DY 42: Delay and Feedback Dynamics

Time: Thursday 9:30–11:00 Location: BH-N 128

Invited Talk DY 42.1 Thu 9:30 BH-N 128

Time-delayed feedback control of self-organized structures in dissipative systems — •Svetlana Gurevich[1], Felix Tabbert[1], and Alexander Kraft[2] — [1]Institut für Theoretische Physik, Universität Münster, Wilhelm-Klemm-Str.9, D-48149, Münster, Germany — [2]Institut für Theoretische Physik, Technische Universität Berlin Hardenbergstr. 36 D-10623 Berlin

We are interested in the dynamical properties of periodic and localized structures in the Swift-Hohenberg equation subjected to a delayed feedback. We shall show that variation in the delay time and the feedback strength leads to the emergence of complex spatio-temporal patterns. In addition we show that the presence of spatial inhomogeneties strongly influences dynamical behavior of the system, resulting in the formation of intricate oscillatory structures.

DY 42.2 Thu 10:00 BH-N 128

Dynamics of the self-coupled FitzHugh-Nagumo system in the limit of small delays — •Larissa Bauer[1,2], Lionel Weicker[3], Thomas Erneux[3], and Philipp Hövel[1,2] — [1]Technische Universität Berlin — [2]Bernstein Center for Computational Neuroscience Berlin — [3]Université Libre de Bruxelles

We consider delay-induced oscillations in a paradigmatic model of neural dynamics, FitzHugh-Nagumo system, which is subject to Pyragas-type self-coupling. The uncoupled model is operated in the excitable regime close to a Hopf bifurcation, where the system exhibits a stable fixed point. We compare an analytical derivation of the period with numerical simulations. For large delays, the self-coupling sets the timescale of the oscillations. For small delays or small coupling strengths, however, an activation time has to be taken into account.

DY 42.3 Thu 10:15 BH-N 128

Feedback control of flow vorticity at low Reynolds numbers — •Maria Zeitz, Jenny Triptow, Peter Kalle, and Holger Stark — Institut für Theoretische Physik, Technische Universitat Berlin, D-10623 Berlin

Our goal is to explore feedback control strategies to stabilize novel dynamic flow patterns in microfluidic model systems. As a first example, we investigate a Newtonian fluid in a circular geometry realizable by a long rotating cylinder. The fluid vorticity satisfies a diffusion equation. We control fluid flow via the angular velocity of the circular boundary, which we determine from the mean vorticity in the sensing area using two control strategies: feedback with hysteretic switching or with time delay.

Hysteretic feedback control generates self-regulated stable oscillations in time the frequency of which can be adjusted over several orders of magnitude by tuning the feedback parameters.

Historically time-delayed feedback was developed in order to stabilize orbits in a chaotic system. Here, we show that it can be used as well to destabilize an inherently stable system such as vortex diffusion. For large values of feedback gain we find that vorticity diverges exponentially in time. Adjusting the parameters accurately, the vorticity oscillates with a stable amplitude. Large delay times promote oscillation pulses of vorticity, resulting in a complex time periodic pattern.

In a next step we apply these control strategies to more complex fluids. We present first results on the viscoelastic two-fluid system.

DY 42.4 Thu 10:30 BH-N 128

A fundamental dichotomy for dynamical systems with variable delay — •Andreas Otto, David Müller, and Günter Radons — Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany

Dynamical systems with time-varying delays can describe various phenomena in many fields such as biology, chemistry, economy, engineering and physics. We identify two fundamentally different classes of variable delays. *Conservative* delays are related to quasiperiodicity and are equivalent to constant delays. On the other hand, *contractive* delays are characterized by mode-locking and cannot be converted to constant delays.

Time-varying delays are often generated by a common transport mechanism resulting in a conservative delay. However, typical models for time-varying delays often represent both, conservative and contractive delays, depending extremely sensitive on the delay parameters. In fact, starting from a conservative delay, we show that no continuous parameter change is possible without passing a contractive delay or equivalently modeling unphysical situations.

The type of the delay affects the dynamics of the associated time delay system. For conservative delays the asymptotic scaling of the Lyapunov spectrum is logarithmic, similar to the well-known behavior for constant delays. In contrast, for contractive delays the asymptotic scaling of the Lyapunov spectrum is linear. The presented results are independent of the specific form or the attractor of the time delay system as well as independent of the specific form of the variable delay.

DY 42.5 Thu 10:45 BH-N 128

Dynamical behaviors in time-delay systems with delayed feedback and digitized coupling — •Chiranjit Mitra[1], G. Ambika[2], and Soumitro Banerjee[1,3] — [1]Indian Institute of Science Education and Research, Kolkata 741246, India — [2]Indian Institute of Science Education and Research, Pune 411008, India — [3]King Abdulaziz University, Jeddah, Saudi Arabia

We consider a network of delay dynamical systems connected in a ring via unidirectional positive feedback with constant delay in coupling. For the specific case of Mackey-Glass systems on the ring topology, we capture the phenomena of amplitude death, isochronous synchronization and phase-flip bifurcation as the relevant parameters are tuned. Using linear stability analysis and Master Stability Function approach, we predict the region of amplitude death and synchronized states respectively in the parameter space and study the nature of transitions between the different states. For a large number of systems in the same dynamical configuration, we observe splay states, mixed splay states and phase locked clusters. We extend the study to the case of digitized coupling and observe that these emergent states still persist. However, the sampling and quantization reduce the regions of amplitude death and induce phase-flip bifurcation.