VI International Conference on Mathematics and its Applications in Science and Engineering (ICMASE 2025)



## Emergence of Multirhythmicity in Cortical Networks with Two Types of Inhibition

Arnab Dey Sarkar<sup>1,\*</sup>, Bard Ermentrout<sup>2</sup>

<sup>1</sup>Graduate Student, University of Pittsburgh <sup>2</sup>Distinguished University Professor, PhD, University of Pittsburgh

## Abstract

We study a network model composed of three interacting neuronal populations: pyramidal (Pyr) cells, parvalbumin-positive (PV) interneurons, and somatostatin-positive (SST) interneurons. Starting from a network of globally coupled quadratic integrate-and-fire (QIF) neurons with heterogeneous inputs, we reduce the full spiking network to a low-dimensional mean-field model consisting of 9 ordinary differential equations (ODEs) — three for each population.

This reduced system captures the essential dynamics of the network, allowing for tractable bifurcation and phase space analysis. We demonstrate the emergence of multistability, oscillatory switching, and coexisting rhythms (mixed beta states) across the populations. In particular, we find that the strength and directionality of inter-population interactions critically depend on SST-IN-mediated inhibition, which modulates transitions between distinct beta-band oscillatory states.

Our results reveal how multiple subtypes of inhibitory neurons coordinate to generate and regulate complex beta dynamics, with potential implications for understanding neural mechanisms underlying motor control, cognitive function, and beta-band abnormalities observed in disorders such as Parkinson's disease.

## References

 AlexandrosGelastopoulos1, NancyJ.Kopell, Interactionsofmultiplerhythmsina biophysicalnetworkofneurons, JournalofMathematicalNeuroscience, (2020) 10:19.

<sup>\*</sup> Corresponding Author's E-mail: ard129@pitt.edu

VI International Conference on Mathematics and its Applications in Science and Engineering

## (ICMASE 2025)

[2] Guang Chen, Yuan Zhang, Xiang Li, ..., Huizhong W. Tao, Malte J. Rasch, Xiaohui Zhang, Distinct Inhibitory Circuits Orchestrate Cortical beta and gamma Band Oscillations, Chen et al., 2017, Neuron 96, 1403–1418.