Soft Living Active and Adaptive Matter

The Equation of State of a Tissue

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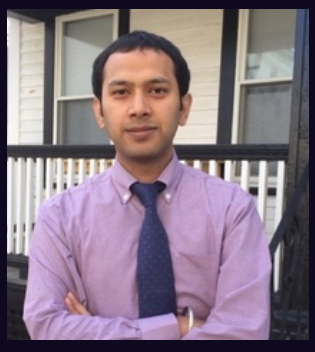
Abstract:

An equation of state is something you hear about in introductory thermodynamics, for example, the Ideal gas equation. The ideal gas equation relates the pressure, volume, and the number of particles of the gas, to its temperature, uniquely defining its state. This description is possible in physics when the system under investigation is in equilibrium or near equilibrium. In biology, a tissue is modeled as a fluid composed of cells. These cells are constantly interacting with each other through mechanical and chemical signaling, driving them far from equilibrium. Can an equation of state exist for such a messy interacting system? In this talk, I show that the presence of strong cell-cell interaction in tissues gives rise to a novel non-equilibrium, size-dependent surface tension, something unheard of for classical fluids. This surface tension, in turn, modifies the packing of cells inside the tissue generating a size-dependent density and pressure. Finally, we show that a combination of these non-equilibrium pressure and densities can yield an equation of state for biological tissues arbitrarily far from equilibrium. In the end, I discuss how this new paradigm of size-dependent biological properties gives rise to novel modes of cellular motion in tissues

Date:
05/23/2022

Time:
9:00 AM-10:15 AM (PT)
12:00 PM-1:15 PM (ET)

About the speaker:



Vikrant Yadav is an Associate Research Scientist at the Department of Biomedical Engineering at Yale, where he works in the lab of Prof. Michael Murrell. He is interested in studying cytoskeletal mechanics and how it relates to mechanical and thermodynamical properties of cells and tissues. He uses experiments, agent-based simulations, ideas from continuum mechanics, and non-equilibrium thermodynamics to understand the behavior of simple biological systems arbitrarily far from equilibrium.

An experimental physicist by training, Vikrant got his Ph.D. studying granular mechanics of rod-like particles at Clark University in the group of Prof. Arshad Kudrolli. He then joined as a postdoctoral fellow at the University of Massachusetts – Amherst in the group of Prof. Jennifer Ross, where he trained as a biophysicist and worked with reconstituted cytoskeletal networks. He has a Master's degree in Physics from the Indian Institute of Technology – Kharagpur.

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Sign up at physics.ucmerced.edu/slaam/ to be included in the mailing list to receive a Zoom link.

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