Ben-Gurion University of the Negev
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Optical Nanoprobes for the Nonequilibrium Features of Life

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Abstract:

Far-from-equilibrium processes constantly dissipate energy while converting a free-energy source to another form of energy. Living systems, for example, rely on an orchestra of molecular motors that consume chemical fuel to produce mechanical work. Drawing inspiration from biology, where the underlying nonequilibrium activity give rise to a plethora of emergent collective phenomena such as adaptation, pattern-formation, prediction, self-replication, decision-making, computation, etc., we strive to capture their mechanistic essence in order to mimic life-like behavior in synthetic systems. In this talk, I will describe two features of living systems, namely, time-irreversibility, and nonequilibrium self-assembly. I will introduce a novel approach to quantify the breaking of time-reversal symmetry and estimate the dissipation from time-series measurements, even in the absence of observable currents. Further, I will explore the added benefits achieved by nonequilibrium driving, identify distinctive collective phenomena that emerge in nonequilibrium self-assembly, and demonstrate the interplay between the assembly speed, kinetic stability, and relative population of dynamical attractors. Finally, I will describe my experimental work on optical nanoprobes for molecular targets and active processes using fluorescent single-walled carbon nanotubes.

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