

CURRICULUM VITAE of M. Gregory Forest
October 19, 2013

Present Positions:

Grant Dahlstrom Distinguished Professor of Mathematics
Joint Appointment, Department of Biomedical Engineering
Director, Carolina Center for Interdisciplinary Applied Mathematics
The University of North Carolina at Chapel Hill (UNC-CH)

Mailing Address: CB 3250, UNC Chapel Hill, Chapel Hill, NC 27599-3250

Major Fields:

Mathematics & Modeling of Complex Fluids, Nano-Particle Dispersions, Diffusive & Hydrodynamic Transport Phenomena in Soft Matter, Lung Biology, Cell Mechanochemistry, Nonlinear Waves

Educational History:

B.S., Mathematics, University of New Orleans, May 1972
M.S., Mathematics, University of New Orleans, December 1973
Ph.D., Mathematics, University of Arizona, August 1979
Ph.D. Adviser: David W. McLaughlin

Tenure-Track Faculty Positions:

University of North Carolina at Chapel Hill, 1996-present
Ohio State University, 1979-1996

Visiting Academic Positions:

Department of Mathematics, University of California-Berkeley: March-May, 1983

Center for Nonlinear Studies, Los Alamos National Laboratory: January 1985;
January-March 1986, 1989 & 1990; January-May 1987; February, 1991-1993

Department of Mathematics, Princeton University: September-December 1986

Mathematical Sciences Research Institute, Berkeley: January '91, March '93 & '94

Program in Applied Mathematics, University of Colorado-Boulder: August, 1990

Department of Mathematics, University of Utah: January-June, 1995

Institute for Mathematics & Its Applications, Univ. of Minnesota: Sept-Nov, 2009

Administrative Positions Held (at UNC-CH):

Associate Chair of Applied Mathematics: 1996-1998, 2000-2004
Senior Associate Dean for the Sciences, College of Arts and Sciences: 1998-2000
Co-Director, Institute for Advanced Materials, 2002-2012
Interim Director, Institute for Advanced Materials, 2012-2013
Director, Carolina Center for Interdisciplinary Applied Mathematics, 2012-present

Scholarly Recognition:

Fellow of the Society for Industrial and Applied Mathematics, 2012

Consulting Experience:

Los Alamos National Laboratory; Hoechst-Celanese Corporation, Charlotte, NC;
Corning, Inc., Corning, NY; Liquidia Technologies, Durham, NC

Publications

1. Multiphase averaging and the inverse spectral solution of the KdV equation (with H. Flaschka and D.W. McLaughlin), *Comm. Pure Appl. Math.*, Vol. 33, 739-784 (1980).
2. Spectral theory for the periodic sine-Gordon equation: a concrete viewpoint (with D.W. McLaughlin), *J. Math. Phys.*, Vol. 23(7), 1248-1277 (1982).
3. Modulations of sinh-Gordon and sine-Gordon wavetrains (with D.W. McLaughlin), *Studies in Appl. Mathematics*, Vol. 68, 11-59 (1983).
4. On the modulational stability of two-phase sine-Gordon wavetrains (with N. Ercolani and D.W. McLaughlin), *Studies in Applied Math.*, Vol. 71(2), 91-101 (1985).
5. Modulations of perturbed sine-Gordon wavetrains (with D.W. McLaughlin), *SIAM J. Applied Math.*, Vol. 44(2), 287-300 (1984).
6. The geometry of real sine-Gordon wavetrains (with N. Ercolani), *Comm. Math. Physics*, Vol. 99, 1-49 (1985).
7. Modulational instabilities of periodic sine-Gordon waves: a geometric analysis (with N. Ercolani and D.W. McLaughlin), *Lectures in Appl. Math.*, Vol. 23, 149-166 (1985).
8. Oscillations and instabilities in near integrable pde's (with N. Ercolani and D.W. McLaughlin), *Lectures in Applied Mathematics*, Vol. 23, 3-46 (1985).
9. The origin and saturation of modulational instabilities (with N. Ercolani and D. W. McLaughlin), *Physica D*, Vol. 18, 472-474 (1986).
10. Geometry and modulation theory for the periodic nonlinear Schrödinger equation (with J. E. Lee), *IMA Volumes in Mathematics and Its Applications*, Vol. 2, 35-70, Springer-Verlag (1986).
11. A one-dimensional theory for viscoelastic fluid jets, with application to extrudate swell and draw-down under gravity (with S. Bechtel and D. Bogy), *Journal of Non-Newtonian Fluid Mechanics*, Vol. 21, 273-308 (1986).
12. A quasi-periodic route to chaos in a near-integrable PDE (with A. Bishop, D. W. McLaughlin and E. Overman), *Physica D*, Vol. 23, 293-328 (1986).

13. Hamiltonian structure for the modulation equations of a sine-Gordon wavetrain (with N. Ercolani, D.W. McLaughlin, and R. Montgomery), *Duke Mathematical Journal* Vol. 55(4), 949-983 (1987).
14. Effective stress rates of viscoelastic free jets (with S. Bechtel and K. Lin), *J. Non-Newtonian Fluid Mechanics*, Vol. 26, 1-41 (1987).
15. On the behavior of viscoelastic free jets with elliptical cross-section (with S. Bechtel and K. Lin), *J. Non-Newtonian Fluid Mechanics*, Vol. 27, 87-126 (1988).
16. Correlations between chaos in the perturbed sine-Gordon equation and finite modal equations, *Proceedings of Fourth Inter. Conf. on Nonlinear Evol. Eq. and Dyn. Syst.*, Montpellier, France, June 1987, edited by J. Leon, World Scientific (1988). An extended abstract in *Proceedings Cornell MSI Workshop*, May, 1987.
17. Geometry of the modulational instability III. Homoclinic orbits (with N. Ercolani and D.W. McLaughlin), *Physica D*, Vol. 43, 349-384 (1990).
18. 1-D closure models for 3-D incompressible viscoelastic free jets: von Kármán flow geometry and elliptical cross-section (with S. Bechtel, D. Holm, and K. Lin), *J. Fluid Mechanics*, Vol. 196, 241-262 (1988).
19. A quasiperiodic route to chaos in a near-integrable p.d.e.: homoclinic crossings (with A.R. Bishop, D.W. McLaughlin, and E.A. Overman), *Physics Letters A*, Vol. 127, 335-340 (1988).
20. Geometry of the modulational instability, Part I: Local analysis (with N. Ercolani and D.W. McLaughlin), *Memoirs of the A.M.S.*, unpublished.
21. Geometry of the modulational instability, Part II: Global analysis (with N. Ercolani and D.W. McLaughlin), *Memoirs of the A.M.S.*, unpublished.
22. Modal representations of chaotic attractors for the driven, damped pendulum chain (with A.R. Bishop, D.W. McLaughlin, and E.A. Overman), *Phys. Lett. A* Vol. 144, 17-25 (1990).
23. Numerical evidence for global bifurcations leading to switching phenomena in long Josephson junctions (with S. Pagano, R. Parmentier, et.al.), *Journal of Wave Motion*, Vol. 22, 213-226 (1990).
24. Correlations between chaos in a perturbed sine-Gordon equation and a truncated model system, (with A.R. Bishop, R. Flesch, D.W. McLaughlin, and E.A. Overman), *SIAM Journal of Math. Analysis*, Vol. 21(6), 1-26 (1990).
25. Change-of-type behavior in viscoelastic slender jet models (with Q. Wang), *Theoretical and Computational Fluid Dynamics*, Vol. 2, 1-25 (1990).
26. Numerical inverse spectral transform for the periodic sine-Gordon equation: theta function solutions and their linearized stability, (with R. Flesch and A. Sinha), *Physica D*, Vol. 48, 169-231 (1991).
27. Modeling fiber-spinning processes with a comprehensive perturbation theory, (with S. E. Bechtel and J. Cao), *FED - Vol. 124*, refereed proceedings of symposium on Recent Developments in Non-Newtonian Flows and Industrial Applications, ASME Press (1991).
28. Frequency and phase locking of spatially periodic perturbed sine-Gordon breather trains, (with S. P. Sheu and A. Sinha), *SIAM J. Applied Mathematics*, Vol. 52(3), 746-761 (1992).
29. Enhancement of optical bistability by periodic layering, (with R. Camassa and R. Knapp), *Nonlinearity*, Vol. 5, 721-742 (1992).
30. Practical applications of a higher order perturbation theory for slender viscoelastic jets and fibers, (with S. Bechtel and J. Cao), *Journal of Non-Newtonian Fluid Mechanics*, Vol. 41, 201-273 (1992).

31. Closure to all orders in 1-D models for slender viscoelastic free jets: An integrated theory for axisymmetric torsionless flows, (with S. Bechtel and K. Lin), *Journal of Stability and Applied Analysis of Continuous Media*, Vol. 2, 1-43 (1992).
32. Instability-driven energy transport in nearly integrable, many degree-of-freedom Hamiltonian systems, (with C. Goedde and A. Sinha), *Physical Review Letters* Vol. 68(18), 2722-2725 (1992).
33. Non-isothermal modelling of fiber spinning, (with S. Bechtel and Q. Wang), refereed proceedings of Symposium on Recent Advances in Non-Newtonian Fluid Flows, 1992 Winter Annual Meeting, ASME, edited by D.A. Siginer, Vol. 153, 37-48, ASME Press, New York (1992).
34. Illustration of an optimization procedure for fiber-spinning operating conditions: Maximum draw ratio under a Maxwell thin-filament model, (with S. Bechtel, J. Cao), *Journal of Rheology*, Vol. 37 (2), 237-287 (1993).
35. Fully nonlinear modal equations for nearly integrable partial differential equations, (with N. Ercolani, D. McLaughlin and A. Sinha), *Journal of Nonlinear Science*, Vol. 3, 393-426 (1993).
36. Chaotic transport and integrable instabilities in a nearly integrable, Hamiltonian, discrete sine-Gordon lattice, (with C. Goedde and A. Sinha), *Physica D*, Vol. 67, 347-386 (1993).
37. Dynamics of slender viscoelastic free jets, (with Q. Wang), *SIAM J. Appl. Math.* Vol. 54(4), 996-1032 (1994).
38. A numerical study of nearly integrable modulation equations, (with A. Sinha), *Singular Limits of Dispersive Wave Equations*, edited by N. Ercolani, I. Gabbitov, D. Levermore and D. Serre, Plenum Publishing (1994).
39. Computation and stability of fluxons in a singularly perturbed sine-Gordon model of the Josephson junction, (with D. Brown, B. Miller and N. A. Petersson), *SIAM J. Appl. Math.*, Vol. 54(4), 1048-1066 (1994).
40. Numerical simulations of non-isothermal fiber spinning processes, (with Qi Wang), *Recent Advances in Non-Newtonian Flows*, ASME Press, New York, refereed proceedings of ASME Summer Meeting, Lake Tahoe, June, 1994, edited by G. Vradis and D.A. Siginer (1994).
41. 1-D models for thin filaments of polymeric liquid crystals, (with Q. Wang and S.E. Bechtel), *Developments in Non-Newtonian Flows*, ASME Press, New York, refereed proceedings of ASME International Congress and Exposition, Chicago, IL, November, 1994, edited by S.E. Bechtel and D. Siginer (1994).
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44. Torsional effects in high-order viscoelastic thin-filament models, (with S. Bechtel, K. Bolinger and J. Cao), *SIAM J. Appl. Math.*, Vol. 55(1), 58-99 (1995).
45. A new model to determine dynamic surface tension and elongational viscosity using oscillating jet measurements, (with S.E. Bechtel, J.A. Cooper, N.A. Petersson, D.L. Reichard, A. Saleh, V. Venkataramanan), *Journal of Fluid Mechanics*, Vol. 293, 379-403 (1995).

46. Recovery of the Rayleigh capillary instability from slender 1-D inviscid and viscous models, (with S.E. Bechtel and C.D. Carlson), *Physics of Fluids*, Vol. 7(12), 2956-2971 (1995).
47. Modeling and computation of the onset of failure in polymeric liquid filaments, (with S.E. Bechtel and Q. Wang), *Journal of Non-Newtonian Fluid Mechanics*, Vol. 58, 97-129 (1995).
48. Thermomechanical equations governing a material with prescribed temperature-dependent density, with application to non-isothermal plane Poiseuille flow, (with D. Cao and S.E. Bechtel), *J. Applied Mechanics* Vol. 63(4), 1011-1018 (1996).
49. 1-D models for thin filaments of liquid crystalline polymers: coupling of orientation and flow in the stability of simple solutions, (with Q. Wang and S.E. Bechtel), *Physica D* Vol. 99(4), 527-554 (1997).
50. Exploiting accurate spinline measurements for elongational material characterization, (with V. Ramanan, V. Gauri, K. Koelling, S. Bechtel), *J. Rheology*, Vol. 41(2), 1-24 (1997).
51. One-dimensional isothermal spinning models for liquid crystalline polymer fibers, (with Q. Wang, S. Bechtel), *J. Rheology*, Vol. 41(4), 821-850 (1997).
52. Onset of oscillations in nonsoliton pulses in nonlinear dispersive fibers, (with Kenneth T-R McLaughlin), *J. Nonlinear Science*, Vol. 7, 43-62 (1998).
53. The effect of dynamic surface tension on the oscillation of slender elliptical Newtonian jets, (with S. E. Bechtel, N. Youssef, H. Zhou), *J. Applied Mechanics*, Vol. 65(3), 694-704 (1998).
54. Viscoelastic free surface jets and filaments, (with S. E. Bechtel and J. Cao), invited contribution for Proceedings for the Symposium on Rheology and Fluid Mechanics of Nonlinear Materials, ASME International Mechanical Engineering Congress and Exposition, Dallas, TX (1998).
55. A thin-filament melt spinning model with radial resolution of temperature and stress, (with G. Henson, D. Cao, and S. Bechtel), *J. Rheology* (2), 329-360 (1998).
56. The role of microstructure in taming the Rayleigh instability of cylindrical jets, (with Q. Wang), *Physica D*, Vol. 123, 161-182 (1998).
57. Anisotropic microstructure-induced reduction of the Rayleigh instability for liquid crystalline polymers, (with Q. Wang), *Physics Lett. A*, Vol. 245, 518-526 (1998).
58. Free surface viscoelastic and liquid crystalline polymer fibers and jets, (with S. E. Bechtel, Q. Wang, H. Zhou), invited book chapter in **Advances in Non-Newtonian Flows and Rheology**, Part B, 1069-1116, edited by D. Siginer, D. De Kee, R. Chhabra, Elsevier Science Publishers (1998).
59. Dynamics of free surface and pure elongational flows of liquid crystalline polymers, (with Q. Wang and H. Zhou), **Rheology and Fluid Mechanics of Nonlinear Materials**, edited by D. Siginer and D. DeKee, FED-Vol. 246, MD-Vol. 81, ASME, New York, 101-114 (1998).
60. An isothermal model for high-speed spinning of liquid crystalline polymer fibers-Coupling of flow, orientation, and crystallization, (with T. Ueda), *Journal of Non-Newtonian Fluid Mechanics*, Vol. 84, 109-121 (1999).
61. Near-equilibrium dynamics of Doi models for liquid crystal polymer flows: catastrophic and regularized behavior, (with Q. Wang), *Journal of Non-Newtonian Fluid Mechanics*, Vol. 83, 131-150 (1999).

62. An anelastic, scale-separated model for mixing, with application to atmospheric transport phenomena, (with R. McLaughlin), *Physics of Fluids*, Vol. 11(4), 1-13 (1999).
63. On the exact solution of the geometric optics approximation of the defocusing nonlinear Schrodinger equation, (with O. Wright and K. T-R McLaughlin), *Physics Letters A*, Vol. 257, 170-174 (1999).
64. A model study of the spinning of thermotropic liquid crystalline polymers: Fiber performance predictions and bounds on throughput, (with Q. Wang and H. Zhou), *Advances in Polymer Technology*, Vol. 18(4), 314-335 (1999).
65. Non-soliton pulse evolution in normally dispersive optical fibers, (with N. Kutz and K. T-R McLaughlin), *J. Optical Society of America B*, Vol. 16(11), 1856-1862 (1999).
66. Nonhomogeneous patterns with core defects in elongational flows of liquid crystal polymers, (with Q. Wang and H. Zhou), *J. Rheol.*, Vol. 43(6), 1573-1582 (1999).
67. Thermotropic liquid crystalline polymer fibers, (with H. Zhou and Q. Wang), *SIAM J. Appl. Math.*, Vol. 60(4), 1177-1204 (2000).
68. Non-focusing instabilities in coupled, integrable nonlinear Schrodinger PDEs, (with O. Wright, D.W. McLaughlin, and D. Muraki), *J. Nonlinear Science*, Vol. 10, 291-331 (2000).
69. Exact banded patterns from a Doi-Marrucci-Greco model of nematic liquid crystal polymers, (with Q. Wang and H. Zhou), *Physical Review E*, Vol. 61(6), 6665-6672 (2000).
70. Homogeneous pattern selection and director instabilities of nematic liquid crystal polymers induced by elongational flows, (with Q. Wang and H. Zhou), *Physics of Fluids*, Vol. 12(3), 490-498 (2000).
71. On the construction of orbits homoclinic to plane waves in integrable coupled nonlinear Schrodinger systems, (with S. Sheu and O. Wright), *Physics Letters A*, Vol. 266, 24-33 (2000).
72. On the Backlund-Gauge transformation and homoclinic orbits of a coupled nonlinear Schrodinger system, (with O. Wright), *Physica D: Nonlinear Phenomena*, Vol. 141, 104-116 (2000).
73. Some Riemann-Green functions for the geometric optics approximation of the defocusing nonlinear Schrodinger equation, (with O. Wright and K. T-R McLaughlin), refereed proceedings of the 16th IMACS World Congress (2000).
74. Methods for the exact construction of mesoscale patterns in rod-like nematic liquid crystal polymers, (with Q. Wang and H. Zhou), *Physica D-Nonlinear Phenomena*, Vol. 152, 288-309 (2001).
75. A model for a spreading and melting droplet on a heated substrate, (with D. M. Anderson and R. Superfine), *SIAM J. Appl. Math.*, Vol. 61(5), 1502-1525 (2001).
76. On the flow-phase diagram for discotic liquid crystals in uniaxial extension and compression, (with Q. Wang and H. Zhou), *Liquid Crystals*, Vol. 28(5), 717-720 (2001).
77. Non-Newtonian viscous oscillating free surface jets, and a new strain-rate dependent viscosity form for flows experiencing low strain rates, (with S. Bechtel, K. Koelling, N. Youseff, and H. Zhou), *Rheol. Acta*, Vol. 40, 373-383 (2001).
78. Transient behavior of thermal optical glass fiber drawing processes, (with H. Zhou), *European J. Appl. Math.*, Vol. 12(4), 479-496 (2001).

79. Symmetries of the Doi kinetic theory for nematic polymers of arbitrary aspect ratio: at rest and in linear flows, (with Q. Wang and R. Zhou), *Physical Review E*, Vol. 66, 031712 (2002).
80. Explicit flow-aligned orientational distribution functions for dilute nematic polymers in weak shear, (with Q. Wang and R. Zhou), refereed proceedings of ASME International Mechanical Engineering Congress, N.O., La., IMECE2002-32185 (2002).
81. Full-tensor alignment criteria for sheared nematic polymers (with R. Zhou, Q. Wang), *J. Rheology*, Vol. 47(1), 105-128 (2003).
82. Monodomain response of finite-aspect-ratio macromolecules in shear and related linear flows, (with Q. Wang), *Rheologica Acta*, Vol. 42, 20-46 (2003).
83. An integrable model for stable:unstable wave coupling phenomena, (with O. Wright), *Physica D*, Vol. 178, 173-189 (2003).
84. Computational observation of a weakly compressible mixing barrier in idealized anelastic fluid equations, (with R. McLaughlin and H. Zhou), *Physics of Fluids*, Vol. 15(10), 2872-2885 (2003).
85. Thermal expansion models of viscous fluids based on limits of free energy, (with S. Bechtel, F. Rooney, Q. Wang), *Phys. Fluids*, Vol. 15(9), 2681-2693 (2003).
86. The weak shear kinetic phase diagram for nematic polymers, (with Q. Wang, R. Zhou), *Rheologica Acta*, Vol. 43(1), 17-37 (2004).
87. Internal constraint theories for thermal expansion of viscous fluids, (with S.E. Bechtel, F.J. Rooney), *Int. J. Engineering Science*, Vol. 42, 43-64 (2004).
88. Structure scaling properties of confined nematic polymers in plane Couette cells: the weak flow limit, (with Q. Wang, H. Zhou, R. Zhou), *J. Rheology*, Vol. 48(1), 175-192, January/February (2004).
89. Scaling behavior of kinetic orientational distributions for dilute nematic polymers in weak shear, (with Q. Wang, R. Zhou), *JNNFM* Vol. 116(2-3), 183-204 (2004).
90. A kinetic theory for solutions of nonhomogeneous nematic liquid crystalline polymers with density variations, (with Q. Wang, R. Zhou), *Journal of Fluids Engineering*, Vol. 126, 180-188 (2004).
91. Monodomain response of arbitrary aspect ratio nematic polymers in general linear planar flows, (with Q. Wang, R. Zhou, E. Choate), *JNNFM*, Vol. 118(1), 17-31 (2004).
92. Kinetic theories and mesoscopic models for solutions of nonhomogeneous liquid crystal polymers, (with C. Calderer, Q. Wang), *JNNFM*, Vol. 120(1), 69-78 (2004).
93. Likelihood & expected-time statistics of monodomain attractors in sheared discotic and rod-like nematic polymers, (with X. Zheng, R. Zhou, Q. Wang), *Rheol. Acta*, Vol. 43(1), 17-37 (2004).
94. The flow-phase diagram of Doi theory for sheared nematic polymers, II: finite shear rates, (with R. Zhou, Q. Wang), *Rheol. Acta*, Vol. 44(1), 80-93 (2004).
95. Chaotic boundaries of nematic polymers in mixed shear and extensional flows, (with R. Zhou, Q. Wang), *Physical Review Letters*, Vol. 93(8), 088301, (2004).
96. Exact scaling laws for electrical conductivity properties of nematic polymer nano-composite monodomains, (with X. Zheng, R. Lipton, R. Zhou, Q. Wang), *Advanced Functional Materials*, Vol. 15(4), 627-638, April (2005).
97. Kinetic structure simulations of nematic polymers in plane Couette cells, I: The algorithm and benchmarks, (with R. Zhou, Q. Wang), *SIAM Multiscale Modeling and Simulation*, Vol. 3(4), 853-870 (2005).

98. Extension-enhanced conductivity of liquid crystalline polymer nano-composites, (with H. Zhou, X. Zheng, Q. Wang, R. Lipton), *Macromolecular Symposia*, Vol. 28, 81-85 (2005).
99. A numerical study of unsteady, thermal, glass fiber drawing processes, (with H. Zhou), *Communications in Mathematical Sciences*, Vol. 3(1), 27-45 (2005).
100. Connections between stability, convexity of internal energy, and the second law for compressible Newtonian fluids, (with S.E. Bechtel, F. Rooney, and Q. Wang), *ASME J. Applied Mechanics*, Vol. 72, 299 (2005).
101. Anisotropy and dynamic ranges in effective properties of sheared nematic polymer nano-composites, (with X. Zheng, R. Zhou, Q. Wang, R. Lipton), *Advanced Functional Materials*, Vol. 15, 2029-2035 (2005).
102. Hydrodynamic theories for mixtures of polymers and rod-like liquid crystalline polymers, (with Q. Wang), *Physical Review E*, Vol. 72, 041805: 1-17 (2005).
103. Anisotropy and heterogeneity of nematic polymer nano-composite film properties, (with R. Zhou, Q. Wang, X. Zheng, R. Lipton), *Institute for Mathematics and Its Applications*, Vol. 141, **Modeling of Soft Matter**, 85-98 (2005).
104. A new proof on uniaxial equilibria of a 3-dimensional Smoluchowski equation, (with H. Zhou, H. Wang, and Q. Wang), *Nonlinearity*, Vol. 18, 2815-2825 (2005).
105. Kinetic structure simulations of nematic polymers in plane Couette cells, II: In-plane structure transitions, (with R. Zhou, Q. Wang), *SIAM Multiscale Modeling and Simulation*, Vol. 4(4), 1280-1304 (2005).
106. Alignment and rheo-oscillator criteria for sheared nematic polymer films in the monolayer limit, (with J. Lee, R. Zhou), *Discrete and Continuous Dynamical Systems (DCDS)*, Vol. 6, 339-356 (2006).
107. Anchoring distortions coupled with plane Couette & Poiseuille flows of nematic polymers in viscous solvents: morphology in molecular orientation, stress & flow, (with H. Zhou), *DCDS*, Vol. 6, 407-425 (2006).
108. On weak plane Couette and Poiseuille flows of rigid rod and platelet ensembles, (with Z. Cui, Q. Wang, H. Zhou), *SIAM J. Applied Math*, Vol. 66(4), 1227-1260 (2006).
109. A classical problem revisited: Rheology of nematic polymer monodomains in small amplitude oscillatory shear, (with E. Choate), *Rheologica Acta*, Vol. 46(1), 83-94 (2006).
110. Monodomain dynamics for rigid rod & platelet suspensions in strongly coupled coplanar linear flow and magnetic fields, II: Kinetic theory, (with S. Sircar, Q. Wang, R. Zhou), *Phys. Fluids*, Vol. 18, 103102:1-14 (2006).
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115. Nematic liquids in weak capillary Poiseuille flow: structure scaling laws and effective conductivity implications, (with H. Zhou), *Int. J. Numerical Analysis & Modeling*, Vol. 4 (3), 460-477 (2007).
116. Nano-rod suspension flows: a 2D Smoluchowski-Navier-Stokes solver, (with R. Zhou, Q. Wang), *Int. J. Numerical Analysis & Modeling*, Vol. 4(3), 478-488 (2007).
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119. Microscopic-macroscopic simulations of rigid-rod polymer hydrodynamics: heterogeneity & rheochaos, (with R. Zhou, Q. Wang), *SIAM Multiscale Modeling & Simulation*, Vol. 6(3), 858-878 (2007).
120. Effects of strong anchoring on the dynamic moduli of heterogeneous nematic polymers, (with E. Choate, Z. Cui), *Rheol. Acta*, Vol. 47, 223-236 (2008).
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126. Oscillating hydrodynamical jets in steady shear of nano-rod dispersions, (with S. Heidenreich, S. Hess, S. H. L. Klapp, X. Yang, R. Zhou, Q. Wang), 15th International Congress on Rheology and 80th Annual Meeting of the Society of Rheology, August 3-8, 2008, XVTH INTERNATIONAL CONGRESS ON RHEOLOGY - THE SOCIETY OF RHEOLOGY 80TH ANNUAL MEETING, Vol. 1027: 168-170 (2008).
127. Effects of tilted director angle anchoring conditions on the dynamic moduli of heterogeneous nematic polymers, (with E. Choate, Z. Cui, L. Ju), 15th International Congress on Rheology and 80th Annual Meeting of the Society of Rheology, August 3-8, 2008, XVTH INTERNATIONAL CONGRESS ON RHEOLOGY - THE SOCIETY OF RHEOLOGY 80TH ANNUAL MEETING, Vol. 1027: 481-483 (2008).

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131. Sheared nematic liquid crystal polymer monolayers, (with H. Wang, H. Zhou), Discrete & Continuous Dynamical Systems B, Vol. 11(2), 497-517 (2009).
132. Time-domain methods for passive microrheology and anomalous diffusive transport in soft matter, (with J. Fricks, L. Yao, T. Elston), SIAM J. Appl. Math., Vol. 69(5), 1277-1308 (2009).
133. Dynamic defect morphology and hydrodynamics of sheared nematic polymers in two space dimensions, (with X. Yang, Q. Wang, W. Mullins), J. Rheology, Vol. 53(3), 589-615, May/June (2009).
134. Quench sensitivity of defects and shear banding in nematic polymer film flows, (with X. Yang, W. Mullins, Q. Wang), J. Non-Newtonian Fluid Mechanics, Vol.159 (1-3), 115-129 (2009).
135. On the exact solution for smooth pulses of the defocusing nonlinear Schrodinger modulation equations prior to breaking, (with O. Wright, C-J Rosenberg), Nonlinearity, Vol. 22, 2287-2308 (2009).
136. Transient anomalous diffusion of tracer particles in soft matter, (with S. McKinley, L. Yao), J. Rheology, Vol. 53(6), 1487-1506 (2009).
137. A simple model for non-topological defects in sheared nematic polymer monodomains, (with E. Choate, L. Yao, X. Zheng, R. Zhou), J. Computational and Theoretical Nanosciences, Vol. 7, 787-794 (2010); special issue on Nematic Liquid Crystalline Polymers and Nanocomposites, Forest, Zhou, Wang Editors.
138. Mathematical studies and simulations of nematic liquid crystalline polymers and nanocomposites (A review), (with H. Zhou, H. Wang), J. Comput. Theor. Nanosci. Vol. 7, 645-660 (2010); special issue on Nematic Liquid Crystalline Polymers and Nanocomposites, Forest, Zhou, Wang Editors.
139. 2D Lid-driven cavity flow of nematic polymers: an unsteady sea of defects, (with X. Yang, Q. Wang, W. Mullins), Soft Matter, Vol. 6, 1138-1156 (2010).
140. A 2-D kinetic theory for monodomain flows of polymer-rod nanocomposites, (with L. Liao, Q. Wang), Communications in Computational Physics, Vol. 7, No. 2, 250-282 (2010).
141. Effects of strong anchoring on the dynamic moduli of heterogeneous nematic polymers II: Oblique anchoring angles, (with E. Choate, L. Ju), Rheologica Acta, DOI:10.1007/s00397-009-0397-1 (2010).
142. Dynamic texture scaling of sheared nematic polymers in the large Ericksen number limit, (with S. Heidenreich, S. Hess, R. Zhou, X. Yang), J. Non-Newtonian Fluid Mechanics, Vol. 165 (13), 687-697 (2010).
143. Spatial Stress and Strain Distributions of Viscoelastic Layers in Oscillatory Shear, (with B. Lindley, B. Smith, S. Mitran, D. Hill), Mathematics and Computers in Simulation, DOI:10.1016/j.matcom.2010.07.031 (2010).

144. A Kinetic Theory and Benchmark Predictions for Polymer Dispersed, Semi-Flexible Macromolecular Rods or Platelets, (with J. Li, Q. Wang, R. Zhou), *Physica D: Nonlinear Phenomena*, Vol. 240, 114–130 (2011).
145. Shearing the I-N phase transition of liquid crystalline polymers: long-time memory of defect initial data, (with K. Xu, X. Yang), *Discrete and Continuous Dynamical Systems B*, Vol. 15 (20), 457-473 (2011).
146. Shear cell rupture of liquid crystal droplets in a viscous fluid, (with X. Yang, C. Liu, J. Shen), *J. Non-Newtonian Fluid Mechanics*, Vol. 166, 487-499 (2011).
147. Dependence of the dynamic moduli of heterogeneous nematic polymers on planar anchoring relative to flow direction, (with E. Choate), *Rheol. Acta*, Vol. 50 (9-10), 767-778 (2011).
148. Computational and Modeling Strategies for Cell Motility, (with Q. Wang, X. Yang, D. Adalsteinsson, T. Elston, K. Jacobson, M. Kapustina), invited chapter for **Computational Modeling of Biological Systems: From Molecules to Pathways**, N. Dokholyan, Editor, Springer, Biological and Medical Physics Series, ISBN 978-1-4614-2145-0 (2012).
149. LCP droplet dispersions: a two-phase, diffuse-interface kinetic theory and global droplet defect predictions, (with Q. Wang, X. Yang), *Soft Matter*, Vol. 8, 9642-9660 (2012). DOI: 10.1039/c2sm25512j
150. Ring-waves dominate mass transport in air-driven core-annular flows, (with R. Camassa, H. R. Ogrosky, J. Olander), *Phys. Rev. E* 86, 066305 (2012).
151. Modeling and Simulations of Drop Pinch-Off from Liquid Crystal Filaments and the Leaky Liquid Crystal Faucet (with X. Yang, H. Li, C. Liu, J. Shen, Q. Wang), *J. Computational Physics*, Vol. 236, 1-14 (2013). DOI: <http://dx.doi.org/10.1016/j.jcp.2012.10>.
152. A New Twist on Stokes' Second Problem: Partial Penetration of Nonlinearity in Sheared Viscoelastic Layers, (with P. Vasquez, Y. Jin, K. Vuong, D. Hill), *JNNFM*, DOI: <http://dx.doi.org/10.1016/j.jnnfm.2012.12.016> (2013).
153. Pericentric Chromatin Loops Function as a Non-linear Spring in Mitotic Force Balance, (with A. Stephens, P. Vasquez, R. Haggerty, L. Vicci, J. Verdassdonk, F. Shi, R. Taylor, M. Falvo, K. Bloom, *et al.*), *Journal of Cell Biology*, Vol. 200 (6), 757–772 (2013). www.jcb.org/cgi/doi/10.1083/jcb.201208163
154. A mechanochemical model for auto-regulation of lung airway surface layer volume, (with G. Herschlag, G.J.M. Garcia, B. Button, R. Tarran, B. Lindley, B. Reinhardt, T. Elston), *Journal of Theoretical Biology*, Vol. 325, 42-51, (2013). <http://dx.doi.org/10.1016/j.jtbi.2013.01.023>.
155. Kinetic theory and simulations of active polar liquid crystalline polymers, (with Q. Wang, R. Zhou), *Soft Matter*, Vol. 9, 5207-5222, (2013). DOI: <http://dx.doi.org/10.1039/C3SM27736D>
156. Nonlinear signatures of entangled polymer solutions in active microbead rheology, (with J. Cribb, P.A. Vasquez, P. Moore, S. Norris, S. Shah, R. Superfine), *Journal of Rheology*, Vol. 57, 1247-1265 (2013).
157. Individual pericentromeres behave as an ensemble in the yeast spindle, (with A. Stephens, C. Snider, J. Haase, R. Haggerty, P. Vasquez, K. Bloom), *Journal of Cell Biology*, accepted (2013).
158. Percolation-induced exponential scaling in the large current tails of random resistor networks, (with F. Shi, S. Wang, P. Mucha), *SIAM Multiscale Modeling and Simulation*, accepted (2013).

159. Interphase chromosomes fluctuate like confined and tethered polymer chains, (with J. Tyler, P. Vasquez, R. Barry, T. Barry, S. Goodwin, K. Bloom), *Molecular Cell*, accepted (2013).

Submitted papers

- Network-based assessments of percolation-induced current distributions in sheared rod macromolecular dispersions, (with F. Shi, P. Mucha, S. Wang, R. Zhou), *SIAM Multiscale Modeling and Simulation*, June 2013.
- Structure formation in sheared polymer-rod nanocomposites, G. Ji, M.G. Forest, Q. Wang, *Discrete and Continuous Dynamical Systems B*, July 2013.
- Transient antibody-mucin interactions produce a dynamic molecular shield against viral invasion, A. Chen, S. McKinley, S. Wang, F. Shi, P. Mucha, M.G. Forest, S. Lai, *Biophysical Journal*, September 2013.
- A Biophysical Basis for Mucus Concentration (wt%) as a Candidate Biomarker for Airways Disease: relationships to clearance in health and stasis in disease, D. B. Hill, S. McKinley, P. Vasquez, J. Mellnik, A. Vose, F. Mu, N. Alexis, R. Boucher, M.G. Forest, *PLoS ONE*, September 2013.

UNC preprints, to be submitted

- Modeling neutralization kinetics of HIV by broadly neutralizing monoclonal antibodies in genital secretions coating the cervicovaginal mucosa, (with S. McKinley, A. Chen, F. Shi, S. Wang, P. Mucha, S. Lai), to *PLoS ONE*.
- Dielectric anisotropy and scaling behavior in sheared 3D nano-rod dispersions, (with S. Wang, F. Shi, P. Mucha, X. Zheng, R. Zhou).
- Microheterogeneity metrics for diffusion in soft matter, (with J. Mellnik, P. Vasquez, S. McKinley, N. Pillai, J. Witten, D. Hill).
- *Complex Fluids and Soft Structures in the Human Body*, (with P. Vasquez), Invited Chapter for **Complex Fluids in Biological Systems**, Springer, edited by Saverio Spagnolie.

Non-research scholarly articles

- “Mathematical challenges in nanoscience and nanotechnology”, an essay for the September 2000 Workshop on "Societal Implications of Nanoscience and Nanotechnology", U.S. Interagency Working Group on Nanoscience and Nanotechnology, Washington, DC, Kluwer Academic Publishers (2001).
- “Nano-Materials: Can we do the Math?” solicited essay by the American Association for the Advancement of Science, for posting on the EurekAlert! website for international journalists (2002).

Federal Grant Support (current):

- Co-PI, N.S.F. Research Training Grant, “Mathematical Fluids Theory, Modeling, and Experiment”, 10/1/2010-9/30/2015, PI: R. McLaughlin, UNC.
- Co-PI, NSF-NIGMS, “Mathematically Guided Experiments of Lung Mucus Transport Properties”, 6/15/2011-6/14/2015, PI: D. Hill (UNC Cystic Fibrosis and Pulmonary Biology Center)
- Co-PI, NSF, “MIRT: Stressed Polymers - Exploiting Tension in Soft Matter”, 9/15/2011 - 8/31/2014, PI: S. Sheiko (UNC Chemistry)
- Co-PI, Air Force Office of Scientific Research, "Multiscale Mathematics for Nano-Particle-Endowed Active Membranes and Films", 6/01/2012-5/31/2015, PI: Q. Wang (University of South Carolina)
- PI, Army Research Office, "Statistical Multiscale Property Metrics for Nanorod and Nanoplatelet Composite Membranes and Films", 11/01/2012-10/31/2015, Co-PI: P. Mucha, UNC
- Co-PI, National Institutes of Health, “Cytoskeletal Oscillations: Mathematical Modeling Integrated with Experiments”, 5/1/2012-4/30-2015, PI: T. Elston, UNC

Teaching Recognition:

Meritorious Teaching Award, Liberal Arts College, University of Arizona, 1979

Ph.D. Students Advised, Year of Degree, Current Affiliation

- Jong-Eao Lee, “Geometry and modulation theory for the periodic nonlinear Schrödinger equation”, 1986, National Chiao Tung University, Taiwan
- Karen Bolinger, “Pointwise closure models for slender, non-Newtonian free jets”, 1990, Clarion University, Clarion, PA
- Qi Wang, “Dynamics of slender viscoelastic free jets”, 1991, University of South Carolina, Columbia, SC
- Jian-Zhong Cao, “Higher Order Perturbation Theory for Slender Viscoelastic Jets and Fibers with Torsion”, 1992, deceased
- S. P. Sheu, “Homoclinic Orbits for a System of Coupled Nonlinear Schrodinger Equations”, 1992, National Chung-Hsing University, Taiwan
- C. D. Carlson, “An analysis of the Rayleigh capillary instability in slender jets”, 1996, Mitsubishi Polyester Film, Columbus, NC
- Xiaoyu Zheng, “On the effective properties of nematic polymer nano-composites”, 2006, Kent State University, Kent, OH
- Eric Choate, “Dynamic moduli and linear viscoelasticity of nematic polymers”, 2007, Radford University, Radford, VA
- Joohee Lee, “Mathematical descriptions of nematic polymers in the monolayer limit”, 2007, Ewha Women’s College, S. Korea
- Lingxing Yao, “Viscoelasticity at Microscopic and Macroscopic Scales: Characterization and Prediction”, 2007, visiting position, Case Western Reserve University, Cleveland, OH
- Brandon Lindley, “Linear and Nonlinear Shear Wave Propagation in Viscoelastic Fluids”, 2008, Naval Research Laboratory, Bethesda, MD
- Ke Xu, “Mathematics of microrheology with applications to pulmonary liquids”, 2009, Simulations Plus, Lancaster, CA

- Feng (Bill) Shi, “Modeling networks and dynamics in complex systems”, 2013, co-advised with Peter Mucha, Computation Institute, University of Chicago.

Current Ph.D. Students

- Simi Wang (co-adviser Peter Mucha); Yuan Jin; John Mellnik; Caitlin Hult

M.S. Students at UNC-CH, advised or co-advised

- Greg Robbins, 2002
- Alison Hall, 2003
- John Bakken, 2005
- Jessica Wehner, 2010

Postdoctoral Scholars Supervised & Co-Supervised

- B. Maulik, Battelle Postdoctoral Fellowship, 1988-1990
- D. Muraki, AFOSR funding, 1990
- O. Wright, AFOSR funding 1991-1993
- B. Umarov, funded by Uzbek Academy of Science, 1990
- C. Goedde, Battelle Postdoctoral Fellowship, 1990-1992, NSF, 1992-1994
- J. Cao, AFOSR funding, 1992-1995
- H. Zhou, UNC and AFOSR funding, 1996-1999
- T. Ueda, UNC and AFOSR funding, 1996-1997
- D. Anderson, UNC and AFOSR funding, 1997-1999
- R. Zhou, UNC and AFOSR funding, 2001-2004
- L. Lee, UNC Virtual Lung Project funding, 2003-2005
- Z. Cui, UNC and AFOSR funding, 2005-2007
- X. Zheng, NASA funding, 2006
- C. Hohenegger, ARO funding, w/ P. Mucha, 2006-2007
- L. Yao, NIH and NSF funding, 2007-2008
- J. Lee, ARO and UNC funding, 2007-2009
- X. Yang, AFOSR funding, 2007-2009
- B. Lindley, NSF funding, summer of 2008
- E. Choate, NSF funding, 2009-2010
- P. Vasquez, NSF and DOE funding, 2010-present
- A. Chen, SAMSI-UNC postdoc, current NIH funding, 2011-present

Undergraduate Honors Theses Advised

- R. Waters, with E. T. Samulski, Electrospinning of Liquid Crystals, 2005
- B. Smith, Stress Filtering in Sheared Viscoelastic Layers and Hypotheses for Biological Relevance, 2007

Selected Presentations (2009 - present)

- 2009, The interplay between hydrodynamic feedback and defects in sheared nematic liquids, Workshop on Complex Fluids, Modeling and Numerics, Ecole des Ponts, Paris, France, January 5.

- 2009, The Virtual Lung Project at UNC, Courant Institute of Mathematical Sciences, NYU, Fluid Mechanics Seminar, February 18.
- 2009, Coupling of Biochemistry and Stresses: A Mechanism for Lung Airway Water Volume Regulation, SIAM Annual Computational Sciences & Engineering Meeting, Miami, FL, March 5
- 2009, Transport in Viscoelastic Media, The 6th IMACS International conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory, Athens, GA, March 25
- 2009, The Virtual Lung Project at UNC, SIAM Southeastern Sectional Meeting, Plenary Lecture, April 5
- 2009, The Virtual Lung Project at UNC, Colloquium in honor of Steve Rosencrans, Department of Mathematics, Tulane University, May 6
- 2009, Uniquely biological challenges for rheology, Plenary lecture, Institute for Mathematics and Its Applications, Workshop on Rheological Measurements and Constitutive Modeling, University of Minnesota, Minneapolis, MN, September 17
- 2009, Anomalous diffusion of tracers in polymeric liquids, Society of Rheology Annual Meeting, Microrheology and Microfluidics Session, Madison, WI, October 19
- 2010, The Virtual Lung Project at UNC, University of California at San Diego, Mathematics, February 18
- 2010, Dynamic defect morphology and hydrodynamics of sheared nematic polymers in physically confined geometries, LSU, Baton Rouge, LA, Applied Mathematics Seminar, April 26
- 2010, Defect diagnostics for nematic polymer flows, Dynamical Systems and PDEs conference, Barcelona, Spain, June 1
- 2010, Soft matter and mathematics as seen through three model systems, Lead-off lecture of NSF Workshop on Mathematical Modeling and Computer Simulations for Soft Materials, Colorado State University, September 13
- 2010, Length-scale dependent flow and diffusive transport in biological fluids, Math Biology Colloquium Series, Duke University, Durham, NC, November 19
- 2011, Mathematical Problems Derived From Lung Biology, UNC Mathematics Graduate Seminar, February 14
- 2011, Lengthscale-dependent microrheology of soft biological materials, SIAM Computational Science & Engineering Annual Meeting, Reno, NV, March 4
- 2011, Anomalous diffusion in soft matter materials: experiment, theory and simulations, SIAM CS&E Meeting, Reno, NV, March 4
- 2011, The Virtual Lung Project at UNC: What's Math Got to Do with It? University of British Columbia-Pacific Institute for Mathematical Sciences Distinguished Lecture, Vancouver, BC, Canada, March 18
- 2011, Kinetic Theory of Complex Fluids, University of Wisconsin-University of Maryland Workshop on Kinetic Theory, Madison, WI, May 25
- 2011, Anomalous Diffusion in Soft Matter, International Conference on Applied Mathematics and Interdisciplinary Research, Beijing Computational Science Research Center, Beijing, China, June 16
- 2011, Community detection in social networks meets percolation-induced transport properties of sheared nano-rod dispersions, Workshop on Complex Fluids and Flows in Industry and Nature, University of British Columbia, July 14

- 2011, Hydrodynamics of nano-rod and nano-platelet dispersions, Minisymposium on Computational Modeling of Multiscale Systems with Dynamic Constitutive Laws, Organizers S. Mitran, D. Trebotich, International Congress of Industrial and Applied Mathematics (ICIAM), Vancouver, BC, July 19
- 2011, Flow and diffusive transport in viscoelastic soft matter, Minisymposium of the same title, Organizer M.G. Forest, International Congress of Industrial and Applied Mathematics (ICIAM), Vancouver, BC, July 21
- 2011, Defect hydrodynamics of nematic polymers, Liquid Crystals Minisymposium, Organizer P. Palffy-Muhorah, International Congress of Industrial and Applied Mathematics (ICIAM), Vancouver, BC, July 22
- 2012, The Dissipative Side of Fluctuation-Dissipation in Soft Matter, tutorial plenary for SAMSI Workshop on Nonlocal Continuum Models for Diffusion, Mechanics, and Other Applications, SAMSI, Research Triangle, NC, June 25
- 2012, Nematics near and far from equilibrium, SIAM Annual Meeting, Minneapolis, MN, Minisymposium on Mathematics & Mechanics of Soft Matter, Organizers: Raffaella De Vita & Paolo Biscari, July 11
- 2012, Illustrative examples of building collaborations between mathematics and biology/medicine, Young Investigators' Workshop, Mathematical Biosciences Institute (MBI), Columbus, OH, August 28
- 2012, Overview of flow and diffusive transport properties of lung mucus, Workshop on Cilia-Induced Fluid Mechanics, MBI, Columbus, OH, October 17
- 2012, Active nematic flows, American Physical Society-Division of Fluid Dynamics Annual Meeting, San Diego, CA, Mini-Symposium in Memory of Daniel D. Joseph, Organizer: Howard Hu, November 19
- 2013, Defects in nematic polymer hydrodynamics, Isaac Newton Institute, Cambridge University, Mathematics of Liquid Crystals Program, Workshop on Symmetry, Bifurcation and Order Parameters, January 9
- 2013, The Virtual Lung Project, Department of Applied Mathematics, University of Colorado - Boulder, Distinguished Lecture Series, April 5
- 2013, Mathematical and Numerical Challenges in Living Biological Materials, International Conference on Numerical Analysis and Applied Mathematics, Rhodes, Greece, September 24

Professional Activities and Service (Recent)

- Director, Carolina Center for Interdisciplinary Applied Mathematics, UNC Chapel Hill, 2012-
- Chair, External Advisory and Review Board, South Carolina Project on Organ Biofabrication, NSF-NIH funded, 2009-2014; Chair, 2010-
- Co-Director, UNC Institute for Advanced Materials, Nanoscience & Technology, 2002-present; Interim Director, Fall 2012-January 2013.
- Scientific Advisory Board for the *Mathematics of Liquid Crystals* research programme (<http://www.newton.ac.uk/programmes/MLC/index.html>) at the Isaac Newton Institute, University of Cambridge, from 7 January - 5 July 2013
- Co-Chair, SIAM Conference on Mathematical Aspects of Materials Science, June 9-12, 2013
- Chair, SIAM Activity Group on the Life Sciences, Jan 2013 - Dec 2014
- Steering Committee, UNC Center for Cancer Nanotechnology Excellence, 2010-

- Scientific Advisory Committee, NSF-Mathematical Biosciences Institute (MBI), The Ohio State University, Columbus, OH, 2011-
- External Advisory Committee, Institute for Applied Mathematics and Computational Science, Texas A&M University, 2009-
- Scientific Advisory Board, Interdisciplinary Mathematics Institute, the University of South Carolina, College of Arts and Sciences, 2010-
- Associate Editor for SIAM Journal on Applied Mathematics, 2000-
- Associate Editor for Continuum Mechanics & Thermodynamics, 2003-
- Editorial Board of Communications in Applied Mathematics and Computational Science, 2007-
- Editorial Board of Journal of Non-Newtonian Fluid Mechanics, 2010-
- Organizing Committee, SIAM Conference on the Life Sciences, San Diego, CA, August 7-11, 2012
- Co-Chair, Organizing Committee, Workshop on Cilia- and Flagella-Induced Fluid Mechanics, Mathematical Biosciences Institute, Ohio State, Oct 15-18, 2012