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Stochastic Oscillations in Biology

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Oscillations are ubiquitous in biology and are widely thought to play an essential functional role. Most biological systems are also inherently stochastic, and a key challenge for modelers is to understand how the function of the oscillation can remain robust despite significant noise. This talk has two main components. In the first component, I will outline a general method for studying the effect of noise on discrete chemical reaction networks with a large number of particles. Assuming that the averaged system (obtained by taking the large N limit) is oscillatory, I perform a phase reduction procedure to map the high dimensional stochastic system to a one-dimensional phase. I then outline an accurate approximation for the stochastic dynamics of the phase, and I bound the probability of the system leaving a neighborhood of the oscillation, showing that over timescales diverging in N, this is exponentially unlikely. In the second part of the talk I will touch on recent work to understand intracellular stochastic oscillations in calcium. This mechanism of oscillation is different, because the averaged system is not necessarily oscillatory, and stochastic fluctuations can play an essential role even in the large N limit.