Indian Institute of Science
Centre for BioSystems Science and Engineering
BSSE Seminar

4th September 2019 (Wednesday), 4:00 PM, MRDG Seminar Hall, 1st floor, Biological Sciences Building

Out-of-Equilibrium Modeling of Biomembranes

Dr. Nikhil Walani

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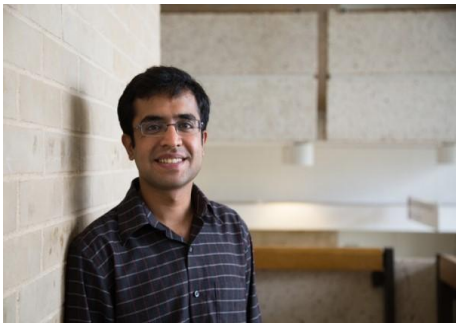
ABOUT THE SPEAKER



Dr. Nikhil Walani is currently a postdoctoral researcher at computational mechanics group in UPC (BarcelonaTech) working with Prof. Marino Arroyo. He did his PhD from University of Houston (Fall 2015) with Prof. Ashutosh Agrawal and researched the mechanics of cellular transport. He showed the presence of snapthrough instability in clathrin mediated endocytosis and received the Best Dissertation Award amongst engineering graduates for Fall 2015. Prior to this, he was at IIT Kanpur for the Bachelors in Civil Engineering. He is currently working on theoretical and computational modeling chemo-physical interaction of proteins with cell membranes.

ABSTRACT

Biological cells and various organelles within them are enveloped by membrane that provides selective barrier to allow for their specific functions. These membranes are made up of lipids stacked in bilayers with a typical thickness of 4-5 nm. This is much smaller as compared with their lateral dimensions of a few microns for organelles and cells, allowing them to be treated as surfaces. This surface has a unique property of being viscous fluid for in-plane deformations while exhibiting curvature elasticity for out of plane deformations. This combination allows the cells to retain structural integrity while being malleable enough to adapt its shape in response to applied forces. These membranes are frequently brought out of equilibrium due to interaction with various proteins, a set of which are curved and interact with the membrane by preferentially binding or diffusing to the similarly curved regions of the surface. Membrane-protein interaction is important for many cellular processes such as endocytosis, where the membranes are required to undergo large deformations to engulf the nutrients, or mechano-protection of cells under stretches and osmotic shocks, by opening up of protein formed membrane folds such as caveolae and tubes to buffer area. To address these issues, we propose a model based on Onsager's variational principle of irreversible thermodynamics. We depict the dynamics of sorption and diffusion of curvature inducing proteins on an evolving membrane shape. The resulting calculations allow us to understand various experimental observations and systematically predict the curvature sensing or generation capabilities of a protein-membrane system depending on a few key physico-chemical parameters.