Seminar/Talk

Zooming Through the Cellular Labyrinth: Journeys to the Nuclear Pore and Chromatin

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Host: Martin Loose

Biomolecular dynamics govern cellular architecture, homeostasis, and adaptive responses to environmental stress. While structural biology has been transformative in defining molecular form and function, many essential processes are driven by transient and mechanically coupled dynamics that remain difficult to capture. Cryo-EM and X-ray crystallography provide exquisite structural detail but are limited in temporal resolution and often require non-physiological conditions, whereas spectroscopic approaches such as FRET and NMR lack direct real-time visualization of structural transitions. High-speed atomic force microscopy (HS-AFM) bridges this gap by enabling real-time nanoimaging of biomolecular dynamics under near-physiological conditions with high spatiotemporal resolution and minimal perturbation. In this talk, I will show how HS-AFM moves us beyond static snapshots toward living structural landscapes, focusing on nuclear pore complexes (NPCs), chromatin organization, microtubule dynamics, and extracellular vesicles. Our work reveals that NPCs are highly dynamic, mechanically adaptive assemblies that regulate nucleocytoplasmic transport while shaping perinuclear chromatin architecture. HS-AFM captures transient interactions between NPCs and chromatin-associated proteinsgenome guardians coordinating transcription, DNA repair, and stress responses. Extending this dynamic view to cytoskeletal systems, we also visualize asymmetric protofilament failure and spontaneous rescue events during microtubule disassembly, revealing unexpected stabilization mechanisms. Conceptually, this nanoscale perspective aligns with active-matter studies showing how single-filament propertiessuch as flexibility, density, and chiralitygovern emergent mesoscopic order, exemplified by chiral and nematic phase transitions in reconstituted cytoskeletal filaments. Together, these findings demonstrate how nanoscale dynamics at organelle and filament interfaces integrate transport, genome regulation, and cytoskeletal remodeling, providing a framework for understanding disease-relevant processes in cancer, neurodegeneration, infertility, and viral infection.

Thursday, January 29, 2026 01:00pm - 02:00pm

Moonstone Bldg / Ground floor / Seminar Room G (I24.EG.030g)

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