DY 36 Nonlinear Dynamics, Synchronization and Chaos II

Time: Wednesday 16:15–18:00 Room: HÜL 186

DY 36.1 Wed 16:15 HÜL 186

Oscillatory Zoning: Nonlinear Dynamics and Self-Organization Governing Crystal Growth from Solution — •Felix Kalischewski[1], Ihor Lubashevsky[2], and Andreas Heuer[1] — [1]Institut für Physikalische Chemie, Westfälische Wilhelms-Universität, 48149 Münster — [2]Theory Department, General Physics Institute, Russian Academy of Sciences, Moscow, 119991 Russia

A large number of solid solutions grown from aqueous media exhibit fluctuating end-member concentrations along the core-rim profile. This phenomenon, called "oscillatory zoning", can be attributed to complex self-organizing effects resulting from competition between thermodynamics and kinetics.

In contrast to existing phenomenological models, we developed a model based on epitaxial growth driven by bulk-diffusion, ad/desorption, surface-diffusion, and finally adatom-incorporation. The critical nonlinearity enters through the dependence of the adatom-crystal interactions on the crystal-composition.

First, we present a linear stability analysis of our "Boundary Reaction Diffusion Model", as well as its 1D evolution in time obtained by numerical analysis. Second, we expand the numerical scheme to 2D to explore the synchronization behavior observed in experiments.

DY 36.2 Wed 16:30 HÜL 186

Step meandering in epitaxial growth — •Frank Hausser and Axel Voigt — caesar, Ludwig-Erhard-Allee 2, 53175 Bonn

Asymmetric attachment kinetics at the atomic steps on a crystalline surface leads to a morphological instability: slightly perturbed straight steps begin to meander. The small amplitude (linear) regime of this instability is well understood [1]. We present results on the nonlinear regime, which are based on numerical simulations of the corresponding moving boundary problem [2]. Three types of nonlinear evolution are found: (a) endless growth of the meander amplitude; (b) stationary profile with fixed amplitude; (c) mushroom formation and pinch-off. Moreover, the influence of anisotropic edge energies as well as edge diffusion is investigated.

[1] G.S. Bales, A. Zangwill, Phys. Rev. B 41 (1990) 5500
[2] E. Bänsch, F. Haußer, O. Lakkis, B. Li, A. Voigt, J. Comp. Phys. 194 (2004) 409

DY 36.3 Wed 16:45 HÜL 186

Robust control of torsionfree unstable periodic orbits — •Klaus Höhne[1], Chol-Ung Choe[1,2], Hiroyuki Shirahama[1,3], Hartmut Benner[1], and Kestutis Pyragas[4] — [1]Institut für Festkörperphysik, TU Darmstadt, Germany — [2]Department of Physics, University of Science, Pyongyang, DPR Korea — [3]Ehime University, Matsuyama, Japan — [4]Semiconductor Physics Institute, Vilnius, Lithuania

Torsionfree unstable periodic orbits cannot be stabilized by conventional time-delayed feedback control. The most simple example of such an orbit occurs at a subcritical Hopf bifurcation. Analytical and numerical investigations showed successful control of a torsionfree unstable periodic orbit in an unstable van der Pol oscillator by applying the idea of a nonlinear unstable time-delayed feedback controller [1].

We succeeded to stabilize a torsionfree unstable periodic orbit in experiment by an electronic circuit realization of this model. The experiment pointed out that the basin of attraction of the controlled orbit is very small, so that the practical application of this method might be difficult. In order to achieve robust control of such an orbit we modified the nonlinear coupling of the unstable time-delayed feedback control. We discuss the advantages of this method in comparison with the original idea.

[1] K. Pyragas et al., Phys. Rev. E **70**, 026412

DY 36.4 Wed 17:00 HÜL 186

Stationary Hamiltonian transport with dc bias — •Denisov Sergey — MPIPKS, Dresden

We obtain stationary transport in a Hamiltonian system with ac driving in the presence of a dc bias. A particle in a periodic potential under the influence of a time-periodic field possesses a mixed phase space with regular and chaotic components. An additional external dc bias allows to separate effectively these structures. We show the existence of a stationary current which originates from the persisting invariant manifolds (regular islands, periodic orbits, and cantori). The transient dynamics of the accelerated chaotic domain separates fast chaotic motion from ballistic type trajectories which stick to the vicinity of the invariant submanifold. Experimental studies with cold atoms in laser-induced optical lattices are ideal candidates for the observation of these unexpected findings.

DY 36.5 Wed 17:15 HÜL 186

Synchronization of an aeroacoustical system — •Markus Abel, Karsten Ahnert, and Steffen Bergweiler — Universität Potsdam, 14469 Potsdam

A classical example of synchroniyation concerns the simultaneous sound emission of two organ pipes. We have measured the response of an organ pipe to an external source as well as the sznchroniyation properties of two organ pipes positioned side by side. We investigate two different questions. First, the mutual influence of two pipes with different pitch. In analogy to the coupling of two nonlinear oscillators with feedback, one observes a frequency locking, which can be explained by synchronization theory. Second, we measure the dependence of the frequency of the signals emitted by two mutually detuned pipes with varying distance between the pipes. The spectrum shows a broad “hump” structure, not found for coupled oscillators. This indicates a complicated aeroacoustical coupling of the two jets creating the acoustic field when exiting from the pipe mouth. We interpre the measurements in terms of a simplified model.

DY 36.6 Wed 17:30 HÜL 186

Time-delayed feedback control with variable phase-dependent coupling — •Philipp Hövel[1], Eckehard Schöll[1], and Hans-Jürgen Wünsche[2] — [1]Technische Universität Berlin, 10623 Berlin, Germany — [2]Humboldt-Universität zu Berlin, 12489 Berlin, Germany

During the last decade time-delayed feedback methods have been successfully used to control unstable periodic orbits as well as unstable steady states[1]. In most of the theoretical analysis, this control method is considered in the realization of diagonal coupling, i.e., the control force applied to the i-th component of the system is a function of exclusively the same component. Although diagonal coupling is suitable for a theoretical investigation, it is often not feasible for an experiment. Therefore we consider the more general case where control is effected by a non-diagonal coupling matrix. Specifically, we investigate the time-delayed feedback scheme for a rotational coupling matrix parametrized by a variable phase. We present an analysis of the domain of control and show the application to optical systems [2] where the optical phase is an additional degree of freedom.

[1] P. Hövel and E. Schöll, Phys. Rev. E **72**, 046203 (2005)
[2] V. Z. Tronciu, H.-J. Wünsche, M. Wolfrum, and M. Radziunas, submitted to Phys. Rev. E (2005)

DY 36.7 Wed 17:45 HÜL 186

Universal features of hydrodynamic Lyapunov modes in extended systems with continuous symmetries — •Hong-liu Yang and Günter Radons — Institute of Physics, Chemnitz University of Technology, D-09107 Chemnitz

We study the Lyapunov instability of spatially extended systems with continuous symmetries. Numerical and analytical evidence is presented to show that hydrodynamic Lyapunov modes (HLMs) do exist in lattices of coupled Hamiltonian and dissipative maps. More importantly, we find that HLMs in these two class of systems are different with respect to their spatial structure and their dynamical behavior. To be concrete, the corresponding dispersion relations of Lyapunov exponent versus wavenumber are characterized by $\lambda \sim k$ and $\lambda \sim k^2$, respectively. Moreover, the HLMs in Hamiltonian systems are propagating, whereas those of dissipative systems show only diffusive motion. Extensive numerical simulations of various systems, including coupled map lattices (CMLs), the dynamical XY model, and the Kuramoto-Sivashinsky equation confirm that the existence of HLMs is a very general feature of extended dynamical systems with continuous symmetries and that the above-mentioned differences between the two classes of systems are universal.