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Dynamic phases in control and information processing biological circuits SURIYANARAYANAN VAIKUNTANATHAN, University of Chicago — Recent work using the mathematical framework of large deviation theory has shown that fluctuations about the steady state can have a particularly rich structure even in extremely simple non-equilibrium systems [Phys. Rev. E. 89, 062108, 2014]. In certain instances the fluctuations can encode the presence of a dynamical phase with properties distinct from those of the steady state of the system. The transition between these two regimes is akin to a first order thermodynamic phase transition. Specifically, it implies an extreme sensitivity of the system to changes in certain sets of parameters. I will show that such dynamical phase transitions can serve as a general organizing principle to understand biological circuits that are involved in information processing and control. I will focus on two specific examples: adaptation control in E. coli chemotaxis and ultra sensitive response of the E. coli flagella motor, to illustrate these calculations. This work also elucidates the role played by energy dissipation in ensuring control and suggests general guidelines for the construction of robust non equilibrium circuits that perform various specified functions.

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