

Center for Soft Matter and Biological Physics
Department of Physics, Virginia Tech
Annual Report – Fiscal Year 2020

The Center for Soft Matter and Biological Physics was chartered on February 12, 2016. This annual report covers the period July 1, 2019 through June 30, 2020.

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 Steering Committee:

- Dr. Daniel Capelluto, Associate Professor, Department of Biological Sciences, College of Science
- Dr. Shengfeng Cheng, Associate Professor, Department of Physics, College of Science
- Dr. William Ducker, Professor, Department of Chemical Engineering, College of Engineering
- Dr. Vinh Nguyen, Associate Professor, Departments of Physics and Nanoscience, College of Science

Center Director and Steering Committee elections were scheduled for March 2020 but had to be postponed. We held these elections through an online polling platform in August.

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

2. List of Faculty Affiliated with the Center Regular faculty members (34) as of June 30, 2020:

- Dr. Rana Ashkar, Assistant Professor, Department of Physics, College of Science
- Dr. Justin Barone, Professor, Department of Biological Systems Engineering, College of Agriculture and Life Science and 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, Assistant Professor, Department of Biological Sciences, 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, Assistant 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. Priyanka, since January 2018, ARO 450484
- Dr. Saptarshi Chakraborty, since January 2019 – April 2020, SU 235371
- Dr. Abhishek K. Singh, since May 2019, AFOSR 450618
- Dr. Chengyuan Wen, since January 2020, NSF 418270
- Dr. Vinh Ho, Since May 2020, NASA 426703

Graduate research assistants:

- Tabassum Ahmed, ½ GRA fall 2019 and full GRA summer 2020, AFOSR 450589
- Ahmadreza Azizi, GRA summer 2019, ½ GRA Fall 2019, ARO 450484
- Chi Chen, ½ GRA summer 2020, SU 235371
- Jason Czak, GRA summer 2019 and 2020, ½ GRA fall 2019 and spring 2020, ARO 450484
- Luan Doan, GRA summer 2019 and 2020, NSF 418270
- Ryan Xi Hao, ½ GRA fall 2019 and full GRA summer 2020, AFOSR 450589
- Vinh Ho, GRA summer 2019, NASA 426703
- Chinmay Katke, GRA summer 2020, ARO 450484
- Teshani Kumarage, GRA ½ summer 2020, SU 235371
- Bingham Liu, GRA summer 2020, NSF 480341
- Ruslan I. Mukhamadiarov, GRA summer 2019 and 2020, ½ GRA fall 2019 and spring 2020, DOE 429262
- Riya Nandi, GRA summer 2019 and summer 2020, ½ GRA fall 2019 and spring 2020, ARO 450484
- Christy Pius, GRA summer I 2020, ARO 450484
- Brendan Quinlan, GRA summer 2020, NASA 426703
- Hadi Rahmaninejad, ½ GRA summer 2020, SU 235371
- Shannon R. Serrao, GRA summer 2019, ½ GRA fall 2019, ARO 450484
- James Stidham, ½ GRA summer 2019 and 2020, ½ GRA spring 2020, ½ GRA fall 2020 DOE 429262: ½ GRA fall 2019 and spring 2020, NSF 479739
- Hong Yao, GRA summer 2019, ARO 450484, ½ GRA fall 2019 and spring 2020, GRA summer 2020, DOE 429262
- Yifei Wang, GRA summer 2019 and 2020, AFOSR 450618
- Chengyuan Wen, GRA fall 2019, AFOSR 450589

Undergraduate research students:

- Jiarong Cui, physics and nanoscience, summer 2019, Hamlett Undergrad Research
- Bryan Dobbins, summer 2020, SU-235741
- Joshua Eager, physics and nanoscience, summer 2019, Hamlett Undergrad Research
- Hayden Hollenbeck, physics, fall 2019, spring and summer 2020, AFOSR 450589
- Yisheng Huang, physics, summer 2020 NSF 480341
- Hana Mir, summer 2020, NSF 479739
- Julie Nguyen, physics, fall 2019 and spring 2020, SU 235371
- Finn Jr Arthur Obrien, physics and nanoscience, summer 2019, Hamlett Undergrad Research
- Prashant Pradhan, nanoscience, summer 2019, Hamlett Undergrad Research

4. **Classified Staff**

- Katrina Loan, Program Support Technician, funded through A-21 program. During her third year, Ms. Loan's salary will be provided by the Office of the Vice President for Research (70%) and the Center for Soft Matter and Biological Physics (30%).

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.

We propose as its 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. G. Don Taylor, Professor, Department of Industrial and Systems Engineering, and Vice President for Research and Innovation

V. Major Grants Received in 2019-2020

New grants:

- U.S. National Science Foundation (NSF 450589), 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.

Continuing grants:

- National Aeronautics and Space Administration (NASA 418127) support, *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 21, 2020; total volume \$ 912,459.
- 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 – April 14, 2021; 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.
- 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 – July 31, 2021; total volume \$ 368,000 for four years.
- Luther and Alice Hamlett Undergrad Research (444364) support, PI Vinh Nguyen (Physics, 100 %): September 10, 2017 – March 31, 2023; total volume \$ 40,000.
- 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 – June 14, 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 01, 2018 – June 30, 2021; 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 – August 14, 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 – June 30, 2021; total volume \$ 260,000 for three years.

VI. Major Proposals Submitted or Pending

- National Institutes of Health (NIH), (R21), *Magnetic Field Effects on Spatial Cell in the Limbic System*, PI John Phillips (Biological Science, 80 %), co-PI Vinh Nguyen (Physics, 10%), co-PI Eric Smith (Statistics, 10%): April 1, 2020 – March 31, 2022; total volume \$ 448,141 for two year.
- 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., £ 554,335; Uwe C. Täuber (Physics) and Michel Pleimling (Physics), \$ 338,411; January 1, 2021 – December 31, 2023 (submitted June 11, 2020).
- National Institutes of Health (NIH), *The effect of membrane composition and commonly used drugs on the entry mechanism of coronavirus into pulmonary cell membranes*; Rana Ashkar (Physics), (submitted June 2020-pending).
- 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, \$ 229,935): January 1, 2021 – December 31, 2023; total volume \$ 1,199,671.

VII. Significant Accomplishments in 2019-2020

1. Center for Soft Matter and Biological Physics Seminar Series

- September 9, 2019: Dr. Carolina Tallon, Materials Science and Engineering, Virginia Tech:
Rocket Science meets Colloidal Surface Science: Near-Net-Shaping of Dense and Porous Temperature Ceramics for Extreme Applications
- September 23, 2019: Vinh Ho, Physics, Virginia Tech:
Fast and High Responsivity Graphene-based Photodetectors at Room-temperature by Engineering Dielectric Films.
- September 30, 2019: Prof. Rui Qiao, Mechanical Engineering, Virginia Tech
Modeling of interfacial and Transport Phenomena: Ionic Self-assemble, Active Colloids, and Beyond.

2. Center for Soft Matter and Biological Physics Symposium

The Center held its fifth annual symposium entirely online May 20, 2020, organized by Shengfeng Cheng (Department of Physics), featuring 16 speakers from different departments within Virginia Tech. Due to the COVID-19 pandemic no poster session was held, nor was there any awards presented.

- Nadir Kaplan, Physics, Virginia Tech
Morphogenesis and morphometrics of soft systems.
- John Phillips, Biological Sciences, Virginia Tech
Did the evolution of a photoreceptor-based?
- Sohan Kale, Mechanical Engineering, Virginia Tech
Upscaling active-gel theory of actomyosin cortex to epithelial tissue mechanics.
- Riya Nandi, Physics, Virginia Tech
Stochastic modeling of dynein motors on a one-dimensional lattice.
- Abhishek Singh, Physics, Virginia Tech
High precision megahertz to terahertz spectroscopy.
- Michel Pleimling, Physics, Virginia Tech
Creating order out of chaos: local control of reaction-diffusion systems.
- Priyanka, Physics, Virginia Tech
A PD control strategy for a dynamical network model.

- Layne T. Watson, Computer Science, Virginia Tech
A new algorithm for parameter estimation in stochastic models.
- Djordje Minic, Physics, Virginia Tech
The universality of genetic code, and beyond.
- Justin Barone, Biological Systems Engineering, Virginia Tech
Fragmentation of plastics into microplastics.
- William Ducker, Chemical Engineering, Virginia Tech
Adsorption of molecules in highly confined geometries.
- Lou Madsen, Chemistry, Virginia Tech
Nanoscale confinement and intermolecular effects on transport in polymer membranes.
- Jiangtao Cheng, Mechanical Engineering, Virginia Tech
A universal mechanism of nanoscale transport of interfacial liquids near a solid surface.
- Jonathan Boreyko, Mechanical Engineering, Virginia Tech
Tree-inspired water harvesting.
- Xukun He, Mechanical Engineering, Virginia Tech
Evaporation of squeezed water droplets between two parallel hydrophobic/superhydrophobic surfaces.
- Shengfeng Cheng, Physics, Virginia Tech
Nanoparticle-induced phase separation in miscible liquids.

3. Center for Soft Matter and Biological Physics Meetings

Through the Fall 2019 and the first half of the Spring 2020 semester (Fridays 4.00 – 5.00 p.m.), the Center held informal meetings, organized by Vinh Nguyen (Department of Physics), to promote scientific exchange and incite possible research collaborations (<https://csmb.phys.vt.edu/events/Discussion.html>):

- July 12, 2019: Prof. David Minh (Chemistry, Illinois Institute of Technology)
New Computational Tools for Designing Compounds Active Against Biological Macromolecules
- July 26, 2019: Connor Mackert (Physics, Virginia Tech)
Gray Scott Model Parameter Adjustment Effects

- August 2, 2019: Vinh Ho (Physics, Virginia Tech)
Broadband and High Responsivity Graphene-based Photodetectors at Room-temperature
- August 23, 2019: Anri Karanovich (Physics, Virginia Tech)
Nonlinear Dynamics and Chaos: Fractals and Strange Attractor
- Oct. 18, 2019: Ahmadreza Azizi (Physics, Virginia Tech)
Critical Phenomena in Presence of Symmetric Absorbing States
- Feb. 7, 2020: Dr. Abhishek Singh (Physics, Virginia Tech)
Insights into Hydration Dynamics at Sub-picosecond Timescales
- June 1, 2020: Prof. Uwe Tauber (Physics, Virginia Tech)
Introduction to Critical Phenomena and the Renormalization Group, Part 1
- June 8, 2020: Prof. Uwe Tauber (Physics, Virginia Tech)
Introduction to Critical Phenomena and the Renormalization Group, Part 2
- June 15, 2020: Prof. Uwe Tauber (Physics, VT)
Introduction to Critical Phenomena and the Renormalization Group, Part 3
- June 22, 2020: Shengfeng Deng (Physics, Virginia Tech)
A coupled two-species model for the pair contact process with diffusion
- June 29, 2020: Ruslan Mukhamadiarov (Physics, Virginia Tech)
Temperature Interfaces in the Katz-Lebowitz-Spohn Driven Lattice Gas

4. Research Publications with Center Affiliation

- Barton L. Brown, Uwe C. Täuber, and Michel Pleimling,
Skymion relaxation dynamics in the presence of quenched disorder,
Physical Review B **100**, 024410 – 1-8 (9 July 2019)
[\[https://journals.aps.org/prb/abstract/10.1103/PhysRevB.100.024410\]](https://journals.aps.org/prb/abstract/10.1103/PhysRevB.100.024410).
- Deepali Shirsekar, Nguyen Q. Vinh, Bob R. Mahan, and Kory J. Priestley,
Design and demonstration of an automated bidirectional reflectometer for low-reflectivity optical coatings,
American Society of Thermal and Fluids Engineering, ISSN 2379-1768, (17 July 2019)
[\[https://doi.org/10.1615/TFEC2019.fmi.027537\]](https://doi.org/10.1615/TFEC2019.fmi.027537).
- Wen Xiong, Tuo-Xian Tang, Evan Littleton, Arbu Karchini, Iulia M. Lazar, and Daniel G.S. Capelluto,

Preferential phosphatidylinositol 5 phosphate binding contributes to a destabilization of the VHS domain structure of Tom1,

Scientific Reports **PMID: 31350523**, (26 July 2019)

[<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6659632/>].

- Alex T. Kriegel and William A. Ducker,
Removal of bacteria from solids by bubbles: Effect of solid wettability, interaction geometry, and liquid-vapor interface velocity,
American Chemical Society-Langmuir **35**, 12817-12830 (25 August 2019)
[<https://pubs.acs.org/doi/pdf/10.1021/acs.langmuir.9b01941>].
- Uwe C. Täuber,
Fluctuations and correlations in chemical reaction kinetics and population dynamics, in:
Chemical kinetics - Beyond the textbook, eds. K. Lindenberg, R. Metzler, and G. Oshanin,
World Scientific Publ., Chap. 1 – 1-34 (September 2019)
[<https://www.worldscientific.com/worldscibooks/10.1142/q0209>].
- Yifei Wang, Vinh X. Ho, Prashant Pradhan, Mike P. Cooney, and Nguyen Q. Vinh,
Graphene-Germanium quantum dot photodetector with high sensitivity,
Proceeding of SPIE **11088**, 100888 (9 September 2019)
[<https://doi.org/10.1117/12.2529371>].
- Luan C. Doan, Bob R. Mahan, Kory J. Priestley, and Nguyen Q. Vinh,
Measuring bidirectional reflectance distribution of low reflectivity surfaces in the near infrared,
Proceeding of SPIE **11103**, 11030I (11 September 2019)
[<https://doi.org/10.1117/12.2529629>].
- Ali Charkhesht, Djamila Lou, Ben Sindle, Chengyuan Wen, Shengfeng Cheng, and
Nguyen Q. Vinh,
*Insights into hydration dynamics and cooperative interactions in glycerol-water mixtures
by terahertz dielectric spectroscopy,*
The Journal of Physical Chemistry B **41**, 8791-8799 (20 September 2019)
[<https://doi.org/10.1021/acs.jpcc.9b07021>].
- Jeffery B. Weiss, Baylor Fox-Kemper, Dibyendu Mandal, Arin D. Nelson, and
Royce K. P. Zia,
Nonequilibrium oscillations, probability angular momentum, and the climate system,
Journal of Statistical Physics **179**, 1010-1027 (9 October 2019)
[<https://doi.org/10.1007/s10955-019-02394-1>].
- X. Wang and M. Pleimling,
*Online gambling of pure chance: wager distribution, risk attitude, and anomalous
diffusion,* Scientific Reports **9**, 14712, 1-17 (11 October 2019)
[<https://www.nature.com/articles/s41598-019-50168-2>].

- Joel Marcos Serrano, Tianyu Liu, Assad U. Khan, Brandon Botset, Benjamin J. Stovall, Zhen Xu, Dong Guo, Ke Cao, Xi Hao, Shengfeng Cheng, and Guoliang Liu, *Composition design of block copolymers for porous carbon fibers*, Chem. Mater. **31**, 8898-8907 (23 October 2019) [<https://doi.org/10.1021/acs.chemmater.9b02918>].
- Yow-Ren Chang, Eric R. Weeks, Daniel Barton, Jure Dobnikar and William A. Ducker, *Effect of topographical steps on the surface motility of the bacterium pseudomonas aeruginosa*, ACS Biomaterials and Engineering, **5**, 6436-6445 (28 October 2019) [<https://pubs.acs.org/doi/pdf/10.1021/acsbiomaterials.9b00729>].
- Weigang Liu and Uwe C. Täuber, *Nucleation of spatio-temporal structures from defect turbulence in the two-dimensional complex Ginzburg–Landau equation*, Physical Review E **100**, 052210 – 1-15 (20 November 2019) [<https://journals.aps.org/pre/abstract/10.1103/PhysRevE.100.052210>].
- Barbara L. DeButts, Renee V. Thompson, and Justin R. Barone, *Hydrolyzed wheat protein as a self-assembled reinforcing filler in synthetic isoprene rubber vulcanizates*, Industrial Crops and Technology **141**, 111815 (1 December 2019) [<https://doi.org/10.1016/j.indcrop.2019.111815>].
- Ruslan I. Mukhamadiarov, Priyanka, and Uwe C. Täuber, *Transverse temperature interfaces in the Katz-Lebowitz-Spohn driven lattice gas*, Physical Review E **100**, 062122, 1 – 13 (16 December 2019) [<https://journals.aps.org/pre/abstract/10.1103/PhysRevE.100.062122>].
- Barbara L. DeButts and Justin R. Barone, *Processing-property relationships in wheat protein-isoprene rubber composites*, Rubber Chemistry and Technology (2 January 2020) [<https://doi.org/10.5254/rct.20.80448>].
- Binqun Luan and Shengfeng Cheng, *Potential interference with microtubule assembly by graphene: a tug-of-war* Nanoscale **12**, 4968-4974 (10 January 2020) [<https://doi.org/10.1039/C9NR10234E>].
- Harshwardhan Chaturvedi, Ulrich Dobramysl, Michel Pleimling, and Uwe C. Täuber, *Critical scaling and aging near the flux-line-depinning transition*, Physical Review B **101**, 024515 – 1-8 (21 January 2020) [<https://journals.aps.org/prb/abstract/10.1103/PhysRevB.101.024515>].

- Weigang Liu and Uwe C. Täuber,
Aging phenomena in the two-dimensional complex Ginzburg-Landau equation,
EPL (Europhysics Letters) **128**, 30006 – 1-7 (24 January 2020)
[<https://iopscience.iop.org/article/10.1209/0295-5075/128/30006>].
- Vinh X. Ho, Yifei Wang, Brendan Ryan, Luke Patrick, Hongxing X. Jiang, Jingyu Y. Lin,
and Nguyen Q. Vinh,
Observation of optical gain in Er-doped GaN epilayers,
Journal of Luminescence **221**, 117090 (31 January 2020)
[<https://doi.org/10.1016/j.jlumin.2020.117090>].
- Priyanka, Uwe C. Täuber, and Michel Pleimling,
*Feedback control of surface roughness in a one-dimensional Kardar-Parisi-Zhang
growth process*,
Physical Review E **101**, 022101 – 1-8 (3 February 2020)
[<https://journals.aps.org/pre/abstract/10.1103/PhysRevE.101.022101>].
- Ryan. Baker and Michel Pleimling,
The effect of habitats and fitness on species coexistence in systems with cyclic dominance,
Journal of Theoretical Biology **486**, 110084, pp. 1-8 (7 February 2020)
[<https://www.sciencedirect.com/science/article/pii/S0022519319304539?via%3Dihub>].
- Rana Ashkar, Robert M. Dalgliesh, Roger Pynn, Alan D. F. Dunbar, Richard A. L. Jones,
and Andrew J. Parnell,
*Profile retrieval of a buried periodic structure using spin echo grazing incidence neutron
scattering*,
American Institute of Physics, Applied Physics Letters **116**, 101602 (12 March 2020).
[<https://aip.scitation.org/doi/10.1063/1.5140616>].
- Laura E. Hanzly, Barbara L. DeButts, Danielle Shell, and Justin R. Barone,
Protein aggregation in aqueous polyvinyl alcohol solutions, Green Materials **8**, 32-39
(17 March 2020)
[<https://doi.org/10.1680/jgrma.19.00012>].
- Myung-Eun Song, Deepam Maurya, Yifei Wang, Jue Wang, Min-Gyu Kang, David
Walker, Pam A. Thomas, Scott T. Huxtable, Robert J. Bodnar, Nguyen Q. Vinh, and
Shashank Priya,
*Phase transitions and phonon mode dynamics of $Ba(Cu_{1/3}Nb_{2/3})O_3$ and $Sr(Cu_{1/3}Nb_{2/3})O_3$
for understanding thermoelectric response*,
American Chemical Society Applied Energy Materials **3**, 3939-3945 (13 April 2020)
[<https://dx.doi.org/10.1021/acsaem.0c00342>].
- Chengyuan Wen, Bingham Liu, Josh Wolfgang, Timothy E. Long, and Shengfeng Cheng,

Determination of glass transition temperature of polyimides from atomistic molecular dynamics simulations and machine-learning algorithms,
Journal of Polymer Science **58**, 1521-1534 (13 April 2020)
[<https://doi.org/10.1002/pol.20200050>].

- Rana Ashkar,
Selective dynamics in polymeric materials: Insights from quasi-elastic neutron scattering Spectroscopy,
American Institute of Physics, Journal of Applied Physics **127**, 151101 (17 April 2020)
[<https://aip.scitation.org/doi/10.1063/1.5144243>].
- Tuo-Xian Tang, Carla V. Finkelstein, and Daniel G. S. Capelluto,
The C-terminal motif of Phafin2 inhibits PH domain binding to phosphatidylinositol 3-phosphate,
Biochim Biophys Acta-Biomembranes, invited paper for special issue on Membrane Proteins, Structures, Functions and Native Nanodiscs,
Science Direct. **1862**, 6, 183230 (1 June 2020)
[<https://www.sciencedirect.com/science/article/pii/S0005273620300559>].

5. Submitted Papers with Center Affiliation

- Ahmadreza Azizi and Michel Pleimling
Critical phenomena in presence of symmetric absorbing states: a microscopic model with tunable parameters,
submitted to Physical Review E **102**, 022112 (sub. 24 June 2019), (pub. 10 August 2020)
[<https://doi.org/10.1103/PhysRevE.102.022112>].
- K. Sitarachu and R. K. P. Zia,
Exact microcanonical statistical analysis of transition behavior in Ising chains and strips,
Journal of Statistical Mechanics: Theory and Experiment **2020**, P073204 (sub.10 February 2020), (pub.7 July 2020)
[<https://iopscience.iop.org/article/10.1088/1742-5468/ab97bc>].
- Saptarshi Chakraborty, Milka Doktorova, Trivikram R. Molugu, Frederick A. Heberle, Haden L. Scott Boris, Dzikovski Michihiro, Laura-Roxana Stingaciu, Robert F. Standaert, Francisco Barrera, John Katsaras, George Khelashvili, Michael F. Brown, and Rana Askhar,
How cholesterol stiffens unsaturated lipid membranes,
ReData, The University of Arizona, in press (sub.13 March 2020), (pub. 4 August 2020)
[https://arizona.figshare.com/articles/dataset/Reassessment_of_Membrane_Mechanics_How_Cholesterol_Stiffens_Unsaturated_Lipid_Membranes/12712856].
- E. G. Kelley, P. Butler, Rana Ashkar, R. Bradbury, and M. Nagao,
Scaling relationship for the elastic moduli and viscosity of mixed liquid membranes

Proc. Natl. Acad. Science, (13 March 2020).

- Wei Song, Carter J Gottschalk, Anne M. Brown, Andrew Biscardi, Tuo-Xian Tang, Jeffery F. Ellena, Carla V. Finkielstein, and Daniel G. S. Capelluto, *Structural, in silico, and functional analysis of Disabled-2-derived peptide for recognition of sulfatides*, Science Report **10**, 13520 (9 May 2020) [<https://doi.org/10.1038/s41598-020-70478-0>].
- Saeed Behzadinasab, Alex Chin, Mohsen Hosseini, Leo Poon, and William A. Ducker, *A surface coating that rapidly inactivates SARS-CoV-2*, American Chemical Society, Applied Materials & Interfaces **12**, 31, 34723-34727 (20 May 2020) [<https://doi.org/10.1021/acsami.0c11425>].
- Ruslan I. Mukhamadiarov, Shengfeng Deng, Shannon R. Serrao, Priyanka, Riya Nandi, Louis Hong Yao, and Uwe C. Täuber, *Social distancing and epidemic resurgence in agent-based Susceptible-Infectious-Recovered models*, submitted to Scientific Reports (3 June 2020) [<https://arxiv.org/abs/2006.02552>].
- Chengyuan Wen, Roy Odle, and Shengfeng Cheng *Coarse-grained molecular dynamics modeling of a branched polyetherimide* Submitted to Macromolecules (19 June 2020) [<https://arxiv.org/abs/2006.08715>].
- James Stidham and Michel Pleimling, *Late stages in the ordering of magnetic skyrmion lattices*, submitted to Physical Review B (5 June 2020).
- Xiang Li, Mauro Mobilia, Alastair M. Rucklidge, and Royce K. P. Zia, *How does homophily shape the dynamics of an adaptive network?* submitted to Physical Review Research (June 2020).

6. Invited Presentations with Center Affiliation

- Uwe C. Täuber, *Non-equilibrium relaxation and critical aging of flux lines following current quenches*, 15th International Workshop on Magnetism and Superconductivity at the Nanoscale, Coma-ruga, Spain (4 July 2019).
- Uwe C. Täuber, *Temperature interfaces in the Katz-Lebowitz-Spohn driven lattice gas*,

Workshop *the Many Facets of Non-equilibrium Physics: From Many-Body Theory to Quantum Thermodynamics*, Mazara del Vallo, Italy (12 July 2019).

- Nguyen Q. Vinh,
Influence of hydration and protein collective motions on biological activities,
2019 TSRC workshop on *Water Structure, Dynamics, and Thermodynamics in Biology*,
Telluride, Colorado (15 July 2019).
- Nguyen Q. Vinh,
Design and demonstration of an automated bidirectional reflectometer for low-reflectivity optical coatings,
The 4th Thermal and Fluids Engineering Conference (17 July 2019)
- Royce K. P. Zia,
Understanding the extreme Thouless effect in a sample, dynamics social network-the XIE model,
Center for Simulation Physics, The University of Georgia, (27 August 2019).
- Uwe C. Täuber,
Nucleation and aging transient dynamics in the two-dimensional complex Ginzburg-Landau equation,
LPMCM Seminar, CNRS Grenoble, France (28 August 2019).
- Royce K. P. Zia,
Nonequilibrium statistical mechanics: Small steps at a vast frontier of “pure and applied” theoretical physics,
Physics and Astronomy, University of Georgia (29 August 2019).
- Uwe C. Täuber,
Stochastic spatial predator-prey models,
Seminar, Swiss Federal Institute of Aquatic Science and Technology Eawag, Dübendorf, Switzerland (2 September 2019).
- J. M. Zavada (presenter), Hongxing X. Jiang, Jingyu Y. Lin, and Nguyen Q. Vinh,
Erbium doped GaN for laser applications,
8th International Workshop on Photoluminescence in Rare Earths: Photonic Materials and Devices, Nice, France (4 September 2019).
- Uwe C. Täuber,
Non-equilibrium relaxation and critical aging of flux lines following current quenches,
Discussion Meeting of the EPSRC NetworkPlus on Emergence and Physics Far from Equilibrium on *Horizons for Emergence and Non-Equilibrium Physics*, King's College London, U.K. (12 September 2019).

- Royce K. P. Zia,
Nonequilibrium statistical mechanics: A growing frontier of “pure and applied” theoretical physics,
Physics and Astronomy, University of Tennessee (16 September 2019).
- Shengfeng Cheng,
Drying of soft matter solutions,
2019 DoE Center for Integrated Nanotechnologies (CINT) Annual Meeting: Computation and Theory of Soft Matter, Santa Fe, NM (23 September 2019).
- Uwe C. Täuber,
Temperature interfaces in the Katz-Lebowitz-Spohn driven lattice gas,
Statistical Physics and Complexity Seminar, University of Edinburgh, U.K.
(25 September 2019).
- Uwe C. Täuber,
Temperature interfaces in the Katz-Lebowitz-Spohn driven lattice gas,
Leeds Applied Nonlinear Dynamics (LAND) Seminar, University of Leeds, U.K.
(1 October 2019).
- Uwe C. Täuber,
Stochastic spatial predator-prey models,
Joint Applied Mathematics and Math-Bio Seminar, University of Leeds, U.K.
(2 October 2019).
- Uwe C. Täuber,
Temperature interfaces in the Katz-Lebowitz-Spohn driven lattice gas,
DAMTP Statistical Physics and Soft Matter Seminar, University of Cambridge, U.K.
(8 October 2019).
- Uwe C. Täuber,
Temperature interfaces in the Katz-Lebowitz-Spohn driven lattice gas,
Theorie-Kolloquium, Universität zu Köln (Cologne), Germany (11 October 2019).
- Uwe C. Täuber,
Stochastic spatial predator-prey models,
Theorie 1 Seminar, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
(14 October 2019).
- Uwe C. Täuber,
Stochastic spatial predator-prey models,
Soft Matter / Biophysics Lunch Seminar, Ludwig-Maximilians-Universität München.
Munich, Germany (22 October 2019).

- Shengfeng Cheng,
Stratification in drying soft matter solutions: Molecular dynamics modeling,
CECAM Workshop: Applications of Diffusiophoresis in Drying, Freezing and Flowing
Colloidal Suspensions, Lausaane, Switzerland (31 October 2019).
- Shengfeng Cheng,
Polymer informatics,
Macromolecules Innovation Institute Technical Conferences and Review, Blacksburg, VA,
(4 November 2019).
- Shengfeng Cheng,
Drying of polymer solutions,
Macromolecules Innovation Institute Technical Conferences and Review, Blacksburg, VA,
(4 November 2019).
- Cihan Nadir Kaplan,
Morphing hard and soft matter by reaction-transport dynamics,
86th Annual Meeting of the APS Southeastern Section,
Wrightsville Beach, NC (7 November 2019).
- Uwe C. Täuber,
Temperature interfaces in the Katz-Lebowitz-Spohn driven lattice gas,
Joint SISSA / ICTP Seminar, Scuola Internazionale Superiore di Studi Avanzati (SISSA).
Trieste, Italy (21 November 2019).
- Rana Ashkar,
Biomimetic Lipid Membranes: A neutron scattering and simulations perspective,
MRS Fall Meeting and Exhibit, Boston, MA (5 December 2019).
- Royce K. P. Zia,
What is Physics – a personal perspective,
Physics, University of Houston (6 December 2019).
- Rana Ashkar,
Effects of domains on matrix dynamics in phase-separated model membranes,
256th ACS Annual Meeting: Biomembrane Structure, Mechanics & Dynamics
Symposium, Philadelphia, PA (25 March 2020).
- Rana Ashkar,
Cholesterol stiffens saturated and unsaturated phosphocholine membranes,
256th ACS Annual Meeting: Biomembrane Structure, Mechanics & Dynamics
Symposium, Philadelphia, PA (25 March 2020).
- Rana Ashkar,

Large Scale Structures: Small angle scattering and Reflectometry" and "Quasi-elastic Neutron Scattering,
Neutron and X-ray Summer School jointly conducted by Argonne National Lab and Oak Ridge National Lab (June 2020).

7. Provisional Patents: – Not applicable.

8. Awards and Recognitions

Faculty:

- Rana Ashkar
Chair, APS Site Visits Committee 2019-2020
Serves on the Penn State Neutron Science Advisory Council

Graduate students:

- Ruslan I. Mukhamadiarov,
Ray F. Tipword Graduate Scholarship,
Department of Physics, Virginia Tech, April 2020
- Riya Nandi,
Clayton D. Williams Graduate Fellowship in Theoretical Physics,
Department of Physics, Virginia Tech, April 2020
- James Stidham,
Hassinger Graduate Fellowship,
Department of Physics, Virginia Tech, April 2020
- Teshani Kumarage,
College of Science's Graduate Opportunity Fellowship,
Department of Physics, Virginia Tech, 2020

Undergraduate students:

- Julie Nguyen,
Daniel C. & Delia F. Grant Scholarship,
ESM DA Summer Internship
Department of Physics, Virginia Tech, 2020

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.

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.

VIII. Industrial Affiliates Program – Not applicable.

IX. Report of Financial Condition

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Center Financial Report Fiscal Year 2020		Center Financial Projection Fiscal Year 2021	
Operations Account (176188)		Operations Account (176188)	
Starting Balance	\$ 36,314.45	Starting Balance	\$ (0.01)
	Income		Income
Starts FY2020	\$ (36,314.46)	A21 Award	\$ 22,050
	Expenses		Expenses
		70% Staff Salary (Katrina Loan)	\$ (28,480)
Ending Balance	\$ (0.01)	Ending Balance	\$ (6,429.51)
Overhead Account (235052)		Overhead Account (235052)	
Starting Balance	\$ 38,527.66	Starting Balance	\$ 38,472.70
	Income		Income
Overhead Earnings	\$ 17,463.16	Overhead Earnings	\$ 35,000
	Expenses		Expenses
Salary	\$ (15,563.14)	Seminar	\$ (4,700)
Seminar Travel	\$ (1,044.92)	Symposium	\$ (5,700)
Faculty Travel	\$ (555.01)	Student Travel	\$ (2,000)
Seminar Supplies and Meals	\$ (286.93)	Center's Awards	\$ (1,010)
Student Travel	\$ (639.20)	Supplies & Budget	\$ (362)
Centers Symposium Travel	\$ -		
Centers Symposium Awards	\$ -		
Supplies & Budget	\$ (202.78)		
Center's Summer workshop	\$ -	30% Staff Salary (Katrina Loan)	\$ (12,206)
Other Charges	\$ -		
Ending Balance	\$ 37,698.84	Ending Balance	\$ 47,495.70

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 held our regular Center Director and Steering Committee elections through an online polling platform in August 2020.

Re-elected as Center Director:

Dr. Uwe C. Täuber, Professor, Department of Physics, College of Science, Faculty of Health Sciences

Elected 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

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.