

Phase-amplitude Descriptions of Stochastically Forced Neural Oscillators

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The study of stochastically forced limit-cycle oscillators has seen much attention in recent years. Typical approaches to study such systems involve the reduction of the system to one described solely by a phase on-cycle, using the same machinery as for the deterministic case, namely, through the infinitesimal phase response curve. This reduction can be performed under the assumption that the strength of the forcing is weak, and that the limit cycle is sufficiently strongly attracting. However, the main limitation of this approach is that invariant structures at a finite distance away from the limit cycle can have pronounced effects of the emergent behaviour of the system. Since a phase-only model uses information local to the limit cycle, these models cannot capture the effects of such structures. Where the strength of the noise is not weak, and the deterministic part of the system is multi-stable, stochastic forcing can cause sample paths to switch between basins of attractions of different invariant sets. In this talk, I will introduce a coordinate system for planar models, akin to the phase-only description, that includes an amplitude variable that captures the distance away from the limit cycle. I will use this coordinate system to study a canonical model introduced as a model for fluctuations of EEG recordings in the alpha band. Using this model, I will discuss how the nature of the stochastic forcing can shift bifurcations, destroy attractors and affect transition rates between attractors.