

Nicholas J. Moore

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Department of Mathematics.

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Recent positions

- 2020–present** US Naval Academy, Tenure-Track Faculty
- 2014–2020** Florida State University, Assistant Professor of Mathematics
Promoted to Associate Professor with Tenure (2020)
- 2010–2014** Courant Institute of Mathematical Sciences, Postdoc, Mentor: Michael Shelley

Education

- 2010** Ph.D. Mathematics, University of North Carolina, Chapel Hill
Advisors: Richard M. McLaughlin and Roberto Camassa
- 2005** B.S. Mathematics (Summa Cum Laude), minor in Physics, University of Tennessee

Research interests

Applied and computational mathematics broadly, including numerical methods, applied PDEs, especially moving-interface problems, fluids, biological and geophysical applications, rare and extreme events, statistical physics, stochastics, machine-learning and neural networks, applied complex analysis and conformal-mapping-based numerical methods.

Recent external funding

- 2020–2023 **NSF DMS Computational Mathematics**, M. N. J. Moore and B. Quaife
Title: "Erosion, Transport, and Dispersion in Granular and Porous Media", award number 2012560.
Awarded \$249,636 over 3 years. Lead PI at time of award (changed to co-PI with relocation)
- 2017–2020 **Simons Foundation, Collaboration Grants for Mathematicians**
"Dynamic interactions between fluid flows and moving boundaries", awarded \$42,000 over 5 years.

Publications

In Press

- P.J. Baddoo, N.J. Moore, A.U. Oza, D.G. Crowdy, "Generalization of waving-plate theory to multiple interacting swimmers", in press at *CPAM*, 2022.

Published

Underline indicates a graduate student, undergraduate student, or postdoc advised by me.

- J.M. Huang and N.J. Moore, "Morphological attractors in natural convective dissolution", *Phys. Rev. Lett.*, **128**, 024501, 2022. **Featured in Physics and Editor's Suggestion**
- N.J. Moore, C. Tyler Bolles, Andrew J. Majda, Di Qi, "Anomalous waves triggered by abrupt depth changes: laboratory experiments and truncated KdV statistical mechanics", *Journal of Nonlinear Science*, **30**(6), 3235–3263, 2020.
- S.H. Chiu, M.N.J. Moore, B.D. Quaipe "Viscous Transport in Eroding Porous Media", *Journal of Fluid Mechanics*, **893**, 2020. **Selected for JFM cover art in volume 893.**
- P.S. Eastham, M.N.J. Moore, N.G. Cogan, Q. Wang, and O. Steinbock "Multiphase modeling of precipitation-induced membrane formation", *Journal of Fluid Mechanics*, **888**, 2020.
- K. Khazmutdinova, D. Nof, D. Tremain, M. Ye, M.N.J. Moore, "A minimal model for predicting ventilation rates of subterranean caves", *Journal of Cave and Karst Science*, **81**(4), 264–274, 2019. arXiv preprint arXiv:1808.10478
- M. McCurdy, M.N.J. Moore, X. Wang "Convection in a coupled fluid-porous media system", *SIAM Journal on Applied Mathematics* **79**(6), 2313–2339, 2019.
- L.J. Gray, J. Jakowski, M.N.J. Moore, W. Ye, "Boundary integral analysis for non-homogeneous, incompressible Stokes flows", *Advances in Computational Mathematics*, **45**(3), 1729–1734, 2019.
- I.C. Sorribes, M.N.J. Moore, H.M. Byrne, H.V. Jain, "A Biomechanical Model of Tumor-induced Intracranial Pressure and Edema in Brain Tissue", *Biophysical Journal*, **116**(8), 1560–1574, 2019.
- A.J. Majda, M.N.J. Moore, D. Qi "Statistical dynamical model to predict extreme events and anomalous features in shallow water waves with abrupt depth change", *PNAS*, **116**(10), 3982–3987, 2019.
- C.T. Bolles, K. Speer, M.N.J. Moore, "Anomalous wave statistics induced by abrupt depth change", *Physical Review Fluids*, **4**(1), 011801, 2019.
- B. Quaipe and M.N.J. Moore, "A boundary-integral framework to simulate viscous erosion of a porous medium", *Journal of Computational Physics*, **375**, 1–21, 2018.
- M.N.J. Moore, "A fast Chebyshev method for simulating flexible-wing propulsion", *Journal of Computational Physics*, **345**, 792–817, 2017.
- M.N.J. Moore, "Riemann-Hilbert problems for the shapes formed by bodies dissolving, melting, and eroding in fluid flows", *CPAM*, **70**(9), 1810–1831, 2017.
- M.N.J. Moore, "Torsional spring is the optimal flexibility arrangement for thrust production of a flapping wing", *Physics of Fluids*, **27**(9), 091701, 2015.
Most read this month in October and November of 2015.
- J.M. Huang, M.N.J. Moore, L. Ristroph, "Shape dynamics and scaling laws for a body dissolving in fluid flow", *Journal of Fluid Mechanics Rapids*, **765**, R3, 2015.
- M.N.J. Moore, "Analytical results on the role of flexibility in flapping propulsion", *Journal of Fluid Mechanics*, **757**, 599–612, 2014.
- M.N.J. Moore, L. Ristroph, S. Childress, J. Zhang, M.J. Shelley, "Self-similar evolution of a body eroding in a fluid flow", *Physics of Fluids*, **25**, 116602, 2013.
Selected as **Editor's Pick** in April 2014.

- L. Ristroph, M.N.J. Moore, S. Childress, M.J. Shelley, J. Zhang, "Sculpting of an erodible body by flowing water", *PNAS*, **109**(48), 19606–19609, 2012.
- M.N.J. Moore and M.J. Shelley, "A weak-coupling expansion for viscoelastic fluids applied to dynamic settling of a body", *J. Non-Newtonian Fluid Mechanics*, **183-184**, 25–36, 2012.
- R. Camassa, R.M. McLaughlin, M.N.J. Moore and K. Yu, "Stratified flows with vertical layering of density: experimental and theoretical study of flow configurations and their stability", *Journal of Fluid Mechanics*, **690**, 571–606, 2012.
- R. Camassa, R.M. McLaughlin, M.N.J. Moore, A. Vaidya, "Brachistochrones in potential flow and the connection to Darwin's theorem", *Physics Letters A*, **372**, 6742–6749, 2008.
- M.N.J. Moore, L.J. Gray, and T. Kaplan, "Evaluation of supersingular integrals: Second-order boundary derivatives", *International Journal for Numerical Methods in Engineering*, **69**, 1930–1947, 2007.

Under review

- H. Sun, N.J. Moore, "Rigorous criteria for anomalous waves in truncated KdV statistical mechanics", under review at *Journal of Statistical Physics*, 2021.
arXiv preprint arXiv:2010.02970

Some popular articles written about my research

- Video: Mythical 'Freak Waves' are real and scientists are learning how they are formed, *MSN*, 2019.
- Scientists May Have Solved the Mystery of "Rogue Waves", Eleanor Hook, *Physics Central*, 2019.
- Variations in seafloor create freak ocean waves, Kathleen Haughney, *FSU News*, 2019.
Story also featured on *Science Daily*, *Phys.org*, *Physics Buzz*, *World News Buz*.
- Scientists uncover mystery behind catastrophic 'freak waves', Melissa Breyer, *treehugger.com*, also featured on *Tech2.org*, 2019.
- "Mathematics for optimal wing design", Kevin Knudson, *Forbes: Science Section*, 2015.
- "Ornithopters: Making maximally-efficient man-made wings", Bob Novella, *Skeptics' Guide*, 2015.
- "Math equations help build optimal bird wing", Kathleen Haughney, *Tallahassee Democrat*, 2015.
- "Science Finally Determines How Many Licks it Takes to Get to the Center of a Tootsie Pop", Maya Rhodan, *Time*, 2015.
- "How Many Licks Does It Take To Get To A Tootsie Pop's Center?", Renee Montagne, *NPR*, 2015.
- "How many licks to finish a lollipop? Formula models how water currents shape and dissolve solids", *Science Daily*, 2015.
- "The Lollipop Hypothesis", *Science Friday*, 2015.
- "Erosion has a point - and an edge, NYU researchers find", featured on NYU and NSF websites, 2012.
- "UNC oil estimate", interview with reporter Bob Buckley featured on WGHP Fox8, 2010.

Educational and mentoring accomplishments

- Nominated for **University Teaching Award**, Florida State University, 2020.
- **PhD supervisor** for Patrick Eastham (PhD in Biomathematics 2020)
Patrick was awarded an **NSF Graduate Student Research Fellowship** for 2017-2020.
- **PhD supervisor** for Matthew McCurdy (PhD in Applied and Computational Mathematics, 2020)
- **PhD supervisor** for Hui Sun (PhD expected 2022)
- **Postdoctoral mentor** for Francesca Bernardi, 2019-2020.
- **PhD supervisor** for Karina Khazmutdinova (PhD in Geophysical Fluid Dynamics 2016)
- **External examiner** for PhD candidate James Hewett at the University of Canterbury, New Zealand; supervisor M. Sellier, Mechanical Engineering; defense Fall 2017. James was recently awarded an **MBIE Science Whitinga Fellowship** (2021) which includes funding to support collaboration with myself.
- **Honors Thesis supervisor** for C. Tyler Bolles, 2017.
Tyler received the prestigious **IDEA grant** at Florida State University, and his research was selected for special recognition at the **FSU President's Showcase** in Fall 2016.
- **Filmed educational video** "Using Mathematics to Optimize Wing Design" for use by the CPALMS foundation (Florida K-12 education), 2016.
- Graduate courses instructed:
 - Partial Differential Equations 1-2 (Florida State University, 2016-17, 2017-18, 2018-2019)
 - Methods of Applied Mathematics (Florida State University, 2015)
 - Classical Mechanics (New York University, 2014)
 - Seminar on Modeling Geophysical Flows (Florida State University, 2014)
- Undergraduate courses instructed:
 - Mathematical Modeling with Computation (Florida State University, intermittently 2017-2020)
 - Partial Differential Equations 1 (US Naval Academy, Fall 2020)
 - Partial Differential Equations 2 (Florida State University, Spring 2020)
 - Differential Equations (US Naval Academy Spring 2021, also instructed course at Florida State University and New York University)
 - Discrete Mathematics (New York University, Fall 2013)
 - Calculus 1 (US Naval Academy Fall 2020, also instructed course at New York University and University of North Carolina)
 - Calculus 2 (New York University)
 - Calculus 3 (Florida State University)
- Served or serving on:
 - 15 PhD committees (5 Applied Mathematics, 3 Biomathematics, 1 Financial Mathematics, 3 Mechanical Engineering, 1 Geophysical Fluid Dynamics, 1 Physics, 1 Scientific Computing)
 - 2 Masters committees (both Biomathematics)

- 8 Honors Thesis committees (3 Applied Mathematics, 1 Biomathematics, 2 Physics, 1 Engineering, 1 Atmospheric Science)
- Directed individual studies:
 - Luke Termorshuizen (undergraduate USNA, 2021). Topic: Numerical framework for simulating laser-beam propagation through turbulent media.
 - Hui Sun (graduate student FSU, 2018). Topic: Exploration of the KdV system.
 - Gabriel Siewart (undergraduate FSU, 2018). Topic: Fourier analysis of sound timbre.
 - Samuel Pelletier (undergraduate FSU, 2018). Topic: Fourier analysis of sound timbre.
 - Zhifeng Deng (graduate student FSU, 2017). Topic: Computing Integrated Kinetic Energy of storm systems.
 - Patrick Eastham (graduate student FSU, 2016) Topic: Numerical methods and inertial cavitation.
 - Julia Ream (undergraduate FSU, 2016) Topic: Biological fluid dynamics and swimming mechanics.
 - Tyler Bolles (undergraduate FSU, 2015) Topic: Topographic rogue waves.
 - Sean Buchanan (undergraduate FSU, 2015). Topic: Ice shelf morphology and dynamics.
- Wrote recommendation letters for 12 undergraduate students and 11 graduate students.

Recent professional activities

- **Conference organizer** for the SIAM Southeast Atlantic Sectional (SEAS) meeting, held at Florida State University, Spring 2017 (with B. Quaife, X. Wang, and X. Wang).
- **Minisymposium organizer** for special sessions held at recent SIAM and AMS meetings:
 - SIAM Mathematics of Planet Earth (Garden Grove, CA, 2020; cancelled due to COVID-19): "Recent advancements in geophysical fluid dynamics"; co-organizer with J. Mac Huang.
 - SIAM Southeast Atlantic Sectional meeting (FSU, 2017): "Computational issues in geosciences"
 - AMS Sectional Meeting (College of Charleston, 2017): "Special Session on Fluid-Boundary Interactions"
 - SIAM CSE meeting (Atlanta, GA, 2017): "Flow-Induced Shaping Processes: Erosion, Dissolution, Ablation, and Phase Change"
 - SIAM Southeastern Atlantic Section Conference (University of Georgia, 2016): "Fluids: modeling, analysis and simulation"
- Referee for several top journals including: *Science*, *Physical Review Letters*, *Journal of Fluid Mechanics*, *SIAM Journal on Applied Mathematics*, *Proceedings of the Royal Society A*, *Physics of Fluids*, *Aeolian Research*, *Physical Review E*, *International Journal of Heat and Mass Transfer*, *Meccanica*, and others.
- Referee for grant proposals and fellowships: American Chemical Society, Petroleum Research Fund; MBIE Science Whitinga Fellowship Application (New Zealand).

Recent university services

- **Mathematics Colloquium Chair**, USNA Math Dept, 2020–present.
- Mathematics Department Research Committee, USNA Math, 2020–present.

- Majors Curriculum Committee, USNA Math Dept, 2020–present.
- Department Liaison, USNA Math Dept, 2020–present.
- **Organizer for Applied Mathematics Colloquium**, FSU Math Dept, 2016–2020.
- **Hiring Committee for Tenure-Track Faculty**, FSU Math Dept, 2015–16 and 2017–18.
- **Graduate Program Committee**, FSU Geophysical Fluid Dynamics Institute, 2017–2020.
- Hiring Committee for the Sir James Lighthill Postdoctoral Scholar, FSU Math Dept, 2018-19.
- Mathematics Research Enhancement Program selection committee, FSU Math Dept, Fall 2018–2020.
- Mentor for graduate-student instructors of Calculus 3, 2017.
- Panelist for undergraduate research grants (the IDEA grant), Florida State University, 2016
- Proposal reviewer for the Council on Research & Creativity, Florida State University, 2015
- Faculty volunteer for "Math Fun Day" held at Florida State University, 2014.
- Faculty representative for graduation, Florida State University (Fall 2014, Spring 2015, Summer 2016)

Invited talks at colloquia and workshops (selected)

- **Lehigh University**, Mathematics Seminar November 2021
- **University of Michigan**, Applied and Interdisciplinary Seminar November 2021
- **New Jersey Institute of Technology**, Fluid Mechanics Seminar October 2021
- **University of Geneva**, Applied Physics Seminar July 2021
- **University of North Carolina**, Applied Mathematics Seminar April 2021
- **University of California San Diego**, Mechanical and Aerospace Engineering Seminar October 2020
- **United States Naval Academy**, Mathematics Colloquium February 2020
- **Imperial College of London**, Fluid Dynamics Seminar November 2019
- **Isaac Newton Institute at University of Cambridge, UK** October 2019
Workshop on complex analysis: techniques, applications and computations.
- **University of Victoria**, British Columbia July 2019
Workshop in honor of Andrew Majda's 70th birthday.
- **Southern University of Science and Technology**, China, Mathematics Colloquium June 2019
- **Massachusetts Institute of Technology**, Earth Atmosphere and Planetary Sciences March 2019
- **Virginia Commonwealth University**, Biomath Seminar October 2018
- **Imperial College of London**, ACCA workshop May 2018
- **Case Western Reserve University**, Mathematics Colloquium March 2018
- **University of Canterbury**, Christchurch, NZ February 2018
IUTAM Symposium on Recent advances in moving boundary problems in mechanics

- **Courant Institute of Mathematical Sciences**, Applied Math Seminar February 2018
- **Banff International Research Station (BIRS)** workshop at Casa Matemática Oaxaca October 2017
- **Florida State University**, Mechanical Engineering Seminar September 2017
- **Woods Hole Oceanographic Institution**, Geophysical Fluid Dynamics Lecture Series August 2017
- **Geophysical Fluid Dynamics Institute**, 50th Anniversary Workshop May 2017
- **University of Wisconsin**, Applied and Computational Mathematics Seminar October 2016
- **Woods Hole Oceanographic Institution**, Geophysical Fluid Dynamics Lecture Series July 2016
- **Duke University**, Mathematical Biology Colloquium February 2016
- **Florida State University**, Scientific Computing Colloquium January 2016
- **Fudan University** (Shanghai, China)
Mathematics of Geophysical Flows and Turbulence Workshop August 2015
- **United States Naval Academy**, Mathematics Colloquium February 2014
- **Temple University**, Mathematics Colloquium February 2014
- **New Jersey Institute of Technology**, Fluid Mechanics Seminar January 2014
- **University of North Carolina**, PDEs seminar August 2013
- **New Jersey Institute of Technology**, Fluid Mechanics Seminar April 2013
- **University of Tennessee**, Mathematics Colloquium February 2013
- **University of Sydney**, Mathematics Seminar August 2012
- **University of North Carolina**, Applied Mathematics Colloquium July 2012
- **Courant Institute of Mathematical Sciences**, Applied Math Lab Seminar September 2010
- **Cha-Cha Days Workshop**, held at University of Central Florida November 2009

Invited presentations at conference mini-symposia (selected)

- **American Geophysical Union** (New Orleans, LA) December 2021
Invited to poster session on "Advances in Computational Analysis in Geophysical Processes: Applied Math Perspectives on Multiscale and Stochastic Models"
- **SIAM Annual Meeting**, Toronto, Canada (Cancelled due to COVID-19) July 2020
Invited to special session "Vortex and vortex-body dynamics"
- **AMS Sectional Meeting** (Madison, WI) Sep 2019
Invited to special session "Geophysical Fluid Dynamics: Modeling, Reduction and Simulation"
- **IMACS International Conference on Nonlinear Waves** (Athens, GA) April 2019
Invited to special session on "Physical Applied Mathematics"
- **Invited Session Speaker at APS March Meeting** March 2019
Invited speaker at session "Flow driven pattern formation in wet granular medium"

- **SIAM Southeastern Atlantic Section Conference** held at UNC, Chapel Hill March 2018
Invited to session "Fluid-Boundary Interactions at Intermediate and Low Reynolds Number"
- **SIAM Conference on Nonlinear Waves and Coherent Structures** (Philadelphia, PA) August 2016
Invited to special session on "Fluid-structure interactions and biological applications"
- **SIAM Conference on the Life Sciences** (Boston, MA) July 2016
Invited to special session on "Fluid-structure interactions for locomotion"
- **8th International Congress of Industrial and Applied Mathematics** (Beijing, China) August 2015
Invited to special session on "Fluid-structure interaction problems"

Contributed talks (selected)

- **APS Division of Fluid Dynamics** (Atlanta, GA) November 2018
- **AMS Sectional Meeting** (Charleston, SC) March 2017
Co-organized minisymposium "Special Session on Fluid-Boundary Interactions" and gave presentation "How Focused Flexibility Maximizes the Thrust Production of Flapping Wings"
- **SIAM CSE meeting** (Atlanta, GA) February 2017
Co-organized minisymposium on "Flow-Induced Shaping Processes: Erosion, Dissolution, Ablation, and Phase Change" and gave presentation "How bodies erode and dissolve in fluid flows"
- **SIAM Southeastern Atlantic Section** (Athens, GA) March 2016
Co-organized minisymposium "Fluids: modeling, analysis and simulation" and gave presentation "How bodies erode and dissolve in fluid flows"
- **APS Division of Fluid Dynamics** (Boston, MA) November 2015
- **APS Division of Fluid Dynamics** (San Francisco, CA) November 2014
- **Society of Engineering Science 51st Technical Meeting** held at Purdue University October 2014
- **APS Division of Fluid Dynamics** (Pittsburgh, PA) November 2013
- **APS Division of Fluid Dynamics** (San Diego, CA) November 2012
- **APS Division of Fluid Dynamics** (Baltimore, MD) November 2011
- **APS Division of Fluid Dynamics** (Long Beach, CA) November 2010

References

- Michael J. Shelley (postdoc mentor)
Lilian & George Lyttle Professor of Applied Mathematics,
Courant Institute of Mathematical Sciences and Flatiron Institute.
- Daniel Rothman
Professor of Geophysics and Co-director of the Lorenz Center, Massachusetts Institute of Technology.
- Darren Crowdy
Professor in Applied Mathematics, Imperial College of London.
- Leslie Greengard
Professor of Mathematics, Courant Institute of Mathematical Sciences and Flatiron Institute.
- Xiaoming Wang (collaborator and former FSU colleague)
Professor of Mathematics, Southern University of Science and Technology, Shenzhen, China.
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- Kevin Speer (collaborator and former FSU colleague)
Professor of Oceanography and Director of the Geophysical Fluid Dynamics Institute,
Florida State University.
- Mathieu Sellier
Professor of Engineering and Department Head, University of Canterbury, New Zealand.
- Saverio Spagnolie
Associate Professor of Mathematics, University of Wisconsin, Madison.
- Samuel Stechman
Professor of Mathematics, University of Wisconsin, Madison.
- Arshad Kudrolli
Professor of Physics, Clark University.
- Giray Okten (former FSU colleague)
Professor of Mathematics, Florida State University.
- Bryan Quaife (collaborator and former FSU colleague)
Assistant Professor of Scientific Computing, Florida State University.
- David Kopriva (former FSU colleague and teaching reference)
retired from Florida State University
- Roberto Camassa (PhD co-advisor)
Kenan Distinguished Professor of Mathematics, University of North Carolina.
- Richard M. McLaughlin (PhD co-advisor)
Professor of Mathematics, University of North Carolina.