Dynamics of the Quorum Sensing Switch: Stochastic and Non-equilibrium Effects

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Cells must face the ubiquitous presence of noise at the level of signaling molecules. The latter constitutes a major challenge for the regulation of cellular functions including communication processes. In the context of prokaryotic communication, the so-called quorum sensing (QS) mechanism relies on small diffusive molecules that are produced and detected by cells. This poses the intriguing question of how bacteria cope with the fluctuations for setting up a reliable information exchange. I will present models of gene expression that accounts for the main biochemical processes that describe the QS mechanism. Within that framework we have studied the role that diffusion plays in the regulation of the dynamics and the fluctuations of signaling molecules. In addition, we have unveiled the contribution of different sources of noise, intrinsic and transcriptional, in the QS mechanism. I will show that the interplay between noisy sources and the communication process produces a repertoire of dynamics that depends on the diffusion rate. Importantly, the total noise shows a non-monotonic behavior as a function of the diffusion rate. QS systems seems to avoid values of the diffusion that maximize the total noise. These results point towards the direction that bacteria have adapted their communication mechanisms in order to improve the signal-to-noise ratio and to promote adaptability.

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