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Quantum Optics,
Quantum Nanophysics
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INVITATION

to a **TALK** by

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The geometry of neuronal population dynamics and scaling of its dimensionality using cellular resolution cortex-wide recording of neuroactivity

Friday, March 8th 2024, 14:15 h

Location: Ernst-Mach Lecture Hall, 2nd floor, Boltzmanngasse 5

Hosted by: Markus Arndt

Abstract

Understanding how sensory information is represented, processed and leads to generation of complex behavior is the major goal of systems neuroscience. However, the ability to detect and manipulate such large-scale functional circuits has been hampered by the lack of appropriate tools and methods that allow parallel and spatiotemporally specific manipulation of neuronal population activity while capturing the dynamic activity of the entire network at high spatial and temporal resolutions.

A central focus of our lab is the development and application of new optics-based neurotechnologies for large-scale, high-speed, and single-cell resolution interrogation of neuroactivity across model systems. Through these, we have consistently pushed the limits on speed, volume size, and depth at which neuronal population activity can be optically recorded at cellular resolution. Amongst others have demonstrated whole-brain recording of neuroactivity at cellular resolution in small model

systems as well as more recently near-simultaneous recording from over 1 million neurons distributed across both hemispheres and different layers of the mouse cortex at cellular resolution.

At the same time the widespread application of mathematical and computational tools for dimensionality is a reflection of the commonly held view in the field that neural dynamics can be approximated by low-dimensional “latent” signals that represent neural computations. However, what would be the biological utility of such a redundant encoding scheme, and what is the appropriate resolution and scale of recording to understand brain function? Imaging neural activity at cellular resolution and near-simultaneously across mouse cortex, we have recently found unbounded scaling of dimensionality of neuronal population activity with neuron number in populations sizes of up to one million neurons. Our data suggests that while half of the neural variance is contained within about sixteen dimensions that are correlated with behavior, the majority of the reliable dimensions which collectively account for the other half of total neuronal variance do not have any immediate behavioral or sensory correlates. The activity patterns underlying these higher dimensions are fine-grained and cortex-wide, highlighting that large-scale, cellular-resolution recording is required to uncover the full substrates of neuronal computations.