Emerging regularity in stochastic population dynamics - Coupled Circadian clocks in Anabaena

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Abstract

The classical approach to population dynamics relies on characterizing the densities of species through a system of ordinary differential equations, which incorporates the interactions being at play. As opposed to this formulation, a different level of modeling can be invoked by focusing instead on an individual-based description, which is intrinsically stochastic. For finite size populations, demographic noise acts as a source of endogenous perturbation, shaking the system from the inside. In this talk I will discuss, in simple terms and building on examples, how the noisy component of the dynamics, as stemming from the discreteness of the scrutinized sample, can yield the emergence of quasi-regular patterns. Microscopic disorder can hence materialize in macroscopic order, a counterintuitive mechanism which could be exploited by living systems to orchestrate a multitude of different functions. As an example, I will report our recent findings on the dynamics of a circadian clock-controlled gene at the individual cell level in Anabaena, a multicellular filamentous cyanobacterium. A stochastic one-dimensional toy model of coupled clock cores and their phosphorylation states reproduces the experimentally observed spatio-temporal coherence along filaments thus providing a robust description of coupled circadian clocks in a multicellular organism.

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