



## ICTS Biophysics Seminar

**Title** : Self-Organization Driven by Biochemically Enhanced Diffusion: Active Thermodynamic Force and Maxwell's Demon

**Speaker** : Tetsuhiro Hatakeyama (Earth-Life Science Institute, Japan)

**Date** : Wednesday, 11 March 2026

**Time** : 11:30 AM (IST)

**Abstract** : How do biological systems generate macroscopic order from microscopic fluctuations? In this presentation, we propose a unified theoretical framework showing that the enhancement of non-directional motion coupled with biochemical reactions is a fundamental driver of self-organization. We discuss two distinct phenomena where activity-dependent increases in undirected motility lead to the emergence of order.

At the cellular level, we elucidate the spatial patterning of mitochondria in nerve axons, where ATP synthesis locally intensifies the non-directional fluctuations of mitochondria. This enhancement in undirected motion generates an "active thermodynamic force," an effective repulsion that autonomously organizes the mitochondria into an equidistant spatial array.

At the molecular level, we demonstrate how Enhanced Enzyme Diffusion (EED), the acceleration of an enzyme's diffusion during catalysis, functions as a Maxwell's demon. This enhancement acts as a memory of past reactions, driving the system away from chemical equilibrium.

**Venue** : Feynman Lecture Hall

Zoom Link: <https://icts-res-in.zoom.us/j/93273708120?pwd=nnR2KcEQKvSJKQfb4D4vyyHauhrsiG.1>

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