DY 18: Delay and Feedback Dynamics

Time: Monday 17:00–18:15 Location: ZEU 147

DY 18.1 Mon 17:00 ZEU 147

Satellite instability in Passively Mode-Locked Integrated External-Cavity Surface Emitting Lasers — Christian Schelte[1,2], •Denis Hessel[2], Julien Javaloyes[1], and Svetlana Gurevich[2,3] — [1]Departament de Física, Universitat de les Illes Balears & Institute of Applied Computing and Community Code (IAC-3), Cra. de Valldemossa, km 7.5, E-07122 Palma de Mallorca, Spain — [2]Institute for Theoretical Physics, University of Münster, Wilhelm-Klemm-Str. 9, D-48149 Münster, Germany — [3]Center for Nonlinear Science (CeNoS), University of Münster, Corrensstrasse 2, D-48149 Münster, Germany

We are interested in a pulse instability appearing in passively modelocked integrated external-cavity surface-emitting lasers (MIXSELs) modelled by delayed algebraic differential equations (DADEs). The micro-cavity geometry induces third order dispersion (TOD) that can lead to a train of satellites on the leading edge of a pulse. We show that those can become unstable due to carrier interaction. The resulting limit cycle is born in a global bifurcation of the saddle-node infinite period (SNIPER) type and exhibits behavior characteristic of excitable systems.

DY 18.2 Mon 17:15 ZEU 147

Analysing and Optimizing the Nonlinear Memory Capacity of Photonic Reservoir Computing — •Felix Köster and Kathy Lüdge — Institut für Theoretische Physik, TU Berlin, Hardenbergstraße 36, 10623 Berlin

Reservoir computing is a neuromorphic inspired machine learning paradigm that utilizes the naturally occurring computational capabilites of dynamical systems. In this work, we investigate the linear and nonlinear memory capacity of a delay-based class-A-laser reservoir computer via numerical simulations. We show that the reservoir computing performance is deeply connected to the total memory capacity and that resonances between the information injection rate and the delay time of the laser system play a crucial role in optimizing the reservoir. Additionally, we study the method of speed gradient descent as an optimization scheme for a delay based reservoir computer. By applying this method we can force our reservoir into having certain memory capacities tailored for a specific task.

DY 18.3 Mon 17:30 ZEU 147

Non-local effects in external cavity passively mode-locked lasers — •Jan Hausen[1], Christian Schelte[2,3], Julien Javaloyes[2], Svetlana V. Gurevich[2,3], and Kathy Lüdge[1] — [1]TU Berlin, Hardenbergstrasse 36, 10623 Berlin — [2]Universitat de les Illes Balears, Cra. de Valldemossa, km 7.5. Palma (Illes Balears) — [3]WWU Münster, Wilhelm-Klemm-Strasse 9, 48149 Münster

Asymmetrical geometries can improve the performances of passively mode-locked vertical external-cavity surface-emitting lasers and give rise to non-equidistant pulse patterns. We show that these geometries create non-local effects; by analyzing a previously developed delay differential equation model, we derive rigorously a Master equation from the pulse evolution that contains such non-local terms. Setting adequate boundary conditions, we extend our analysis to the dynamics of intermediate cavities (600ps), particularly relevant for high performance mode-locking. We study the influence of the non-locality stemming from the asymmetric position of the elements in the cavity and we recover the bifurcation structure of non-equidistant pulse patterns.

DY 18.4 Mon 17:45 ZEU 147

Optimale Regeleigenschaften eines Zufluss-Abfluss-Systems fern vom Gleichgewicht — •Claus Fütterer[1,2] und Katja Prasol[1,2] — [1]Biophysical Tools GmbH — [2]Labor für Biophysik, Leipzig

Die Regelung einer intensiven Größe in einem vorgegebenen Volumen kann durch Anpassung von Zufluss und Abflusswiderständen für eine dieses Volumen durchströmende extensive Größe erreicht werden. Dies ist ein Muster, das man in zahlreichen biologischen Systemen und in vielen technologischen Anwendungen wiederfindet.

Als konkrete Anwendung diskutieren wir die Regelung des pneumatischen Drucks für die mikro-und mesofluidische Strömungskontrolle. Hierzu modellieren wir ein System mit einem kleinen Druckvolumen, welches über Ventile mit konstanter Quelle und Senke verbunden ist. Das diskutierte Verfahren ist eine Weiterentwicklung des "PI"-Reglers.

Wir präsentieren eine kurze Herleitung der durch Gegenkopplung linearisierten Gleichungen und diskutieren Eigeschaften der analytischen Lösungen, wie Anstiegszeit und Stabilität. Wir können hierbei Formeln für optimale Regelparameter für schnellste, überschwingerfreie Einregelzeit ableiten. Hierbei unterscheiden wir zwischen statischen Sollwerten, nicht-stetigen und stetigen Sollwertfunktionen, wie z.B. einer Sinusfunktion. Die Analogie zum Federpendel hilft bei der Interpretation der Zusammenhänge.

Zuletzt betrachten wir noch Optimierungsmöglichkeiten sowie in Anwendungen häufig auftretende endliche Regelstrecken und nichtlineare Effekte.

DY 18.5 Mon 18:00 ZEU 147

An event-based model for synchronization in digital phase locked loops — •Sara Ameli Kalkhouran, Lucas Wetzel, and Frank Jülicher — Max Planck Institute for physics of complex systems, Dresden, Germany

We study synchronization in digital phase-locked loops, which are two state oscillators in a feedback loop. The state of the oscillator, either high or low, is represented by sets of discrete event-times at which signals switch between these states and a low pass filter acts as the controlling element. One advantage of this model is that the implementation of noise, so-called timing-jitter, can be done in a physically sound way as it can be added directly to the event-times.

We have developed a numeric and analytic framework within which one can study the case of free-running oscillation (oscillator in open loop) as well as entrainment with an external reference (closed-loop). This model can be generalized for variety of discrete-continuous systems; Having the response function of a system, e.g. obtained from experiments, our approach can be used to analyse the dynamics of a variety of systems in which the timing of an event is controlled in a self-tuned manner; like cell division, or firing in a neural population.