



PHYSICS COLLOQUIUM: Collective Behavior Underlying the Mechanobiology of Tissues

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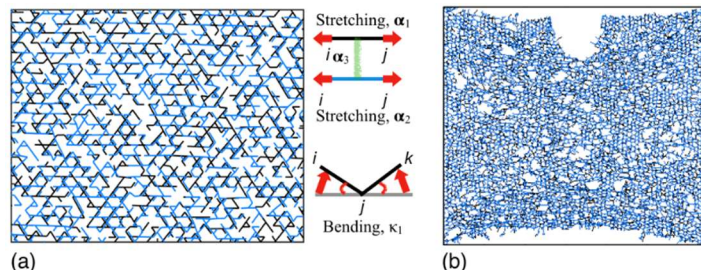
About The Speaker:

Das is a theoretical soft matter and biophysicist, and is an Associate Professor of Physics at the Rochester Institute of Technology. Her group's research focuses on the interplay of mechanics, statistical mechanics, and geometry in structure-function properties of cells and tissues, supported by awards from the National Science Foundation, Keck Foundation, Moore Foundation, and Research Corporation. Das is also an advocate for women and under-represented groups in Physics and is committed to increasing their participation and visibility in STEM. Das received her Ph.D. in Physics from the Indian Institute of Science, Bangalore, India, and did postdoctoral research at Harvard University, UCLA, and Vrije Universiteit Amsterdam in the Netherlands. She has been on the faculty at RIT since 2012.

Date:
9/18/2020

Time:
10:30 AM-11:50 AM

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Abstract:

Living cells and tissues are highly mechanically sensitive and active. Mechanical forces and stimuli influence the shape, motility, and functions of cells, modulate the behavior of tissues, and play a key role in diseases as different as osteoarthritis and cancer metastasis. In this talk, I will discuss how collective biophysical properties of tissues emerge from the interplay between different mechanical properties and statistical physics of underlying components. I will use examples of two complementary tissue types to illustrate how the emergent mechanobiology of tissues is facilitated by their heterogeneous and composite nature, and proximity to phase transitions. I will start with mechanical structure-function relationships in articular cartilage (AC), a soft tissue that has very few cells, and its mechanical response is primarily due to its network like extra-cellular matrix. AC is a remarkable tissue: it can support loads exceeding ten times our body weight and bear 60+ years of daily mechanical loading and resist fracture, despite having minimal regenerative capacity. I will discuss the biophysical principles underlying this exceptional mechanical response using the framework of rigidity percolation theory, and compare our predictions with experiments done by our collaborators. Next, I will discuss how differences in cell mechanics, adhesion, and proliferation in a co-culture of breast cancer cells and healthy breast epithelial cells may modulate experimentally observed phase separation and transport properties. Our results may provide insights into the mechanobiology of tissues with cell populations with different physical properties present together, such as during the formation of embryos or the initiation of tumors. By obtaining a mechanistic understanding of the biophysical properties of these two systems, we hope to elucidate principles underlying the robustness and tunability of tissue properties and gain insights into design principles for soft robotics.

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