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Stochastic Chemical Kinetics in Biochemical Reaction Networks.
GAREGIN PAPOIAN, YUEHENG LAN, The University of North Carolina at Chapel Hill — We used various analytic and numerical methods to elucidate complex dynamics in stochastic signal transduction. We demonstrate that the commonly used linear noise approximation to solving the chemical master equation fails when the number of proteins becomes too low. Consequently, we developed a new analytical approximation to the solution of the master equation, based on the generating function approach, which works in a much wider range of protein number fluctuations. We show that in a linear signaling pathway, a reaction rate at a node could be tuned so the node acts either as a noise amplifier or as a noise filter. For more complex cascades, we mapped the stochastic chemical kinetics master equation into a quantum field theoretical problem, which we solved using the variational principle. We demonstrate stochastic resonance in signal transmission in enzymatic cascades with and without feedback loops.

Garegin Papoian
The University of North Carolina at Chapel Hill

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