Connectivity and Synchronous Firing in Growing Cortical Neuronal Networks

Chi Keung Chan

Institute of Physics, Academia Sinica

Spontaneous synchronized activity is an important phenomenon in developing neuronal cultures. However, the network dynamics underlying such activity are still not well understood. Network connectivity (k) of growing cortical neural cultures are studied by synchronized firing and determined from measured correlations between fluorescence intensities of firing neurons. The bursting frequency (f) during synchronized firing of the networks is found to be an increasing function of k. With f taken to be proportional to k, a simple random model with a k dependent connection probability $p(k)$ has been constructed to explain our experimental findings successfully. The growth of the network is consistent with the model of an early enhanced growth of connection, but followed by a retarded growth once the synchronized cluster is formed. Microscopic models with dominant excluded volume interactions are consistent with the observed exponential decay of the mean connection probability as a function of the mean network connectivity. The biological implications of the growth model are also discussed.