BMC Neuroscience

Poster presentation

Open Access

Modeling the coupling of single neuron activity to local field potentials

Serafim Rodrigues*[1] and Peter beim Graben[2]

Address: [1]Integrative and Computational Neuroscience Unit (UNIC), CNRS, Paris, 1 Avenue de la Terrasse, 91198 Gif-sur-Yvette, France and [2]School of Psychology, University of Reading, Reading, Whiteknights, PO Box 217, UK

Email: Serafim Rodrigues* - serafim.rodrigues@gmail.com

* Corresponding author

from Eighteenth Annual Computational Neuroscience Meeting: CNS*2009
Berlin, Germany. 18–23 July 2009

Published: 13 July 2009

BMC Neuroscience 2009, **10**(Suppl 1):P291 doi:10.1186/1471-2202-10-S1-P291

This abstract is available from: http://www.biomedcentral.com/1471-2202/10/S1/P291

This work presents a first step towards a modeling paradigm that enables to link mesoscopic neurodynamics with single-cell activity. A common approach to describe large-scale activity, such as local field potentials (LFP), is via the so called *neural field equations* [1,2]. At the neuronal scale, *spiking models*, such the Hodgkin-Huxley [3] and leaky-integrate neurons, can be employed [4]. However, explaining the link between these levels of descriptions, which are ubiquitous for understanding the coupling of single unit activity to the electromagnetic mean-field, are still unresolved and very much a topic of intense debate and research. We approach this problem by developing a dynamic network model for the interaction of pyramidal and inhibitory cells by adding two observable equations to the dynamical evolution law of the network. One observable accounts for the intracellular activity (i.e. spiking activity) and the other one for LFP. In particular, the LFP observable is made possible by monitoring the evolution of the dipole dynamics of each pyramidal cell characterized by in-flow and out-flow of currents in the apical and basal dendrites. In addition, following [5], we link single cell activity and their electrotonic properties to mesoscopic neurodynamics and their corresponding parameters by deriving an equivalent Amari neural field equation with mean-field coupling [6]. We also show the validity of this approach by large-scale computations for various connectivity topologies and demonstrate how this description could further our understanding of LFP.

References

1. Amari SI: **Dynamics of pattern formation in lateral-inhibition type neural fields.** *Biological Cybernetics* 1997, **27:**77-87.
2. Abbott LF: **Lapique's introduction of the integrate-and-fire model neuron (1907).** *Brain Research Bulletin* 1999, **50:**303-304.
3. beim Graben P, Kurths J: **Simulating global properties of electroencephalograms with minimal random neural networks.** *Neurocomputing* 2008, **71:**999-1007.
4. Hodgkin A, Huxley A: **A quantitative description of membrane current and its application to conduction and excitation in nerve.** *J Physiology* 1952, **117:**500-544.
5. Richardson KA, Schiff SJ, Gluckman BJ: **Control of traveling waves in the mammalian cortex.** *Physical Review Letters* 2005, **94:**028103.
6. Wilson HR, Cowan JD: **A mathematical theory of the functional dynamics of cortical and thalamic nervous tissue.** *Kybernetik* 1973, **13:**55-80.