Anastasia Lavrova
Physics Institute, Humboldt University at Berlin
e-mail: aurebours@googlemail.com
L. Schimansky-Geier
Physics Institute, Humboldt University at Berlin

Dynamical switching between network states in the hippocampal circuit

It is known that hippocampus is a structure required for processes of learning and memory [1]. Gloveli et al. [2] reported that the dynamics of neuron network of CA3 region exhibits some types of oscillations, so called gamma (30-80 Hz) and theta(4-12 Hz) rhythms. These oscillations are responsible for information transmission, storage, and spatial encoding [3]. Also, it have been shown that gamma and theta rhythms are generated by different types of cells in CA3 region of hippocampus.

We have considered a minimal network scheme, which describes connections between different types of cells. We have developed model based on this scheme which reproduces important physical characteristics of the oscillations of all cells types: the period, amplitude and phase shift. The model allows us to analyze the influence of synaptic strengths on the network synchronization and dynamical switching between theta, gamma, and bursting regimes. In particular, we perform a thorough bifurcation analysis and identify parameters of synaptic connections that can efficiently induce switches in the network activity.

References

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