SOE 25: Networks: From Topology to Dynamics (joint session BP / SOE / DY)

Joint session with SOE and DY organized by BP.

Time: Thursday 16:45–17:45 Location: H43

SOE 25.1 Thu 16:45 H43

Fluctuations and transients in the actin cytoskeleton of chemotactic amoeba — •Jose Negrete JR[1,2], Alain Pumir[3], Hsing-Fang Hsu[2], Christian Westendorf[4], Marco Tarantola[2], Carsten Beta[2,5], and Eberhard Bodenschatz[2,6,7] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Max Planck Institute for Dynamics and Selforganization, Göttingen, Germany — [3]Ecole Normale Supérieure de Lyon, France — [4]University of Graz, Austria — [5]University of Potsdam, Germany — [6]University of Göttingen, Germany — [7]Cornell University, Ithaca, USA

Biological systems with their complex biochemical networks are known to be intrinsically noisy. Here we investigate the oscillatory dynamics in the actin cytoskeleton of chemotactic amoeboid cells. We show that the large phenotypic variability in the polymerization dynamics can be accurately captured by a generic nonlinear oscillator model in the presence of noise. The relative role of the noise is fully determined by a single dimensionless parameter, experimentally measurable, and whose distribution completely characterizes the possible cellular behavior. Also, we perturbed experimentally the oscillatory cytoskeletal dynamics by a short chemoattractant pulse and measured the spatio-temporal response of filamentous actin reporter, LimE, and depolymerization regulators Coronin1 and Aip1. After pulsing, we observed self oscillating cells to relax back to their oscillatory state after a noisy transient. Particularly long transients were observed for cells initially displaying highly correlated oscillations.

SOE 25.2 Thu 17:00 H43

Distribution of pair-wise covariances in neuronal networks — •David Dahmen[1], Markus Diesmann[1,2,3], and Moritz Helias[1,3] — [1]Inst. of Neurosc. and Med. (INM-6) and Inst. for Advanced Simulation (IAS-6) and JARA BRAIN Inst. I, Jülich Research Centre, Germany — [2]Dept. of Psychiatry, Psychotherapy and Psychosomatics, Medical Faculty, RWTH Aachen University, Aachen, Germany — [3]Dept. of Physics, Faculty 1, RWTH Aachen University, Germany

Massively parallel recordings of spiking activity in cortical circuits show large variability of covariances across pairs of neurons [Ecker et al., Science (2010)]. In contrast to the low average, the wide distribution of covariances and its relation to the structural variability of connections between neurons is still elusive. Here, we derive the formal relation between the statistics of connections and the statistics of integral pairwise covariances in networks of Ornstein-Uhlenbeck processes that capture the fluctuations in leaky integrate-and-fire and binary networks [Grytskyy et al., Front. Comput. Neurosci. (2013)]. Spin-glass mean-field techniques [Sompolinsky and Zippelius, Phys. Rev. B (1982)] applied to a generating function representing the joint probability distribution of network activity [Chow and Buice, J. Math. Neurosci. (2015)] yield expressions that explain the divergence of mean covariances and their width when the coupling in the linear network approaches a critical value. Using these relations, distributions of correlations provide insights into the properties of the structure and the operational regime of the network. Partly supported by Helmholtz Association: VH-NG-1028 and SMHB; EU Grant 604102 (HBP).

SOE 25.3 Thu 17:15 H43

Global stability reveals critical components in the structure of multi-scale neural networks — •Jannis Schuecker[1,4], Maximilian Schmidt[1,4], Sacha J. van Albada[1], Markus Diesmann[1,2,3], and Moritz Helias[1,3] — [1]Inst of Neurosci and Medicine (INM-6) and Inst for Advanced Simulation (IAS-6) and JARA BRAIN Institute I, Jülich Research Centre — [2]Department of Psychiatry, Psychotherapy and Psychosomatics, Medical Faculty, RWTH Aachen University — [3]Department of Physics, Faculty 1, RWTH Aachen University — [4]These authors contributed equally

One of the major challenges of neuroscience is the integration of the available experimental data into a coherent model of the brain. In this endeavor, the exploration of the inevitable uncertainties in anatomical data should be guided by physiological observations. To this end we devise a method based on a mean-field reduction of spiking network dynamics for shaping the phase space of large-scale network models according to fundamental activity constraints, prohibiting quiescence and requiring global stability. In particular, we apply this framework to a multi-area spiking model of macaque visual cortex and obtain plausible layer- and area-specific activity [Schuecker et al. 2015, arXiv:1509.03162] by controlling the location of the separatrix dividing the phase space into realistic low-activity and unrealistic high-activity states. The study systematically identifies modifications to the population-level connectivity within and between areas critical for the stability of the network. Partly supported by Helmholtz association: VH-NG-1028 and SMHB; EU Grant 604102 (HBP).

SOE 25.4 Thu 17:30 H43

From Interactions to Topology: A Population Dynamics Approach to Network Formation — •Adrian Fessel and Hans-Günther Döbereiner — Institut für Biophysik, Universität Bremen, Deutschland

We present a mean-field model integrating interactions between populations of nodes to mimic the evolution of transportation networks. Changes in network topology are partitioned in basic events representing, e.g., fusion or growth of network fragments. Local dependencies are reflected by rate constants modifying the frequency of occurence of a given event.
The model presented shows promising results when compared to the percolating network of the slime-mold *Physarum polycephalum* [*Phys. Rev. Lett.* **109**, 078103 (2012)].