East Carolina University®
Departments of Physics

Physics Colloquium

Friday, March 7th, Room N109, Howell Science Complex
3:15 p.m. (Refreshments at 3:00 p.m.)

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Biomolecules are confined within a crowded, complex intercellular environment. Proper cellular functionality requires separation into a spatially controlled organization. This organization, known as condensates, may be membrane-bound or membrane-less and is formed through phase separations. As a result, phase separation serves as a universal mechanism for creating compartments in living cells. However, compartments and cells are not static; they continuously undergo shape changes. Therefore, the phase transition temperature and pressure fluctuate within systems with moving boundaries (moving surfaces or manifolds). Typically, three laws—the Young-Laplace, Kelvin, and Gibbs-Thomson equations—are used to model thermodynamic changes in systems with nearly static, spherical shapes. Generalizing these laws to describe shape dynamics has proven to be a complicated challenge that requires new advancements in differential geometry known as calculus for moving surfaces (CMS). I apply CMS to derive equations for surface dynamics or moving manifolds. Specific solutions to these equations generalize the Young-Laplace, Kelvin, and Gibbs-Thomson laws, transforming our understanding of colloidal sciences. These solutions also function as manifold solutions for the Navier-Stokes equations. Therefore, the incompressible Navier-Stokes equations have geometric solutions constrained by the curvature tensor of the closed smooth manifold for every smooth surface velocity field. Consequently, solutions converge in systems with constant volumes, significantly influencing cell shape dynamics and membrane pattern formation. Cells are nearly incompressible systems, so their shape dynamics and patterning result from surface dynamics.

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