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University of Miami, Physics Department Colloquium

Date: Wednesday, Jan 28, 2026
Time: 4:00 pm – 5:00 pm
Location: Physics Library – Rm 335, Knight Physics Building

Topology, Geometry, and Dynamics of Living Matter

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Abstract

Living systems exhibit rich geometries and display intriguing, nontrivial spatiotemporal dynamics and pattern formation. In the first part of this talk, I demonstrate how continuum descriptions can be systematically constructed and employed to understand and predict the mechanical pattern formation and dynamics of active living suspensions, including bacterial colonies, eukaryotic cells and tissues, and active microtubule suspensions, in both two and three dimensions.

As a concrete example, I show in detail how such continuum theories can be used to understand the emergence of topological defects in two-dimensional systems and disclination lines in three-dimensional active filament suspensions. These frameworks naturally give rise to interfacial patterns in bacterial systems and enable the identification of the characteristic length and time scales governing the development of these patterns.

Many living systems—such as tissues and embryos—are neither strictly two-dimensional nor fully three-dimensional, but instead form thin, active layers. In the second part of the talk, I discuss how finite thickness fundamentally influences the evolution of such systems. I present a systematic continuum framework that captures shape deformations, thickness variations, and fluid flows in thin living layers embedded in three-dimensional space and composed of active force-generating units. I then illustrate the applicability of these theories to a range of biological phenomena, including growth and morphogenesis in the unicellular ----alga Caulerpa and digit formation in vertebrates.