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Poster presentation

Stability of splay states for pulse-coupled neuronal networks: finite size versus finite pulse-width effects

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The dynamics of collective states observed in globally coupled neuronal networks is still an open problem. In particular, although it is claimed that the periodic firing state ("splay state") is stable only for excitatory coupling [1], counterexamples have been found for inhibitory coupling as well [2]. Moreover, the stability of the splay states has been analyzed only in the mean field limit [1,3,4]. Our aim is to investigate simultaneously, for a pulse-coupled network of leaky integrate-and fire neurons, the effect of the number N of neurons as well as of the pulse-width of the post-synaptic potentials. Finite-N networks can be studied by suitably modifying the map-like formalism [5,6] usually adopted to implement numerically the model. As a result, we find that the stability of the splay state depends crucially on a parameter that is proportional to the width of the delivered pulses rescaled to the average interspike interval. More precisely, we show that the Floquet spectrum of eigenvalues is made of two components, one of which coincides with that one predicted by the mean-field analysis [1]. Depending on the value of the relevant parameter, the second component may be responsible for the occurrence of instabilities which in turn suggest the failure of the continuum limit approximation. Finally, for sufficiently small pulse-width we observe that the splay state can be stable even for inhibitory coupling.

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