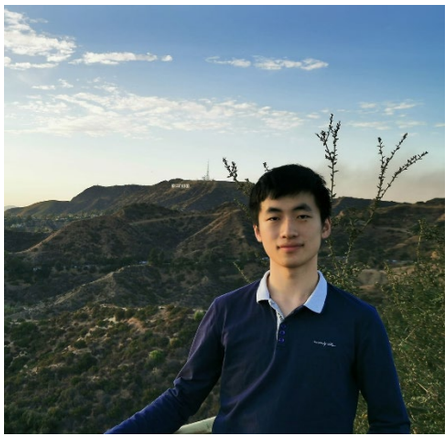
PHYSICAL MATH SEMINAR

Nonequilibrium Physics of Biological Functions: Bacterial Chromosome Segregation and Chemotaxis Signaling as Examples



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ABSTRACT:

Living systems operate far from equilibrium. Continuous dissipation of free energy is required to fulfill a wide range of biological functions—from error correction and environmental sensing to collective behaviors. The close connection between dissipation and function raises two physics questions: (1) How can we quantify dissipation in a complex biological system, especially when only mesoscopic degrees of freedom are accessible? (2) What is the mechanism by which nonequilibrium dynamics is harnessed to execute specific functions?

This talk will cover our progress on both fronts. To address the first question, we developed a renormalization-group-type analysis in coarse-grained nonequilibrium systems, which revealed a scaling law for energy dissipation. I will then focus primarily on the second question and present our recent work on two nonequilibrium processes in Escherichia coli: how nonequilibrium polysome dynamics couples chromosome segregation to cell growth, and how dissipative interactions in the chemosensory array enhance signaling speed, sensitivity, and robustness. These examples illustrate the importance of nonequilibrium processes in living systems.

TUESDAY, APRIL 22, 2025

2:30 PM – 3:30 PM

Building 2, Room 449

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