Center for Soft Matter and Biological Physics
Department of Physics, Virginia Tech
Annual Report – Fiscal Year 2025

The Center for Soft Matter and Biological Physics was chartered on February 12, 2016.
This annual report covers the period July 1, 2024, through June 30, 2025.

I. Mission Statement of the Center for Soft Matter and Biological Physics

The mission of the Center for Soft Matter and Biological Physics is to advance the rapidly growing research areas of soft matter and biological physics, in alignment with the long-range plans of the Department of Physics, the College of Science, and Virginia Tech. Special attention will be extended to how these developments can address many of the most significant problems currently facing society, including effective drug design and delivery, next-generation materials, programmable biology, and models for human disease.

Center members will enjoy the benefits of a formal, unifying organizational structure that will focus their research projects and both nucleate new and strengthen existing cooperative interdisciplinary efforts in soft matter and biological physics across campus. The Center structure will enhance its members' opportunities to attract external research funding and to propose large collaborative center grants. In addition, the Center will increase its members' visibility both within Virginia Tech and externally and facilitate the establishment of a vibrant Center scientific seminar series.

The objectives of the Center for Soft Matter and Biological Physics are to

- serve as a formal unifying and trans-disciplinary organizational structure that supports the science program in soft matter and biological physics at Virginia Tech.
- increase the number of joint external grants from member investigators of the Center.
- develop collaborative Center proposals that focus on research and education in the areas of soft matter and biological physics and seek expanded external funding from government and foundational sources.
- support the weekly joint Condensed Matter/Soft Matter and Biological Physics seminar series with (mostly) external speakers.
- organize an annual symposium and/or summer school within the Center to promote both research and education in the areas of soft matter and biological physics.
- participate in the organization of local, national, and international conferences and workshops that include the Virginia Soft Matter Workshop series (an annual workshop that rotates among major Virginia institutions); and to attract national and international conferences to Virginia Tech.
- develop an educational module in collaboration with other Virginia Tech institutes such as the Macromolecules Innovation Institute (MII) to provide instruction and training to Virginia Tech students who are interested in or need an exposure to soft matter and biological physics.

II. Classification of Center and Organizational Structure

1. Organization

The Center for Soft Matter and Biological Physics is a departmental center administered by the Department of Physics in the College of Science.

Department Chair and Center Administrator:

- Dr. Mark Pitt, Professor, Department of Physics, College of Science

Center Director and Contact Person:

- Dr. Shengfeng Cheng, Associate Professor, Department of Physics, College of Science

Center Steering Committee:

- Dr. Rana Ashkar, Associate Professor, Department of Physics, College of Science
- Dr. Bahareh Behkam, Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Guoliang (Greg) Liu, Professor, Department of Chemistry, College of Science
- Dr. Vinh Nguyen, Associate Professor, Department of Physics, College of Science
- Dr. Jing Chen, Associate Professor, Department of Biological Sciences, College of Science

Center Website: https://csmb.phys.vt.edu
Center Google Scholar profile:
https://scholar.google.com/citations?view_op=list_works&hl=en&authuser=3&hl=en&user=-HKNSwMAAAAJ&sortby=pubdate&authuser=3

2. List of Faculty Affiliated with the Center

Regular faculty members (40) as of July 1, 2024 – June 30, 2025:

- Dr. Rana Ashkar, Associate Professor, Department of Physics, College of Science
- Dr. Justin Barone, Professor, Department of Biological Systems Engineering, College of Engineering
- Dr. Michael Bartlett, Associate Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Bahareh Behkam, Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Jonathan Boreyko, Associate Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Yang Cao, Associate Professor, Department of Computer Science, College of Engineering
- Dr. Daniel Capelluto, Professor, Department of Biological Sciences, College of Science
- Dr. Jing Chen, Associate Professor, Department of Biological Sciences, College of Science

- Dr. Jiangtao Cheng, Associate Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Shengfeng Cheng, Associate Professor, Department of Physics, College of Science
- Dr. Sanket Deshmukh, Associate Professor, Department of Chemical Engineering, College of Engineering
- Dr. David Dillard, The Adhesive & Sealant Science Professor, Department of Biomedical Engineering and Mechanics, College of Engineering
- Dr. William Ducker, Professor, Department of Chemical Engineering, College of Engineering
- Dr. Alan Esker, Professor, Department of Chemistry, College of Science
- Dr. Jean Heremans, Professor, Department of Physics, College of Science
- Dr. Sohan Kale, Assistant Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Nadir Kaplan, Assistant Professor, Department of Physics, College of Science
- Dr. Giti Khodaparast, Professor, Department of Physics, College of Science
- Dr. Oleg Kim, Assistant Professor, Department of Biomedical Engineering and Mechanics, College of Engineering
- Dr. Shihoko Kojima, Associate Professor, Department of Biological Sciences, College of Science
- Dr. Arina Korneva, Assistant Professor, Department of Biomedical Engineering and Mechanics, College of Engineering
- Dr. Guoliang (Greg) Liu, Professor, Department of Chemistry, College of Science
- Dr. Louis Madsen, Professor, Department of Chemistry, College of Science
- Dr. James McClure, Research Associate Professor, Virginia Tech National Security Institute/
- Dr. Steve Melville, Professor, Department of Biological Sciences, College of Science
- Dr. Djordje Minic, Professor, Department of Physics, College of Science
- Dr. Vinh Nguyen, Associate Professor, Department of Physics, College of Science
- Dr. Amrinder Nain, Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Alexey Onufriev, Professor, Department of Computer Science, College of Engineering
- Dr. Mark Paul, Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Michel Pleimling, Professor, Department of Physics and Associate Dean for Academic Programs, College of Science
- Dr. David Popham, Professor, Department of Biological Sciences, College of Science
- Dr. Rui Qiao, Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Hans Robinson, Associate Professor, Department of Physics, College of Science
- Dr. Vicki Soghomonian, Associate Professor, Department of Physics, College of Science
- Dr. Carolina Tallon, Associate Professor, Department of Materials Science and Engineering, College of Engineering
- Dr. Uwe Täuber, Professor, Department of Physics, College of Science, Faculty of Health Sciences

- Dr. Zhenhua Tian, Assistant Professor, Department of Mechanical Engineering, College of Engineering
- Dr. José Vargas-Muniz, Assistant Professor, Department of Biological Sciences, College of Science
- Dr. Layne Watson, Professor, Department of Computer Science, College of Engineering

Affiliated Emeriti Faculty Members (6):

- Dr. Herve Marand, Professor emeritus, Department of Chemistry, College of Science
- Dr. John Phillips, Professor emeritus, Department of Biological Sciences, College of Science
- Dr. Jimmy Ritter, Associate Professor emeritus, Department of Physics, College of Science
- Dr. John Tyson, University Distinguished Professor emeritus, Department of Biological Sciences, College of Science
- Dr. Dick Zallen, Professor emeritus, Department of Physics, College of Science
- Dr. Royce Zia, Professor emeritus, Department of Physics, College of Science

3. List of Postdocs and Students Supported by Center Administered Funds

Postdoctoral research associates:

- Dr. Suryabrahmam Buti, summer 2024 and 2025, SU 235371 and NSF DMR 481376

Graduate research assistants:

- Narguess Alizade, Physics, since May 2024, SU-235741, OH 238823
- Chathurika Arachchige, ½ GRA, summer 2025, NSF DMR 481376
- Maxwell T. Bessey, Physics, since May 2024, SU-235741
- Kenneth Distefano, Physics, ½ GRA, summer 2024, NSF 480724
- Kalani H. Ellepola, Physics, GRA summer 2024, NASA 426753
- Xi Hao, Macromolecular Science and Engineering, GRA summer 2024 and 2025 NSF 480341
- Dinidu Hathnagoda, Physics, ½ GRA summer 2024 and 2025, NSF DMR 481376
- Chinmay Katke, Physics, since January 2021 through May 2025, SU 235741
- Bingham Liu, Physics, GRA summer 2024 and 2025, NSF 480341
- Abir Malakar, Mechanical Engineering, since fall 2024, NSF 481322 support fall 2025
- Danielle Miller, Mechanical Engineering, since fall 2024, Hord GRA support fall 2025
- Tharindu D. Rajapaksha, Physics, GRA summer 2024, NASA 426733
- Fahim Bin Selim, Physics, since April 2024, SU 235741
- Sara Shabani, Physics, summer 2024, and spring 2025, DHHS 45167
- Mohammad Swedat, Mechanical Engineering, since fall 2023, GTA support fall 2025
- Jack Tapocik, Mechanical Engineering, since fall 2022, GTA support fall 2025
- Fangzhou Yu, Physics, GRA summer 2024 and 2025, NSF 480341
- Junwen Wang, Mechanical Engineering, GRA summer 2024 and 2025, NSF 480341

Undergraduate research students:

- Dominic Arseni, Physics, fall 2024 through summer 2025, NSF DMR 481376
- Karina Belkina, Physics, fall 2024 through summer 2025, NSF DMR 480341
- Cecelia Cashin, Nanoscience, fall 2024 through summer 2025, NSF DMR 481376
- Matthew Crane, Physics, fall 2024 through summer 2025, NSF DMR 481376
- Thomas Garrison, Physics, fall 2024 through summer 2025, First Year Undergraduate Research (FURF) program, CMDA Undergraduate Research Award, and NSF DMR 480341
- JC Hartman, Physics, spring 2025, NSF DMR 480341
- Mason Hill, Physics, spring 2025, NSF DMR 480341
- Bokyoung Kim, Nanomedicine, fall 2024 through summer 2025, NSF DMR 481376
- Kinley Koch, Nanoscience, summer 2024, Hamlett Undergrad Research
- Dillon Luke, Physics, spring 2025
- Nathan Peters, Nanoscience, summer 2024, Hamlett Undergraduate Research
- Mason Whittington, Nanoscience, summer 2024, Hamlett Undergraduate Research

4. Classified Staff

- Katrina Lockhart-Elfeky, Program Support Technician, funded through the A-21 program (from FY2018 to FY2026), the Department of Physics, and Center for Soft Matter and Biological Physics. In FY 2025, 12% of the staff salary was covered by the A-21 program and the rest was covered by the Department of Physica and the Center. In FY 2026, 6% of the staff salary will be covered by the A-21 program.

5. Department Fiscal Staff

- Jacqueline Woodyard, Director of Business Operations, Department of Physics
- Sherri Collins, Grant Coordinator, Department of Physics

III. Amendments to the Center Charter

N/A.

IV. Stakeholder Committee

The Center does not have an established Stakeholder Committee. We propose as members:

- Dr. Mark Pitt, Professor and Chair, Department of Physics
- Dr. John Morris, Professor, Department of Chemistry and Associate Dean for Research, College of Science
- Dr. Daniel Sui, Professor, Vice President for Research and Innovation

V. Major Grants Received in 2024-2025

New grants:

- U.S. National Science Foundation (NSF 481376), Division of Materials Research *Collaborative Research: Emergent Dynamics and Scaling Laws in Bioinspired Lipid Membranes*, PI Rana Ashkar (Physics 100%): September 1, 2024 - August 31, 2027, total volume $397,545

- Alfred P. Sloan Foundation, Sloan Research Fellowship, (453664), *Unraveling mesoscopic dynamics and adaptive design principles in bioinspired lipid membranes*, PI Rana Ashkar (Physics 100%): September 15, 2025 – September 14, 2027, total volume $75,000

Continuing grants:

- Luther and Alice Hamlett Undergrad Research (444364), PI Vinh Nguyen (Physics, 100 %): September 10, 2017 – June 30, 2025; total volume $ 84,500 for eight years.

- U.S. National Science Foundation (NSF 480222), Division of Materials Research (DMR), *Lithography on a nanosphere-an optical approach to arbitrarily patterned patchy particles,* PI Hans Robinson (Physics, 70%), co-PI Webster Santos (Chemistry, 30%): September 1, 2019 – August 31, 2024; total volume $ 496544 for five years.

- U.S. National Science Foundation (NSF 480341, 480342), Division of Materials Research (DMR), *CAREER: Nonequilibrium physics in drying soft matter solutions*; PI Shengfeng Cheng (Physics, 100%): June 1, 2020 – May 31, 2026; total volume $ 514,786 for six years.

- National Aeronautics and Space Administration (NASA 426733), *Smart Polyimide Expandable Collector to enable Investigations for Earth Science (SPECIES)*, PI Vinh Nguyen (Physics, 100%), August 1, 2021 – July 31, 2025; total volume $ 210,421 for three years.

- National Aeronautics and Space Administration (NASA 426753), *Array of depLoyable dIffractivE Neoteric opticS (ALIENS)*, PI Vinh Nguyen (Physics, 100%), September 01, 2022 – July 31, 2025; total volume $65,067 for three years.

- U.S. National Science Foundation (NSF 480672), Division of Molecular and Cellular Biosciences (MCB), EAGER*: Topographically induced lateral organization in biomimetic lipid membranes,* PI Rana Ashkar (Physics, 100%): August 1, 2021 – July 31, 2024; total volume $ 297,204 for three years.

- Joint U.K. Engineering and Physical Sciences Research Council (EPSRC) / U.S. National Science Foundation (NSF 480724), Division of Mathematical Sciences (DMS), *EPSRC EP/V014439/1 & NSF-DMS-2128587, Eco-evolutionary dynamics of fluctuating*

populations, PIs: Mauro Mobilia and Alastair Rucklidge (University of Leeds, U.K.), £ 443,468. PI Uwe C. Täuber (Physics, 50 %) and co-PI Michel Pleimling (Physics, 50 %):
August 15, 2021 – July 31, 2024; total volume $ 300,000 for three years.

- U.S. National Science Foundation (NSF 480972, 480971), Major Research Instrumentation Program (MRI), *Development of an Optical Super-resolution Instrument for Measuring Concentration Profiles and Diffusion Dynamics in Thin Films*, PI William A. Ducker (Chemical Engineering, 50%), co-PI Hans Robinson (Physics, 50%): September 1, 2022 – August 31, 2025, total volume $ 530,376 for three years.

VI. Major Proposals Submitted or Pending

- U.S. National Science Foundation (NSF), Division of Materials Research (DMR), Research Experience for Undergraduates (REU) Program, *REU Site: Training Highschoolers and Undergraduates in Methods across Biology and Soft-matter -- a Unified Perspective (THUMBS-UP)*. PI: Rana Ashkar (Physics, 50%), co-PI: Shengfeng Cheng (Physics, 50%). July 1, 2024 – June 30, 2027; total volume $358,784 for three years, declined.

- SONY Women in Technology Award with Nature, PI Rana Ashkar (Physics, 100%), total volume $250,000 for three years, declined.

- U.S. Army Research Office (ARO), Mechanical Sciences Branch, *Spatio-temporal structures in inhomogeneous complex systems,* PI Uwe C. Täuber (Physics, 50 %), co-PI Michel Pleimling (Physics, 50 %); total volume $ 621,117 for three years, submitted September 2024, pending.

- U.S. National Science Foundation (NSF), Division of Materials Research (DMR), CAREER Program, *CAREER: Multiscale Design and Control of Fast Deforming Hydrogels*. PI: C. Nadir Kaplan (Physics, 100%): February 1, 2025 – January 31, 2030; total volume $471,845 for five years, pending.

- U.S. National Science Foundation (NSF), Division of Materials Research (DMR), CMMT Program, *Bottom-up design of complex morphologies from accretive growth*. PI: C. Nadir Kaplan (Physics, 100%): February 1, 2026 – January 31, 2029; total volume $213,886 for three years, pending.

- ACS Petroleum Research Fund, New Direction Program, *Machine Learning-Based Molecular Modeling of Polymers.* PI: Shengfeng Cheng (Physics, 100%): September 1, 2026 – August 31, 2028, total volume $125,000 for two years, pending.

VII. Significant Accomplishments in 2024-2025

1. Center for Soft Matter and Biological Physics Symposium

The 2024 Annual Symposium of the Center for Soft Matter and Biological Physics was organized by Profs. Rana Ashkar, Nadir Kaplan, and Shengfeng Cheng, and was held on August 31, 2024. The symposium featured two external keynote speakers, two external speakers, and fourteen internal presenters from various departments at Virginia Tech. A poster session was held, and awards were announced at the end of the symposium.

Keynote External Speakers:

- Prof. Emanuela Del Gado, Georgetown University, *Soft particulate networks and their hidden hierarchical nature*
- Prof. Daniel Goldman, Georgia Tech*, Life at low coasting number*

Invited External Speakers:

- Matthew Asker, University of Leeds, *Fixation and extinction in fluctuating metapopulations with migration subject to bottlenecks*
- Jason Czak, James Madison University*, Creating novel patterns with localized perturbations in non-linear reaction-diffusion systems*

Internal Speakers:

- Suryabrahmam Buti, Physics, Virginia Tech, *A novel approach to tuning biomembrane structure and organization using Gemini surfactants*
- Saptarshi Chatterjee, Biological Sciences, Virginia Tech*, Predicting karyotypic outcomes in polyploid cell division through mathematical modeling*
- Shengfeng Cheng, Physics, Virginia Tech, *An analytical interaction potential for thin rods*
- Kenneth Distefano, Physics, Virginia Tech, *A tale of timescales: A prevention mechanism for total extinction within finite stochastic systems*
- William Ducker, Chemical Engineering, Virginia Tech, *Evaporation from porous coatings*
- Wenge Huang, Mechanical Engineering, Virginia Tech, *Low-temperature Leidenfrost-like jumping of sessile droplets on microstructured surfaces*
- Ohnyoung Hur, Mechanical Engineering, *Virginia Tech, Designing liquid metal microstructures from spherical to ellipsoidal via direct ink method and applications*
- Mohamed Khattab, Physics, Virginia Tech, *Chemical species transport near a sharp corner*
- Egor Kolesnikov, Physics, Virginia Tech, *Fast, yet accurate molecular simulations: explicit ions in implicit water*
- Denis Kucherenko, Engineering Mechanics, *The effect of pore pressure in fluid-saturated composites: a mathematical model applied to the human optic nerve*
- Guoliang Liu, Chemistry, Virginia Tech*, Plastics and surfactants-the two seemingly unrelated materials meet*
- Vinh Nguyen, Physics, Virginia Tech, *Diffractive optics lenses on polyimide membranes*

- Sara Shabani, Physics, Virginia Tech, *Stochastic modeling of gene drives: Strategies for mosquito population control with male-linked genes*
- Venkata Yashasvi Lolla, Mechanical Engineering*, Unique droplet dynamics on oil-impregnated fibers*

Poster Awards:

- Megan Collins, Biological Sciences (Capelluto group), Virginia Tech, *Cas9-targeted mPing insertion in yeast*
- Soumil Joshi, Chemical Engineering (Deshmukh's group), Virginia Tech, *Development of transferable coarse-grained lipid models*
- Nuwayo Eric Munyaneza, Chemistry (Liu's Group), Virginia Tech, *Upcycling of polyolefin waste to high-value surfactants*

2. Center for Soft Matter and Biological Physics Seminar Series

The Center held seminars through the fall 2024 and the spring 2025 semesters (Mondays 4.00 – 5.00 p.m.), hosted by different center members, to promote scientific exchange and incite possible research collaborations (https://csmb.phys.vt.edu/events/Seminar.html).

- August 26, 2024: Dr. Matthew Asker, University of Leeds, United Kingdom, *Fixation and extinction in fluctuating metapopulations with migration subject to bottlenecks*
- September 9, 2024: Prof. Jiangtao Cheng, Virginia Tech, Blacksburg, VA, *Low-temperature Leiden frost-like jumping of sessile droplets on microstructured surfaces*
- December 9, 2024: Prof. Baoxing Xu., University of Virginia, Charlottesville, VA, *Mechanically trainable structures enabled by soft-hard materials integration*
- January 27, 2025: Binghan Liu, Virginia Tech, Blacksburg, VA, *Physical mechanism and control of stratification in drying films of colloidal mixtures*
- February 10, 2025: Prof. Thang Pham, Virginia Tech, Blacksburg, VA, *Nanostructured quantum materials: From deterministic synthesis to multimodal characterization*
- February 14, 2025: Chinmay Katka, Virginia Tech, Blacksburg, VA, *Chemically driven soft bioinspired materials-4 billion years apart*
- March 31, 2025: Prof. Mesfin Tsige University of Akron, Akron, OH, *Computational approaches to understanding and predicting polymer surface properties*
- April 7, 2025: Prof. Kimberly L. Weirich, Clemson University, Clemson, SC, *Capillary-induced biopolymer network formation and remodeling*
- April 21, 2025: Prof. Burcu Gurbuz, Johannes Gutenberg University, Mainz, Germany, *Analyzing a mathematical model of reacting diffusing system*
- April 25, 2025: Dr. Nicholas Smith, Georgie Tech, Atlanta, GA, *Multiferroic control in 2D materials*
- May 5, 2025: Prof. Peter Yunker, Georgia Tech, Atlanta, GA, *Multicellular is different*

3. Research Publications with Center Affiliation

- Teshani Kumarage, Sudipta Gupta, Nicholas B. Morris, Fathima T. Doole, Haden L. Scott, Laura-Rozana Stingaciu, Sai Venkatesh Pingali, John Katsaras, George Khelashvili, Milka Doktorova, Michael F. Brown, and Rana Ashkar
  Cholesterol modulates membrane elasticity via unified biophysical laws,
  Nature Communications **16** (78), 7024-4594 (published 31 July 2025)
  [https://doi.org/10.1038/s41467-025-62106-0]

- Mohamed Swailem, Ulrich Dobramysl, Ruslan Mukhamadiarov, and Uwe C. Täuber
  Agent-based Monte Carlo simulations for reaction-diffusion models, population dynamics, and epidemic spreading,
  American Journal of Physics **93**, 659-681 (published 23 July 2025)
  [https://doi.org/10.1119/5.0282284].

- Alina D. Peshkova, Ekaterina K. Rednikova, Rafael R. Khismatullin, Oleg V. Kim, Vladimir R. Muzykantov, Prashant K. Purohit, Rustem I. Litvinov, John W. Weisel
  Red blood cell aggregation within a blood clot causes platelet-independent clot shrinkage,
  Blood Advances (2025) 9 (14): 3418–3428 (2025) (published 22 July 2025)
  [https://doi.org/10.1182/bloodadvances.2024015533]

- Binghan Liu, Gary S. Grest, Shengfeng Cheng
  Effect of particle shape on stratification in drying films of binary colloidal mixtures,
  Journal of Chemical Physics **163**(3), 034904 (published 21 July 2025)
  [https://doi.org/10.1063/5.0270685]

- Luke H. Elder, Alexey V. Onufriev
  Using Deep Graph Neural Networks Improves Physics-Based Hydration Free Energy Predictions Even for Molecules Outside of the Training Set Distribution
  Journal of Physical Chemistry B **129**(29), 7483–7498 (2025) (published 11 July 2025)
  [https://doi.org/10.1021/acs.jpcb.5c02263]

- Samira Mali, Igor S. Tolokh, Erik Cross, Alexey V. Onufriev
  Quantifying conformational heterogeneity of 3D genome organization in fruit fly
  PLoS One **20**(7): e0326927 (2025) (published 3 July 2025)
  [https://doi.org/10.1371/journal.pone.0326927]

- Wenya Shu, Nadir Kaplan
  A multiscale theory for mesenchymal cell migration in a straight or curved channel confinement,
  Biophysical Journal **124**(15), 2428-2441 (published 24 June 2025)
  [https://doi.org/10.1016/j.bpj.2025.06.020]

- Tania Ghosh, Royce K. P. Zia, Kevin E. Bassler

Extreme Value Statistics of Community Detection in Complex Networks with Reduced Network Extremal Ensemble Learning (RenEEL)
Entropy **27**(6), 628 (2025) (published 11 June 2025)
[https://doi.org/10.3390/e27060628]

- Ayoyinka O. Okedigba, Emery L. Ng, Mawuli Deegbey, M. Luciana Rosso, William Ngo, Ruoshi Xiao, Haibo Huang, Bo Zhang, Valerie Vaissier Welborn, Daniel G. S. Capelluto
  Soybean Lectin Cross-Links Membranes by Binding Sulfatide in a Curvature-Dependent Manner
  Journal of Agricultural and Food Chemistry **73**(22), 14020-14031 (2025) (published 24 May 2025)
  [https://doi.org/10.1021/acs.jafc.5c04336]

- Sascha Wald, Louie Hong Yao, Thierry Platini, Chris Hooley, and Federico Carollo
  Stochastic resetting in discrete-time quantum dynamics: steady states and correlations in few-qubit systems
  Quantum **9**, 1742 (2025) (published 13 May 2025)
  [https://doi.org/10.22331/q-2025-05-13-1742]

- Leslie Howe, Yifei Wang, Kalani H. Ellepola, Vinh X. Ho, Rosalie L. Dohmen, Marlo M. Pinto, Wouter D. Hoff, Michael P. Cooney, Nguyen Q. Vinh
  Interfacial Photogating of Graphene Field-Effect Transistor for Photosensory Biomolecular Detection
  Advanced Electronic Materials **11**, 2400716 (2025) (published 19 May 2025)
  [https://doi.org/10.1002/aelm.202400716]

- Louie Hong Yao
  Digital quantum simulation of reaction–diffusion systems on lattice
  The European Physical Journal B **98**(81) (2025) (published 3 May 2025)
  [https://doi.org/10.1140/epjb/s10051-025-00930-5]

- Alexander Y. Afanasyev, Alexey V. Onufriev
  Multiplateau Force–Extension Curves of Long Double-Stranded DNA Molecules
  ACS Omega **10**(15), 14816–14825 (2025) (published 10 April 2025)
  [https://doi.org/10.1021/acsomega.4c09605]

- Junwen Wang, Shengfeng Cheng
  Analytical sphere-thin rod interaction potential,
  The European Physical Journal E **48**, 15 (2025) (published 7 April 2025)
  [https://doi.org/10.1140/epje/s10189-025-00480-9]

- Rommie E. Amaro et al.
  The need to implement FAIR principles in biomolecular simulations
  Nature Methods **22**, 641–645 (2025) (published 2 April 2025)
  [https://doi.org/10.1038/s41592-025-02635-0]

- Mykhailo Potomkin, Oleg Kim, Yuliya Klymenko, Mark Alber, Igor S. Aranson
  Durotaxis and extracellular matrix degradation promote the clustering of cancer cells,
  iScience **28**(3), 111883 (2025) (published 21 March 2025)
  [https://doi.org/10.1016/j.isci.2025.111883]

- James E. McClure, Ming Fan, Steffen Berg, Ryan T. Armstrong, Carl Fredrik Berg, Zhe Li, Thomas Ramstad
  Derivation of A Representative Elementary Volume (REV) for Upscaled Two-Phase Flow in Porous Media
  Petrophysics **66**(01): 68–79 (2025) (published 3 February 2025)
  [https://doi.org/10.30632/PJV66N1-2025a5]

- Ala'a F. Eftaiha, Suryabrahmam Buti, Nicholas B. Morris, Abdussalam K. Qaroush, Khaleel I. Assaf, Dina M. Foudeh, Suhad B. Hammad, and Rana Ashkar
  Modification of Liposomal Properties by an Engineered Gemini Surfactant,
  Langmuir **41**(5), 1268 (2025) (published 25 January 2025)
  [https://doi.org/10.1021/acs.langmuir.4c03043]

- Leslie Howe, Kalani H. Ellepola, Nusrat Jahan, Brady Talbert, James Li, Michael P. Cooney, Nguyen Q. Vinh
  Characterization and Modeling of Interfacial Photogating Effect in Graphene Field-Effect Transistor Photodetectors on Silicon
  ACS Applied Electronic Materials **7**(3), 1305–1313 (2025) (published 21 January 2025)
  [https://doi.org/10.1021/acsaelm.4c02268]

- Shivam Vora, Saptarshi Chatterjee, Ariel Andrew, Ramyashree Prasanna Kumar, Martina Proctor, Zhen Zeng, Ritupaarna Bhatt, Deborah Nazareth, Madushan Fernando, Mathew J. K. Jones, Yaowu He, John D. Hooper, Nigel A. J. McMillan, Jelena Urosevic, Jamal Saeh, Jon Travers, Daniela Cimini, Jing Chen and Brian Gabrielli
  Aurora B inhibition induces hyper-polyploidy and loss of long-term proliferative potential in RB and p53 dp53-defectivec cells,
  Cell Death and Disease **16**, 7 (2025) (published 8 January 2025)
  [https://doi.org/10.1038/s41419-024-07329-7]

- Junwen Wang, Gary D. Seidel, Shengfeng Cheng
  Analytical interaction potential for Lennard-Jones rods,
  Physical Review E 111, 015403 (2025) (Published 3 January 2025)
  [https://doi.org/10.1103/PhysRevE.111.015403]

- Negin Forouzesh, Fatemeh Ghafouri, Igor S. Tolokh, Alexey V. Onufriev
  Optimal Dielectric Boundary for Binding Free Energy Estimates in the Implicit Solvent
  Journal of Chemical Information and Modeling **64(**24), 9433–9448 (2024) (published 10 December 2024)
  [https://doi.org/10.1021/acs.jcim.4c01190]

- Uwe C. Täuber
  Stochastic spatial Lotka-Volterra predator-prey models,
  in *Order, disorder, and criticality. Advanced problems of phase transition theory and complex systems*,
  World Scientific Publ., Singapore, Vol. VIII, Y. Holovatch (ed.), Chap. 2, 67-115 (published 16 October 2024).
  [https://doi.org/10.1142/9789819800827_0002]

- Wen Xiong, Tiffany G. Roach, Nicolas Ball, Marija Corluka, Josephine Beyer, Anne M. Brown, Daniel G.S. Capelluto
  An internal linker and pH biosensing by phosphatidylinositol 5-phosphate regulate the function of the ESCRT-0 component TOM1
  Structure **32**(10), 1677-1690.e5 (2024) (published 3 October 2024)
  [https://doi.org/10.1016/j.str.2024.08.003]

- Egor S. Kolesnikov, Yeyue Xiong, and Alexey V. Onufriev
  Implicit Solvent with Explicit Ions Generalized Born Model in Molecular Dynamics: Application to DNA,
  Journal of Chemical Theory and Computation **20**(19), 8724-8739 (2024) (published 16 September 2024)
  [https://doi.org/10.1021/acs.jctc.4c00833]

- Anthony Morciglio, Royce K. P. Zia, James M. Hyman, Yi Jiang
  Understanding the Oscillations of an Epidemic Due to Vaccine Hesitancy,
  Mathematical Biosciences and Engineering **8**(21), 6829-6846 (2024) (published 9 August 2024)
  [https://doi.org/10.3934/mbe.2024299]

- Mohamed Swailem, Uwe C. Täuber
  Computing macroscopic reaction rates in reaction-diffusion systems using Monte Carlo simulations
  Physical Review E **110**, 014124 (2024) (published 17 July 2024)
  [https://doi.org/10.1103/PhysRevE.110.014124]

- Leslie Howe, Tharindu D. Rajapaksha, Kalani H. Ellepola, Vinh X. Ho, Zachary Aycock, Minh L. P. Nguyen, John P. Leckey, Dave G. MacDonnell, Hyun Jung Kim, and Nguyen Q. Vinh
  High-Efficiency Multilevel Phase Lenses with Nanostructures on Polyimide Membranes,
  Advanced Optical Materials **12**, 2400847 (2024) (published 16 July 2024)
  [https://doi.org/10.1002/adom.202400847]

- Royce K P Zia
  Signals of Detailed Balance Violation in Nonequilibrium Stationary States: Subtle, Manifest, Extraordinary,

Journal of Physics A **28**(57), 285003 (2024) (published 2 July 2024)
[https://iopscience.iop.org/article/10.1088/1751-8121/ad5ac8]

- Igor S. Tolokh, Dan E. Folescu, and Alexey V. Onufriev
  Inclusion of Water Multipoles into the Implicit Solvation Framework Leads to Accuracy Gains
  Journal of Physics Chemistry B **128**(24), 5855-5873 (2024) (published 11 June 2024)
  [https://doi.org/10.1021/acs.jpcb.4c00254]

We have established a Google Scholar profile for the Center for Soft Matter and Biological Physics to make it easier to track publications and citations affiliated to the Center. See https://scholar.google.com/citations?view_op=list_works&hl=en&authuser=3&hl=en&user=-HKNSwMAAAAJ&sortby=pubdate&authuser=3

4. Submitted Papers with Center Affiliation

- G. E. Freire Oliveira, R. Dickman, M. O. Lavrentovich, R. K. P. Zia
  Pattern formation in a coupled driven diffusive system
  [https://doi.org/10.48550/arXiv.2509.00220]
  (Submitted 29 August 2025)

- Matthew Asker, Mohamed Swailem, Uwe C. Täuber, and Mauro Mobilia,
  Fixation and extinction in time-fluctuating spatially structured metapopulations,
  submitted to Physical Review Research. (revised 21 August 2025)
  [https://doi.org/10.48550/arXiv.2504.08433]

- Sara Shabani, Sahar Jafarbegloo, Sadegh Raeisi, Fakhteh Ghanbarnejad
  Tweets vs Pathogen Spread: A Case Study of COVID-19 in American States
  [https://doi.org/10.48550/arXiv.2508.04187]
  (Submitted 6 August 2025)

- Maxim O. Lavrentovich and R. K. P. Zia
  The Central Limit Theorem and a Cautionary Tale
  American Journal of Physics (submitted 7 June 2025)

- Lluís Hernández-Navarro, Kenneth Distefano, Uwe C. Täuber, and Mauro Mobilia,
  Slow spatial migration can help eradicate cooperative antimicrobial resistance in time-varying environments,
  PLoS Computational Biology (submitted 3 January 2025)
  [https://doi.org/10.1101/2024.12.30.630406].

- T. Kumarage, S. Gupta, N. B. Morris, F. T. Doole, H. L. Scott, L.-R. Stingaciu. S. V. Pingali, J. Katsaras, G. Khelashvili, M. Doktorova, M. F. Brown, R. Ashkar

Cholesterol Modulates Membrane Elasticity via Universal Biophysical Laws
Nature Communications (submitted 20 August 2024)

5. Faculty Invited Presentations with Center Affiliation

- Rana Ashkar
  Lessons from nature: How membrane dynamics shape health and technology
  Oak Ridge National Laboratory, Oak Ridge, TN (August 2025).

- Rana Ashkar
  Unified laws of membrane elasticity: From fundamental principles to practical applications,
  Biophysical Society Thematic Meeting Beyond Simple Models: The Consequences of Membrane Complexity in Living Systems, Copenhagen, Denmark (July 2025)

- Shengfeng Cheng
  Diffusiophoresis and stratification in drying colloidal mixtures
  The Mid-Atlantic Soft Matter Workshop, Baltimore, MD (May 30, 2025)

- Cihan Nadir Kaplan
  Rapid nonlinear hydrogel diffusiophoresis
  Bioinspired Science: IRES BioFlow Workshop, Universidad Adolfo Ibáñez, Santiago, Chile (May 23, 2025)

- Shengfeng Cheng
  Diffusiophoresis in colloidal suspensions
  Bioinspired Science: IRES BioFlow Workshop (presented online, May 23, 2025)

- Justin R. Barone
  Thermodynamic cycle
  MII Technical Conference and Review, Blacksburg, VA (April 2025)

- Cihan Nadir Kaplan
  Mechanobiology of mesenchymal migration: from holistic to reductionist modeling
  Biological Physics/Physical Biology (BPPB) online seminar (April 2025)

- Rana Ashkar
  Biomimetic membranes: From evolved structures to artificial cells
  MII Conference and Technical Review, Virginia Tech, Blacksburg, VA (April 2025).

- Rana Ashkar
  Unraveling the molecular mechanisms of emergent elasticity in lipid-sterol membranes
  APS Global Physics Summit, Anaheim, CA (March 2025)

- Cihan Nadir Kaplan, Chinmay Katke
  Rapid nonlinear hydrogel diffusiophoresis

APS Global Physics Summit, Anaheim. CA (March 2025)

- Jing Chen
  Mechanical dynamics and efficiency of growing chain-mediated bacterial sliding motility
  Center for Theoretical Biological Physics, Rice University, Houston, TX (25 March 2025)

- Uwe C. Täuber,
  Population dynamics and epidemics: stochastic spatial models,
  PrepaTec Querétaro, Tecnológico de Monterrey, Querétaro, Mexico (presented online, 20 March 2025).

- Mohamed M. Khattab, Cihan Nadir Kaplan
  Transport of chemical signals within cell filopodia
  ASCB Cell Bio 2024, San Diego, CA (December 2024)

- Cihan Nadir Kaplan
  A Nonconvex Neural Network Optimizer for Multiphysics Problems
  Defense TechConnect, Austin, TX (December 2024)

- Uwe C. Täuber,
  Stochastic population dynamics,
  Physics Department Colloquium, Virginia Tech, Blacksburg, VA (8 November 2024).

- Rana Ashkar
  Unified elastic behavior of biomembranes: Biophysical significances and potential Applications
  Chemistry, University of Tennessee, Knoxville, TN (November 2024).

- Uwe C. Täuber,
  Stochastic population dynamics,
  Yunnan University, Kunming, China (3 November 2024).

- Uwe C. Täuber,
  Stochastic population dynamics,
  School of Physics and Information Technology, Shaanxi Normal University, Xi'an, China (1 November 2024).

- Chinmay Katke, Cihan Nadir Kaplan
  Variational formulation of physics-informed neural networks (vfPINN)
  APS DFD Meeting, Salt Lake City, UT (November 2024)

- Cihan Nadir Kaplan, Chinmay Katke
  Rapid, nonlinear diffusiophoretic swelling of chemically responsive hydrogels
  APS DFD Meeting, Salt Lake City, UT (November 2024)

- Mohamed M. Khattab, Cihan Nadir Kaplan
  Vortex-driven chemical species transport near a sharp corner
  APS DFD Meeting, Salt Lake City, UT (November 2024)

- Rana Ashkar
  Smart nanostructured interfaces: Biologically inspired to biologically applied,
  International Symposium on Stimuli-Responsive Materials, Windsor, CA (October 2024)

- Justin R. Barone
  Cool polymers
  Virginia Soft Matter Workshop, James Madison University, Harrisonburg, VA (October 2024)

- Uwe C. Täuber,
  Stochastic population dynamics
  Institute of Particle Physics Forum, Central China Normal University, Wuhan, China (29 October 2024).

- Cihan Nadir Kaplan, Chinmay Katke
  Rapid, nonlinear diffusiophoretic swelling of chemically responsive hydrogels
  International Soft Matter Conference 2024, Raleigh, NC (July 2024)

- Rana Ashkar
  Membrane elasticity and phase separation with free and bound sterols
  Biological Membranes and Membrane Proteins Meeting, Santa Fe, NM (June 2024)

- Shengfeng Cheng
  Molecular dynamics modeling of dispersion drying and biofilament self-assembly
  The 5th International Symposium on Soft Matter Science and Engineering (SMSE 2024), Guangzhou, China (June 2024)

- Shengfeng Cheng
  A polymer chain model based on an analytical rod-rod interaction potential
  The 14th International Symposium on Polymer Physics, Chongqing, China (June 2024)

6. Post Doctoral and Students Invited Presentations with Center Affiliation

- Ekanayake Mudiyanselage Dinidu Hathnagoda
  Undercovering the origins of emergent membrane dynamics using sterol-lipid conjugation
  ACS Spring Meeting (March 2025)

- Ekanayake Mudiyanselage Dinidu Hathnagoda
  Discovering the hidden mechanisms of membrane rigidity through sterol lipid conjugation,
  MII Conference and Technical Review (March 2025)

- Suryabrahmam Buti
  Sterol-modified lipids: Engineered regulators of molecular organization in biological and synthetic cell membranes
  MII Conference and Technical Review (March 2025)

- Mohamed Swailem, Kenneth Distefano, and Uwe C. Täuber,
  Stochastic population dynamics of competing species in driven or spatially inhomogeneous systems,
  Westlake Forum on Statistical Physics and Complex Systems, Zhejiang University, Hangzhou, China (26 October 2024).

- Kenneth Distefano, Shannon R. Serrao, Mohamed Swailem, Canon Zeidan, and Uwe C. Täuber,
  Boundary influx prevents fixation / extinction in spatially extended stochastic population dynamics with cyclic and hierarchical domination,
  XLIV Dynamics Days Europe 2024, Constructor University, Bremen, Germany (29 July 2024).

- Mohamed Swailem, Kenneth Distefano, Canon Zeidan, and Uwe C. Täuber,
  Stochastic population dynamics of competing species in driven or spatially inhomogeneous systems,
  Leeds 2024 Eco-Evolutionary Dynamics (L24EEDs) Workshop on Mathematical Modelling of Microbial Communities: Cooperation, Dynamics and Resistance, University of Leeds, Leeds, U.K. (10 July 2024).

7. Provisional Patents

N/A

8. Awards and Recognitions

Faculty:

- Rana Ashkar was elected as a member of the advisory committee of the Quite Intense Kinetics Reflectometer (QIKR) and the Wide-Angel Spin Echo (EXPANSAE) instruments to be commissioned at the Second Target Station (STS) at Oak Ridge National Lab (2021-2024).

- Rana Ashkar was selected as a Sloan Research Fellow in Physics, awarded by the Alfred Sloan Foundation to exceptional early-career scientists whose creativity and innovation position them as emerging leaders in their fields (1 September 2025).

- Rana Ashkar was elected vice chair of the NCNR User Group (NUG) executive committee.

- Rana Ashkar received the Alumni Award for Excellence in Graduate Academic Advising (An annual award to one faculty member at Virginia Tech who "serves advisees in exemplary ways").

- Rana Ashkar was elected chair of the APS Committee on the Status of Women in Physics.

Graduate students:

- Dinidu Hathnagoda received the Physics Department Award for Graduate Teaching Excellence (spring 2025)

- Chathurika Arachchige awarded poster prize at the Physics Department poster session (May 2025)

- Mohammad Swedat was awarded the best poster at the μFIP 2025 Conference (18 June 2025)

- Jack Tapocik awarded the Walts Fellowship (2024)

- Jimmy Kaindu awarded the Saunders Family Graduate Fellowship for Interdisciplinary Mechanical Engineering (2024)

Undergraduate students:

- Matthew Crane awarded first place poster at Physics Department poster session (May 2025)

- Cecelia Cashin received a Luther and Alice Hamlett Undergraduate Research Scholarship (Fall 2024)

- Kerin Gorrasi awarded the Brian and Andrea Remond Undergraduate Research Fellowship (2025)

- Nicholas Landicho awarded the Brian and Andrea Remond Undergraduate Research Fellowship (2025)

- Aaron Marshall awarded the Brian and Andrea Remond Undergraduate Research Fellowship (2025)

- Katherine Tyler awarded the Brian and Andrea Remond Undergraduate Research Fellowship (2025)

- Teshani Kumarage, Lab alumna, essay was featured as an inaugural voice in the Living Futures series (9 January 2025) [https://medium.com/@livingfutures/from-roots-to-horizons-a-journey-through-time-and-science-6d907ef14527].

- Thomas Garrison awarded the FURF Undergraduate Student Research Grant (Fall 2024).

9. Student Travel Grants

In January 2017, the Center established a grant to support conference travel for graduate students whose advisers who are affiliated with the Center, but do not have current external funding available for this purpose. The students are requested to submit a brief application with presentation title, abstract, and conference description, all connected with research related to the Center's mission. The students can be awarded up to $ 400 for conference travel. Four student travel grants may be issued for each spring and fall semester per year. This year's recipients were:

- Kenneth Distefano, Department of Physics, Virginia Tech
  Slow spatial migration can help eradicate cooperative antimicrobial resistance in time-varying environments
  Summer School on Soft Solids and Complex Fluids, Amherst, MS (2-6 June 2025)

- Sara Shabani, Department of Physics, Virginia Tech
  Stochastic modeling of male-linked gene drives: Strategies for mosquito population control
  Summer School on Soft Solids and Complex Fluids, Amherst, MS (2-6 June 2025)

- Jimmy Kaindu, Department of Mechanical Engineering, Virginia Tech
  Capacitive fog harvesting; A scalable and ozone-free electrostatic approach
  5th Conference on Micro Flow and Interfacial Phenomena, Santa Barbara, CA (15-18 June 2025)

- Chinmay Katke, Department of Physics, Virginia Tech
  Variational formulation of physics informed neural networks (vfPINN)
  APS Division of Fluid Dynamics, Salt Lake City, UT (24-26 November 2024)

VIII. Industrial Affiliates Program

N/A

IX. Report of Financial Condition

Financial Activity Report

For Year Ending June 30, 2025

All reports are attached
Supporting our totals

Center Name: Center for Soft Matter and Biological Physics

Date Prepared: 9/29/2025

Oversight Responsibility: Katrina Lockhart-Elfeky

Sponsored Project Activity:

		Current Fiscal Year				Next Fiscal Year's Projections		
Fund No.	Sponsor	Beginning Balance	Revenues	Expenditures	Ending Balance	Revenues	Expenditures	Balance
426733	Smart Polyimide Expandable Collection	147,649.98		(141,212.38)	6,437.60	11,585.12	(11,585.12)	-
426753	Array of depLoyable diffractive Neo	44,792.00		(44,791.99)	0.01	5,115.25	(5,115.25)	-
444364	Nguyen-Hamlett Undergrad Research	98,500.00	-	(79,643.83)	18,856.17	18,444.62	(18,444.62)	-
445171	Optically Controlled Spin Transport	31,579.16	-	(29,328.66)	2,250.50	2,250.50	(2,250.50)	-
446627	Ashkar Hamleet Undergard Research	4,000.00	-	(4,608.17)	(608.17)	1,351.59	(1,351.59)	-
468455	Residual Fund- Vinhs	10,765.92		(5,007.48)	5,758.44	5,758.44	(5,758.44)	-
480222	Lithography on nanoshpere-an opt	203,791.00	-	(203,791.00)	-	-	-	-
480341	Career: Nonequilibrium Physics	344,934.00	-	(281,297.19)	63,636.81	63,636.81	(63,636.81)	-
480342	PSC- Shengfeng Cheng	12,000.00	-	(12,000.00)	-	12,000.00	(12,000.00)	-
480576	NSF-BSF Tapered Bottlebrush	28,331.00	-	(28,327.01)	3.99	3.99	(3.99)	-
480672	EAGER: Topographically Induced Late	196,676.00	-	(196,674.73)	1.27	1.27	(1.27)	-
480724	DMS-EPSRC Eco-Evolutionary Dynamics	204,066.00	-	(200,989.17)	3,076.83	3,076.83	(3,076.83)	-
480972	MRI: Development of an Optical Supe	63,763.00	-	(17,511.13)	46,251.87	46,251.87	(46,251.87)	-
481376	NSF-Soft CMP 2023-Rana	175,021.00	-	(78,238.76)	96,782.24	96,782.24	(96,782.24)	-
	Subtotal:	1,565,869.06	-	(1,245,182.74)	145,665.32	169,476.29	(169,476.29)	-

Sponsored Project Cost Sharing Activity:

		Current Fiscal Year				Next Fiscal Year's Projections		
Fund No.	Sponsor	Beginning Balance	Revenues	Expenditures	Ending Balance	Budget	Expenditures	Balance
	Subtotal:							

X. Major Issues of the Center

In FY2025, we have revived the annual symposia, seminars, discussion meetings, and social activities within the Center. We will continue to organize seminars and annual symposia with external speakers, and to support other related conferences.

The Center is organizing the 10th Virginia Soft Matter Workshop at Virginia Tech in October, 2025.

The Center will organize an international symposium on statistical physics in May 2026 at Virginia Tech.

Due to the uncertainty in the funding landscape, the Center's revenue is facing more challenges. We are currently exploring a wide range of options to raise funds to support the Center's activities, including student travels.

Our principal task over the next few years remains to generate new interdisciplinary research collaborations leading to collaborative grant proposals.

We intend to also explore further new course developments, ideally across departments and colleges, and to establish a summer school related to the Center's research mission.

We will apply again for the Research Experiences for Undergraduates (REU) program of the US National Science Foundation in 2026.

September 30, 2025

Dr. Shengfeng Cheng
Associate Professor of Physics, Virginia Tech
Director, Center for Soft Matter and Biological Physics