



2023 SEMINAR SERIES

Attend virtually: <https://udel.zoom.us/j/91386404306>*INTERFACIAL COLLOIDAL INTERACTIONS, DYNAMICS, AND ASSEMBLY: FROM BIOMEMBRANES TO ORDERED 2D MATERIALS*

OCT 20 | 10:00 AM | 102 COLBURN LAB

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Soft matter interfaces are ubiquitous across diverse technologies ranging from pharmaceuticals to chemical formulations. They occur whenever surface-active molecules or particles appear at fluid interfaces, giving the interface distinct properties in response to flow, deformation, and external fields. This talk will focus on colloidal interactions in two such systems: crowded artificial biological membranes and anisotropic particles at air-water interfaces. The lateral diffusion of cell membrane inclusions, such as integral membrane proteins, drives critical biological processes like cell signaling and membrane trafficking. In the first part of the talk, we discuss the effects of increasing concentration of model membrane inclusions in an artificial cell membrane on inclusion diffusivity and the apparent viscosity of the membrane. By multiple particle tracking of fluorescent microparticles bound to the bilayer, we measure a transition from expected Brownian dynamics to subdiffusive behavior and a concurrent increase in the apparent membrane viscosity as the particle area fraction increases towards physiological levels of crowding. These results demonstrate how membrane crowding can nontrivially alter fluidity and dynamics, which has implications for understanding membrane protein interactions and nanoparticle-membrane transport processes. In the second part of the talk, we highlight our recent discovery that particle surface porosity severely attenuates the capillary attraction between colloidal ellipsoids at fluid interfaces, enabling the development of ordered anisotropic 2D monolayers. Previously, anisotropic particles pinned at fluid interfaces tended towards disordered multi-particle configurations due to large, orientationally-dependent, capillary forces, which is a significant barrier to exploiting these particles to create functional self-assembled materials. To create long-range ordered structures with complex configurations via interfacially trapped anisotropic particles, control over the interparticle interaction energy is necessary. We first developed the synthesis of polymer ellipsoids with controlled nanoscale surface topography (roughness and porosity). By monitoring the dynamics of two particles approaching one another, we find that porous particles exhibit a strikingly shorter-range capillary interaction potential. Interferometry measurements of the fluid deformation surrounding a single particle quantitatively confirm the decrease in capillary interaction energy and point to roughness-induced changes to interfacial pinning as the mechanism for reduced attraction. Lastly, we show how this reduction in interparticle capillary attraction and alteration in interfacial pinning manifests in the overall 2D interfacial assembly of such particles, informing an approach for the development of anisotropically ordered 2D materials.

ABOUT THE SPEAKER

Peter Beltramo is an Assistant Professor in the Department of Chemical Engineering at UMass Amherst. He earned a BS in Chemical Engineering from the University of Pennsylvania in 2009 and a PhD in Chemical Engineering from the University of Delaware in 2014, where he studied the electrokinetics and self-assembly of colloidal suspensions. Before starting at UMass Amherst in 2018, he completed a postdoc in Soft Materials at ETH Zurich. At UMass, his lab studies interfacial soft matter in contexts ranging from membrane biophysics and biomimetic materials to particle stabilized emulsions and ordered 2D materials. His recent recognitions include the NSF CAREER Award, ACS-PRF Doctoral New Investigator Award, and a Lilly Teaching Fellowship at UMass Amherst.

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