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Noise and robustness in the cyanobacterial circadian oscillator
DAVID LUBENSKY, University of Michigan — Like humans and most higher animals, photosynthetic cyanobacteria possess an autonomous 24-hour circadian clock that allows them to anticipate daily changes in their environment. This oscillator is known to be extremely stable, with a correlation time on the order of 100 days in a single, isolated cell, even in the absence of any entraining signals from the environment. The origin of such remarkable robustness, however, remains mysterious. Here, we present a stochastic model of the biochemical circuitry underlying the clock, including both transcriptional feedback and the post-translational phosphorylation cycle that is thought to be the core oscillator. We find that the phosphorylation oscillator in isolation is highly resistant to the intrinsic noise associated with molecular discreteness, but that a growing, dividing cell is a considerably more challenging environment in which to sustain stable oscillations. We suggest that coupling the phosphorylation cycle to a clock based on delayed negative transcriptional feedback may substantially increase the robustness of both oscillators and detail how this enhancement comes about.

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