DY 15: Reaction Diffusion Systems

Time: Wednesday 10:00–11:00 Location: H46

DY 15.1 Wed 10:00 H46

Excitation patterns in inhomogeneous media from the FitzHugh-Nagumo equations and the Belousov-Zhabotinsky reaction — •Claudia Lenk[1], Mario Einax[1], J. Michael Koehler[1], and Philipp Maass[1,2] — [1]Institut für Physik, Technische Universität Ilmenau, 98684 Ilmenau, Germany. — [2]Fachbereich Physik, Universität Osnabrück, 49069 Osnabrück, Germany.

Spatial inhomogeneities of the control parameters in reaction-diffusion systems play a crucial role for the occurrence of self-excitatory sources like spiral waves and ectopic foci. Here we present a systematic analysis of locally reduced resting state stabilities and increased excitabilities in terms of dynamical phase diagrams based on the FitzHugh-Nagumo equations. These phase diagrams specify regions of spiral wave and ectopic activity in dependence of the size and strengths of the modified regions. We further study the mutual disturbance of wavefronts that emanate from two pacemakers and propagate in regions connected by a small bridge. In particular we address the question how this disturbance can lead to fibrillatory states. Our results are partly compared to experiments that we performed for the Belousov-Zhabotinsky reaction in a silica gel with a spatially inhomogeneous catalyst (Ferroin) distribution. In these experiments the coupling of catalyst spots arranged in 4x4 arrays is investigated in dependence of the spot size and spot distance.

DY 15.2 Wed 10:15 H46

Effects of discrete cell coupling on propagation of scroll waves in three-dimensional excitable media — •Sergio Alonso[1], Markus Bär[1], and Alexander V. Panfilov[2] — [1]Physikalisch-Technische Bundesanstalt, Berlin, Germany — [2]Utrecht University, Utrecht, The Netherlands

Wave propagation in the heart has a discrete nature due to the discrete intercellular connections via gap junctions. Although effects of discreteness on wave propagation has been studied for traveling waves and 2D vortices, its possible effects on 3D vortices (scroll waves) are largely unexplored. We study the effect of discrete cell coupling on wave propagation in a generic model of excitable medium and show that reduced cell coupling decreases the excitability of the waves in excitable lattices giving rise to negative line tension of scroll waves.

DY 15.3 Wed 10:30 H46

Inward Rotating Spiral Waves in Glycolysis — •Ronny Straube[1], Ernesto M. Nicola[2], and Thomas Mair[3] — [1]Systems Biology Group, Max-Planck-Institute for Dynamics of Complex Technical Systems, D-39106 Magdeburg — [2]Max-Planck-Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, D-01187 Dresden, Germany — [3]Biophysics Group, Institute of Experimental Physics, Otto-von-Guericke University, Universitätsplatz 2, D-39106 Magdeburg, Germany

The mechanisms for spiral wave formation in reaction-diffusion systems are well known. Much less is known about the conditions under which inward propagating waves can be observed. After their discovery in chemical model systems [1,2] anti-waves have now been generated as waves of glycolytic activity in an extract of yeast cells (under review), which represents a biochemical model system for the energy metabolism. We show that in such allosteric enzyme systems inward propagating waves can only emerge if the number of enzyme subunits is sufficiently large – in agreement with the octameric structure of yeast phosphofructokinase. In addition, we provide evidence that the formation of these anti-waves is favoured if the enzyme activation step exhibits negative cooperativity.

[1] V. K. Vanag, I. R. Epstein. Science **294**, 835-837 (2001).
[2] X. Shao et.al. Phys. Rev. Lett. **100**, 198304 (2008).

DY 15.4 Wed 10:45 H46

Pattern formation in neuronal ensembles coupled by the external medium — •Nikolaos Kouvaris, Felix Müller, and Lutz Schimansky-Geier — Institute of Physics, Humboldt University of Berlin, Newtonstr. 15, D-12489 Berlin, Germany

The variation of extracellular concentrations can affect the firing activity in neuronal fields. As an example we mention the release of potassium ions that lower the threshold of neurons. This process can influence strongly the behavior of single neurons and of large ensembles. We address this problem by studying simplified excitable units modeled as a FitzHugh - Nagumo system coupled to a third variable describing the exterior. The release of the chemical agent is due to the firing events. That leads to pattern formation in the spatially extended system ranging from spirals and moving clusters to inverted structures. As an abstract modification for the excitable system, we consider a discrete two-state excitable unit. Each state, firing or refractory, is characterized by a waiting time density depending on the external concentrations. We study the dynamics of a single unit embedded in the extracellular medium as well as interacting units in the spatially extended situation. In these models the neuronal interaction is only chemically via the released and diffusing substrate at large time scales. All other neuronal interaction is modeled as noise.

1. D. E. Postnov, F. Müller, R. B. Schuppner and L. Schimansky-Geier, Phys. Rev. E 80, 031921 (2009).
2. T. Prager, M. Falcke, L. Schimansky-Geier and M. Zaks, Phys. Rev. E 76, 011118 (2007).