THE EMERGENCE OF SPONTANEOUS ACTIVITY IN NEURONAL CULTURES

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In vitro neuronal networks of dissociated hippocampal or cortical tissues are one of the most attractive model systems for the physics and neuroscience communities. Cultured neurons grow and mature, develop axons and dendrites, and quickly connect to their neighbors to establish a spontaneously active network within a week [1]. The resulting neuronal network is characterized by a combination of excitatory and inhibitory integrate–and–fire units coupled through synaptic connections, and that interact in a highly nonlinear manner. The nonlinear behavior emerges from the dynamics of both the neurons' membrane potential and synaptic transmission, together with intrinsic biological noise. These ingredients give rise to a rich repertoire of phenomena that are still poorly understood, including the emergence and maintenance of periodic spontaneous activity, avalanches of activity, propagation of activity fronts, synchronization, or activity-driven plasticity. In this work we present some experimental results on the rich activity of cultured neuronal networks, and introduce a theoretical and numerical model to describe the experimental observations. We finally discuss on the applicability of the experimental and theoretical resources to gain insight on general functional aspects of neuronal tissues.

[1] J. P. Eckmann et al. Phys. Rep. **449**, 5476 (2007).