MICHAEL M. NORTON

mike.m.norton [at] gmail.com • www.mmnorton.com

EDUCATION

University of Pennsylvania *2015*
PhD, Mechanical Engineering
Dynamics and statics of liquid-liquid and gas-liquid interfaces on non-uniform substrates at the micron and sub-micron scales
Advisor: Haim H. Bau, Committee: Kathleen Stebe and Howard Hu

Rochester Institute of Technology *2009*
BS and MS, Mechanical Engineering, *summa cum laude*
Modeling problems in mucus viscoelasticity and mucociliary clearance
Advisor: Risa J. Robinson, Committee: Steven J. Weinstein and David Gee

RESEARCH EXPERIENCE

Research Scientist at Rochester Institute of Technology 8/2021 – Present
Advisor: Moumita Das *Rochester, NY*

Research Assistant Professor at the Center for Neural Engineering, Pennsylvania State University 8/2019 – 7/2021
Advisor: Steven Schiff *State College, PA*

Postdoctoral Associate in Physics at Brandeis University 12/2015 – 8/2019
Advisors: Seth Fraden and Michael F. Hagan *Waltham, MA*

Research Intern at Institut polytechnique de Grenoble 6/2011 – 8/2011
Advisors: Franz Bruckert and Marianne Weidenhaupt *Grenoble, France*

Research Co-op in Thermal Analysis and Microfluidics Lab, Mechanical Eng., Rochester Institute of Technology 12/2006 – 3/2007, 6/2007 – 9/2007
Advisor: Satish Kandlikar *Rochester, NY*

SELECTED PUBLICATIONS AND PREPRINTS

5. **M. M. Norton** and P. Grover. Mechanochemical Topological Defects in an Active Nematic. Under review for *Physical Review Letters*. arXiv:2210.03796

4. **M. M. Norton**, P. Grover, M. F. Hagan, and S. Fraden, Optimal Control of Active Nematics. *Physical Review Letters*, vol. 125, no. 17, pp. 178005, Oct. 2020. **Editor's Suggestion.**

3. **M. M. Norton***, N. Tompkins*, M. C. Cambria, J. Held, and S. Fraden. Dynamics of Reaction-Diffusion Oscillators in Star and other Networks with Cyclic Symmetries Exhibiting Multiple Clusters. *Physical Review Letters*, vol. 123, no. 14, pp. 148301, Oct. 2019. *Equal contribution.

2. A. Opathalage*, **M. M. Norton***, M. Juniper, B. Langeslay, S. A. Aghavmi, S. Fraden, and Z. Dogic. Self-organized dynamics and the transition to turbulence of confined active nematics. *Proceedings of the National Academy of Sciences*, vol. 116, pp. 4788-4797, 2019. *Equal contribution.

1. **M. M. Norton**, A. Baskaran, A. Opathalage, B. Langeslay, S. Fraden, A. Baskaran, and M. Hagan. Insensitivity of active nematic liquid crystal dynamics to topological constraints. *Physical Review E*, 97, 012702, 2018. **Editor's Suggestion.**

ALL PEER-REVIEWED PUBLICATIONS

20. T. E. Bate, M. E. Varney, E. H. Taylor, J. H. Dickie, C.-C. Chueh, **M. M. Norton**, and K.-T. Wu. Self-mixing in microtubule-kinesin active fluid from nonuniform to uniform distribution of activity. *Nature Communications,* 13, 6573, 2022.

19. I. Hunter*, **M. M. Norton***, B. Chen, C. Simonetti, J. Touboul, and S. Fraden. Pattern formation in a four-ring reaction-diffusion network with heterogeneity. *Physical Review E*, vol. 105, no. 2, pp. 024310, Feb. 2022. *Equal contribution.

18. C. Wagner, **M. M. Norton**, J. Park, and P. Grover. Exact coherent structures and phase space geometry of pre-turbulent 2D active nematic channel flow. *Physical Review Letters*, vol. 128, no. 2, pp. 028003, Dec. 2021. **Editor's Suggestion.**

17. T. Sauer, T. Berry, D. Ebeigbe, **M. M. Norton**, A. Whalen, and S. Schiff. Identifiability of infection model parameters early in an epidemic. *SIAM Journal on Control and Optimization Special Section on Mathematical Modeling, Analysis, and Control of Epidemics*, pp. S27-S48, Nov. 2021.

16. P. Ssentongo, C. Fronterre, A. Geronimo, P. O. Omadi, S. A. Sinnar, A. J. Whalen, S J. Greybush, Y. Wang, O. T. Bernard, Sarah Nahalamba, P. K. Mbabazi, J. Muvawala, A. J. B. Muwanguzi, H. Greatrex, **M. M. Norton**, P. Diggle, and S. J. Schiff. Pan-African evolution of within- and between-country COVID-19 dynamics. *Proceedings of the National Academy of Sciences*, vol. 118, no. 28, 2021.

15. M. Moustaka, **M. M. Norton**, V. Horvath, B. Blanc, and S. Fraden. Partition, reaction and diffusion coefficients of Bromine in elastomeric polydimethylsiloxane. *J. Phys. Chem. B*, vol. 125, no. 22, pp. 5937–5951, 2021.

14. L. M. Lemma, **M. M. Norton**, A. Tayar, S. DeCamp, S. A. Aghvami, S. Fraden, M. F. Hagan, and Z. Dogic. Multiscale Dynamics in Two Dimensional Active Nematics. *Physical Review Letters*, vol. 127, no. 14, pp. 148001, Sept. 2021. **Editor's Suggestion.**

13. Z. Zhou, C. Joshi, R. Liu, **M. M. Norton**, L. Lemma, Z. Dogic, M. F. Hagan, S. Fraden, and P. Hong. Machine Learning Forecasting of Active Nematics. *Soft Matter*, vol. 17, no. 3, pp. 738-747, 2020.

12. **M. M. Norton**, P. Grover, M. F. Hagan, and S. Fraden, Optimal Control of Active Nematics. *Physical Review Letters*, vol. 125, no. 17, pp. 178005, Oct. 2020. **Editor's Suggestion.**

11. **M. M. Norton***, N. Tompkins*, M. C. Cambria, J. Held, and S. Fraden. Dynamics of Reaction-Diffusion Oscillators in Star and other Networks with Cyclic Symmetries Exhibiting Multiple Clusters. *Physical Review Letters*, vol. 123, no. 14, pp. 148301, Oct. 2019. *Equal contribution.

10. A. Opathalage*, **M. M. Norton***, M. Juniper, B. Langeslay, S. A. Aghavmi, S. Fraden, and Z. Dogic. Self-organized dynamics and the transition to turbulence of confined active nematics. *Proceedings of the National Academy of Sciences*, vol. 116, pp. 4788-4797, 2019. *Equal contribution.

9. T. Litschel, **M. M. Norton**, V. Tserunyan, and S. Fraden. Engineering Reaction-Diffusion Networks with Properties of Neural Tissue. *Lab on a Chip*, vol. 18, no. 5, pp. 714–722, 2018. **Front Cover.**

8. **M. M. Norton**, A. Baskaran, A. Opathalage, B. Langeslay, S. Fraden, A. Baskaran, and M. Hagan. Insensitivity of active nematic liquid crystal dynamics to topological constraints. *Physical Review E*, 97, 012702, 2018. **Editor's Suggestion.**

7. S. A. Aghvami, A. Opathalage, Z. K. Zhang, M. Ludwig, M. Heymann, **M. M. Norton**, N. Wilkins, and S. Fraden. Rapid prototyping of cyclic olefin copolymer (COC) microfluidic devices. *Sensors and Actuators, B: Chemical*, 247(March):940–949, 2017.

6. N. M. Schneider, J. H. Park, **M. M. Norton**, F. M. Ross, and H. H. Bau. Automated analysis of evolving interfaces during *in-situ* electron microscopy. *Advanced Structural and Chemical Imaging*, 2(1):1-11, 2017.

5. F. Panciera, **M. M. Norton**, S. B. Alam, S. Hofmann, K. Mølhave, and F. M. Ross. Controlling nanowire growth through electric field-induced deformation of the catalyst droplet. *Nature Communications*, 7:1–8, 2016.

4. N. M. Schneider, **M. M. Norton**, B. J. Mendel, J. M. Grogan, F. M. Ross, and H. H. Bau. Electron-Water Interactions and Implications for Liquid Cell Electron Microscopy. *The Journal of Physical Chemistry C*, 118(38):22373–22382, 2014.

3. **M. M. Norton**, T. Brugarolas, J. Chou, D. Lee, and H. H. Bau. Ellipsoidal particles encapsulated in droplets. *Soft matter*, 10:4840–4847, 2014.

2. S. J. Belfer, H.-S. Chuang, B. L. Freedman, J. Yuan, **M. M. Norton**, H. H. Bau, and D. M. Raizen. Caenorhabditis-in-Drop Array for Monitoring C. elegans Quiescent Behavior. *SLEEP*, 1;36(5):689-698, 2013.

1. **M. M. Norton**, R. J. Robinson, and S. J. Weinstein. Model of ciliary clearance and the role of mucus rheology. *Physical Review E*, 83(1):1–12, 2011.

MANUSCRIPTS UNDER REVIEW

2. **M. M. Norton** and P. Grover. Mechanochemical Topological Defects in an Active Nematic. Under review for *Physical Review Letters*. arXiv:2210.03796

1. F. Bertillot, C. U. Martin, O. Zajac, **M. M. Norton**, K. Alessandri, L. Plater, B. Gurchenkov, L. Andrique, F. Fage, A. Asnacios, C. Lamaze, M. Das, J. Maître, P. Nassoy, and D. M. Vignjevic. Compressive stress triggers fibroblasts spreading over cancer cells to generate carcinoma in situ organization. Under revision for *Science Advances*. Original submission November 2021.

MANUSCRIPTS IN PREPARATION

5. **M. M. Norton** and M. Das. Defect Dynamics in an Active Viscoelastic Nematic. In preparation for *Physical Review Letters*.

4. C. G. Wagner, R. Pallock, **M. M. Norton**, J.S. and Park, P. Grover. Exploring regular, exotic and turbulent flow states in active nematic channel flow via Exact Coherent Structures

3. **M. M. Norton**, C. Simonetti, and S. Fraden. Optimal Spatiotemporal Control of an Inhibitor-Coupled 3-Ring Oscillator Network. In preparation for *Chaos*.

2. M. E. Moustaka, **M. M. Norton**, C. Simonetti, I. Hunter, J. Sheehy, and S. Fraden. Dynamics of a three-ring reaction-diffusion chemical oscillator network. In preparation for *Chaos*.

1. **M. M. Norton**, N. M. Schneider, F. M. Ross, and H. H. Bau. Dynamics of nanoscale bubbles growing in a tapered conduit. arXiv:1712.03427. In preparation for *Langmuir*.

GRANTS AND PROPOSALS

- **Department of Energy, BES-MSE-Biomolecular Materials (DE-SC0022280)** *in progress*
  Dynamics and control of active nematics using nonlinear reduced-order models $450,447
  Role: Co-I Aug. 2021 - Jul. 2024

- **Pennsylvania State University, Huck Institute Coronavirus Seed Fund** *completed*
  Model-driven social distancing and resource allocation strategies for COVID-19 and other infectious diseases through an optimal control and data assimilation framework $59,262
  Role: PI Apr. 2020 - Oct. 2020

TEACHING EXPERIENCE

Brandeis University Summer 2018
Lead instructor for Introduction to Microfluidics Technology (1 week workshop).
Supervisor: Anique Olivier-Mason *Waltham, MA*
www.brandeis.edu/mrsec/news-and-events/summer-microfluidics.html

University of Pennsylvania Spring 2011
Teaching Assistant: Recitation instructor for Thermodynamics (MEAM203).
Supervisor: Haim Bau *Philadelphia, PA*
Awarded "Outstanding Teaching Assistant"

University of Pennsylvania Fall 2010, Fall 2011
Teaching Assistant: Lab instructor for Introduction to Mechanics (MEAM147).
Supervisors: Katherine Kuchenbecker (2010) and Robert Carpick (2011) *Philadelphia, PA*

PROFESSIONAL ACTIVITIES

- Assistant organizer at *Upstate New York Soft Matter Workshop*, Rochester, NY, 2022. https://sites.google.com/view/nysoftmatterworkshop/home
- Co-chair of *Nonlinear Dynamics of Active Fluids and Transition to Active Turbulence*, National Congress on Theoretical and Applied Mechanics, 2022.

INVITED TALKS

20. M. M. Norton, *Mechanochemical Topology Sensing in Active Nematics*, Biological Physics and Physical Biology Seminar, 2022.
19. M. M. Norton, *Mechanochemical Defects in an Active Nematic: How to build a reaction-diffusion system that senses topology*, Brandeis University MRSEC, 2022.
18. M. M. Norton, *Optimal control and design of cytoskeleton-based dynamic biomaterials*, American Physical Society, March Meeting, 2022.
17. M. M. Norton, *Towards Model-Based Control of Active and Living Systems*, Brandeis University Winter School, 2022.
16. M. M. Norton *Towards model-based control of active matter: active nematics and oscillator networks*, Soft, Living, Active and Adaptive Matter (SLAAM) Seminar, University of California, Merced, 2022.
15. M. M. Norton, *Design and Control of Active Nematics*, Active Matter, Telluride Science workshop, 2021.
14. M. M. Norton, *Towards Active Matter Cybernetics: Optimal Control of Active Nematics*, Department of Applied Mathematics and Theoretical Physics - Statistical Physics and Soft Matter Seminar, University of Cambridge, 2020.
13. M. M. Norton, *Spatiotemporal Optimal Control of an Extensile Active Nematic Suspension*, Brandeis University MRSEC, 2020.

12. M. M. Norton, P. Grover, M. F. Hagan, and S. Fraden, *Optimally Controlling the Director Field of Extensile Active Nematic Suspensions*, Beyond Active Fluids, SIAM/CAIMS Joint Annual Meeting, 2020. *Session canceled due to Coronavirus.*

11. M. M. Norton, *Design and optimal control of reaction-diffusion oscillator networks*, Squishy Physics, Harvard Soft Matter Group, 2019.

10. M. M. Norton, *Dynamical pattern formation in chemical oscillator networks*, Computational Biophysics Group, Flatiron Institute, 2018.

9. M. M. Norton, *Dynamical pattern formation in active suspensions and oscillator networks*, Mitsubishi Electric Research Laboratories (MERL), 2018.

8. M. M. Norton, *Slow-fast dynamics of a confined active nematic suspension*, Brandeis University, MRSEC Interdisciplinary Research Group Seminar, 2018.

7. M. M. Norton, *Hydrodynamics of active topological defects near boundaries in nematic suspensions*, Brandeis University Winter School, 2018.

6. M. M. Norton, *Design and Nonlinear Control of Synthetic Reaction-Diffusion Networks with Inhibitory and Excitatory Connections*, Physics Colloquium at Tufts University, 2017.

5. M. M. Norton, *Towards Nonlinear Control of Reaction-Diffusion Networks and Active Nematic Materials*, Brandeis University MRSEC retreat, 2017.

4. M. M. Norton, *The effect of hydrodynamic and topological constraints on a confined active nematic material*, Brandeis University, MRSEC Interdisciplinary Research Group Seminar, 2016.

3. M. M. Norton *Growth and Transport of Nanobubbles*, Brandeis University MRSEC Seminar, 2015.

2. M. M. Norton, *Electron-Microscopy of Liquid Interfaces: Bubbles and Contact Line Dynamics*, Kate Gleason College of Engineering at Rochester Institute of Technology, 2015.

1. M. M. Norton, H. H. Bau, *Capillary Surfaces on Non-Uniform Substrates at the Micro- and Nano-Scales* MEAM Departmental Seminar, University of Pennsylvania, 2014.

SELECTED CONFERENCES

16. M. M. Norton, R. Vizarreta, E. Abbondanzieri, A. Meyer, M. Das, *Bacterial chromatin as a phase-separating nematic elastomer*, American Physical Society, Division of Fluid Dynamics, 2021.

15. C. Wagner, M. M. Norton, JS. Park, P. Grover, *Exact coherent structures (ECS) and transition to turbulence in a confined active nematic*, American Physical Society, Division of Fluid Dynamics, 2021.

14. M. M. Norton, P. Grover, M. Hagan, S. Fraden, *Switching Between Coherent Flow Structures in an Active Nematic Fluid using Optimal Control*, Society for Industrial and Applied Mathematics, Dynamics Systems, 2021.

13. M. M. Norton, P. Grover, M. Hagan, S. Fraden, *Spatiotemporal optimal control of active nematics actuated by activity strength and vorticity*, American Physical Society, Division of Fluid Dynamics, 2020.

12. M. M. Norton, M. Hagan, S. Fraden, *Spatiotemporal Control of an Extensile Active Nematic Suspension*, American Physical Society, Division of Fluid Dynamics, 2019.

11. M. M. Norton, N. Tompkins, B. Blanc, M. Cambria, J. Held, S. Fraden, *Chemical oscillators on star graphs, theory and experiment*, American Physical Society, March Meeting, 2019.

10. C. Simonetti, M. M. Norton, M. E. Moustaka, S. Fraden, *Control of a Multistable 3-ring Network of Chemical Oscillators*, American Physical Society, March Meeting, 2019.
9. M. M. Norton, A. Opathalage, B. Langeslay, A. Baskaran, M. Hagan, Z. Dogic, S. Fraden, *Self-organized multi-time-scale dynamics in a confined active nematic*, American Physical Society, Division of Fluid Dynamics, 2018.
8. M. M. Norton, *Engineering Non-Equilibrium Materials with Controllable Spatiotemporal Patterns: Oscillator Networks and Active Suspensions*, Meet the Faculty Candidates (poster session), American Institute of Chemical Engineers Annual Meeting, 2018.
7. M. M. Norton, A. Baskaran, A. Opathalage, A. Baskaran, M. F. Hagan, S. Fraden, *Investigating the effect of hydrodynamic and topological constraints on a confined active nematic material*, American Physical Society, March Meeting, 2017.
6. M. M. Norton, C. Girabawe, T. Litschel, S. Fraden, *Nonlinear Control of a Repulsively-Coupled Triad Network with Multiple Attractors*, Society for Industrial and Applied Mathematics, Dynamical Systems, 2017.
5. M. M. Norton, T. Litschel, I. Hunter, R. Boros, V. Tserunyan, A. Mitchell, B. Blanc, C. Girabawe, M. F. Hagan, S. Fraden, *Modeling Arrays of Belousov-Zhabotinsky Oscillators*, Gordon Research Conference, Oscillations and Dynamic Instabilities in Chemical Systems, 2016.
4. M. M. Norton, F. M. Ross, H. H. Bau, *Nano bubble migration in a tapered conduit in the asymptotic limits of zero capillary and Bond Numbers: Theory and Experiments*, American Physical Society, Division of Fluid Dynamics, Fall 2015.
3. M. M. Norton, J. H. Park, Kodambaka, S., Ross, F., H. H. Bau, *Dynamics of Sub-Micron Bubbles Growing in a Wedge in the Low Capillary Number Regime*, American Physical Society, Division of Fluid Dynamics, Fall 2014.
2. M. M. Norton, T. Brugarolas, J. Chou, D. Lee, H. H. Bau, *Dynamics of viscous fluid jets containing solid particles at low Reynolds number*, American Physical Society, Division of Fluid Dynamics, 2013.
1. M. M. Norton, T. Brugarolas, J. Chou, D. Lee, H. H. Bau, *Encapsulating Ellipsoids in Drops*, American Physical Society, Division of Fluid Dynamics, 2012.

PAST AND CURRENT MENTEES

Undergraduate Students (*senior thesis title or research area*):

- Remi Boros, Brandeis University, *Phase Dynamics of Coupled Oscillators in Microfluidic Lattices*, 2016-2017. Currently a graduate student in Physics at U.C. Santa Barbara
- Amanda Chisholm, Brandeis University, *Belousov-Zhabotinsky Lattices with Microfluidics*, 2017-2018
- Blake Langeslay, Brandeis University, *Topological Defects as Structural Markers in an Active Nematic*, 2017-2018. Currently a graduate student in Mechanical Engineering at University of Illinois Urbana-Champaign
- Chris Simonetti, Brandeis University, *Using Bifurcation and Optimal Control Theories to Analyze Stability of States in the 3-ring BZ Network*, 2017-2019, thesis awarded Highest Honors. Financial software developer and consultant.

- Ruoshi Liu, Brandeis University, *machine learning and image processing of active fluids*, 2017-2019. Transferred to Columbia University to complete B.S. degree in Computer Science.
- Zoe Weiss, Pennsylvania State University and Harvard University, *modeling brain growth regulation*, 2020-2021.
- Renzo Vizarreta, Rochester Institute of Technology (McNair Scholar), *modeling mixtures of passive and self-propelling particles*, 2021-2022.

Graduate Students (*thesis or research area*):

- Camille Girabawe, PhD, Brandeis University, *Synchronization In Pairs of Chemical Oscillators*, 2015-2017. Manager at Adobe.
- Alex Mitchell, MS, Brandeis University, *Computational Modeling of Neural Circuit-Like Coupled Belousov-Zhabotinsky Reactions,* 2016-2017. Currently a PhD candidate in Neuroscience.
- Marilena Moustaka, PhD, Brandeis University, *Nonlinear Chemical Dynamics of Three Coupled Chemical Oscillators*, 2016-2021. Research Scientist at Oxford Nanopore.
- Ian Hunter, PhD, Brandeis University, *Controlling Pattern Formation in Complex Networks*, 2016-2021. Research Scientist at E-Ink.
- Zahra Zarei, PhD student, Brandeis University, *active fluids and microfluidics*, 2017-present.

AWARDS

- Outstanding Intern, Minatec Exchange Program, Grenoble, France, 2011
- Outstanding Teaching Assistant, MEAM, University of Pennsylvania, 2011
- Outstanding Undergraduate Scholar, RIT, 2008
- Pi Tau Sigma Honors Society, 2009
- Kate Gleason College of Engineering, RIT, Dean's List all Quarters, 2004-2009
- Kate Gleason College of Engineering, RIT, Presidential Scholarship, 2004