

Patrick T. Underhill

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Rensselaer Polytechnic Institute
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Troy, NY 12180
(518)276-3032

EDUCATION

Massachusetts Institute of Technology, Cambridge, MA

Ph.D. in Chemical Engineering, September 2006
Advisor: Professor Patrick S. Doyle
Thesis Topic: Systematic Development of Coarse-grained Polymer Models

Washington University, St. Louis, MO

B.S. in Chemical Engineering, Summa Cum Laude, May 2001
B.S. in Physics, Summa Cum Laude, May 2001
School of Engineering Valedictorian

PROFESSIONAL EXPERIENCE

Rensselaer Polytechnic Institute, Troy, NY

<i>Professor, Chemical and Biological Engineering</i>	2020-Present
<i>Associate Professor, Chemical and Biological Engineering</i>	2014-2020
<i>Assistant Professor, Chemical and Biological Engineering</i>	2008-2014

University of Wisconsin-Madison, Madison, WI

<i>Postdoctoral Research Associate, Chemical and Biological Engineering</i>	2006-2008
Advisor: Professor Michael D. Graham	

AWARDS AND HONORS

RPI Chemical and Biological Engineering Outstanding Teacher Award, 2019
RPI School of Engineering Outstanding Teacher Award, 2015
Arthur B. Metzner Award, Society of Rheology, 2013
RPI Chemical and Biological Engineering Outstanding Teacher Award, 2012
NSF CAREER Award, 2010-2015
NSF Graduate Research Fellowship, 2001-2005

PUBLICATIONS

- 45) Anukta Datta, Xiaoyan Wang, Shawn D. Mengel, Audra J. DeStefano, Rachel A. Segalman, Patrick T. Underhill, and Matthew E. Helgeson. "A Gram-Charlier analysis of scattering to describe nonideal polymer conformations", *Macromolecules*, **57**, 9518-9535, 2024.
- 44) Emily K. Makowski, Hsin-Ting Chen, Tiexin Wang, Lina Wu, Jie Huang, Marissa Mock, Patrick T. Underhill, Emma Pelegri-O'Day, Erick Maglalang, Dwight Winters, and Peter M. Tessier. "Reduction of monoclonal antibody viscosity using interpretable machine learning", *mAbs*, **16**, 2303781, 2024.
- 43) Shangren Zhu and Patrick T. Underhill. "Stochastic kinetic theory applied to coarse-grained polymer model", *J. Chem. Phys.*, **160**, 114903, 2024.
- 42) Pranav Ramesh, Mary Margaret Sta Cruz, Surya Karla, Juhong Ahn, Sangwoo Lee, Patrick T. Underhill, and Georges Belfort. "A new class of "structure-by-design" polymer membranes for organic solvent nanofiltration with controllable selectivity", *J. Mem. Sci.*, **692**, 122296, 2024.
- 41) Jiamen Zhang, Gregory S. Smith, Patrick T. Corona, Patrick T. Underhill, L. Gary Leal, and Matthew E. Helgeson. "Self-consistent connected-rod model for small-angle scattering from deformed semiflexible chains in flow", *Macromolecules*, **57**, 201-216, 2023.
- 40) Juhong Ahn, Liwen Chen, Patrick T. Underhill, Guillaume Freychet, Mikhail Zhernenkov, and Sangwoo Lee. "Continuous transition of colloidal crystals through stable random orders", *Soft Matter*, **19**, 3257, 2023. (Cover Image)
- 39) Saverio Spagnolie and Patrick T. Underhill. "Swimming in complex fluids", *Annu. Rev. Condens. Matter Phys.*, **14**, 381-415, 2023.
- 38) Sabitoy Singh Virk and Patrick T. Underhill. "Application of a simple short-range attraction and long-range repulsion colloidal model toward predicting the viscosity of protein solutions", *Molecular Pharmaceutics*, **19**, 4233-4240, 2022.
- 37) Toluwanimi O. Bello, Sangwoo Lee, and Patrick T. Underhill. "Mesoscale simulation approach for assembly of small deformable objects", *Soft Matter*, **18**, 5106, 2022.

- 36) Edmund Tang, Sabitoj Singh Virk, and Patrick T. Underhill. "Coupling between long ranged repulsions and short ranged attractions in a colloidal model of zero shear rate viscosity", *J. Rheology*, **66**, 491, 2022.
- 35) Angelo C. Setaro and Patrick T. Underhill, "Dumbbell kinetic theory for polymers in a combination of flow and external electric field," *Phys. Rev. E*, **100**, 052501, 2019.
- 34) Aditya Raghunandan, Amir H. Hirsra, Patrick T. Underhill, and Juan M. Lopez, "Predicting steady shear rheology of condensed-phase monomolecular films at the air-water interface," *Phys. Rev. Lett.*, **121**, 164502, 2018.
- 33) Edmund M. Tang and Patrick T. Underhill, "Examination of the statistical effects associated with tracking propulsive particles," *Langmuir*, **34**, 10694-10701, 2018.
- 32) Purba Chatterjee, Edmund M. Tang, Pankaj Karande, and Patrick T. Underhill, "Propulsion of catalytic Janus spheres in viscosified Newtonian solutions," *Phys. Rev. Fluids*, **3**, 014101, 2018.
- 31) John J. Keating, Mirco Sorci, Istvan Kocsis, Angelo A. Setaro, Mihail Barboiu, Patrick T. Underhill, and Georges Belfort, "Atmospheric Pressure Plasma - ARGET ATRP Modification of Poly(ether sulfone) Membranes: A Combination Attack," *J. Mem. Sci.*, **546**, 151-157, 2018.
- 30) Purba Chatterjee, Greg Sowiak, and Patrick T. Underhill, "Effect of Phase Change on the Rheology and Stability of Paraffin Wax-in-Water Pickering Emulsions," *Rheol. Acta*, **56**, 601-613, 2017.
- 29) Yuzhou Qian, Peter R. Kramer, and Patrick T. Underhill, "Stochastic Kinetic Theory for Collective Behavior of Hydrodynamically Interacting Active Particles," *Phys. Rev. Fluids*, **2**, 043104, 2017.
- 28) Patrick T. Underhill, Amir H. Hirsra, and Juan M. Lopez, "Modeling Steady Shear Flows of Newtonian Liquids with non-Newtonian Interface," *J. Fluid Mech.*, **814**, 5-23, 2017.
- 27) Harsh Pandey, Sylvia A. Szafran, and Patrick T. Underhill, "Passive trapping of Rigid Rods Due to Conformation-dependent Electrophoretic Mobility," *Soft Matter*, **12**, 3121-3126, 2016.
- 26) Harsh Pandey and Patrick T. Underhill, "Coarse-grained Model of Conformation-dependent Electrophoretic Mobility and its Influence on DNA Dynamics," *Phys. Rev. E*, **92**, 052301, 2015.
- 25) Liyun Ren, Rahmi Ozisik, Shiva P. Kotha, and Patrick T. Underhill, "Highly Efficient Fabrication of Polymer Nanofiber Assembly by Centrifugal Jet Spinning: Process and Characterization," *Macromolecules*, **48**, 2593-2602, 2015.
- 24) Rangarajan Radhakrishnan and Patrick T. Underhill, "Influence of Shear on Globule Formation in Dilute Solutions of Flexible Polymers," *J. Chem. Phys.*, **142**, 144901, 2015.
- 23) Sandeep Chilukuri, Cynthia H. Collins, and Patrick T. Underhill, "Dispersion of Flagellated Swimming Microorganisms in Planar Poiseuille Flow," *Phys. Fluids*, **27**, 031902, 2015.
- 22) Yaser Bozorgi and Patrick T. Underhill, "Large Amplitude Oscillatory Shear Rheology of Dilute Active Suspensions," *Rheol. Acta*, **53**, 899-909, 2014. (*invited contribution for a special issue for rheologists early in their career.*)
- 21) Yaser Bozorgi and Patrick T. Underhill, "Effects of Elasticity on the Nonlinear Collective Dynamics of Self-propelled Particles," *J. Non-Newtonian Fluid Mech.*, **214**, 69-77, 2014.
- 20) Sandeep Chilukuri, Cynthia H. Collins, and Patrick T. Underhill, "Impact of External Flow on the Dynamics of Swimming Microorganisms near Surfaces," *J. Phys.: Condens. Matter*, **26**, 115101, 2014.
- 19) Rangarajan Radhakrishnan and Patrick T. Underhill, "Simulations of the Large Amplitude Oscillatory Shear Response of Polymer-colloid Globules," *AIChE J.*, **60**, 1365-1371, 2014. (*invited contribution for a special issue in honor of R. Byron Bird's birthday.*)
- 18) Patrick T. Underhill, "Viscosity/Rheological Measurements," in *Colloid and Surface Chemistry: A Laboratory Guide for Exploration of the Nano World*, Seyda Bucak and Deniz Rende, editors, CRC Press, 41-49, 2013.
- 17) Rangarajan Radhakrishnan and Patrick T. Underhill, "Fluctuations in the Coil-stretch Transition of Flexible Polymers in Good Solvents: A Peak due to Non-linear Force Relation," *Phys. Rev. E*, **88**, 012606, 2013.
- 16) Yaser Bozorgi and Patrick T. Underhill, "Role of Linear Viscoelasticity and Rotational Diffusivity on the Collective Behavior of Active Particles," *J. Rheol.*, **57**, 511-533, 2013.
- 15) Rangarajan Radhakrishnan and Patrick T. Underhill, "Impact of Solvent Quality on the Hysteresis in the Coil-stretch Transition of Flexible Polymers in Good Solvents," *Macromolecules*, **46**, 548-554, 2013.
- 14) Rangarajan Radhakrishnan and Patrick T. Underhill, "Models of Flexible Polymers in Good Solvents: Relaxation and Coil-stretch Transition," *Soft Matter*, **8**, 6991-7003, 2012.
- 13) Yaser Bozorgi and Patrick T. Underhill, "Effect of Viscoelasticity on the Collective Behavior of Swimming Microorganisms," *Phys. Rev E*, **84**, 061901, 2011.
- 12) Patrick T. Underhill and Michael D. Graham, "Correlations and Fluctuations of Stress and Velocity in Suspensions of Swimming Microorganisms," *Phys. Fluids*, **23**, 121902, 2011.
- 11) Juan P. Hernandez-Ortiz, Patrick T. Underhill, and Michael D. Graham, "Dynamics of confined suspensions of swimming particles," *J. Phys.: Condens. Matter*, **21**, 204107, 2009.
- 10) Patrick T. Underhill, Juan P. Hernandez-Ortiz, and Michael D. Graham, "Diffusion and Spatial Correlations in Suspensions of Swimming Particles," *Phys. Rev. Lett.*, **100**, 248101, 2008.

- 9) Patrick T. Underhill and Patrick S. Doyle, "Accuracy of Bead-spring Chains in Strong Flows," *J. Non-Newtonian Fluid Mech.*, **145**, 109-123, 2007.
- 8) Patrick T. Underhill and Patrick S. Doyle, "DNA Stretch During Electrophoresis Due to a Step Change in Mobility," *Phys. Rev. E*, **76**, 011805, 2007.
- 7) Patrick T. Underhill and Patrick S. Doyle, "Alternative Spring Force Law for Bead-spring Chain Models of the Worm-like Chain," *J. Rheol.*, **50**(4), 513-529, 2006.
- 6) Patrick T. Underhill and Patrick S. Doyle, "Development of Bead-Spring Polymer Models Using the Constant Extension Ensemble," *J. Rheol.*, **49**(5), 963-987, 2005.
- 5) Patrick S. Doyle and Patrick T. Underhill, "Brownian Dynamics Simulations of Polymers and Soft Matter," in *Handbook on Materials Modeling, Volume I: Methods and Models*, Sidney Yip, editor, 2619-2630, 2005.
- 4) Patrick T. Underhill and Patrick S. Doyle, "On the Coarse-graining of Polymers into Bead-spring Chains," *J. Non-Newtonian Fluid Mech.*, **122**, 3-31, 2004.
- 3) Wolfgang Bauer, Scott Pratt, Christopher Morling, and Patrick Underhill, "The Nuclear Fragmentation Phase Transition and Rare Isotope Production," *Heavy Ion Physics*, **14**, 29-38, 2001.
- 2) Scott Pratt, Wolfgang Bauer, Christopher Morling, and Patrick Underhill, "Rare Isotope Production in Statistical Multifragmentation," *Phys. Rev. C*, **63**, 034608, 2001.
- 1) David B. Hall, Patrick Underhill, and John M. Torkelson, "Spin Coating of Thin and Ultrathin Polymer Films." *Polymer Engineering and Science*, **38**(12), 1998.

INVITED LECTURES

- 39) Columbia University Chemical Engineering Department seminar, New York, NY (2023)
- 38) Drexel University Chemical Engineering Department seminar, Philadelphia, PA (2022)
- 37) CECAM Workshop on Out-of-Equilibrium Soft Matter in Complex Media, Lausanne, Switzerland (2019)
- 36) Amgen seminar, Thousand Oaks, CA (2019)
- 35) BIRS Complex Fluids in Biological Systems Workshop, Banff, Ontario, Canada (2018)
- 34) Fundamental Problems in Active Matter Workshop, Aspen, CO (2018)
- 33) University of Southern California Chemical Engineering Department seminar, Los Angeles, CA (2017)
- 32) Amgen seminar, Thousand Oaks, CA (2017)
- 31) California Institute of Technology Chemical Engineering Department seminar, Pasadena, CA (2017)
- 30) 3M Tech Forum seminar, St. Paul, MN (2017)
- 29) RWTH Aachen Chemical Engineering Department Seminar, Aachen, Germany (2017)
- 28) Syracuse University Chemical Engineering Department Seminar, Syracuse, NY (2016)
- 27) Active Fluids Minisymposium, SIAM annual meeting, Chicago, IL (2014)
- 26) Society of Rheology Metzner Award Presentation, Montreal, Canada (2013)
- 25) City College of New York Levich Institute Seminar, New York, NY (2013)
- 24) Brown University Engineering Department Seminar, Providence, RI (2013)
- 23) University of Nevada-Reno Mechanical Engineering Department Seminar, Reno, NV (2013)
- 22) University of Massachusetts-Amherst Polymer Science and Engineering Department Seminar, Amherst, MA (2013)
- 21) Carnegie Mellon University Chemical Engineering Department Seminar, Pittsburgh, PA (2012)
- 20) Binghamton University Physics Department Seminar, Binghamton, NY (2012)
- 19) DuPont BEST/Horizons in Biotechnology seminar series, Wilmington, DE (2012)
- 18) University of Illinois Mechanical Engineering Department Seminar, Urbana-Champaign, IL (2012)
- 17) SIAM Conference on Applications of Dynamical Systems, Snowbird, UT (2011)
- 16) New England Complex Fluids Workshop, Yale University, New Haven, CT (2010)
- 15) Brandeis University Materials Research Center Seminar, Waltham, MA (2009)
- 14) Workshop on Soft Active Materials: From Granular Rods to Flocks, Cells and Tissues, Syracuse, NY (2009)
- 13) New York University Courant Institute Seminar, New York, NY (2009)
- 12) Syracuse University Physics Department Seminar, Syracuse, NY (2009)
- 11) Lehigh University Chemical Engineering Department Seminar, Lehigh, PA (2008)
- 10) Rensselaer Polytechnic Institute Chemical and Biological Engineering Department Seminar, Troy, NY (2008)
- 9) Washington University Energy, Environmental and Chemical Engineering Department Seminar, St. Louis, MO (2008)
- 8) University of Delaware Chemical Engineering Department Seminar, Newark, DE (2008)
- 7) University of Washington-Seattle Chemical Engineering Department Seminar, Seattle, WA (2008)
- 6) University of South Carolina Chemical Engineering Department Seminar, Columbia, SC (2008)
- 5) University of Pennsylvania Chemical and Biomolecular Engineering Department Seminar, Philadelphia, PA (2008)
- 4) Georgia Tech Chemical and Biomolecular Engineering Department Seminar, Atlanta, GA (2008)

- 3) Rheology Research Center Seminar, Madison, WI (2007)
- 2) Workshop on Multiscale Rheological Models for Fluids, Montreal, Canada (2004)
- 1) MIT Physics Department Condensed Matter Seminar, Cambridge, MA (2004)

GRANTS

Active

- 4) DOE (7/2024-6/2027), \$310,486 (PI, 100%)
Collaborative Research: Understanding the role of polymer topology on molecular deformation and scission under extreme shear using in situ neutron scattering
- 3) NSF/CASIS Transport on ISS Program (8/2023-7/2026), \$452,847 (Co-PI, 40%)
ISS: Protein flow and gelation in the absence of solid-wall nucleation
- 2) NSF Particulate and Multiphase Program (7/2023-6/2026), \$352,903 (PI, 100%)
New theoretical and simulation approach for understanding packing structures of soft self-adjusting objects
- 1) DOE (10/2019-10/2025), \$3,000,000 (co-PI, 19%)
Transformational molecular layer deposition tailor-made size-sieving sorbents for post-combustion CO₂ capture

Completed

- 12) ACS-PRF New Directions Program (9/2021-8/2024), \$110,000 (PI, 100%)
Phase separation of particles in flow using a stochastic kinetic theory
- 11) DOE (7/2020-6/2024), \$310,486 (PI, 100%)
Collaborative Research: Understanding the role of polymer topology on molecular deformation and scission under extreme shear using in situ neutron scattering
- 10) NSF Separations Program (9/2018-8/2022), \$348,987 (PI, 100%)
Trapping and separating objects in free solution by exploiting conformation-dependent electrophoretic mobility
- 9) NSF Particulate and Multiphase Program (9/2018-8/2022), \$224,576 (PI, 100%)
Collaborative Research: GOALI: Nanoparticle analysis of antibody colloidal interactions and their influence on viscoelastic properties of concentrated antibody solutions
- 8) DOE Office of Basic Energy Sciences (2/2016-1/2018), \$376,000 (co-PI, 50%)
Combinatorial and high throughput membrane synthesis and testing: Tailoring membrane surfaces to applications
- 7) NSF Particulate and Multiphase Program (10/2015-9/2017), \$151,641 (PI, 50%)
Propulsion of enzyme-coated Janus particles through complex environments
- 6) NSF Applied Mathematics Program (9/2012-8/2016), \$361,658 (co-PI, 50%)
DynSyst_Special_Topics: Correlations and stochastic dynamics in suspensions of swimming microorganisms
- 5) NSF Interfacial Processes and Thermodynamics Program (5/2012-4/2016), \$299,997 (co-PI, 50%)
Self-assembly mediated by aqueous interfaces: A novel computational study of structure, thermodynamics, and dynamics
- 4) NSF CAREER Award (Fluid Dynamics Program) (5/2010-4/2016), \$400,000
CAREER: Multiscale modeling of collective behavior of bacteria
- 3) Rensselaer Polytechnic Institute Seed Grant (1/2014-6/2015), \$35,000 (PI, 50%)
Designing nanomotors that move by enzymatic self-diffusiophoresis
- 2) American Physical Society Grant (7/2012-12/2012), \$7,000
The Fluid Dynamics Demo Kit: Fluid Physics on the Road
- 1) Rensselaer Polytechnic Institute Seed Grant (1/2012-12/2012), \$18,661 (co-PI, 50%)
A novel therapeutic strategy for targeting breast cancers

GROUP MEMBERS/ALUMNI

Current

Postdoctoral Associates

Rahul Kumar

Ph.D. Students

Xiaoyan Wang, Gaurang Shukla

Alumni

Postdoctoral Associates

Shreyash Gulati

Ph.D. Students

Rangarajan Radhakrishnan, Kajetan Sikorski, Yaser Bozorgi, Sandeep Chilukuri, Suhas Rao, Harsh Pandey, Purba Chatterjee, Yuzhou Qian, Edmund Tang, Angelo Setaro, Sabitoj Singh Virk, Toluwanimi Bello, Shangren Zhu, Mary Margaret Sta. Cruz

Undergraduate Students

Katherine Woychik, Hannah Fix, Michael McIntyre, Amanda Knight, Briana Kilburg, Zachary Menteur, Connor Schleicher, Hannah Clough, Jonathan Volpe, Tyler Gruttadauria, Megan Balfe, Seth Ludwig, Greg Sowiak, Sylvia Szafran, Nick McNeill, Rahul Sujanani, Guinevere Tillinghast, Samuel Keller, Conner Burns, Tejus Shastri, Zhiyuan Xu, Alex Rishty

TEACHING

Mathematical Methods for Chemical Engineers, Fall 2024
Advanced Transport Phenomena, Spring 2024
From Single Molecules to Complex Fluids, Fall 2023
Advanced Transport Phenomena, Spring 2023 (co-taught with G. Belfort)
From Single Molecules to Complex Fluids, Fall 2022
Advanced Transport Phenomena, Spring 2022
CBE PhD On-Ramp Seminar, Fall 2021
Introduction to Computational Chemical Engineering, Fall 2021
Advanced Transport Phenomena, Spring 2021
CBE PhD On-Ramp Seminar, Fall 2020
From Single Molecules to Complex Fluids, Fall 2020
Advanced Transport Phenomena, Spring 2020
CBE PhD On-Ramp Seminar, Fall 2019
Introduction to Computational Chemical Engineering, Fall 2019
Advanced Transport Phenomena, Spring 2019
Introduction to Computational Chemical Engineering, Fall 2018
Transport Phenomena II, Spring 2018
Transport Phenomena II, Spring 2017
From Single Molecules to Complex Fluids, Fall 2016
Transport Phenomena II, Spring 2016
Introduction to Chemical Engineering, Fall 2015
Mathematical Methods for Chemical Engineers, Fall 2015
Transport Phenomena II, Spring 2015
Mathematical Methods for Chemical Engineers, Fall 2014
From Single Molecules to Complex Fluids, Spring 2014
Mathematical Methods for Chemical Engineers, Fall 2013
Advanced Transport Phenomena, Spring 2013
Mathematical Methods for Chemical Engineers, Fall 2012
From Single Molecules to Complex Fluids, Spring 2012
Mathematical Methods for Chemical Engineers, Fall 2011
Transport Phenomena II, Spring 2011
Mathematical Methods for Chemical Engineers, Fall 2010
From Single Molecules to Complex Fluids, Spring 2010
Mathematical Methods for Chemical Engineers, Fall 2009
Advanced Fluid Mechanics, Spring 2009 (co-taught with G. Belfort)
Engineering Aspects of Sustainable Energy, Spring 2009 (co-taught with G. Belfort)

SERVICE AND LEADERSHIP

RPI

2019-2022	Department Graduate Program Director
2016-2017, 2023	Department Faculty Search Committee
2015-2024	Department Graduate Committee
2015-2016	Department Outreach Committee
2009-2018, 2024	Undergraduate Advising
2010-2024	Graduate Program Recruiting
2013-2014	School of Engineering Curriculum Committee
2010-2014	PREFACE Program (for students from underrepresented groups)
2009-2014	Michael Abbott Lectureship Series
2012-2013	Department Faculty Search Committee
2009-2013, 2023	Fall Department Seminar Series
2010	Faculty Intervention Program

External Review

2009- 2024 NSF Proposal Review Panels
2018-2024 DOE Proposal Review
Journals Journal of Fluid Mechanics, Journal of Non-Newtonian Fluid Mechanics, Rheologica Acta, Experimental Mechanics, Journal of Colloid and Interface Science, Electrophoresis, Macromolecular Theory & Simulations, Journal of the Royal Society Interface, Soft Matter, Biopolymers, Physical Review E, Physical Review Letters, Physical Review Fluids, Physical Review X, European Physical Journal, Journal of Chemical Physics, Journal of Porous Media, Journal of Rheology, Macromolecules, Physics of Fluids.

PROFESSIONAL ORGANIZATIONS

New England Complex Fluids Group
 Organizer of Workshop at RPI, June, 2010
Society of Rheology
 Member of Metzner Award Committee, 2016-2018
 Chair of Metzner Award Committee, 2018
 Member of Bingham Medal Award Committee, 2020-2022
 Chair of Bingham Medal Award Committee, 2022
 Technical Program Co-chair 2021 Annual Meeting
Society for Industrial and Applied Mathematics
American Institute of Chemical Engineers
 Area 01D (Transport Phenomena) Co-chair of programming 2009-2011
 Area 01D (Transport Phenomena) Chair of programming 2011-2015
 Area 01J (Fluid Mechanics) Programming Committee 2010-2025
 Area 01J (Fluid Mechanics) Meeting Programming Chair 2013
 Area 01J (Fluid Mechanics) Co-chair 2018-2020
 Area 01J (Fluid Mechanics) Chair 2020-2022
American Physical Society
American Physical Society-Division of Fluid Dynamics
 Member of Committee in Education and Careers, 2012-2015
US National Committee on Theoretical and Applied Mechanics
 Society Representative, 2019-2023
 Subcommittee on Education and Outreach, 2022-2024