Monday, December 07, 2020, 14:00 hrs
Zoom Meeting

Guest Lecture

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Cortical variability and pattern formation in exact neural field models

Neural mass models and their spatially extended counterpart, neural field models, have extensively been used since the 1970s to model the coarse-grained activity of large populations of neurons. They have proven particularly useful for understanding large-scale brain dynamics. However, they are phenomenological in nature and do not generally represent proper mathematical reductions of the original network dynamics. As such, there is in general no clear relationship between the parameters in the neural mass model and those in the full network of spiking neurons. In this talk I will present two mean-field approaches that exactly link the single neuron dynamics to the population activity and thereby allow for elucidating how single neuron and network properties may contribute to and affect large-scale activity patterns.

In the first part, I will address stimulus-dependent tuning of cortical variability in ring attractor networks. I will present a stochastic neural field model for finitely many Poisson neurons with absolute refractoriness that are located around a one-dimensional ring, and quantify the influence of the network size as well as of neuronal refractoriness on the fluctuation-induced drift of a bump attractor and on the suppression of variability following the onset of a stimulus.

In the second part, I will present the first exactly reduced neural field model that incorporates electrical synapses. Specifically, I will consider spatially extended networks of quadratic integrate-and-fire (QIF) neurons with chemical and electrical synapses. Importantly, the connectivity of neurons via electrical synapses—so-called gap junctions—is fundamentally different from chemical synapses, as they mainly couple inhibitory neurons of the same type in a more locally restricted area than inhibitory (chemical) synapses do. As I will show, the distinct spatial ranges of electrical vis-à-vis chemical synapses prove to be of critical importance for large-scale pattern formation, which can be studied by means of a Turing instability analysis.

For more information, please contact Nancy Muschall at muschall@cbs.mpg.de or phone +49 341 9940-2287