Soft Living Active and Adaptive Matter

Liquid-liquid phase separation out of equilibrium

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Abstract:

Living cells contain millions of enzymes and proteins, which carry out multiple reactions simultaneously. To optimize these processes, cells compartmentalize reactions in membraneless liquid condensates. Certain features of cellular condensates can be explained by principles of liquid-liquid phase separation studied in material science. However, biological condensates exist in the inherently out of equilibrium environment of a living cell, being driven by force-generating microscopic processes. These cellular conditions are fundamentally different than the equilibrium conditions of liquid-liquid phase separation studied in materials science and physics. How condensates function in the active riotous environment of a cell is essential for understanding of cellular functions, as well as to the onset of neurodegenerative diseases. Currently, we lack model systems that enable rigorous studies of these processes. Living cells are too complex for quantitative analysis, while reconstituted equilibrium condensates fail to capture the non-equilibrium environment of biological cells. To bridge this gap, we reconstituted a DNA based membraneless condensates in an active environment that mimics the conditions of a living cell. We combine condensates with a reconstituted network of cytoskeletal filaments and molecular motors, and study how the mechanical interactions change the phase behavior and dynamics of membraneless structures. Studying these composite materials elucidates the fundamental physics rules that govern the behavior of liquid-liquid phase separation away from equilibrium while providing insight into the mechanism of condensate phase separation in cellular environments.

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Time:
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About the speaker:

Dr. Alexandra Tayar is an LSRF simons foundation postdoctoral fellow at University of California, Santa Barbara. She studies active matter at the Dogic lab, and develops DNA-based soft materials and force sensors.

Dr. Tayar received her Ph.D. in physics from the Weizmann Institute, where she developed microfluidic tools and studied the non linear dynamics of cell-free gene expression

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