SOE 9: Symposium: Synchronization Patterns in Complex Dynamical Networks (organized by Jakub Sawicki, Sabine Klapp, Markus Bär and Jens Christian Claussen) (joint session DY/SOE)

The program of this session is embedded in a symposium supported by DPG section DY and SOE as well as TU Berlin, SFB 910 and the BCSCCS e.V in Honor of Professor Eckehard Schöll's 70th Birthday. Eckehard Schöll has been the local organizer of the DPG-SKM conferences in Berlin for many years and was awarded the DPG badge of honour (Ehrennadel) for his service to the community.

Time: Friday 13:30–16:00 Location: ESS

Invited Talk SOE 9.1 Fri 13:30 ESS

Network-Induced Multistability Through Lossy Coupling — •Jürgen Kurths — PIK, Potsdam, Germany — HU Berlin, Germany

The stability of synchronized networked systems is a multi-faceted challenge for many natural and technological fields, from cardiac and neuronal tissue pacemakers to power grids. For these, the ongoing transition to distributed renewable energy sources leads to a proliferation of dynamical actors. The de-synchronization of a few or even one of those would likely result in a substantial blackout. Thus, the dynamical stability of the synchronous state has become a leading topic in power grid research. Here we uncover that, when taking into account physical losses in the network, the back-reaction of the network induces new exotic solitary states in the individual actors and the stability characteristics of the synchronous state are dramatically altered. These effects will have to be explicitly taken into account in the design of future power grids. We expect the results presented here to transfer to other systems of coupled heterogeneous Newtonian oscillators.

Invited Talk SOE 9.2 Fri 14:00 ESS

Control of synchronization in two-layer power grids — •Simona Olmi[1], Carl Totz[2], and Eckehard Schöll[2] — [1]Istituto dei Sistemi Complessi - CNR - Firenze, Italy — [2]Technische Universität Berlin - Germany

In this talk we suggest to model the dynamics of power grids in terms of a two-layer network, and use the Italian high voltage power grid as a proof-of-principle example. The first layer in our model represents the power grid consisting of generators and consumers, while the second layer represents a dynamic communication network that serves as a controller of the first layer. In particular, the dynamics of the power grid is modelled by the Kuramoto model with inertia, while the communication layer provides a control signal P_i^c for each generator to improve frequency synchronization within the power grid. We propose different realizations of the communication layer topology and different ways to calculate the control signal. Then we conduct a systematic survey of the two-layer system against a multitude of different realistic perturbation scenarios, such as disconnecting generators, increasing demand of consumers, or generators with stochastic power output. When using a control topology that allows all generators to exchange information, we find that a control scheme aimed to minimize the frequency difference between adjacent nodes operates very efficiently even against the worst scenarios with the strongest perturbations.

30 min. break.

Invited Talk SOE 9.3 Fri 15:00 ESS

Relay and complete synchronization of chimeras and solitary states in heterogeneous networks of chaotic maps — Elena Rybalova[1], Eckehard Schöll[2], and •Galina Strelkova[1] — [1]Institute of Physics, Saratov State University, Astrakhanskaya str. 83, Saratov 410012, Russia — [2]Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

In this talk we discuss the phenomena of relay and complete synchronization in a heterogeneous three-layer network of chaotic maps. In the considered network two remote layers are not directly coupled but interact via a relay layer with which they are pairwise and symmetrically coupled. All the three layers represent rings of nonlocally coupled discrete-time oscillators but the relay layer is completely different in its spatiotemporal dynamics from that of the outer layers. We consider the cases when the individual elements of the relay layer and of the outer layers are described by Lozi maps and Henon maps, respectively, and vice versa. We establish and explore relay and complete synchronization of chimera structures and solitary state modes in a heterogeneous multiplex network and analyze the role of the relay layer structure in the resulted synchronous patterns. The results are illustrated by diagrams of desynchronized and synchronous regimes in the "inter-layer coupling - intra-layer coupling of the relay layer" parameter planes.

Invited Talk SOE 9.4 Fri 15:30 ESS

A bridge between the fractal geometry of the Mandelbrot set and partially synchronized dynamics of chimera states. — •Ralph G Andrejzak — Universitat Pompeu Fabra, Barcelona, Catalonia, Spain

A simple quadratic map with a complex-valued parameter c allows one to generate enormously rich dynamics and patterns. Fractal Julia sets and the Mandelbrot set divide the complex plane into stable and divergent regions of the map's initial conditions and parameters c. What happens if one couples several quadratic maps? We address this question using a minimal two-population network of two pairs of two quadratic maps. In dependence on c, the network enters into qualitatively different dynamical states. The network iterates can diverge to infinity or remain bounded. Bounded solutions can get fully synchronized, fully desynchronized, or enter into different partially synchronized states, including a symmetry-broken chimera state. We will at first inspect examples for these different dynamical states in the domain of the complex-valued iterates of the network. We then illustrate that the boundaries between different dynamical states form intriguing fractal patterns in the domain of the complex-valued c.