DY 29: Spatially Extended Dynamical Systems

Time: Thursday 14:00–16:00 Location: H46

DY 29.1 Thu 14:00 H46

Modeling of the gamma- and theta waves propagation in the region CA3 of hippocampus. — •Anastasia I. Lavrova[1] and Eugene B. Postnikov[2] — [1]Institut für Physik Humboldt - Universität zu Berlin, Deutschland — [2]Staatliche Universität Kursk, Russland

It is known that hippocampus is a structure required for processes of learning and memory [1]. Gloveli et al. [2] reported that the dynamics of neuron network of CA3 region exhibits some types of oscillations, so called gamma (30-80 Hz) and theta(4-12Hz) rhythms. These oscillations are responsible for information transmission, storage, and spatial encoding [1,2]. Also, it have been shown that gamma and theta rhythms are generated by different types of cells in CA3 region of hippocampus. The minimal network scheme, describing connections between different types of cells and its detailed model have been studied in [1,2]. We construct the simple discrete model based on the scheme suggested in [2], which reproduces important physical characteristics of the oscillations of all cells types: the period, amplitude and phase shift. This model allows to analyze an influence of synaptic connections between cells on the mention characteristics. Moreover, we consider a space distribution of the minimal network elements and noise in the interaction between them. We study how the noise can influence on the strength of the cells interaction and gamma and theta waves propagation. 1. Gloveli T., Dugladze T.,Rotstein H.,Traub R., Monyer H., Heinemann U., Whittington M., Kopell N., PNAS, V.102 13295-300,(2005) 2. Tort A., Rotstein H., Dugladze T., Gloveli T., Kopell N., PNAS, V.104, 13490-95, (2007)

DY 29.2 Thu 14:15 H46

effect of mean flow in spiral turbulence — •hira affan and rudolf friedrich — Institute for Theoretical Physics, University of Muenster, Wilhelm-Klemm-Str. 9, D-48149 Muenster, Germany

Spiral turbulence in Rayleigh-Benard convection is studied numerically in the framework of generalized Swift Hohenberg equations. The model equation consist of an order parameter equation for the temperature field coupled to an equation for the mean flow field. In contrast to previous work nonlinearities in the dynamics of the mean flow are retained leading to a two dimensional Navier-Stokes equation coupled to a Swift-Hohenberg equation. We present detailed investigations of nonlinear effects due to the interaction of nonlinear two dimensional flows and the pattern forming process.

DY 29.3 Thu 14:30 H46

Chaotic spatial soliton rays in smooth two-dimensional optical lattices — •Ramaz Khomeriki[1,2,3] and Jerome Leon[3] — [1]Max-Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany
— [2]Department of Physics, Tbilisi State University, 3 Chavchavadze, 0128 Tbilisi, Georgia
— [3]Laboratoire de Physique Théorique et Astroparticules, Université Montpellier 2, Montpellier, France

The light ray of a spatial soliton in an optical film whose refractive index is smoothly modulated (wavelength much larger than the typical soliton width) in both spatial directions is shown to possess chaotic regimes for which the propagation is erratic. This is interpreted as a parametric driven pendulum, obtained by what we believe to be a new perturbative approach of the Maxwell equation. These findings are then demonstrated to compare well to the eikonal law of light ray propagation (nonlinearity compensates diffraction).
REFERENCES:
R. Khomeriki, J. Leon, Phys. Rev. A, 80, (2009) 033822
R. Khomeriki, J. Leon, Optics Letters, 34, (2009) 3376

DY 29.4 Thu 14:45 H46

Substrate Mediated Condensation and Pattern Formation in Thin Liquid Films — •Michael H. Köpf, Svetlana V. Gurevich, and Rudolf Friedrich — Institute for Theoretical Physics, University of Münster, Wilhelm-Klemm-Straße 9, D-48149 Münster

The formation of regular stripe patterns during transfer of surfactant monolayers onto solid substrates is investigated. Two coupled differential equations describing the surfactant density and the height profile of the water subphase are derived within the long-wavelength approximation. If the transfer is carried out in the vicinity of a surfactant first-order phase transition, the interaction with the substrate plays a key role. This effect is included in the surfactant free-energy functional via a height dependent external field. Using transfer velocity and lateral pressure as control parameters a bifurcation from a homogeneous transfer to regular stripe patterns arranged parallel to the contact line is investigated in one and two dimensions. Moreover, in the two-dimensional case a secondary bifurcation to perpendicular stripes is observed in a certain control parameter range.

DY 29.5 Thu 15:00 H46

Magnetic stripe-forcing of an experiment with broken up-down symmetry — •Thomas Friedrich, Ingo Rehberg, and Reinhard Richter — Experimentalphysik 5, Universität Bayreuth

Historically, a spatial forcing was first studied experimentally in electroconvection [1]. More recently, [2] measured inclined layer convection under the influence of lamellar surface corrugations. In both experiments, the first convection pattern beyond a threshold are stripes. What has not been measured so far, is the impact of stripe-forcing on a system with a primary instability to hexagons. The Rosensweig instability in a layer of ferrofluid, is a system with broken up-down symmetry [3] [4]. Consequently its first pattern is a hexagonal one. We apply for the first time a static magnetic stripe-forcing to the Rosensweig instability, and record the response by means of X-rays. The outcome is compared to results, obtained by amplitude equations[5].
[1] M. Lowe, J. Gollub, and T. Lubensky, Phys. Rev. Lett., **51**(9):786–789, 1983
[2] G. Seiden, S. Weiss, J. H. McCoy, W. Pesch, and E. Bodenschatz, Phys. Rev. Lett., **101**(21):214503, 2008.
[3] M. D. Cowley and R. E. Rosensweig, J. Fluid Mech.,**30**:671, 1967.
[4] R. Richter, Physik Journal, **7**:39–44, 2008.
[5] R. Peter, et al., Phys. Rev. E, **71**(4):046212, 2005.

DY 29.6 Thu 15:15 H46

Delocalization and spreading in a nonlinear Stark ladder — •Dmitry Krimer[1], Sergej Flach[1], and Ramaz Khomeriki[1,2] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden — [2]Physics Department, Tbilisi State University, Chavchavadze 3, 0128 Tbilisi, Georgia

We study the evolution of a wave packet in a nonlinear Stark ladder [1]. In the absence of nonlinearity all normal modes are spatially localized giving rise to an equidistant eigenvalue spectrum and Bloch oscillations. Nonlinearity induces frequency shifts and mode-mode interactions. For large strength of nonlinearity we observe a long lived trapped regime with an explosive transition to Bloch oscillations, followed by a subdiffusive spreading at large time scales. For moderate nonlinearities an immediate subdiffusion takes place. Finally, for small nonlinearities we find linear Stark localization as a transient, with subsequent subdiffusion. For single mode excitations and weak nonlinearities stability intervals are predicted and observed upon variation of the dc bias strength, which affect the short and long time dynamics. In all cases, we observe that nonlinearity destroys integrability, introduces chaos, and ultimately leads to a destruction of localization.

[1] D.O. Krimer, R. Khomeriki and S. Flach, Phys. Rev. E 80, 036201 (2009)

DY 29.7 Thu 15:30 H46

Self organizing networks of Belousov-Zhabotinsky oscillator droplets — •Shashi Thutupalli[1], Ralf Seemann[1,2], and Stephan Herminghaus[1] — [1]Max Planck Institute for Dynamics and Self Organization, D-37073, Göttingen, Germany — [2]Experimental Physics, Saarland University, 66041 Saarbrücken

Coupling via chemical communication is widespread in nature, such as in heart dynamics, neuronal networks, bacterial colonies, formation of tissues etc. In such systems, collective behavior emerges due to suitable interactions between the constituent individual elements. Here, we report on self organizing networks of water-in-oil emulsion droplets which exhibit coupled behavior using the non-linear Belousov Zhabotinsky (B-Z) reaction. Using microfluidic techniques, we form surfactant stabilized aqueous droplets (diameter: 50-200 microns) containing the B-Z reaction mixture in a surrounding oil phase. Due to diffusive mixing within the droplets, each individual droplet then acts as an oscillator with a time period (on the order of 10 - 100 seconds) determined by the chemical concentrations. Reaction induced motion of the droplets causes the initially spatially separated droplets to find each other and then aggregate to form droplet networks. The networks are held together by self forming surfactant bilayers between the droplets, which also seemingly act as conduits for chemical connections via ionic transfer. We report on the various phenomena in these droplet networks, such as phase coupled oscillations, bursting modes and coupled trigger waves and elucidate their possible mechanisms.

DY 29.8 Thu 15:45 H46

Directed transport in phase-modulated driven lattices — •Christoph Petri[1], Florian Lenz[1], Fotis Diakonos[2], and Peter Schmelcgher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg — [2]Department of Physics, University of Athens

An analysis of the dynamics of non-interacting particles in a phase-modulated one-dimensional lattice formed by laterally oscillating square potentials is presented. Depending on the properties of the modulation a desymmetrization of phase space occurs, which is based on breaking locally time- reverse and space-invert symmetries. This yields a directed current of particles, whose direction and magnitude is tunable by varying the parameters of the system. Furthermore, the particles show different localization behavior depending on their spatial position if the global height of the potential is chosen appropriately.