BP 57: Networks: From Topology to Dynamics II (Joint Session DY/BP/SOE)

Time: Thursday 15:00–16:15 Location: ZEU 147

BP 57.1 Thu 15:00 ZEU 147

Response Patterns for Fluctuations in Complex Flow Networks — •Xiaozhu Zhang[1], Sarah Hallerberg[1,2], Moritz Moritz Matthiae[3], Dirk Witthaut[3,4], and Marc Timme[1,5] — [1]Network Dynamics, Max Planck Institute for Dynamics and Self-Organization, 37077 Göttingen — [2]Faculty for Engineering and Computer Science, Hamburg University of Applied Science, 20099 Hamburg — [3]Institute for Energy and Climate Research - Systems Analysis and Technology Evaluation (IEK-STE), Forschungszentrum Jülich, 52428 Jülich — [4]Institute for Theoretical Physics, University of Cologne, 50937 Köln — [5]Department of Physics, Technical University of Darmstadt, 64289 Darmstadt

Dynamic collective phenomena prevail in networked systems across physics, biology and engineering. How external signals generate distributed responses patterns in such systems fundamentally underlies their function, yet is far from fully understood. Here we analyze the collective response patterns of oscillatory networks to fluctuating input signals. For an arbitrary network topology, we analytically find distinct response patterns to fall into three distinct frequency regimes: homogeneous responses across the network at low frequencies, topology-dependent resonances at intermediate frequencies and are frequency-dependent, localized responses at high frequencies. These results render regime-specific implications for real-world network design and control, in particular for transport and supply networks, e.g. electric power grids.

BP 57.2 Thu 15:15 ZEU 147

Control of chimeras in small networks — Iryna Omelchenko[1], Oleh Omel'chenko[2], Anna Zakharova[1], Matthias Wolfrum[2], and •Eckehard Schöll[1] — [1]Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstraße 36, 10623 Berlin, Germany — [2]Weierstrass Institute, Mohrenstraße 39, 10117 Berlin, Germany

We propose a control scheme which can stabilize and fix the position of chimera states in small networks [1]. Chimeras consist of coexisting domains of spatially coherent and incoherent dynamics in systems of nonlocally coupled identical oscillators. Chimera states are generally difficult to observe in small networks due to their short lifetime and erratic drifting of the spatial position of the incoherent domain. The control scheme, like a tweezer, might be useful in experiments, where usually only small networks can be realized.

[1] I. Omelchenko, O. E. Omel'chenko, A. Zakharova, M. Wolfrum, and E. Schöll, Phys. Rev. Lett. **116**, 114101 (2016).

BP 57.3 Thu 15:30 ZEU 147

Scaling Laws in Spatial Network Formation — •Nora Molkenthin[1,2] and Marc Timme[1,2] — [1]Network Dynamics, Max Planck Institute for Dynamics and Self-Organization (MPIDS), 37077 Göttingen, German — [2]Institute for Nonlinear Dynamics, Faculty of Physics, University of Göttingen, 37077 Göttingen, Germany

Geometric constraints strongly impact the formation of networked systems. Examples range from amino acid chains folding to proteins structures to rearranging particle aggregates. The dynamical self-organization of the interaction network in such systems is far from fully understood. Here, we analyze a class of spatial network formation processes by introducing a mapping from geometric to graph-theoretic constraints. Combining stochastic and mean field analyses yields an algebraic scaling law for the extent (graph diameter) of the resulting networks with system size, in contrast to logarithmic scaling known for networks without constraints. Intriguingly, the exponent falls between that of self-avoiding random walks and that of space filling arrangements, consistent with experimentally observed scaling (of the spatial radius of gyration) for protein tertiary structures.

BP 57.4 Thu 15:45 ZEU 147

Boolean network analysis reveals interaction networks among low-abundance species in the human gut microbiome — •Jens Christian Claussen[1], Jurgita Skieceviciene[2], Jun Wang[3], Philipp Rausch[6,5], Tom H. Karlsen[4], Wolfgang Lieb[5], John F. Baines[5,6], Andre Franke[5], and Marc-Thorsten Hütt[3] — [1]Computational Systems Biology, Jacobs University Bremen — [2]U Kaunas — [3]KU Leuven — [4]U Oslo — [5]UKSH, U Kiel — [6]MPI Plön

Microbiome compositions in clinical context gained recent interest. Most analyses infer interactions among highly abundant species. The large number of low-abundance species has received less attention. Here we present a novel analysis method based on Boolean operations applied to microbial co-occurrence patterns. We calibrate our approach with simulated data based on a dynamical Boolean network model from which we interpret the statistics of attractor states as a theoretical proxy for microbiome composition. We show that for given fractions of synergistic and competitive interactions in the model our Boolean abundance analysis can reliably detect these interactions. In our human gut microbiome dataset, we find a large number of highly significant synergistic interactions among these low-abundance species, forming a connected network, and a few isolated competitive interactions.

BP 57.5 Thu 16:00 ZEU 147

Complex Contagion and Coordinated Response in Animal Groups — •Winnie Poel[1,6], Bryan Daniels[3], Colin Twomey[2], Iain Couzin[4,5], and Pawel Romanczuk[1,6] — [1]Inst. of Theor. Biol., Dept. of Biol., Humboldt Universität zu Berlin — [2]Dept. of Ecology and Evolutionary Biol., Princeton University, Princeton, US — [3]ASU-SFI Center for Biosocial Complex Systems, Arizona State University, US — [4]Dept. of Collective Behaviour, MPI for Ornithology, Konstanz, Germany — [5]Dept. of Biology, University of Konstanz, Germany — [6]Bernstein Center for Computational Neuroscience Berlin, Germany

Our work focuses on the underlying communication network in animal swarms that enables coordinated movement and collective information processing in large groups while taking into account the limited attention and cognitive ability of each individual. Here, we study the influence of network structure on processes of behavioral complex contagion in fish groups. Specifically, we investigate the spreading of startling behavior in golden shiners on empirically inferred networks built on their individual visual perception of neighbors [1]. Using a simple adapted SIR model [2] we aim to uncover how the spatial configuration of a swarm (and thus its visual interaction network) aid to amplify or dampen out the information send out by a certain individual.

[1] Rosenthal, S., et al., PNAS 112.15 (2015): 4690-4695
[2] Dodds, P., et al., J. Theor. Biol. 232.4 (2005): 587-604