Christopher J. Miles

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

Education

- **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

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

- **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 Smolukowski 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**, Michael J. Shelley, and Saverio E. Spagnolie, Unstable self-stretching and stealth invasion of active matter into a viscous fluid, (to appear in WHOI GFD 2016 proceedings and in preparation for journal submission)

- **University of Michigan: Optimal control of fluid mixing** 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, (submitted)

Industry Research Experience

- **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

- **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.

- **Santa Fe Institute's Complexity Challenge**
  Participant *September 2017*
  - Used a multi-agent reinforcement learning approach to address the research challenge problem.

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*

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

Computer and Programming Skills

- **Programming**: Experience in Python, Javascript, Netlogo, Jupyter notebooks, and Matlab.
- **Version control**: Experience with Git, Mecurial, Github, and Bitbucket.

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 — Devner, CO, November 2017

Presentations

- 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

- 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
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