DY 5: Reaction-Diffusion Systems

Time: Monday 15:00–16:15 Location: H48

DY 5.1 Mon 15:00 H48

Boundary-mediated stabilization of a scroll ring in a tubular reactor — •Pavel Paulau, Harald Engel, and Jakob Löber — Institut für Theoretische Physik, TU Berlin, Hardenbergstr. 36, Sekr EW 7-1, 10623 Berlin, Deutschland

It is known, that the scroll ring solutions to the Complex Ginzburg-Landau-equation have positive filament tension leading to the shrinking and disappearance of the ring. We utilize the fact, that the core of a two-dimensional spiral wave can be locked by the interaction with a Neumann boundary. It is shown, that a scroll ring in a tubular reactor can be stabilized due to interaction with the wall, preventing the shrinking of the scroll ring. The minimal radius of cylinder needed to get the robust stable scroll ring is defined.

DY 5.2 Mon 15:15 H48

Analytic solution for stabilized wave segments in an excitable medium — •Vladimir Zykov and Eberhard Bodenschatz — Max Planck Institute for Dynamics and Self-Organization, D-37077 Goettingen, Germany

The relationships between the medium excitability and the propagating velocity and the shape of a stabilized wave segment in excitable media are analytically derived for the wave with a trigger front and a phase wave at the wave back. Two universal limits restricting the region of existence of wave segments in the parameter space are demonstrated [1]. The predictions of the free-boundary approach are in good quantitative agreement with results from numerical reaction-diffusion simulations performed on the Kessler-Levine model.

[1] V.S. Zykov and E. Bodenschatz, Phys. Rev. Lett., submitted.

DY 5.3 Mon 15:30 H48

Efficient kinetic Monte Carlo method for reaction-diffusion problems with spatially varying annihilation rates — •Karsten Schwarz and Heiko Rieger — Theoretische Physik, Universität des Saarlandes, Saarbrücken

We present an efficient Monte Carlo method to simulate reaction-diffusion processes with spatially varying particle annihilation or transformation rates as it occurs for instance in the context of motor-driven intracellular transport. Like Green's function reaction dynamics and first-passage time methods, our algorithm avoids small diffusive hops by propagating sufficiently distant particles in large hops to the boundaries of protective domains. Since for spatially varying annihilation or transformation rates the single particle diffusion propagator is not known analytically, we present an algorithm that generates efficiently either particle displacements or annihilations with the correct statistics, as we prove rigorously. The numerical efficiency of the algorithm is demonstrated with an illustrative example.

DY 5.4 Mon 15:45 H48

Experimental observation of solitons and backfiring during the electrochemical oxidation of carbon monoxide on Pt — •Philipp R. Bauer[1], Antoine Bonnefont[2], and Katharina Krischer[1] — [1]Physik-Department, TU München, Germany — [2]Institut de Chimie de Strasbourg, CNRS - Université de Strasbourg, France

Pattern formation during the electrooxidation of carbon monoxide is investigated with spatially resolved ATR-FTIR spectroscopy on thin platinum film electrodes. The use of a flow cell setup, in which the electrolyte passes the electrode from one side to the other, is effectively isolating the surface dynamics in one spatial dimension. The dynamic properties of the system are enriched by adding small amounts of halide ions to the solution.

Tracking the adsorbed CO on the surface reveals solitary reaction waves, which move perpendicular to the flow of the electrolyte across the electrode. The waves may backfire, leading to the creation of another wave, which moves in the opposite direction. Furthermore, interpenetrating wave collisions are found, in which two colliding pulses endure the collision and move on. This soliton-like behavior during collisions is explained with a three variable model capturing the interplay of the chemical autocatalysis of the CO-subsystem and two inhibitory variables, namely the potential drop across the electrolyte and the blocking effect of the halide ions.

DY 5.5 Mon 16:00 H48

Controlling the position of fronts — •Jakob Löber, Eckehard Schöll, and Harald Engel — Institut für Theoretische Physik

We present a method to control the position as a function of time of a one-dimensional traveling front solution of a one-component reaction-diffusion system according to a specified protocol of movement. Given this protocol, the control function is found as the solution of a perturbatively derived integral equation. Two cases are considered. First, we derive an analytical expression for the space (x) and time (t) dependent control function $f(x,t)$ valid for arbitrary protocols and arbitrary bistable reaction kinetics. These results for the control agree well with results of an optimal control algorithm. Second, for stationary control the integral equation reduces to a Fredholm integral equation of the first kind. For the Schlögl model, we present an analytical solution of the problem to stop a front at a specified position. All analytical results are in good agreement with numerical simulations of the underlying reaction-diffusion equations. Extensions to two spatial dimensions and other equations supporting traveling wave solutions are considered.