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Phase-locking and bistability in neuronal networks with synaptic depression

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Abstract

We consider a recurrent network of two oscillatory neurons that are coupled with inhibitory synapses. We use the phase response curves of the neurons and the properties of short-term synaptic depression to define Poincaré maps for the activity of the network. The fixed points of these maps correspond to phase-locked modes of the network. Using these maps, we analyze the conditions that allow short-term synaptic depression to lead to the existence of bistable phase-locked, periodic solutions. We show that bistability arises when either the phase response curve of the neuron or the short-term depression profile changes steeply enough. The results apply to any Type I oscillator and we illustrate our findings using the Quadratic Integrate-and-Fire and Morris-Lecar neuron models.

Keywords: Coupled Oscillators, Phase Response Curve, Two-dimensional Poincarè Map, Bistability, Short-Term Synaptic Depression

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