Seminar of SFB 910

Simona Olmi

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Next generation neural mass models: short term synaptic plasticity vs spike frequency adaptation

I will first give a brief overview of the next generation neural mass models, which represent a complete new perspective for the development of exact mean field models of heterogeneous spiking networks [1]. Then I will report recent results on the application of this formalism to reproduce relevant phenomena observed in neuroscience ranging from cross-frequency coupling [2] to theta-nested gamma oscillations [3]. I will finally show how these neural masses can be extended to mimic several operations associated with synaptic-based working memory [4] and to organize neural coding for multi-item messages when introducing spike-frequency adaptation [5].

1. E.Montbrió, D.Pazó, A.Roxin. "Macroscopic description for networks of spiking neurons." Physical Review X 5.2 (2015): 021028; S. Coombes, . Byrne. "Next generation neural mass models." In Nonlinear dynamics in computational neuroscience, pp. 1-16. Springer, Cham (2019).
2. A.Ceni, S. Olmi, A. Torcini, D. Angulo Garcia, "Cross frequency coupling in next generation inhibitory neural mass models", Chaos ,30, 053121 (2020).
3. M. Segneri, H.Bi, S. Olmi, A.Torcini, "Theta-nested gamma oscillations in next generation neural mass models", Frontiers in Computational Neuroscience , 14:47 (2020).
4. H. Taher, A. Torcini, S. Olmi, "Exact neural mass model for synaptic-based working memory", PLOS Computational Biology , 16(12):e1008533 (2020).
5. A. Ferrara, D. Angulo-Garcia, S. Olmi, A. Torcini, "Population spiking and bursting in coupled next generation neural masses with spike-frequency adaptation", in preparation.

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, 31.10.2022 · 10:15h · EW 202/via Zoom

Technische Universität Berlin · Institut für Theoretische Physik · Hardenbergstraße 36 · 10623 Berlin

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Seminar of SFB 910

Alessandro Torcini

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Coherent oscillations in balanced neural networks driven by endogenous fluctuations

We present a detailed analysis of the dynamical regimes observed in a balanced network of identical Quadratic Integrate-and-Fire (QIF) neurons with a sparse connectivity for homogeneous and heterogeneous in-degree distribution. Depending on the parameter values, either an asynchronous regime or periodic oscillations spontaneously emerge. Numerical simulations are compared with a mean field model based on a self-consistent Fokker-Planck equation (FPE). The FPE reproduces quite well the asynchronous dynamics in the homogeneous case by either assuming a Poissonian or renewal distribution for the incoming spike trains. An exact self consistent solution for the mean firing rate obtained in the limit of infinite in-degree allows identifying balanced regimes that can be either mean- or fluctuation-driven. A low-dimensional reduction of the FPE in terms of circular cumulants is also considered. Two cumulants suffice to reproduce the transition scenario observed in the network. The emergence of periodic collective oscillations is well captured both in the homogeneous and heterogeneous set-ups by the mean field models upon tuning either the connectivity, or the input DC current.

The event is part of the group seminar of AG Zakharova at TU Berlin.
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Monday, 31.10.2022 · 11:00h · EW 202/via Zoom

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