ASU Department of Physics
Arizona State University

COLLOQUIUM

Thursday, August 31, 2023

Refreshments at 3:15pm in PSF 186
Colloquium from 3:30pm - 4:30pm in PSF 101

Probing Biomolecular Fluctuations Under Tension with Multi Axial Entropic Spring Tweezer Along Ring-Shaped Origami (MAESTRO)

Professor Rizal Hariadi

Arizona State University

Abstract:

Many processes in cells often operate amidst mechanical tension. To gain insights into the implication of tension for biomolecular dynamics, scientists systematically measure the structural change and functions of biomolecules under mechanical forces. While clever scientific tools have been employed to mechanically manipulate biomolecules under tension, existing technologies often present limitations. The two main pain points are the inability to apply multi-axial tension and low throughput due to intricate operational procedures. In this talk, I will present MAESTRO as a potentially transformative technology for high throughput manipulation of biomolecules under tension. Here, we use the exquisite positional control of DNA origami structures to place 2 or more calibrated entropic springs at 5 nm resolution. These entropic springs exert multi-axial tensions at 0–10 pN on FRET-pair-labeled biomolecules. We benchmark MAESTRO using fluctuation measurements of tethered Holliday junctions immobilized on surfaces and compare our findings with published data obtained using a hybrid of optical trap and TIRF microscope. Further, we extend our measurement to measuring Holliday junction fluctuations far from surfaces using a confocal single-molecule FRET platform, showcasing the versatility and depth of MAESTRO's insights. Finally, I will conclude with a discussion on the transformative potential and future directions of MAESTRO, including using DNA origami nanoarrays for high-throughput single-molecule biophysics of integrin signaling under tension and solving integrin structure under tension using cryo-electron microscopy.

Biography:

Rizal Hariadi was born in Surabaya, Indonesia. He joined Arizona State University in 2016 as an Assistant Professor in the Department of Physics and the Biodesign Institute, where he established BIOmolecular Nanosystems with Increasing Complexity and Size (BIONICS) Laboratory. His passion for science began with an enlightening experience in the Indonesian Physics Olympiad team, leading to his undergraduate degrees at Washington State University under the tutelage of Tom Dickinson, followed by a Ph.D. at California Institute of Technology. There, Rizal focused on the non-equilibrium dynamics of DNA nanotubes and the hydrodynamics of bursting bubbles under the guidance of Erik Winfree and Bernard Yurke. He subsequently completed postdoctoral research in single-molecule biophysics at both the University of Michigan with Sivaraj Shivaramakrishnan and the Wyss Institute at Harvard University with Peng Yin. Currently, his interdisciplinary team at Arizona State University develops precision tools from the molecular to centimeter-scale for bottom-up reconstruction of mechanical systems involved in disease pathogenesis. Along the way, the lab immerses itself in the mystery of the origin of life and develops frugal technologies in the global health context for resource-poor settings. Rizal is the recipient of an Arizona Biomedical Research Commission New Investigator Award and an NIH Director's New Innovator Award. Integral to his research program is creating an inclusive research laboratory that consists of 6 undergraduate, 2 graduate students, 2 postdocs, and a comic illustrator from diverse backgrounds and career goals.

Host: Prof. Cindy Keeler
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