

Center for Soft Matter and Biological Physics
Department of Physics, Virginia Tech
Annual Report – Fiscal Year 2021

The Center for Soft Matter and Biological Physics was chartered on February 12, 2016. This annual report covers the period July 1, 2020, through June 30, 2021.

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 already 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 considerably 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;
- establish a vibrant scientific seminar series on soft matter and biological physics and support the weekly Physics Department Condensed Matter Seminar with (mostly) external speakers;
- establish 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 and Interfaces 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 department 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. Uwe C. Täuber, Professor, Department of Physics, College of Science, Faculty of Health Sciences

Center Director and Steering Committee elections were held in August 2020 through an online polling platform. Center Director Dr. Uwe C. Täuber was reelected. The elected Center Steering Committee for the current two-year term of office consists of:

Center Steering Committee:

- Dr. Justin Barone, Professor, Department of Biological Systems Engineering, College of Agriculture and Life Science and College of Engineering
- Dr. Jonathan Boreyko, Associate Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Daniel Capelluto, Associate Professor, Department of Biological Sciences, College of Science
- Dr. Shengfeng Cheng, Associate Professor, Department of Physics, College of Science

Center Website: <https://csmb.phys.vt.edu>

2. List of Faculty Affiliated with the Center

Regular faculty members (35) as of June 30, 2021:

- Dr. Rana Ashkar, Assistant Professor, Department of Physics, College of Science
- Dr. Justin Barone, Professor, Department of Biological Systems Engineering, College of Engineering
- Dr. Michael Bartlett, Assistant 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, Associate Professor, Department of Biological Sciences, College of Science

- Dr. Jing Chen, Assistant 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. 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 and Chair, Department of Chemistry, College of Science
- Dr. Silke Hauf, Associate Professor, Department of Biological Sciences, 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. Shihoko Kojima, Associate Professor, Department of Biological Sciences, College of Science
- Dr. Guoliang (Greg) Liu, Associate Professor, Department of Chemistry, College of Science
- Dr. Louis Madsen, Professor, Department of Chemistry, College of Science
- Dr. Steve Melville, Associate Professor, Department of Biological Sciences, College of Science
- Dr. Djordje Minic, Professor, Department of Physics, College of Science
- Dr. Reza Mirzaeifar, Associate Professor, Department of Mechanical Engineering, College of Engineering
- Dr. Vinh Nguyen, Associate Professor, Department of Physics, College of Science
- Dr. Alexey Onufriev, Professor, Department of Computer Science, College of Engineering
- Dr. Mark Paul, Professor, Department of Mechanical Engineering, College of Engineering
- Dr. John Phillips, Professor, Department of Biological Sciences, College of Science
- Dr. Michel Pleimling, Professor, Department of Physics and Director, Academy of Integrated Science, 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, Assistant 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. Layne Watson, Professor, Department of Computer Science, College of Engineering

Affiliated Emeriti Faculty Members (5):

- Dr. Herve Marand, Professor emeritus, Department of Chemistry, 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. Sudipta Gupta, since February 2021, SU 235371
- Dr. Vinh Ho, since May 2020, NASA 426703 and NASA 419463
- Dr. Priyanka, January 2018 – December 2020, ARO 450484
- Dr. Wenya Shu, since September 2020, SU 235741
- Dr. Abhishek K. Singh, since May 2019, AFOSR 450618
- Dr. Igor Tolokh, March 2019 – February 2021, NIH 1R21GM131228
- Dr. Chengyuan Wen, January 2020 – January 2021, NSF 418270

Graduate research assistants:

- Tabassum Ahmed, ½ GRA fall 2020, AFOSR 450589
- Sebastian Byrd, GRA summer 2021, NSF 480341
- Jason Czak, GRA summer 2020 and 2021, ½ GRA fall 2020 and spring 2021, ARO 450484
- Luan Doan, GRA summer 2020 and 2021, AFOSR 450618
- Dan Falescu, GRA summer and fall 2020, spring 2021, NIH 1R21GM131228
- Ryan Xi Hao, ½ GRA fall 2020 and spring 2021, GRA summer 2021, AFOSR 450589
- Chinmay Katke, GRA summer 2020, ARO 450484, ½ GRA spring 2021, SU 235741
- Teshani Kumarage, GRA spring and summer 2021, SU 235371
- Bingham Liu, GRA fall 2020, spring 2021, and summer 2021, NSF 480341
- Ruslan I. Mukhamadiarov, GRA summer 2020, ½ GRA fall 2020 and spring 2021, DOE 429262
- Riya Nandi, GRA summer 2020, ½ GRA fall 2020 and spring 2021, ARO 450484
- Brendan Quinlan, GRA summer 2020, NASA 426703
- Hadi Rahmaninejad, GRA spring 2021, ½ GRA summer 2021, SU 235371
- Shannon R. Serrao, GRA summer 2020, ½ GRA fall 2020, ARO 450484
- James Stidham, GRA summer 2020 and 2021, ½ GRA fall 2020 and spring 2021, DOE 429262
- Hong Yao, GRA summer 2020 and summer 2021, ½ GRA fall 2020 and spring 2021, DOE 429262

- Junwen Wang, GRA fall 2020, ½ GRA Spring 2021, GRA summer 2021, AFOSR, 450589
- Yifei Wang, GRA summer 2020, NSF 418270, and GRA summer 2021, NASA 426703

Undergraduate research students:

- Garrett Betzko, nanoscience, summer 2021, 444364 Hamlett undergraduate research
- Eduardo Gonzalez Cantero, nanoscience, spring 2021, 444364 Hamlett undergraduate research
- Carl Chalk, physics, summer 2021, AFOSR 450589
- Wally Borden, physics, summer 2021, SU 235371
- Mira Eisenhauer, data science, Maggie L. Walker Governor's School Richmond, VA, summer research internship funded through U.S. Army Research Office Army Educational Outreach Program (AEOP), summer 2021, ARO 450799
- Nash Gatenby-Latham, physics, summer research internship funded through U.S. Army Research Office Army Educational Outreach Program (AEOP), summer 2021, ARO 450799
- Jacob Hannah, physics, Austin Peay State University, Clarksville, TN, summer research internship funded through U.S. Army Research Office Army Educational Outreach Program (AEOP), summer 2021, ARO 450799
- Yisheng Huang, physics, fall 2020, spring 2021, and summer 2021, NSF 480341
- Jack McLaughlan, physics, summer 2021, NSF 480341
- Hana Mir, physics, summer 2020, fall 2020, spring 2021 NSF, 479739; summer 2021, ARO 450484
- Julie Nguyen, physics, fall 2020 and spring 2021, SU 235371
- Fangzhou Yu, physics, summer 2021, NSF 480341.

4. Classified Staff

- Katrina Loan, Program Support Technician, funded through A-21 program. During her sixth year, Ms. Loan's salary will be provided by the Office of the Vice President for Research (80%) and the Center for Soft Matter and Biological Physics (20%).

5. Department fiscal staff

- Jacqueline Woodyard, Business Manager, Department of Physics
- Sherri Collins, Assistant Business Manager, Department of Physics

III. Amendments to the Center Charter

Not applicable.

IV. Stakeholder Committee

The Center does not currently have a Stakeholder Committee established. Proposed members:

- Dr. Mark Pitt, Professor and Chair, Department of Physics
- Dr. Randy Heflin, Professor, Department of Physics, and Associate Dean for Research and Graduate Studies, College of Science
- Dr. Daniel Sui, Professor, Vice President for Research and Innovation

V. Major Grants Received in 2020-2021

New grants:

- National Aeronautics and Space Administration (NASA 419463), Langley Research Center, *Diffraction optics*, PI: Dr. Vinh Nguyen, (Physics, 100%); December 15, 2020 – November 30, 2021; total volume \$12,571 for one year.
- U.S. Army Research Office (ARO 450799), Undergraduate Research Apprenticeship Program (URAP) supplement through ARO Broad Agency Announcement (BAA), *Control of universal scaling, noise strength, and pattern formation in critical dynamics*; PI Uwe C. Täuber (Physics, 50 %), co-PI Michel Pleimling (Physics, 50 %), May 15 – August 14, 2021; total volume \$ 9,000 for three months.
- The Thomas F. and Kate Miller Jeffress Memorial Trust, *Reversing pathology through informed molecular regulation of lipid rafts*; PI Rana Ashkar (Physics, 70 %), co-PI Sanket Deshmukh (Chemical Engineering, 30 %); July 1, 2021 – June 30, 2022; total volume \$ 100,000 for one year.
- U.S. National Science Foundation (NSF), Division of Molecular and Cellular Biosciences (MCB), Molecular Biophysics: *EAGER: Topographically induced lateral organization in biomimetic lipid membranes*; PI Rana Ashkar (Physics, 100%): August 1, 2021 – July 31, 2023; total volume \$297,204 for two years.
- National Aeronautics and Space Administration, Advanced Component Technology, *Smart polyimide expandable collector to enable investigations for Earth science (SPECIES)*. PI John Leckey (Langley NASA), co-PI Vinh Nguyen (Physics, 50%, \$ 229,935): August 1, 2021 – July 31, 2024; total volume \$ 1,199,671 for three years.
- Joint U.K. Engineering and Physical Sciences Research Council (EPSRC) / U.S. National Science Foundation (NSF) – Division of Mathematical Sciences (DMS), *Eco-evolutionary dynamics of fluctuating populations*; PIs: Mauro Mobilia and Alastair Rucklidge (Department of Applied Mathematics, University of Leeds, U.K.), £ 443,468. PI Uwe C. Täuber (Physics, 50 %), co-PI Michel Pleimling (Physics, 50 %), August 15, 2021 – August 14, 2024; total volume \$ 300,000 for three years.

Continuing grants:

- National Aeronautics and Space Administration (NASA 418127), *Clouds, and the Earth's radiant energy system (CERES) analytical modeling with the MCRT environment*, SSAI/NASA. PI Bob Mahan (Mechanical Engineering, 60 %), co-PI Vinh Nguyen (Physics, 40 % - 418266): December 1, 2016 – November 30, 2021; total volume \$ 912,459 for five years.
- U.S. Army Research Office (ARO 450484), Engineering Sciences Directorate, Mechanical Sciences Division, *Control of universal scaling, noise strength, and pattern formation in critical dynamics*, PI Uwe C. Täuber (Physics, 50 %), co-PI Michel Pleimling (Physics, 50 %), with subcontract to P. S. Krishnaprasad (Electrical and Computer Engineering, University of Maryland): April 15, 2017 – February 15, 2022; total volume \$ 1,622,794 for four years.
- U.S. National Science Foundation (NSF 479739), Division of Materials Research (DMR), Condensed Matter and Materials Theory, *Systems far from equilibrium: relaxation processes and steady-state properties*: PI Michel Pleimling (Physics, 100%): June 1, 2017 – November 30, 2020; total volume \$ 290,000 for three years.
- U.S. National Science Foundation (NSF 418270), Division of Chemistry – CHE, Structure, Dynamics, and Mechanisms B, CHE-1665157, *Unraveling connections among biomolecular structure, interfacial solvent dynamics, and conformational dynamics*; PI Katie Mitchell-Koch (Wichita State University, 50 %), co-PI Vinh Nguyen (Physics, 50 %); August 1, 2017 – January 31, 2022; total volume \$ 368,000 for four years.
- Luther and Alice Hamlett Undergrad Research (444364), PI Vinh Nguyen (Physics, 100 %): September 10, 2017 – June 30, 2025; total volume \$ 45,000 for eight years.
- U.S. Air Force Office of Scientific Research (AFOSR 450589) grant FA9550-18-1-0433, *Understanding enhancement of strength in CNT/NGP-based structural composites*. PI Gary Seidel (Ocean and Aerospace Engineering, 50%), co-PI Shengfeng Cheng (Physics, 50%): June 15, 2018 – December 31, 2021, \$ 618, 229 for three years.
- U.S. Department of Defense, Air Force Office of Scientific Research (AFOSR 450618), FA9550-18-1-0263, *Impact of hydration and collective dynamics on protein functions*, PI Vinh Nguyen (Physics, 100 %): July 1, 2018 – June 30, 2022; total volume \$ 488,779 for three years.
- U.S. Department of Energy (DOE 429262), Office of Basic Energy Sciences (BES) grant DE- FG02-09ER46613, *Non-equilibrium relaxation, aging scaling, and critical depinning dynamics of Skyrmions in disordered magnetic films*, PI Uwe C. Täuber (Physics, 50 %), co-PI Michel Pleimling (Physics, 50 %): August 15, 2018 – December 31, 2021; total volume \$ 450,000 for three years.

- National Aeronautics and Space Administration (NASA 426703): Earth Science Technology Office (ESTO), *Graphene and plasmonic enhanced long-wavelength photodetectors for Earth radiation budget instruments*, PI Vinh Nguyen (Physics, 100 %): September 20, 2018 – March 31, 2022; total volume \$ 260,000 for three years.
- U.S. National Institutes of Health (NIH) 1R21GM131228, *Accurate yet fast implicit solvation*, PI Alexey Onufriev (Computer Science, 100%): March 1, 2019 – February 28, 2021; total volume \$ 250,000 for two 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%): August 26, 2019 – August 31, 2022; total volume \$ 286,821 for three years.
- U.S. National Science Foundation (NSF 480341), Division of Materials Research (DMR), Condensed Matter and Materials Theory, *CAREER: Nonequilibrium physics in drying soft matter solutions*; PI Shengfeng Cheng (Physics, 100%): June 1, 2020 – May 31, 2025; total volume \$ 514,786 for five years.

VI. Major Proposals Submitted or Pending

- National Science Foundation (NSF), *Excellence in Research: Searching for a guiding extremal principle in a living active matter*; PI Chih-Kuan Tung (Physics, North Carolina A&T State University, 70%), co-PI Shengfeng Cheng (Physics, 30%), total volume \$ 470,563 for three years (October 2020).
- Department of Energy (DOE), *A data-intensive computational framework for the discovery of high-performance graphene-polymer heterostructures*; PI Xi Chen (Industrial and Systems Engineering, 30%), co-PI Guoliang Liu (Chemistry, 40%), co-PI Shengfeng Cheng (Physics, 30%), total volume \$ 1,026,586 for three years (May 2021).
- U.K. Engineering and Physical Sciences Research Council (EPSRC) *Emergent quantum-mechanics-like theory for complex adaptive systems - a “mock” quantum theory*, PIs Konstantin Nikolic, Thomas Madsen (both University of West London, U.K.), Djordje Minic (Physics), and Sinisa Pajevic (NIH), £55,715.47 (May 2021).
- U.S. National Science Foundation (NSF), *Manufacturing durable surfaces of biodegradable metal via femtosecond laser short peening assisted mechanochemical process*, PI Rebecca Cai (Materials Science, COE, 50%), co-PI Vinh Nguyen (Physics, 50%): October 1, 2021 – September 30, 2024; total volume \$ 578,429 (May 2021).

VII. Significant Accomplishments in 2020-2021

1. Center for Soft Matter and Biological Physics Symposium

The Center held its fifth annual symposium entirely online May 19, 2021, organized by Shengfeng Cheng, featuring 16 speakers from different departments within Virginia Tech. No poster session was held, and awards were announced at the end of the symposium.

- Justin Barone, Biological Systems Engineering, Virginia Tech
The fringed micelle morphology as a model for biological elastomers
- Jason Czak, Physics, Virginia Tech
Creating novel patterns with spatially localized perturbations in non-linear reaction-diffusion systems
- Luan Doan, Physics, Virginia Tech
The origin and implications of bound water around hemeproteins
- Ming Fan, Mining and Minerals Engineering, Virginia Tech
Modeling capillary fluctuations for fluid flow with lattice Boltzmann methods
- Sudipta Gupta, Physics, Virginia Tech
Space time evolution of vesicles under external perturbation
- Xukun He, Mechanical Engineering, Virginia Tech
Self-driven transport of liquid droplets in V-shaped grooves due to asymmetric evaporation
- Wenge Huang, Mechanical Engineering, Virginia Tech
Thermal circuit analysis of droplet evaporation on hot microstructure superhydrophobic surfaces
- Sohan Kale, Mechanical Engineering, Virginia Tech
Mechanics of microbial adhesion on nano-patterned surfaces
- Chinmay Katke, Physics, Virginia Tech
A multiphase theory for transient osmotic swelling of chemically responsive hydrogels
- Bingham Liu, Physics, Virginia Tech
Dispersing colloidal particles in various solvents: From monomers to oligomers
- Ruslan Mukhamadiarov, Physics, Virginia Tech
Temperature interfaces in the Katz-Lebowitz-Spohn driven lattice gas

- Ranit Mukherjee, Engineering Mechanics, Virginia Tech
Jumping ice
- Priyanka, Physics, Virginia Tech
Boundary effects in a dynein-inspired multilane exclusion process
- Joel Serrano, Chemistry, Virginia Tech
Delineating the solar desalination in meso-and micro-pores
- Wenya Shu, Physics, Virginia Tech
Negative durotaxis of metastatic cells: Insights from a multiscale and chemo-mechanical model
- James Stidham, Physics, Virginia Tech
Emerging spatio-temporal patterns in cyclic predator-prey systems with habitats

2. Center for Soft Matter and Biological Physics Seminar Series

The Center held seminars through the fall 2020 and the spring 2021 semesters (Mondays 4.00 – 5.00 p.m.), organized by Vinh Nguyen, to promote scientific exchange and incite possible research collaborations (<https://csmb.phys.vt.edu/events/Seminar.html>):

- August 31, 2020: Ruslan Mukhamadiarov, Physics, Virginia Tech
Temperature interfaces in the Katz-Lebowitz-Spohn model
- September 28, 2020: Prof. Navid Ghaffarzadegan, Industrial & Systems Engineering, Virginia Tech
Systems sciences, behavioral complexities, and the challenge of dynamic modeling of the spread of COVID-19
- October 5, 2020: Dr. Tatiana Rostovtseva, National Institutes of Health
A mitochondrial throttle: Lipid-mediated protein complexes at the mitochondrial surface
- October 12, 2020: Prof. Carla Finkielstein, Fralin Biomedical Research Institute at Virginia Tech Carilion
Emerging opportunities in cancer chrono-therapy
- October 19, 2020: Prof. Jiajia Zhou, Beihang University, Beijing, China
Onsager variational principle and its applications in soft matter systems
- November 9, 2020: Prof. Michael Bartlett, Mechanical Engineering, Virginia Tech
Multi-functional soft material for electronics and adhesives

- November 16, 2020: Dr. James McClure, Research Computing, Virginia Tech
Modeling multi-phase flow and anomalous diffusion with mesoscopic methods
- December 7, 2020: Prof. Jonathan Boreyko, Mechanical Engineering, Virginia Tech
Winter wonderland: How to suspend, levitate, and launch ice
- January 25, 2021: Dr. Sascha Wald, Coventry University, U.K.
Non-equilibrium dynamics in many-body quantum systems
- March 22, 2021: Prof. Reza Mirzaeifar, Mechanical Engineering, Virginia Tech
Metal-graphene composites
- April 12, 2021: Dr. Michael Salemo, U.S. Army Research Laboratory
Atomistic and coarse-grained polymer modeling: Applications at the Army Research Laboratory

3. Center for Soft Matter and Biological Physics Meetings

The Center held informal meetings, organized by Vinh Nguyen, to promote scientific exchange and incite research collaborations, Fridays, 4.00 – 5.00 p.m. during the semesters and on Mondays over the summer months (<https://csmb.phys.vt.edu/events/Discussion.html>):

- July 6, 2020: Binghan Liu, Physics, Virginia Tech
Molecular dynamics modeling of liquid-liquid mixtures
- July 13, 2020: Dr. Priyanka, Physics, Virginia Tech
Effect of control on one-dimensional surface growth processes
- July 27, 2020: Prof. Vinh Nguyen, Physics, Virginia Tech
Monte Carlo ray-trace diffraction method for studying Fresnel zone plate lens and photons-sieve
- August 3, 2020: Dr. Chengyuan Wen, Physics, Virginia Tech
Molecular dynamics simulations of DNA
- August 10, 2020: Prof. Uwe Täuber, Physics, Virginia Tech
Individual-based simulations of stochastic epidemic models: Controlling disease outbreaks
- September 4, 2020: Prof. William Ducker, Chemical Engineering, Virginia Tech
A surface coating that inactivates SARS-COV-2
- October 2, 2020: Hadi Rahmaninejad, Physics, Virginia Tech
Nanoscale characterization of periodic surfaces based on dynamical scattering theory

- October 9, 2020: Dr. Wenya Shu, Physics, Virginia Tech
Multi-physics modeling of complex materials and structures
- November 6, 2020: Tiffany Roach, Biological Sciences, Virginia Tech
Adaptor functions of TOM1 in health and disease
- November 13, 2020: Prof. Sohan Kale, Mechanical Engineering, Virginia Tech
From active-gel theory of actomyosin cortex to dynamic vertex models of epithelial mechanics
- December 4, 2020: Prof. Michel Pleimling, Physics, Virginia Tech
Dynamic phase transitions in the Ising ferromagnet: Bulk and surface phase diagrams
- January 9, 2021: Prof. Uwe Täuber, Physics, Virginia Tech
Writing useful referee reports and helpful responses
- February 12, 2021: Ranit Mukherjee, Mechanical Engineering, Virginia Tech
To jump, or not to jump, that is the question
- February 19, 2021: James Stidham, Physics, Virginia Tech
Magnetic skyrmion motion in a channel
- March 12, 2021: Prof. Justin Barone, Biological Systems Engineering, Virginia Tech
What can gummy bears teach us about biological elastomers?
- April 2, 2021: Dr. Sudipta Gupta, Physics, Virginia Tech
A scattering approach to self-assembled biosoft materials
- April 16, 2021: Yisheng Huang, Physics, Virginia Tech
Chain conformations and phase separations in polymer solutions at various polymer-solvent interactions
- June 7, 2021: Dr. James McClure, Advanced Research Computing, Virginia Tech
Digital scavenger hunt: Is the geometry of complex micro-structure unique?"
- June 14, 2021: Prof. Uwe Tauber, Physics, Virginia Tech
How to write a paper
- June 21, 2021: Sean McMahon, Physics, Virginia Tech
Mechanical limitations of clostridium perfringens chains
- June 28, 2021: Navid Ghaffarzadegan, Industrial & Systems Engineering, Virginia Tech
Epidemic forecasting: Why did most COVID-19 models fail

4. Research Publications with Center Affiliation

- K. Sitarachu, R. K. P. Zia, and M. Bachmann,
Exact microcanonical statistical analysis of transition behavior in Ising chains and strips,
Journal of Statistical Mechanics: Theory and Experiment **2020**, P073204 (7 July 2020)
[<https://iopscience.iop.org/article/10.1088/1742-5468/ab97bc>].
- Ahmadreza Azizi and Michel Pleimling
Critical phenomena in the presence of symmetric absorbing states: A microscopic spin model with tunable parameters,
Physical Review E **102**, 022112 (10 August 2020)
[<https://doi.org/10.1103/PhysRevE.102.022112>].
- Wei Song, Carter J. Gottschalk, Tuo-Xian Tang, Andrew Biscardi, Jeffrey F. Ellena, Carla V. Finkelstein, Anne M. Brown, and Daniel G. S. Capelluto,
Structural, in silico, and functional analysis of a Disabled-2-derived peptide for recognition of sulfatides,
Scientific Reports **10**, 13520 (11 August 2020)
[<https://doi.org/10.1038/s41598-020-70478-0>].
- Yifei Wang, Vinh X. Ho, Zachary N. Henschel, Prashant Pradhan, Leslie Howe, Michael P. Cooney, and Nguyen Q. Vinh,
Graphene photodetectors based on interfacial photogating effect with high sensitivity,
Proceedings of SPIE **11503**, 1150306 (22 August 2020)
[<https://doi.org/10.1117/12.2569035>].
- Saptarshi Chakraborty, Milka Doktorova, Trivikram R. Molugu, Frederick A. Heberle, Haden L. Scott, Boris Dzikovski, Michihiro Nagao, Lăuă-Roxana Stingaciu, Robert F. Standaert, Francisco Barrera, John Katsaras, George Khelashvili, Michael F. Brown, and Rana Ashkar,
How cholesterol stiffens unsaturated lipid membranes,
Proceedings of the National Academy of Sciences **117**, 21896 (25 August 2020)
[<https://doi.org/10.1073/pnas.2004807117>].
- Elizabeth G. Kelley, Paul D. Butler, Rana Ashkar, Robert Bradbury, and Michihiro Nagao,
Scaling relationships for the elastic moduli and viscosity of mixed lipid membranes,
Proceedings of the National Academy of Sciences, **117**, 23365 (3 September 2020)
[<https://doi.org/10.1073/pnas.2008789117>].
- Vinh X. Ho, Brendan Ryan, Jiarong R Cui, Prashant Pradhan, and Nguyen Q. Vinh,
Optical gain in Er doped GaN multiple quantum wells,
Proceedings of SPIE **11467**, 114671Q (9 September 2020)
[<https://doi.org/10.1117/12.2567850>].

- Luan C. Doan and Vinh Q. Nguyen,
Investigating hydration dynamics and protein collective motions by high-precision dielectric spectroscopy,
Proceedings of SPIE **11499**, 114990O (10 September 2020)
[\[https://doi.org/10.1117/12.2567857\]](https://doi.org/10.1117/12.2567857).
- Nicholas D. Christensen, Catherine E. Wisinger, Leslie A. Maynard, Natasha Chauhan, John T. Schubert, Jonathan A. Czuba, and Justin R. Barone,
Transport and characterization of microplastics in inland waterways,
Journal of Water Process Engineering **38**, 101640 (21 September 2020)
[\[https://doi.org/10.1016/j.jwpe.2020.101640\]](https://doi.org/10.1016/j.jwpe.2020.101640).
- Yeyue Xiong, Parviz Seifpanahi Shabane, and Alexey V. Onufriev,
Melting points of OPC and OPC3 water models,
ACS Omega **5**, 25087 (22 September 2020)
[\[https://doi.org/10.1021/acsomega.0c02638\]](https://doi.org/10.1021/acsomega.0c02638).
- Ksenia S. Onufrieva, Alexey V. Onufriev, Andrea D. Hickman, and James R. Miller,
*Bounds on absolute gypsy moth (*Lymantria dispar dispar*) (*Lepidoptera: Erebidae*) population density as derived from counts in single milk carton traps*,
Insects **11**, 673 (3 October 2020)
[\[https://doi.org/10.3390/insects11100673\]](https://doi.org/10.3390/insects11100673).
- Shengfeng Deng, Wei Li, and Uwe C. Täuber,
Coupled two-species model for the pair contact process with diffusion,
Physical Review E **102**, 042126 (22 October 2020)
[\[https://doi.org/10.1103/PhysRevE.102.042126\]](https://doi.org/10.1103/PhysRevE.102.042126).
- James Stidham and Michel Pleimling,
Late stages in the ordering of magnetic skyrmion lattices,
Physical Review B **102**, 144434 (23 October 2020)
[\[https://doi.org/10.1103/PhysRevB.102.144434\]](https://doi.org/10.1103/PhysRevB.102.144434).
- Riya Nandi and Uwe C. Täuber,
Critical dynamics of anisotropic antiferromagnets in an external field,
Physical Review E **102**, 052114 (11 November 2020)
[\[https://doi.org/10.1103/PhysRevE.102.052114\]](https://doi.org/10.1103/PhysRevE.102.052114).
- Ruslan I. Mukhamadiarov, Priyanka, and Uwe C. Täuber,
Parallel temperature interfaces in the Katz-Lebowitz-Spohn driven lattice gas,
Journal of Statistical Mechanics – Theory and Experiment (JSTAT) **2020**, 113207 (27 November 2020)
[\[https://doi.org/10.1088/1742-5468/abc7b9\]](https://doi.org/10.1088/1742-5468/abc7b9).

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Physicochemical properties of respiratory droplets and their role in COVID-19 pandemics: A critical review,
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Programmable shape changes in bio-inspired thermoplastic elastomer bilayers
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Atomic origins of friction reduction in metal alloys,
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Dynamics of genetic code evolution: The emergence of universality,
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Nanoscale **13**, 10526 (26 May 2021)
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- Teshani Kumarage, Julie Nguyen, and Rana Ashkar,
Neutron spin echo spectroscopy as a unique probe for lipid membrane dynamics and membrane-protein interactions,
Journal of Visualized Experiments, special issue *Neutron scattering in the biological sciences: Techniques and applications* (invited paper, 27 May 2021)
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Macromolecules **54**, 6477 (15 June 2021)
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5. Submitted Papers with Center Affiliation

- Sudipta Gupta and Rana Ashkar,
The dynamic face of lipid membranes,
Soft Matter **17**, 6910 (invited review, published 8 July 2021)
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- Nazia Munir, James R. Mahan, Luan C. Doan, Nguyen Q. Vinh, and Kory J. Priestley,
Gold-black manufacture, microstructure, and optical characterization,
Applied Optics **60**, 6857 (published 4 August 2021)
[<https://doi.org/10.1364/AO.430686>].
- Shannon R. Serrao and Uwe C. Täuber,
Stabilizing spiral structures and population diversity in the asymmetric May-Leonard model through immigration,
European Physical Journal B **94**, 175 (published 24 August 2021)
[<https://doi.org/10.1140%2Fepjb%2Fs10051-021-00168-x>].
- Negin Forouzesh and Alexey V. Onufriev,
MMGB / SA consensus estimates of binding free energy between the novel coronavirus spike protein to the human ACE2 receptor,
posted on bioRxiv (26 August 2020)
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- Nishant Shirodkar, Shengfeng Cheng and Gary Seidel,
Enhancement of mode I fracture toughness properties of epoxy reinforced with graphene nanoplatelets and carbon nanotubes,
submitted to Composites Part B (9 February 2021).
- Abhishek K. Singh, Chengyuan Wen, Shengfeng Cheng, and Nguyen Q. Vinh,
Long-range DNA-water interactions,
submitted to Biophysical Journal (17 May 2021).
- Zhibo Wang, Changhe Zhou, Qi Li, Kunru Wang, Jiamin Miao, Carlos Toro, Shuchi Wu, Yu Tang, Qian Han, Furong Sun, Daniel G. S. Capelluto, Jianyong Li, and Bingyu Zhao,
Xanthomonas euvesicatoria effector XeAvrRxo1 triggers a Rxo1-mediated defense response in Nicotianabenthamiana and its chaperone Xe4429 functions as an antitoxin, a transcription repressor, and an enhancer of XeAvrRxo1 secretion,
submitted to Plant Journal (15 June 2021).
- Yisheng Huang and Shengfeng Cheng,
Chain conformations and phase separation in polymer solutions with varying solvent quality,
submitted to Journal of Polymer Science (3 July 2021).
- Shannon R. Serrao, Shengfeng Deng, Priyanka, Ruslan I. Mukhamadiarov, Lauren M. Childs, and Uwe C. Täuber,
Requirements for the containment of COVID-19 disease outbreaks through periodic testing, isolation, and quarantine,
submitted to Journal of Physics A: Mathematical and Theoretical (9 July 2021)
[\[https://doi.org/10.1101/2020.10.21.20217331\]](https://doi.org/10.1101/2020.10.21.20217331).
- Joel Marcos Serrano, Tianyu Liu, Dong Guo, Zachary L. Croft, John Elliott, Ke Cao, Assad U. Khan, Zhen Xu, Elsaid Nouh, Shengfeng Cheng, and Guoliang Liu,
Up to 50% reduction in water vaporization enthalpy by block copolymer-based porous carbon fibers,
submitted to Science Advances (10 July 2021).
- Jason Czak and Michel Pleimling,
Spatio-temporal patterns emerging from a spatially localized time-delayed feedback scheme,
submitted to Physical Review E (21 July 2021).
- C. Nadir Kaplan and L. Mahadevan,
Geometrical dynamics of edge-driven surface growth,
submitted to Proceedings of the Royal Society A (27 July 2021)
[\[arXiv:2107.14232v1\]](https://arxiv.org/abs/2107.14232v1).

6. Invited Presentations with Center Affiliation

- Rana Ashkar,
Elasticity and phase-separation in amphiphilic self-assemblies: From biology to nanotechnology,
2020 American Conference on Neutron Scattering (virtual, 13 July 2020)
- Rana Ashkar,
Biomimetic lipid membranes from a neutron scattering and simulations perspective,
Department of Chemical and Biomedical Engineering Seminar, University of South Florida (virtual, 16 September 2020)
- Michel Pleimling,
Dynamical phase transitions in the Ising ferromagnet: bulk and surface phase diagrams,
International Webinar in Statistical Physics, Department of Physics, Presidency University, India (virtual, 27 September 2020)
- Daniel Capelluto,
Mechanism of phosphoinositide-dependent modulation of protein trafficking,
Molecular Biology and Genetics Congress, Istanbul Technical University, Istanbul, Turkey (virtual, 3 October 2020)
- Nguyen Q. Vinh,
Graphene-semiconductor nanostructures enabled broadband photodetection,
Colloquium, Department of Physics, Virginia Commonwealth University, VA (6 November 2020).
- Uwe C. Täuber,
Raumzeitliche Korrelationen in stochastischer Populationsdynamik (Spatio-temporal correlations in stochastic population dynamics),
11. jDPG Theorieworkshop *Stochastische Modelle in der Physik* (11th young German Physical Society Theory Workshop *Stochastic Models in Physics*), Germany (virtual, 9 January 2021)
- Rana Ashkar,
Collective dynamics in lipid membranes: From fundamental physics to health and disease,
Department of Physics, College of William & Mary, Williamsburg, VA (virtual, 12 March 2021)
- Priyanka (presenter), Uwe C. Täuber, and Michel Pleimling,
Control of the surface roughness during a growth process described by the Kardar-Parisi-Zhang equation,
2021 American Physical Society March Meeting (virtual, 15 March 2021)

- Shengfeng Cheng,
Stratification in drying colloidal and polymer films,
American Physical Society March Meeting 2021 (virtual, 18 March 2021).
- Uwe C. Täuber,
Stochastic spatial predator-prey models,
Theory Club Seminar, Laboratoire Matière et Systèmes Complexes, Université de Paris,
France (virtual, 22 March 2021)
- Michel Pleimling,
Ordering processes in skyrmion matter,
Seminar in Statistical Physics, Coventry University, U.K. (virtual, 24 March 2021)
- Joseph Zaino and Justin Barone,
Fragmentation of plastics into microplastics (ENVR-3551803),
Division of Environmental Chemistry, Micro- & Nano-Plastics in the Environment:
Detection, Characterization, Fate, and Impact Symposium
American Chemical Society Spring Meeting (virtual, 5 April 2021)
- Rana Ashkar,
*Stiffening effect of cholesterol in saturated and unsaturated phosphatidylcholine
membranes*,
257th American Chemical Society (ACS) Annual Meeting (virtual, 13 April 2021)
- Justin Barone,
In situ nanofiller formation in rubber nanocomposites,
Structure and Dynamics of Polymer Nanocomposites and Filled Rubber Symposium
American Chemical Society Rubber Division Spring Meeting, Independence, OH
(virtual, 28 April 2021)
- Uwe C. Täuber,
Stochastic spatial predator-prey models,
International Webinar on Physics, Pabna University of Science and Technology,
Bangladesh (virtual, 4 June 2021)
- Nguyen Q. Vinh,
Long-range DNA water interactions,
2021 TSRC workshop on “Water Structure, Dynamics, and Thermodynamics in Biology”,
Telluride, CO (27 June 2021)

7. Provisional Patents

Not applicable.

8. Awards and Recognitions

Faculty:

- Rana Ashkar was elected as a member-at-large to the executive committee of the *American Physical Society's* Division of Biological Physics (APS-DBIO), 2021 – 2024.
- Rana Ashkar was elected as a member-at-large to the executive committee of the *SNS/HFIR* User Group (SHUG), 2021 – 2024.
- Uwe C. Täuber was appointed Lead Editor of *Physical Review E*, effective 1 January 2021.

Graduate students:

- Jason Czak
2021 William E. Hassinger Graduate Fellowship, Department of Physics, 22 April 2021
- Teshani Kumarage
Graduate School Doctoral Assistantship, spring 2021
- Rathsara Herath Mudiyansele
2021 Graduate Ladies of Robeson Award, Department of Physics, 22 April 2021
- Hana Mir
2021 Robert Lee Bowden, Jr. Essay Prize, Department of Physics, 22 April 2021
2021 Robert C. Richardson Scholarship, Department of Physics, 22 April 2021
- Riya Nandi
2021 Graduate Ladies of Robeson Award, Department of Physics, 22 April 2021
- Hadi Rahmaninejad
Graduate School Doctoral Assistantship, spring 2021
Achievement award for presentation, American Physical Society, Division of Soft Matter (DSOFT), APS March 2021 Meeting
- Tiffany G. Roach
Initiative for Maximizing Student Development Predoctoral Fellowship (IMSD), summer 2020
- James Stidham
Graduate School Doctoral Assistantship, fall 2020

- Tuo-Xian Tang
Joseph Frank Hunkler Memorial Scholarship, summer 2020
- Hong Yao
2021 Tipsword Graduate Scholarship, Department of Physics, 22 April 2021

Undergraduate students:

- Julie Nguyen
Daniel C. & Delia F. Grant Scholarship, April 2021;
ESM DA Summer Internship, Department of Physics, Virginia Tech, summer 2020:
Materials DA internship, to conduct neutron scattering research on biomimetic membranes at Oak Ridge National Lab (due to COVID transferred to Virginia Tech)

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. Five student travel grants may be issued for each spring and fall semester per year, totaling up to \$ 4,000. Due to the COVID-19 pandemic there were no travel grants issued this year.

10. Student New Collaboration Incentive Awards

In January 2017, the Center established a grant for graduate students supporting new research collaborations related to the Center's mission, aiding planned or ongoing research involving students from different research groups. The students are to submit a brief application with a description of their planned research. If accepted they can be awarded up to \$ 400, possibly later supplemented with a student travel grant. Two grants may be issued in each spring and fall semester per year, totaling up to \$ 800.00. Due to the COVID-19 pandemic there were no awards issued this year.

VIII. Industrial Affiliates Program

Not applicable.

IX. Report of Financial Condition

IX. Report of Financial Condition

Center Financial Report Fiscal Year 2021		Center Financial Projection Fiscal Year 2022	
Operations Account (176188)		Operations Account (176188)	
Starting Balance	\$ 34,358.24	Starting Balance	\$ (1,442.60)
	Income		Income
Starts FY2021	\$ (35,800.84)	A21 Award	\$ 18,900
	Expenses		Expenses
		20% Staff Salary (Katrina Loan)	\$ (8,137)
Ending Balance	\$ (1,442.60)	Ending Balance	\$ 9,320.40
Overhead Account (235052)		Overhead Account (235052)	
Starting Balance	\$ 38,472.70	Starting Balance	\$ 36,485.47
	Income		Income
Overhead Earnings	\$ 18,015.32	Overhead Earnings	\$ 35,000
	Expenses		Expenses
Salary	\$ (18,839.30)	Seminar	\$ (4,700)
Seminar Travel	\$ -	Symposium	\$ (5,700)
Faculty Travel	\$ -	Student Travel	\$ (2,000)
Seminar Supplies and Meals	\$ (647.29)	Center's Awards	\$ (1,010)
Student Travel	\$ -	Supplies & Budget	\$ (362)
Centers Symposium Travel	\$ -		
Centers Symposium Awards	\$ (250.00)	80% Staff Salary (Katrina Loan)	\$ (32,548)
Supplies & Budget	\$ (265.96)		
Center's Summer workshop	\$ -		
Other Charges			
Ending Balance	\$ 36,485.47	Ending Balance	\$ 25,165.97

X. Major Issues of the Center

The Center's financial standing remains very solid. Since March 2020, owing to the COVID-19 pandemic, expenses have been much reduced.

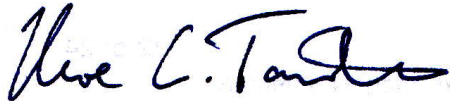
Until March 2020, the Center maintained a very lively and successful seminar series and discussion meetings. The COVID-19 pandemic naturally affected our regular events severely, forcing us to move our annual symposium, seminars, as well as summer discussion meetings to purely online mode. We hope we can resume in-person events over the course of the forthcoming academic year.

We shall continue to organize annual symposia with external speakers, and to support other related conferences.

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

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

September 3, 2021



Dr. Uwe C. Täuber
Professor of Physics, Faculty of Health Sciences, Virginia Tech
Director, Center for Soft Matter and Biological Physics
Lead Editor, Physical Review E