**Institut für Theoretische Physik**
**AG Nichtlineare Dynamik & Strukturbildung**

## Nonlinear Dynamics and Pattern Formation

Understanding and controlling the spontaneous formation, dynamics, and stability of spatio-temporal patterns in non-equilibrium systems is one of the major challenges in nonlinear sciences. We study the emergence of macroscopic spatio-temporal order due to self-organization in physical, chemical and biological systems far from equilibrium. Systems under consideration represent a large number of spatially interacting subunits with bistable, excitable or oscillatory kinetics. As a whole, these systems are capable of showing a variety of pattern formation and unexpected behavior impossible under equilibrium conditions. Our work is interdisciplinary basic research with possible future applications in medicine, chemical engineering, and many other areas.

In more detail our focus is on:

1. Propagation, stability and interaction of traveling localized nonlinear excitations (fronts, pulses, periodic pulse trains, spiral waves, scroll waves, spots) that are fundamental building blocks for regulation and communication inside and between cells, for example. In particular, we are interested in the control of rotating excitation waves by external forcing and feedback-mediated parameter modulation. Recently, we started to study wave propagation under spatial confinement. The results could be useful for the therapy of abnormal electrical wave activity in the heart (tachycardia) or the brain (epilepsy, migraine).
2. Instabilities in media with long-range spatial coupling (global and non-local) arising quite naturally in neural networks, catalytic surface reactions, electrochemical systems and others.
3. Impact of mechanical deformations on pattern formation in reaction-diffusion systems. Here, we study contraction patterns coupled to hydrodynamic flow in protoplasmic droplets of the slime mold Physarum polycephalum, and cell motility on substrates applying phase field models (keratocytes).
4. Experiments on control of chemical waves in an open gel-reactor of the photosensitive Belousov-Zhabotinsky (PBZR) reaction. Synchronization phenomena in populations of chemical oscillators (catalyst-loaded beads immersed in catalyst-free mixtures of the PBZR).
5. Noise-induced pattern formation, stochastic theory of nonlinear processes in spatially extended media with fluctuating parameters. Klimontovich entropy during self-organizing processes.

Kontakt, Index und weiterer Service

Zuletzt aktualisiert: 26.06.14

Kontakt, Inhaltsverzeichnis und weitere Service-Links