Seminar of SFB 910

Johanne Hizanidis

University of Crete

Dynamical properties of neuromorphic Josephson junctions

Neuromorphic computing exploits the dynamical analogy between many physical systems and neuron biophysics. Superconductor systems, in particular, are excellent candidates for neuromorphic devices due to their capacity to operate in great speeds and with low energy dissipation compared to their silicon counterparts. In this study we revisit a prior work on Josephson Junction-based neurons in order to identify the exact dynamical mechanisms underlying the systems neuron-like properties and reveal new complex behaviors which are relevant for neurocomputation and the design of superconducting neuromorphic devices. Our work lies at the intersection of superconducting physics and theoretical neuroscience, both viewed under a common framework, that of nonlinear dynamics theory.

The event is part of the group seminar of AG Zakharova at TU Berlin.
For information on how to access the event, please contact: henning.reinken@itp.tu-berlin.de

Monday, 28.11.2022 · 10:15h · EW 202/via Zoom

Seminar of SFB 910

Astero Provata

National Center for Scientific Research "Demokritos",
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2D networks of neuronal oscillators: effects of locally perturbed connectivity on synchronization properties

We discuss the effects of neuron axons local degeneration in the synchronization properties of networks composed of biological neurons. As a representative system, the Leaky Integrate-and-Fire (LIF) neuronal oscillator is here considered. The unperturbed (intact) network is a typical 2D square lattice neuronal arrangement, while in the perturbed case the connectivity on the 2D lattice is locally broken. Both cases of excitatory and inhibitory couplings are studied. In the case of intact connectivity ("healthy" state) coexisting synchronous and asynchronous domains are formed for appropriate choice of parameter values, also known as chimera states. In the case of broken connectivity ("unhealthy" state), the numerical simulations indicate that a) for inhibitory coupling, the asynchronous domains of the dynamics get displaced to encapsulate the damaged area and b) for excitatory coupling, the traveling waves which are normally present get displaced to avoid the damaged areas. Typical biomedical applications refer to traumas or tumor presence in the brain.

1. Provata, A., Vlamos, P., Effects of Neuron Axons Degeneration in 2D Networks of Neuronal Oscillators. In: Vlamos, P., Kotsireas, I.S., Tarnanas, I. (eds) Handbook of Computational Neurodegeneration, Springer, Cham. (2021).
2. Koulierakis I., Verganelakis D.A., Omelchenko I., Zakharova A., Schll E., Provata A. Structural anomalies in brain networks induce dynamical pacemaker effects Chaos, 30 (11), art. no. 113137, (2020).

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