Colloquium

MAX PLANCK INSTITUTE
FOR DYNAMICS AND
SELF-ORGANIZATION

Stochastic processes in cells and tissues

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Stochastic phenomena play a fundamental role in many biological systems, ranging from gene regulation to cell-fate determination. Understanding such phenomena raises new theoretical challenges at the interface between stochastic processes, statistical physics and computation. In this talk I will present some recent advances that our group has made in this direction. In the first part of the talk, I will show how cells can use phase coexistence to control and suppress protein concentration fluctuations. Using a non-equilibrium model that links active protein synthesis and turnover to the physics of multicomponent phase separation, I will show that concentration fluctuations can be strongly reduced in the presence of phase separated compartments. I will present experimental single-cell data in synthetic and endogenous compartments, which support this prediction. In the second part of my talk, I will focus on inverse problems and how stochastic processes can be robustly inferred from limited experimental data. As an example, I will present a statistical method to quantify CTCF/cohesion-mediated chromatin looping dynamics from two-point live-imaging measurements. The method combines a simple polymer model with a Bayesian filtering approach to infer loop lifetimes and frequencies. When applied to experimental data, this method revealed that chromatin loops are surprisingly rare (~5% looped fraction) and short-lived (~10-30mins loop lifetime). I will conclude my talk by outlining several important challenges for the future.

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