# Synchronization of oscillatory activity and waves in neuronal networks with spatially structured connectivity

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Neural rhythms and collective oscillations are ubiquitously recorded in neural structures. Oscillations with 10-45Hz frequency (in the so-called "$\beta$/low $\gamma$" range) have successfully been modeled in several previous works as arising from reciprocal interactions between excitatory (E) and inhibitory (I) neurons. The synchronization properties of spatially distant E-I modules have been less studied although this knowledge would help to properly interpret recording data. Here, we analyze the dynamical regimes of two oscillatory E-I modules connected by excitatory interactions as well as those of a chain of such modules. We show that long-range excitation can either synchronize or desynchronize oscillatory activity of distinct E-I modules, depending on its strength and the specific considered connectivity. Stochastic action potential emission by individual neurons furthermore gives rise to noise at the module level that tends to disrupt synchronization and can lead to the appearance of phase gradients and of phase waves in a spatially extended network. As a result, the phase dynamics in a 1D chain of E-I modules is found to be described by the Edwards-Wilkinson, KPZ or noisy Kuramoto-Sivashinsky equations. We characterize the above-mentioned phenomena and discuss their relations to experimental observations.