

POSTER PRESENTATION

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Possible mechanisms underlying intermittent synchronous activity in the networks of excitatory and inhibitory bursting neurons

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Basal ganglia circuits in Parkinson's disease constitute a prominent example of neural system of coupled inhibitory and excitatory neurons, which exhibit synchronous activity [1]. The phase-locking of neural activity in this system, as analyzed in experimental data intraoperatively recorded in Parkinsonian patients, exhibits intermittent temporal dynamics [2]. The mechanisms of this intermittent synchronous dynamics make the subject of this study.

The conductance-based network models of subthalamo-pallidal circuitry of basal ganglia have being shown to reproduce the intermittent temporal patterns of phase-locking observed in experiments with high fidelity [3]. We start with this network model of synaptically coupled excitatory subthalamic and inhibitory pallidal bursting neurons. We further reduce it to the model of two mutually coupled inhibitory neurons with self-inhibition. This network is presented at Figure 1. While real subthalamic neurons are excitatory, the resulting two-neurons network is adequate simplification of the original circuitry under assumption of high fidelity of

STN1 STN2

Figure 1 The network architecture. Each connection is inhibitory synapse.

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quite general too.

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to be impacted in Parkinson's disease.

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responses of inhibitory pallidal cells. While this reduc-

tion may be associated with the loss of some other bio-

logically realistic features, it produces a relatively

generic circuit, therefore the studied mechanism may be

We used geometric dynamical systems and singular

perturbation methods to reduce the full model to a sim-

pler set of equations. Mathematical analysis was com-

pleted using three slow variables with two different time

scales. Intermittently synchronous oscillations are gener-

ated by overlapped spiking which crucially depend on

the geometry of slow phase plane and the interplay

between slow variables as well as the strength of

synapses. Two slow variables are responsible for the

generation of out-of-phase stable solution and the other

slower variable for irregular and intermittent activity

pattern. The results of analysis can be traced to particu-

lar values of biophysical parameters (synaptic strength

and parameters of calcium dynamics), which are known

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