A model of Coexistence of Gamma rhythms and Asynchronous and Irregular activity in the cortex

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Abstract

Gamma rhythms are fluctuations in the extracellular electric field, in the range of frequencies of 30-90 Hz, detected through measurements within the brain or on the scalp. This type of rhythm has been associated to several cognitive tasks being largely studied in stimulus-response paradigms. In this work we propose a computational model focusing in spontaneously-generated gamma in cortical areas.

Our model is composed of a network of excitatory and inhibitory neurons recurrently connected in which gamma oscillations are generated exclusively by a subset of the inhibitory population. The model is capable of displaying spontaneous gamma bursts in the modeled LFP, while individual cells spike irregularly with low firing rate and with small level of phase-locking to the rhythm. This particular relationship of the spikes with the global oscillation is a feature that indicates a coexistence between gamma rhythms and asynchronous and irregular (AI) activity.

This coexistence is observed experimentally and might be important to maintain the network responsiveness to external stimuli during the occurrence of gamma oscillations. Here, we describe what is the relation between the number occurrences, gamma power and level of coexistence with certain parameters like the excitability of the network, synaptic strength between groups and synaptic time scales. We show that the level of coexistence can be adjusted through the level of depolarization of the network which brings an interesting insight into the comprehension of gamma generation in different brain states and contexts.

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