SYNCRONIZATION IN BIOPHYSICAL NEURAL NETWORKS

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Electrical recordings of neural activity reveal that synchronous oscillatory behaviour occurs in different brain areas and some of these rhythms (30 – 100 Hz) seem to be implicated in the information coding [Gray & Singer, 1989;]. Experimental results suggest that the binding process, during a sensory task, could be explained by assuming that neuron populations synchronize their firing activities [Gray et al., 1989]. There is increasing evidence that inhibitory interneurons contribute to the brain rhythms by synchronizing the discharges of many pyramidal cells, but how the coupling between interneurons promotes their synchronization is not well understood [Lytton & Sejnowski, 1991; Wang & Rinzel, 1992; Cobb et al., 1995; Whittington et al., 1995; Beirlein et al., 2000]. However, recent studies on the neocortex have shown that both chemical and electrical coupling among cells play an important role in determining the synchronous discharge of coupled Fast-Spiking (FS) interneurons [Galarreta & Hestrin, 1999; Gibson et al., 1999; Beirlein et al., 2000]. In particular it was found that, besides inhibitory chemical synapses, the existence of electrical coupling among FS cells provides an additional synchronization mechanism for FS interneurons.

In this study, by using a biophysical single-compartment model of FS interneuron, we first investigate the dynamical properties of a single self-inhibited unit, then we analyze the synchronization phenomena in small networks of FS cells interacting by means of chemical and electrical synapses. In particular we study how the coupling features (like the decay time of the synaptic current and coupling intensities) influence the synchronization properties of FS cells.

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