DY 14: Delay Dynamics

Time: Tuesday 14:00–15:15 Location: ZEU 255

DY 14.1 Tue 14:00 ZEU 255

Dimension of linear delay differential equations with time-varying delay — •Andreas Otto and Günter Radons — Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany

It is well known, that delay differential equations (DDE) with constant delay constitute an infinite dimensional dynamical system. On the other hand, the phase space of DDE with time-varying delay can be also finite dimensional.

In this contribution we investigate the dimension of DDE with time-varying delay. Depending on the structure of the deviating argument the the asymptotic dimension of the solution space can be infinite or finite. Furthermore, it is possible that the dimension of the solution space is only an infinite dimensional subspace of the domain of the initial function.

We present a method to calculate the dimension of DDE with time-varying delay. The iterated map of the stepwise retarded access by the deviating argument up to values of the initial function can characterize the dimensional behavior of the solution of DDE with time-varying delay. The results of the presented method are verified by the Lyapunov spectrum of the discretized DDE.

DY 14.2 Tue 14:15 ZEU 255

Destabilization of localized structures induced by delayed feedback — •Svetlana Gurevich and Rudolf Friedrich — Institut for Theoretical Physics, University of Münster, Wilhelm-Klemm-Str. 9, D-48149

We study the properties of one- and two-dimensional localized structures in reaction-diffusion systems and in the Swift-Hohenberg equation subjected to a delayed feedback. We compare the spectral properties of both models and show that for reaction-diffusion systems the delay can induce complex behavior of the localized structures, including, e.g., spontaneous motion and breathing of the objects.

DY 14.3 Tue 14:30 ZEU 255

Synchronizing distant nodes: a universal classification of networks — •Valentin Flunkert[1], Serhiy Yanchuk[2], Thomas Dahms[1], and Eckehard Schöll[1] — [1]Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany — [2]Institut für Mathematik, Humboldt Universität Berlin, Unter den Linden 6, 10099 Berlin, Germany

Stability of synchronization in delay-coupled networks of identical units generally depends in a complicated way on the coupling topology. We show that for large coupling delays synchronizability relates in a simple way to the spectral properties of the network topology [1]. The master stability function used to determine stability of synchronous solutions has a universal structure in the limit of large delay: it is rotationally symmetric around the origin and increases monotonically with the radius in the complex plane. This allows a universal classification of networks with respect to their synchronization properties and solves the problem of complete synchronization in networks with strongly delayed coupling.

[1] V. Flunkert, S. Yanchuk, T. Dahms, and E. Schöll, Phys. Rev. Lett. (2010) in print.

DY 14.4 Tue 14:45 ZEU 255

Effect of distributed delays on synchronization dynamics — •Lucas Wetzel[1], Saul Ares[1], Luis G. Morelli[2], Andrew C. Oates[2], and Frank Jülicher[1] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden — [2]Max Planck Institute of Molecular Cell Biology and Genetics, Dresden

We study systems of identical coupled phase oscillators, introducing a delay distribution that weights the contributions to the coupling arising from different past times. We have previously shown that for an arbitrary coupling topology with equal number of neighbors for each oscillator, the frequency and stability of the fully synchronized states only depend on the first moment of the delay distribution.

In this contribution we will explore the dynamics of systems approaching full synchronization. We find analytical expressions, confirmed through numerical simulations, for the exponential decay of small perturbations and the dependence of this decay on the delay distribution. We conclude that distributed delays can change the transient behavior for systems with nearest neighbor coupling, but not in the case of mean field. This result may be relevant to biological systems, where fluctuations in the frequency of individual oscillators keep the system away from the synchronized state, and coupling is required to counteract such fluctuations.

DY 14.5 Tue 15:00 ZEU 255

Global bifurcations in delay differential equations with multiple feedback loops — •Ernesto M. Nicola[1], Saul Ares[2], and Luis G. Morelli[3] — [1]IFISC, Institute for Cross-Disciplinary Physics and Complex Systems (CSIC-UIB), Campus Universitat Illes Balears, E-07122 Palma de Mallorca, Spain. — [2]Max-Planck Institute for the Physics of Complex Systems, Noethnitzer Strasse 38, 01187 Dresden, Germany. — [3]Max-Planck Institute of Molecular Cell Biology and Genetics, Pfotenhauerstrasse 108, 01307 Dresden, Germany.

Feedback loops are ubiquitous in dynamical systems. In particular those systems which are capable of showing oscillations are typically based on a negative feedback loop whose effect is not instantaneous but delayed in time. This delayed feedback is usually described by intermediate variables which relay the information and induce an implicit time delay. Added to this delayed negative feedback, systems with realistic applications typically include extra feedback mechanisms. In this contribution we analyze the effect of this extra feedback loops in simple models showing oscillatory behavior. We include explicit time delays in our models to minimize the number of variables and parameters while keeping the richest possible phenomenology in the models. A thorough bifurcation analysis shows that the addition of extra feedback loops results in a number of global bifurcations appearing. These global bifurcations greatly enrich the dynamics of the oscillators under consideration and offer mechanisms to control the oscillatory behavior of the system.