Stochastic synchrony of neuronal oscillators: A Fokker-Planck study with the finite-element method

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Abstract

The interest in stochastic processes has increased remarkably in the last few years, in part motivated by the investigation of the constructive role of noise in many biological systems. A quantitative description of these phenomena often requires the solution of complicated Fokker-Planck equations (FPE). Here, we apply an efficient approach from computational engineering, the finite-element method, to numerically solve the Fokker-Planck equation in two dimensions. This approach permits us to find the solution to complicated stochastic problems. We illustrate our method by studying the stochastic synchronization of neuronal oscillators, a phenomenon that has attracted considerable attention in neuroscience recently. In particular, we show that resonators (type II neural oscillators) respond and synchronize more reliably when provided correlated stochastic inputs than do integrators (type I neural oscillators). This result is consistent with recent experimental and computational work.

Key words: stochastic synchronization, neuronal reliability, integrators, resonators, computational engineering.