bezruchko et al: Extracting knowledge from time series, Springer 2010.

[2] B. P. Bezruchko et al:, Chaos, Solitons & Fractals 29, p. 82, 2006.

[3] Z. Schuss: Nonlinear Filtering and Optimal Phase Tracking, Springer 2012.

DY 7.18 Mon 17:30 Poster C

Order by disorder in frustrated oscillators — •Florin Ionita[1], Darka Labavić[1], Michael Zaks[2], and Hildegard Meyer-Ortmanns[1] — [1]School of Engineering and Science, Jacobs University Bremen, PO Box 750561, D-28725 Bremen, Germany — [2]Institute of Mathematics, Humboldt-University at Berlin, Rudower Chaussee 25, 12489 Berlin, Germany

We study Kuramoto oscillators on regular and all-to-all topologies with geometric frustration due to repulsive couplings. As a result of this frustration we observe a proliferation of stationary states in the gradient dynamics, which differ by their patterns of phase-locked motion. As a special subset of these states we identify plane-wave solutions and prove their stability. When we turn on additive noise, we observe for an intermediate noise strength an order-by-disorder effect, similarly to the ordering effect that is induced by disorder in frustrated spin systems. Here it means that a disordered state with no synchronization turns into a state with partial synchronization, or a state with a low degeneracy turns into a state with a larger degeneracy of synchronized phases. Similar results are found for active rotators.

DY 7.19 Mon 17:30 Poster C

Entropic Stochastic Resonance of a Flexible Polymer Chain in Confined System — •Zhen Zhang[1,2], Hanshuang Chen[3], and Zhonghuai Hou[1,4] — [1]Institute of Theoretical Physics, Technical University Berlin, Hardenbergstrasse 36, 10623, Berlin, Germany — [2]Department of Chemical Physics, University of Science and Technology of China, Hefei, Anhui, 230026, China — [3]School of Physics and Material Science, Anhui University, Hefei, Anhui, 230039, China — [4]Hefei National Laboratory for Physical Sciences at Microscale, University of Science and Technology of China, Hefei, Anhui, 230026, China

We have investigated the dynamics of a flexible polymer chain in constrained dumb-bell-shape geometry subject to a periodic force and external noise along the longitudinal direction[1]. It is found that the system exhibits a feature of entropic stochastic resonance (ESR), i.e., the temporal coherence of the polymer motion can reach a maximum level for an optimal noise intensity. We demonstrate that the occurrence of ESR is robust to the change of chain length, while the bottleneck width should be properly chosen. A gravity force in the vertical direction is not necessary for the ESR here, however, the elastic coupling between polymer beads is crucial. Our study may shed new light on the understanding of polymer dynamics as well as its control in confined geometry, which is of great importance in biological systems.

[1] Zhen Zhang, Hanshuang Chen, and Zhonghuai Hou,Entropic stochastic resonance of a flexible polymer chain in a confined system, J. Chem. Phys. 137, 044904 (2012).

DY 7.20 Mon 17:30 Poster C

Dependence of irregular excitation patterns on bridge width during interaction of pacemaker — •Yvonne Richter[1], Claudia Lenk[2] und Philipp Maass[1] — [1]Fachbereich Physik, Universität Osnabrück, Germany — [2]Institut für Chemie und Biotechnik, Technische Universität Ilmenau, Germany

Irregular excitation patterns in reaction-diffusion systems are often associated with a reduced performance of the system or pathological states like, e.g. fibrillation of the heart. Understanding the generation of such states is important for the improvement or therapy of these systems. The interaction of two pacemaker located in distinct regions which are only connected by a small bridge can on the one hand generate irregular excitation patterns and on the other hand return the system into a more regular state dependent on the frequency ratio of the two pacemaker. This mechanism is investigated by calculations of the Bueno-Orovio equations. We present a performance comparison of two different calculation methods, finite element method and finite differences method. Additionally, the ability to reduce the calculation time by application of graphic card computation (CUDA) is tested. With the best performing program the dependence of the excitation patterns resulting from the interaction of the two pacemaker on the width of the bridge is studied. The strength of the irregularity, measured by entropy and phase coherence, and changes in the shape of the excitation patterns as well as differences in the frequency ratios, determining the three different irregularity regimes, will be analysed. The results will be compared with the FitzHugh-Nagumo model.

DY 7.21 Mon 17:30 Poster C

Experimental Chimera States in a Network of Mechanical Oscillators — Erik A. Martens[1,2], Shashi Thutupalli[1,3], •Antoine Fourrière[1], and Oskar Hallatschek[1] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Aqua, Technical University of Denmark, Lyngby, Denmark — [3]Dept. of Mechanical & Aerospace Engineering, Princeton University, Princeton, USA

Synchronization of oscillating units is at the heart of numerous natural phenomena. Over the last 10 years, theoretical studies have predicted the existence of counterintuitive 'chimera states', where a population of identical oscillators splits into a synchronous and asynchronous part. For a deep understanding of these collective states and their relevance, the physical mechanisms causing their emergence must be resolved. Here, we use a purely mechanical system of coupled metronomes to show that chimeras emerge naturally from a competition between two antagonistic synchronization patterns. We obtain a spectrum of complex states, encompassing and extending the set of previously described chimeras. Our mechanical model strongly suggests that such states are a ubiquitous feature in nature, manifesting themselves in technological settings ranging from power grids to optomechanical arrays.

DY 7.22 Mon 17:30 Poster C

Nonlocal control of pulse propagation in excitable media — •Clemens Bachmair and Eckehard Schöll — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstraße 36, 10623 Berlin, Germany

We discuss the effects of nonlocal control on propagating waves in excitable media. As a generic model we use a spatially extended FitzHugh-Nagumo system which locally couples with a diffusion term in the activator variable. The control is implemented in a non-invasive way by a convolution with different kernel. A particular focus is placed on the mexican hat function due to its significance in neuroscience. The control gives rise to different phenomena such as wave supression, multiple peak waves and more complex spatiotemporal patterns such as a spiking traveling wave.

DY 7.23 Mon 17:30 Poster C

Curvature dependent Feedback Control of two dimensional Excitation Waves — •Sonja Molnos, Jakob Löber, and Harald Engel — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

The propagating liquid-solid interface in an undercooled fluid can undergo a Mullins-Sekerka-instability, which for example leads to the formation of snowflakes [1]. We investigate a mechanism to create such instabilities in a reaction diffusion system. With the developed curvature-dependent feedback control it is possible to counteract the role of the eikonal equation and thereby destabilize the plane wave front. The appearance of the instability can be suppressed, choosing the the width of the active medium below a certain threshold. This can be explained using the Kuramoto-Sivashinsky equation.

[1] J. S. Langer, Rev. Mod. Phys. 52, 1 (1980)

DY 7.24 Mon 17:30 Poster C

Scroll ring dynamics under spatial Confinement — •Jan Frederik Totz[1], Oliver Steinbock[2], and Harald Engel[1] — [1]Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany — [2]Department of Chemistry and Biochemistry, Florida State University, Tallahassee, FL-32306-4390

Non-planar excitation waves are exhibited by a variety of dissipative non-equilibrium systems, including chemical waves, fuel combustion, catalytic oxidation of CO and electric activity in the heart muscle. Using the Ferroin-catalyzed Belousov-Zhabotinsky reaction, we investigate the dynamics of scroll rings in a chemical medium of adjustable height [1]. The close proximity to the boundaries leads to dramatic changes of the intrinsic dynamics, as the contraction can be reverted into an expansion of the organizing vortex ring. Results from chemical experiments are in good agreement with numerical simulations based on parameters derived from the used chemical concentrations and can be predicted qualitatively with a simple phenomenological model.

[1] Z. A. Jiménez, B. Marts, O. Steinbock, Phys. Rev. Lett. 102, 244101 (2009)

DY 7.25 Mon 17:30 Poster C

Patterns in anisotropic reaction diffusion systems — •Fabian Bergmann, Alexei Krekhov, and Walter Zimmermann — Universität Bayreuth, Theoretische Physik, 95440 Bayreuth, Germany

In 1952, Turing suggested a hypothetical reaction-diffusion model showing spatially periodic pattern. This class of models was recently identified as an important framework for understanding Biological Pattern Formation, such as the formation of pigment stripes in the skin of fishes [1]. Recently, anisotropic diffusion [2] and cross diffusion have been identified as two important extensions of Turing's model [3].

We investigate bifurcation scenarios in anisotropic reaction-diffusion systems including cross diffusion. We find for this class of systems a wide range of parameters, whereby two orthogonally oriented stripe patterns have the same threshold (codimension-two bifurcation). In this case, a nonlinear competition between both stripe orientations takes place beyond threshold. Near threshold this competition is analyzed in terms of amplitude equations, which are derived from the basic reaction-diffusion model. We find three different scenarios: (i) In a wide range of parameters either one or the other stripe pattern is stable, depending on the initial condition. (ii) In a second range the coexistence of both stripe patterns (rectangular patterns) is preferred. (iii) Both cases are separated by a parameter range, where surprisingly, only one of both stripe orientations is stable.

[1] S. Kondo and T. Miura, Reaction-Diffusion Model as Framework for Understanding Biological Pattern Formation, Science 329, 1616 (2010)

[2] H. Shoji, Y. Iwasa, A. Mochizuki and S. Kondo, Directionality of Stripes Formed by Anisotropic Reaction-Diffusion Models, J. Theor. Biol. 214, 349 (2002)

[3] N. Kumar and W. Horsthemke, Effects of cross diffusion on Turing bifurcations in two species reaction-transport systems, Phys. Rev. E 83, 036105 (2011)