DY 11 Nonlinear Dynamics

Zeit: Freitag 10:30–12:30 Raum: TU H2032

DY 11.1 Fr 10:30 TU H2032

Dissipative optical solitons in the presence of a symmetry-breaking pitchfork bifurcation — •Matthias Pesch, Jens-Uwe Schurek, Thorsten Ackemann, and Wulfhard Lange — Institut für Angewandte Physik, Westfälische Wilhelms-Universität Münster, Corrensstr. 2/4, 48149 Münster

In this report, we consider the mechanisms leading to the stabilization of dissipative optical spatial solitons, which are observed in a specific realization of a single-mirror feedback experiment using sodium vapor as the nonlinear medium. This system exhibits a symmetry breaking pitchfork bifurcation leading to (nearly) equivalent homogeneous or patterned states with different polarization. By means of an addressing beam a circular domain of one polarization state existing on a background of the other can be ignited. We observe a curvature-driven shrinkage of the domain that can be counteracted by disturbing the pitchfork bifurcation. A family of spatial solitons can be stabilized if an operation point close to or above the threshold of a modulational instability is chosen. We observe clusters of different solitons, tightly bound compound states of solitons and solitons interacting with fronts.

DY 11.2 Fr 10:45 TU H2032

The influence of the breathing mode on the dynamic of dissipative solitons in a three-component reaction-diffusion system — •Svetlana Gurevich[1], Andreas Liehr[2], Shalva Amiranashvili[1] und Hans-Georg Purwins[1] — [1]Institut für Angewandte Physik, WWU Münster,Corrensstrasse 2-4, 48149 Münster — [2]Freiburger Materialforschungszentrum, Stefan-Meier-Str. 21, D-79104 Freiburg

We investigate the stability of the localized solutions in a three-component reaction-diffusion system with one activator and two inhibitors. Changing the time constants of inhibitors leads to the instability of a stationary solution. In many cases the breating mode comes first and the stationary dissipative soliton undergoes a bifurcation from a stationary to a "breathingßtate.This situation is analyzed performing a multiple scale perturbation expansion up to third order in the vicinity of the bifurcation point. To prove the correctness of the calculations,numerical simulations are carried out showing good agreement with the analytical predictions.

DY 11.3 Fr 11:00 TU H2032

Retinotopic Projections: Self-Organization of Neural Maps in the Visual System — •Martin Güssmann[1], Axel Pelster[2], and Günter Wunner[1] — [1]1. Institut für Theoretische Physik, Universität Stuttgart, Stuttgart, Germany — [2]Fachbereich Physik, Universität Duisburg-Essen, Essen, Germany

Neural connections in the visual system of vertebrates exhibit the essential feature that they conserve neighbourhood relations between different sheets of nerve cells. For instance, neighbouring cells of the retina project onto neighbouring cells of the tectum, a part of the brain which plays an important role in processing optical information. We use a general model for the development of such retinotopic projections between manifolds of different geometries to investigate the generation of ordered patterns between two strings and two planes, respectively. The generation of retinotopic projections between two strings turns out to be very similar to the case of discrete linear chains analyzed previously by Häussler and v.d. Malsburg [1]. It is shown that both for strings and for planes the emerging retinotopic states correspond to stationary solutions of the Häussler-equations. Finally, we present some numerical results of these self-organization processes and discuss, in particular, the influence of different cooperation functions within the retina and tectum.

[1] A.F. Häussler and C. von der Malsburg, J. Theoret. Neurobiol. **2**, 47 (1983)

DY 11.4 Fr 11:15 TU H2032

Nonlinear dynamics of micro-opto-mechanical cavities — •Florian Marquardt, S. M. Girvin, and Jack Harris — Department of Physics, Yale University, New Haven 06520, USA

We present a detailed theoretical analysis of the nonlinear dynamics of a Fabry-Perot cavity mirror moving under the influence of radiation pressure. We will discuss the existence of multiple stable dynamical attractors, the influence of noise, the possibility of tailoring the effective potential via multi-color laser input, and the effects of the dynamics on the output light.

DY 11.5 Fr 11:30 TU H2032

Stochastic Resonance in Colloidal Systems — •Carmen Schmitt[1], Dusan Babic[2], Igor Poberaj[2], and Clemens Bechinger[1] — [1]2. Physikalisches Institut, Universität Stuttgart, 70569 Stuttgart — [2]Faculty of Mathematics and Physics, University of Ljubljana, Jadranska 19, 1000 Ljubljana, Slovenia

The concept of Stochastic Resonance (SR) has been used to describe very different effects such as the periodic occurence of the ice ages, the feeding behaviour of paddlefish or human balance control and visual perception. The essential feature of SR is that in nonlinear systems noise can improve the detection of weak periodic signals.

Although characteristic features of SR have been observed in several experiments, there are only few examples where the effect is studied on a microscopic level. In our experiment we work with a model system where both the length scales and the time scales are conveniently accessible: we investigate the dynamics of colloidal particles fluctuating in double well potentials created by optical tweezers. In contrast to many other experiments, this configuration allows us to study systems of several coupled particles.

We present results on SR in an isolated system [1] and in systems with several coupled particles.

[1] D. Babič, C. Schmitt, I. Poberaj and C. Bechinger, Europhys. Lett. **67**, 158–164 (2004)

DY 11.6 Fr 11:45 TU H2032

Stimulation of subharmonic dynamics in electroconvection patterns — •Jana Heuer[1], Thomas John[2], and Ralf Stannarius[1] — [1]Otto-von-Guericke-Universität Magdeburg — [2]Carl-von-Ossietzky-Universität Oldenburg

Electroconvection (EHC) in nematic liquid crystals is classically driven by periodic sine or square wave voltages. The spontaneous formation of regular patterns is a critical phenomenon and characterized by threshold values for the excitation field.

An important aspect of our investigations is the fundamental influence of the excitation wave form on the dynamic response of the observed dissipative system. We study how the generation of the newly discovered subharmonic pattern regime (first described in [1]) depends on the symmetry of the excitation. Therefore we analyze the spatio-temporal dynamics of the system near the threshold voltage experimentally.

Since electroconvection in nematics can be described by a system of two coupled ordinary differential equations, we compare these experimental results with theoretical calculations. Many other dynamic systems can be characterized by these simple ODEs, thus we try to derive general conclusions about the relationship between the symmetry of the excitation and the dynamic response of the system.

Furthermore we characterize higher instabilities that occur far from threshold compared to the higher instabilies in the classical regimes.

A comprehensive representation of the subharmonic regime is the ambition of our investigations.

[1] T. John and R. Stannarius, Phys. Rev. E 70, 025202 (2004)

DY 11.7 Fr 12:00 TU H2032

Numerisch-analytische Untersuchungen zur verallgemeinerten Kuramoto-Sivashinsky-Gleichung — •Frank Löcse und Günter Radons — Institut für Physik, TU Chemnitz, D-09107 Chemnitz

Eine mikroskopische Beschreibung von Abtragsrate und Schnittfront beim Wasserabrasivstrahlschneiden und verwandten Schneidetechniken (Ionenstrahlschneiden, Laserstrahlschneiden) stößt aufgrund der Komplexität des Problems auf erhebliche Schwierigkeiten. Daher wurde im Sinne eines Landau-artigen Zugangs eine nichtlineare Evolutionsgleichung für die Schnittfront $S(\vec{r},t)$ aufgestellt, die wesentliche Aspekte der Schneidvorgänge qualitativ richtig wiedergibt.

Wir diskutieren das Lösungsverhalten der auf diesem Wege erhaltenen verallgemeinerten Kuramoto-Sivashinsky-Gleichung $\frac{\partial S(\vec{r},t)}{\partial t} + \vec{u}\nabla S(\vec{r},t) = v(\vec{r})\left\{\frac{1}{1+[\nabla S(\vec{r},t)]^2} + \alpha\Delta S(\vec{r},t) + \beta\Delta^2 S(\vec{r},t)\right\}$ für einen weiten Parameterbereich (α,β,u) und verschiedene Strahlfunktionen $v(\vec{r})$ numerisch und zeigen, daß wesentliche Lösungseigenschaften bereits aus einfachen ana-

lytischen Lösungsansätzen folgen.

DY 11.8 Fr 12:15 TU H2032

Crash Test for the Restricted Three-Body Problem — •Jan Nagler — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28334 Bremen, Germany

The restricted three-body problem serves to investigate the chaotic behavior of a small body under the gravitational influence of two heavy primary bodies. We analyze numerically the phase space mixing of bounded motion, escape and crash in this simple model of (chaotic) celestial mechanics. The presented extensive numerical analysis reveals a high degree of complexity. We extend the recently presented findings for the Copenhagen case of equal main masses to the general case of different primary body masses. Collisions of the small body onto the primaries are comparatively frequent, and their probability displays a scale-free dependence on the size of the primaries as shown for the Copenhagen case. Interpreting crash as leaking in phase space the results are related to both chaotic scattering and the theory of *leaking* Hamiltonian systems.