

# Christopher J. Miles

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<http://www.chrisjohnmiles.com/>

Physicist and applied mathematician

Interests: Active matter, fluid mechanics, optimal control theory, and nonlinear dynamics.

## EDUCATION

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- **Massachusetts Institute of Technology** Cambridge, MA  
*Batchelor of Science in Physics with a minor in Mechanical Engineering* Sept. 2006 – June. 2010
- **University of Michigan** Ann Arbor, MI  
*Masters of Science in Applied and Interdisciplinary Mathematics* Sept. 2012 – Dec 2014
- **University of Michigan** Ann Arbor, MI  
*Ph.D. Candidate in Physics* Sept. 2012 – Present
- Advisor: Prof. Charles R. Doering  
Expected graduation date: April 2018

### *Highlighted Graduate Coursework:*

- *Physics:* Quantum Field Theory, Quantum Mechanics, Electromagnetism, Statistical Mechanics, Complex Adaptive Systems, Fractals and Percolation
- *Scientific computing:* Machine Learning, Computer Modeling in Complex Systems, Numerical Methods for Differential Equations, Numerical Linear Algebra
- *Applied mathematics:* Mathematical Fluid Mechanics, Stochastic Processes, Dynamical Systems and Chaos, Measure Theory, Functional Analysis, Complex Analysis, Asymptotic Analysis

## ACADEMIC RESEARCH EXPERIENCE

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- **MIT: Coolant system design for superconducting power transmission** Cambridge, MA  
*Undergraduate Researcher* Spring and Summer 2008
  - Researched feasibility of using long-distance superconducting cables for high-power transmission.
  - Analyzed thermal pathways for different conceived cable designs that vary in coolant, refrigeration set-up, insulation material, superconductor, and internal support structure.
  - Determined pressure and temperature profile of coolant along cable length, which depended on flow rate, cross-sectional area, coolant type, and outside temperature.
  - For more information, see articles:
    - \* [L. Bromberg, P. C. Michael, J. V. Minervini, C. J. Miles, Current lead optimization of cryogenic operation at intermediate temperature in Transactions of the cryogenic engineering conference, AIP Conference Proceedings 1218, 577, 2010](#)
    - \* [L. Bromberg, P. C. Michael, J. V. Minervini, C. J. Miles, Coolant topology options for high temperature superconducting transmission and distribution systems, in Transactions of the cryogenic engineering conference, AIP Conference Proceedings 1218, 871, 2010](#)
- **University of Michigan: Nucleation in acoustic droplet vaporization** Ann Arbor, MI  
*Graduate Student Research Assistant* Spring 2013-July 2016
  - Investigated the physics of acoustic droplet vaporization (the vaporization of micron-sized droplets by ultrasound) to inform the optimization of this mechanism in its potential chemotherapy applications.
  - Constructed a theoretical model of the acoustic wave-droplet fluid dynamic interaction with the addition of classical nucleation theory to predict a nucleation event.
  - Conducted experiments of ultrasound pulses on a bed of droplets to verify the theoretical prediction of the ultrasonic nucleation pressure threshold.
  - For more information, see article: [C. J. Miles, C. R. Doering, O. D. Kripfgans, Nucleation pressure threshold in acoustic droplet vaporization, Journal of Applied Physics 120, 034903, 2016](#)

- **Woods Hole Oceanographic Institution: Invasion of active matter into a fluid** Woods Hole, MA  
*Research Fellow* Summer 2016
  - Conducted research on an active matter system in collaboration with Prof. Michael Shelley (NYU) and Prof. Saverio Spagnolie (UW-Madison).
  - Modeled a bacterial swarm in a continuum model governed by the Smoluchowski equation.
  - Analytically and numerically investigated the nonlinear dynamics of this model under various bacterial configurations.
  - For more information, see pre-print article: [C. J. Miles, Arthur A. Evans, Michael J. Shelley, and Saverio E. Spagnolie, Active matter invasion of a viscous fluid and a no-flow theorem arXiv:1803.05543\[cond-mat.soft\]](#) (submitted)
  
- **University of Michigan: Optimal control of fluid mixing (PhD Thesis)** Ann Arbor, MI  
*Graduate Student Research Assistant* Spring 2013 – Present
  - Constructed and analyzed a shell model, an ordinary differential equation model mimicking the spectral dynamics of the advection-diffusion equation, to study optimal mixing.
  - Discovered that diffusion can limit the mixing effectiveness of incompressible flows in some cases.
  - For more information, see articles:
    - \* [C. J. Miles, C. R. Doering, A shell model for optimal mixing, Journal of Nonlinear Science, 2017](#)
    - \* [C. J. Miles, C. R. Doering, Diffusion-limited mixing by incompressible flows, Nonlinearity, 31, 5, 2018](#)

## INDUSTRY RESEARCH EXPERIENCE

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- **General Atomics: Plasma Fusion Group** San Diego, CA  
*Experimental Research Intern* Summer 2009
  - Studied the thermal pathway along the edge plasma fluid to understand the high-heat flux distribution across the fusion reactor divertor plates. This flux must remain below a critical value to avoid damage.
  - Analyzed the empirical relationship of the divertor heat flux profile to fundamental tokamak parameters such as plasma current, toroidal magnetic field, density, and neutral beam power.
  
- **Continental Tires R&D: Pattern, Contour, and Layout** Hanover, Germany  
*Mechanical Engineering Intern* Fall 2010 – Winter 2011
  - Simulated the interaction between the tire tread and gravel to predict the likelihood of trapping stones in tire tread grooves to assess the potential threat to tire wear and damage.
  - Contributed to early concept-phase development of tire tread pattern designs for upcoming products.
  
- **On-Ramp Wireless: Communications Physical Layer** San Diego, CA  
*Systems Engineering Intern* Summer 2011-Fall 2011
  - Investigated signal interference between ORW's wireless network and WiFi networks.
  - Contributed to system design features to eliminate signal interference problems.
  - Learned digital communications and signal processing fundamentals.

## DATA SCIENCE AND MACHINE LEARNING EXPERIENCE

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- **Santa Fe Institute's Complexity Challenge**  
*Participant* September 2017
  - I implemented Q-learning in a multi-agent system where many agents are attempting to move across a board mimicking transportation problems.
  - Link: [http://www.chrisjohnmiles.com/personal\\_projects/sfic](http://www.chrisjohnmiles.com/personal_projects/sfic)

- **Michigan Datathon hosted by Citadel and Correlation One** Ann Arbor, MI  
*Participant* *November 2017*
  - Chosen to participate based on selective assessment test.
  - Competed with a four-person team against 22 other teams in an intensive seven-hour competition.

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#### UNIVERSITY SERVICE

- **Complex Systems Advanced Academic Workshop** Ann Arbor, MI  
*Co-organizer* *2015-2017*
  - Organize biweekly meetings for graduate student talks, journal discussions, and tutorials
  - Organized Introduction to Agent-Based Modeling short course taught by Bill Rand (July 2015)
  - Organized Complex Systems Research Hackathon (September 2016)
  - Organized Evolutionary Game Theory short course taught by Carl Simon, Charles Doering, and Christoph Adami (July 2017)
  
- **Introduction to Mechanics: Lab. Course** Ann Arbor, MI  
*Graduate Student Instructor* *Fall 2013-Fall 2014*
- **Electromagnetism II** Ann Arbor, MI  
*Graduate Student Assistant* *Spring 2015*
- **Evolutionary Game Theory** Ann Arbor, MI  
*Graduate Student Assistant* *Fall 2016*
- **Electromagnetism (Honors)** Ann Arbor, MI  
*Graduate Student Assistant* *Winter 2017*
- **Theory of Complex Systems** Ann Arbor, MI  
*Graduate Student Assistant* *Fall 2017*
- **Nonlinear Dynamics and Chaos** Ann Arbor, MI  
*Graduate Student Assistant* *Fall 2017*
- **Evolutionary Game Theory** Ann Arbor, MI  
*Graduate Student Assistant* *Winter 2018*
- **Agent-based modeling in complex systems** Ann Arbor, MI  
*Graduate Student Assistant* *Winter 2018*

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#### AWARDS AND FELLOWSHIPS

- National Undergraduate Fellowship in Plasma Science and Fusion Technology Summer 2009
- University of Michigan's Rackham Merit Fellowship June 2012-Present
- Woods Hole Oceanographic Institute's Geophysical Fluid Dynamics Fellowship Summer 2016

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#### COMPUTER AND PROGRAMMING SKILLS

- **Programming:** Experience in Python and Matlab.
- **Version control:** Experience with Git, Mercurial, Github, and Bitbucket.

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#### WORKSHOPS AND CONFERENCES

- Control theory short course Minneapolis, MN, June 2014
- Turbulent transport and mixing workshop - IPAM, UCLA Los Angeles, CA, October 2014
- APS Meeting Division of Fluid Dynamics Boston, MA, November 2015
- Extreme events and criticality in fluid mechanics Toronto, ON, January 2016
- Challenges in non-equilibrium statistical physics and fluid dynamics Provo, UT, May 2016
- Genetic programming: theory and practice Ann Arbor, MI, May 2016

- APS Meeting Division of Fluid Dynamics Portland, OR, November 2016
- Turbulent dissipation, mixing, and predictability workshop Los Angeles, CA, January 2017
- Santa Fe Institute's Complex Systems Summer School Santa Fe, NM, June 2017
- APS Meeting Division of Fluid Dynamics Denver, CO, November 2017
- Dynamics Days 2018 Denver, CO, January 2018
- Fundamental Problems in Active Matter Aspen, CO, January 2017

#### PRESENTATIONS

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- Optimal fluid mixing Ann Arbor, MI, 2014
- Optimization tutorial and fluid mixing Ann Arbor, MI, 2015
- A shell model for optimal fluid mixing Ann Arbor, MI, 2015
- Optimal control of a shell model for mixing Boston, MA, 2015
- A shell model for optimal fluid mixing Ann Arbor, MI, 2015
- Clusters, confinement, and collisions in active soft matter Ann Arbor, MI, 2016
- Nucleation pressure threshold in acoustic droplet vaporization Portland, OR, November 2016
- Unstable self-stretching and stealth invasion of active matter into a fluid Denver, CO, November 2017

#### PUBLICATIONS

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- L. Bromberg, P. C. Michael, J. V. Minervini, **C. J. Miles**, Current lead optimization of cryogenic operation at intermediate temperature in Transactions of the cryogenic engineering conference, AIP Conference Proceedings 1218, 577, 2010
- L. Bromberg, P. C. Michael, J. V. Minervini, **C. J. Miles**, Coolant topology options for high temperature superconducting transmission and distribution systems, in Transactions of the cryogenic engineering conference, AIP Conference Proceedings 1218, 871, 2010
- **C. J. Miles**, C. R. Doering, O. D. Kripfgans, Nucleation pressure threshold in acoustic droplet vaporization, Journal of Applied Physics 120, 034903, 2016
- **C. J. Miles**, C. R. Doering, A shell model for optimal mixing, Journal of Nonlinear Science, 2017, <https://doi.org/10.1007/s00332-017-9400-7>
- **C. J. Miles**, C. R. Doering, Diffusion-limited mixing by incompressible flows, Nonlinearity, 31, 5, 2018
- **C. J. Miles**, Arthur A. Evans, Michael J. Shelley, and Saverio E. Spagnolie, Active matter invasion of a viscous fluid and a no-flow theorem arXiv:1803.05543[cond-mat.soft] (submitted)