Title: A population density approach to the mammalian circadian clock

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Abstract:
With the population density approach, instead of tracking the state of each oscillator in a large population, one may consider the primary variable of interest to be the population density over state space. After accounting for additive Gaussian noise and coupling within the population, the population density is governed by a non-linear and non-local integro-advection-diffusion differential equation. When the state space has many dimensions, it appears that nothing has been gained by trading a large number of state variables for a differential equation with a large number of dimensions. We exploit the fact that the population of limit cycle oscillators occupy only a small amount of the state space. An efficient numerical method for solving the governing equation for the population density results from discretizing over particles in a grid free approach and utilizing a diffusion velocity method. We are thus permitted to study the dynamics of a population of noisy coupled oscillators without having to resort to dimension reduction strategies. In this talk, I will detail our numerical method and present its application to two coupled oscillator problems related to the study of the mammalian circadian clock - the molecular clock and the electrophysiology of neurons within the suprachiasmatic nucleus.

Keywords: population density approach, coupled oscillators, numerical method