DY 65: Partial Synchronization Patterns in Neuronal Networks II (Focus Session joint with DY / SOE / BP) (joint session SOE/DY)

Time: Friday 10:00–12:00 Location: GÖR 226

DY 65.1 Fri 10:00 GÖR 226

Control of chimera states in multilayer networks of FitzHugh-Nagumo neurons — •Giulia Ruzzene and Ralph G. Andrzejak — Universitat Pompeu Fabra, Barcelona, Spain

Chimera states are a widely studied phenomenon in nonlinear science. In oscillator networks, a chimera state is defined as the coexistence of synchronous and aysnchronous groups of nodes. Many analogies have been established between chimeras and natural phenomena, especially with brain dynamics. Here we study the dynamics of a two-layer network of FitzHugh-Nagumo oscillators, which model neuronal dynamics. Chimera states have been observed in this configuration, but only a few studies also deal with the topic of control of chimeras in multilayer networks. Here we apply a control mechanism that we previously developed for chimeras in single-layer networks of phase oscillators. We study the interplay of the control method with the multilayer configuration and show the parameter regions in which the control is effective.

DY 65.2 Fri 10:30 GÖR 226

Effect of Topology upon Relay Synchronization in Triplex Neuronal Networks — •Fenja Drauschke, Iryna Omelchenko, Rico Berner, Jakub Sawicki, and Eckehard Schöll — Institute of Theoretical Physics, Technische Universität Berlin

Complex networks consisting of several interacting layers allow for remote synchronization of distant layers via an intermediate relay layer. We investigate relay synchronization in a three-layer neuronal network and study the effect of the topology of the layers upon the synchronization scenarios. Introducing random topologies either in the outer layers or in the middle (relay) layer leads to an increase of the range of inter-layer coupling strength for which the relay-synchronized state is preserved, compared with regular nonlocal coupling topologies.

DY 65.3 Fri 10:45 GÖR 226

High-order couplings in geometric complex networks of neurons — •Alejandro Tlaie[1,2,3], Inmaculada Leyva[1,2], and Irene Sendiña-Nadal[1,2] — [1]Complex Systems Group & GISC, Universidad Rey Juan Carlos, 28933 Móstoles, Madrid, Spain — [2]Center for Biomedical Technology, Universidad Politécnica de Madrid, Madrid, Spain — [3]Department of Applied Mathematics and Statistics, ETSIT Aeronáuticos, Universidad Politécnica de Madrid, 28040 Madrid, Spain

We explore the consequences of introducing higher-order interactions in a geometric complex network of Morris-Lecar neurons. We focus on the regime where traveling synchronization waves are observed from a first-neighbors-based coupling to evaluate the changes induced when higher-order dynamical interactions are included. We observe that the traveling-wave phenomenon gets enhanced by these interactions, allowing the activity to travel further in the system without generating pathological full synchronization states. This scheme could be a step toward a simple phenomenological modelization of neuroglial networks.

15 min. break

DY 65.4 Fri 11:15 GÖR 226

Multilayer structures in adaptive oscillator networks — •Rico Berner[1,2], Jakub Sawicki[1], and Eckehard Schöll[1] — [1]Institute of Theoretical Physics, Technische Universität Berlin, Germany — [2]Institute of Mathematics, Technische Universität Berlin, Germany

Dynamical systems on networks with adaptive couplings appear naturally in real-world systems such as power grid networks, social networks as well as neuronal networks. We investigate collective behaviour in a paradigmatic network of adaptively coupled phase oscillators. The coupling topology of the network changes slowly depending on the dynamics of the oscillators on an all-to-all coupled background. We show that such a system gives rise to numerous complex dynamics, including relative equilibria and hierarchical multicluster states. Parameter regimes of high multistability are found. An analytic treatment for equilibria as well as multicluster states reveals that existence and stability are significantly influenced by the slow-fast time separation. Interactions between different clusters are further studied numerically and analytically in the framework of multiplex networks. Our results allow for the interpretation of equilibria as functional units in multicluster structures. The results contribute to the understanding of mechanisms for self-organized pattern formation in adaptive networks, such as the emergence of multilayer structure in neural systems and their interaction.

DY 65.5 Fri 11:30 GÖR 226

Hierarchical clusters in adaptive networks with random topology — •Simon Vock[1], Rico Berner[1,2], Eckehard Schöll[1], and Serhiy Yanchuk[2] — [1]Institute of Theoretical Physics, Technische Universität Berlin — [2]Institute of Mathematics, Technische Universität Berlin

Networks of adaptively coupled oscillators show certain synchronization phenomena, such as multi-cluster states or traveling-wave states. While the emergence of these self-organised structures has been previously studied on all-to-all coupled networks, the type of connections and underlying network structure play an important role in the formation of these partially synchronized states. This work extends the investigations towards more complex networks, analysing the influence of random network topologies and changing adaption functions.

DY 65.6 Fri 11:45 GÖR 226

Hierarchical frequency clusters in adaptive networks of phase oscillators — •Jan Fialkowski[1], Rico Berner[1,2], Serhiy Yanchuk[2], and Eckehard Schöll[1] — [1]Institute of Theoretical Physics, Technische Universität Berlin — [2]Institute of Mathematics, Technische Universität Berlin

Adaptive dynamical networks appear in various real-world systems. In this talk, we explain the basic mechanism behind the pattern formation in adaptive networks by considering a simple phenomenological phase oscillator model. Frequency synchronization is shown to be the key phenomenon for the emergence of hierarchical modular network structures. A particular class of phase clusters, called double antipodal clusters, are presented and shown to play an important role in the organization of the high dimensional dynamics. In the end, we also examine the importance of different timescales in the adaptive and oscillatory dynamics.