2024 Symposium on Soft Matter and Biological Physics

Saturday, Aug. 31st, 2024 (130 Hahn Hall North & Auditorium)

9:00 – 9:15 **Welcome & Opening Remarks**
Prof. John Morris (Acting Dean of the College of Science)
Prof. Randy Heflin (Senior Associate Vice President for Research and Innovation)
Prof. Mark Pitt (Chair of the Physics Department)
Prof. Shengfeng Cheng (Director of the Center for Soft Matter and Biological Physics)

Session I: Nadir Kaplan, Chair
9:15 – 10:00 *Keynote: Prof. Daniel Goldman* (Georgia Tech)
Life at low coasting number
10:00 – 10:15 Mohamed Khattab (Kaplan Lab), "Chemical species transport near a sharp corner"
10:15 – 10:30 Suryabrahmam Buti (Ashkar Lab), "A novel approach to tuning biomembrane structure and organization using Gemini surfactants"
10:30 – 10:45 Egor Kolesnikov (Onufriev Lab), "Fast, yet accurate molecular simulations: explicit ions in implicit water"

10:45 – 11:00 Coffee Break

Session II: Uwe Täuber, Chair
11:00 – 11:15 William Ducker, "Evaporation from porous coatings"
11:15 – 11:30 Venkata Yashasvi Lolla (Boreyko Lab), "Unique droplet dynamics on oil-impregnated fibers"
11:30 – 11:45 Denis Kucherenko (Korneva Lab), "The effect of pore pressure in fluid-saturated composites: a mathematical model applied to the human optic nerve"
11:45 – 12:00 Wenge Huang (J. Cheng Lab), "Low-temperature Leidenfrost-like jumping of sessile droplets on microstructured surfaces"
12:00 – 12:15 Vinh Nguyen, "Diffractive optics lenses on polyimide membranes"

12:15 – 1:15 Lunch

Session III: Rana Ashkar, Chair
1:15 – 2:00 *Keynote: Prof. Emanuela Del Gado* (Georgetown University)
Soft particulate networks and their hidden hierarchical nature
2:00 – 2:15 Guoliang Liu, "Plastics and surfactants – the two seemingly unrelated materials meet"
2:15 – 2:30 Ohnyoung Hur (Bartlett Lab), "Designing liquid metal microstructures from spherical to ellipsoidal via direct ink writing: methods and applications"
2:30 – 2:45 Shengfeng Cheng, "An analytical interaction potential for thin rods"

2:45 – 3:15 Coffee Break

Session II: Jing Chen, Chair
3:15 – 3:30 Matthew Asker (University of Leeds) "Fixation and extinction in fluctuating metapopulations with migration subject to bottlenecks"
3:30 – 3:45 Saptarshi Chatterjee (Chen Lab), "Predicting karyotypic outcomes in polyploid cell division through mathematical modeling"
3:45 – 4:00 Jason Czak (James Madison University), "Creating novel patterns with localized perturbations in non-linear reaction-diffusion systems"
4:00 – 4:15 Sara Shabani (Childs Lab), "Stochastic modeling of gene drives: Strategies for mosquito population control with male-linked genes"
4:15 – 4:30 Kenneth Distefano (Täuber Lab), "A tale of timescales: A prevention mechanism for total extinction within finite stochastic systems"

4:30 – 6:00 Business Meeting, Coffee Break, Poster Session

Abstracts of Keynote Talks

Prof. Daniel Goldman (Georgia Tech)

Life at low coasting number

Abstract: In 1974 Purcell authored a paper "Life at Low Reynolds Number" to describe the counterintuitive world of microscopic organisms in which viscous dissipation so dominates inertia that "coasting" is impossible, and that the geometry of a path in an internal movement space dominates self-propulsion. It is typically assumed that a key difference between self-propulsion in the microworld and in the world inhabited by macroscopic organisms (like those studied in my lab) is that inertial effects are negligible in the former, but not the latter. However, our experimental studies and theoretical models of organisms like lizards, snakes and centipedes moving in frictionally dissipative environments (like rough ground and granular media) have revealed that macroscopic locomotion bears similarities to microscopic locomotors. In both environments, a parameter we refer to as the "Coasting number" (which we define as the ratio of coasting time to a cyclic timescale and is related to the ratio of inertial to dissipative forces) is small (<0.1). As such, we can use microscopic organism modeling tools like Resistive Force Theory to gain insight into aspects of self-propulsion in granular and frictional systems. Most generally, the concept of geometric phase in locomotion introduced by Wilczek & Shapere in the 1980s as a framework for locomotion at low Reynolds number allows us to generate hypotheses for optimal movement in macroscopic systems. Coupling this to our approach of modeling living systems with robots (which we refer to as robophysics) gives us insights into control principles for effective locomotion. And surprisingly, our robophysical models show impressive mobility outside the lab, leading to my recent cofounding of a company, Ground Control Robotics, with the goal to develop robot swarms to discover and control weeds in specialty crop fields.

Prof. Emanuela Del Gado (Georgetown University)

Soft particulate networks and their hidden hierarchical nature

Abstract: Colloidal particles or agglomerated proteins, polymers, and other particulates, often form gels, where they are organized into a porous matrix embedded in a continuous fluid phase, providing rigidity and control of the mechanical response even with a small amount of solid material. Particulate gels are great at optimizing mechanical functionalities without necessarily blocking transport or diffusion, have highly adaptive and tunable rheological response, are highly reconfigurable, and can flow, be stretched, squeezed, or fractured. The microscopic physics that controls such rich mechanical behavior is notoriously challenging and elusive. We have developed microscopic simulations and statistical mechanics based analyses to investigate viscoelastic response, stress localization, reconfigurability, yielding, stiffening and failure in this class of materials. New physical understanding of the hierarchies of timescales and lengthscales embedded in the structural and mechanical disorder has emerged, with locally floppy and rigid domains interspersed with each other, and highlighting the importance of the network topology for hierarchical stress transmission and redistribution under load. While gaining insight into a range of experimental observations, these findings help build a new scientific basis for material design in areas from 3D printing to recycling, adaptive behavior and memory encoding.

List of Poster Presentations

1. Oscar Valenzuela (Greg Liu's Group), "3D printable thermally and electrically conductive PEI/LM composite"
2. Junwen Wang (Shengfeng Cheng's Group), "Molecular dynamics simulation of thin rod systems with an analytical interaction potential"
3. Mohammad Shamsodini Lori (Jiangtao Cheng's Group), "Predicting heat transfer and hydraulic characteristics in spray cooling by machine learning"
4. Summer Kantanen (Jason Czak's Group), "The impact of spatially localized feed parameter perturbations on reaction-diffusion systems"
5. Xin Wang (Greg Liu's Group), "Adsorption of model PFAS molecules for electrochemical analysis and remediation"
6. Binghan Liu (Shengfeng Cheng's Group), "Stratification in drying colloidal suspensions"
7. Carlos Posada (Greg Liu's Group), "From strawberry fields to α-olefins: A simple one-step conversion for 'forever' polyethylene waste"
8. Dinidu Hathnagoda (Rana Ashkar's Group), "Scale dependent bending deformations of biomimetic lipid membranes"
9. Chinmay Katke (Nadir Kaplan's Group), "Variational formulation of physics informed neural networks (vfPINN)"
10. Fangzhou Yu (Shengfeng Cheng's Group), "Computing the shape of a surface bubble with a physics-informed neural network"
11. Nuwayo Eric Munyaneza (Greg Liu's Group), "Upcycling of polyolefin waste to high-value surfactants"
12. Kalani Ellepola (Vinh Nguyen's Group), "Interfacial photogating of graphene field-effect transistor for photosensory biomolecular detection"
13. Wuzhou Zu (Michael Bartlett's Group), "Enhancing electrical conductivity of stretchable silver-EGaIn composites through direct ink writing"
14. Nusrat Jahan (Vinh Nguyen's Group), "Graphene field-effect transistors on p-doped semiconductors for photodetection"
15. Cecelia Cashin (Rana Ashkar's Group) "Biophysical effects of sterols on model cell membranes"
16. Megan Collins (Daniel Capelluto's Group), "Cas9- targeted *mPing* insertion in yeast"
17. Brendan Whitfield (Greg Liu's Group), "Multifunctional diblock copolymers for 3D printable nanoporous carbon materials"
18. Mohammad Swedat (Jonathan Boreyko's Group), "How condensation frosting depends on surface orientation and wettability"
19. Yue Zhang (Greg Liu's Group), "Thermal degradation and upcycling of polystyrene - containing polymers with AlCl3 for benzene production"
20. Jiarong Cui (Vinh Nguyen's Group), "Probing dynamics of transferrin aqueous solutions using high sensitivity terahertz dielectric spectroscopy"
21. Nicholas Pietra, Jubayer Alam, Mehedi Babu, Alex Irwin, Rebecca Martin (Lou Madsen's Group), "Self-assembled macromolecular materials for sustainable energy"

22. Ayoyinka Okedigba (Daniel Capelluto's Group), "Binding Affinity as a tool to decipher the interplay between soybean meal Kunitz and Bowman-Birk Trypsin Inhibitors and animal serine proteases"
23. Adeel Zia (Greg Liu's Group), "Transforming polyethylene waste into high-value adhesives: A sustainable approach to upcycling"
24. Tharindu Rajapaksha (Vinh Nguyen's Group), "Fabrication of nanostructures for diffractive optical elements on fused silica glass"
25. Soumil Joshi (Sanket Deshmukh's Group), "Development of transferable coarse-grained lipid models"
26. Chanhong Lee (Michael Bartlett's Group), "Metamaterial adhesives for programmable adhesion through reverse crack propagation"
27. James Li (Vinh Nguyen's Group), "Characterization and modeling of interfacial photogating effect in graphene field-effect transistor photodetectors on silicon"