Diversity-induced decoherence in a slow-fast neuron model

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Abstract: The effects of noise and heterogeneity (or diversity) on neural dynamics have been extensively studied. Some studies emphasized the possibility of amplifying the response of a network to an external signal driven by noise or diversity. Other studies highlighted that noise or diversity could generate significant resonance effects, even without an external signal, causing coherent oscillations. An example of the latter kind is self-induced stochastic resonance (SISR). On the other hand, a few works have analyzed the combined effects of noise and diversity in neural dynamics. These studies mostly led to the conclusion that adding optimal diversity on top of noise results in a further enhancement of resonance effects caused by noise alone, i.e., the role of optimal diversity is always constructive. However, in this talk, we use slow-fast analysis, mean-field approach, and numerical simulations to demonstrate that, in contrast to previous literature, showing that network diversity can always be optimized to enhance collective behaviors such as synchronization or coherence, the effect of diversity on SISR, instead, can only be \textit{antagonistic} --- a nontrivial effect which we call diversity-induced decoherence (DIDC). Our result indicates that diversity's enhancement or deterioration of noise-induced resonance phenomena in neurons strongly depends on the underlying mechanism.
