

# Samuel Walsh

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## Employment

**University of Missouri**, Columbia, MO

2019- Associate Professor  
2013-2019 Assistant Professor

**Courant Institute of Mathematical Sciences**, New York University, New York, NY

2010-2013 Courant Instructor

## Education

2010 PH.D., Applied Mathematics, **Brown University**, Providence, RI

Dissertation: *Stratified steady periodic water waves*  
Thesis Advisor: Walter Strauss

2005 B.S. (with High Honors), Mathematical Sciences, **Carnegie Mellon University**, Pittsburgh, PA

## Research interests

Nonlinear PDE, water waves, mathematical fluid mechanics, nonlinear dispersive equations, infinite-dimensional dynamical systems

## Publications

### SUBMITTED

*Global bifurcation for monotone fronts of elliptic equations*, (with R. M. Chen and M. H. Wheeler), submitted.  
[arXiv:2005.00651](https://arxiv.org/abs/2005.00651).

### APPEARED AND IN PRESS

*Orbital stability of internal waves*, (with R. M. Chen), to appear in Commun. Math. Phys.  
[DOI:10.1007/s00220-022-04332-x](https://doi.org/10.1007/s00220-022-04332-x), [arXiv:2102.13590](https://arxiv.org/abs/2102.13590).

*Smooth stationary water waves with exponentially localized vorticity*, (with M. Ehrnström and C. Zeng), to appear in J. Eur. Math. Soc.

DOI:10.4171/jems/1204, arXiv:1907.07335.

*Traveling water waves — The ebb and flow of two centuries*, (with S. V. Haziot, V. M. Hur, W. Strauss, J. F. Toland, E. Wahlén, and M. H. Wheeler), Q. Appl. Math., vol. **80**(2) (2022), 317–401

DOI:10.1090/qam/1614, arXiv:2109.09208.

*Center manifolds without a phase space for quasilinear problems in elasticity, biology, and hydrodynamics*, (with R. M. Chen and M. H. Wheeler), Nonlinearity, vol. **35**(4) (2022) 1927–1985,

DOI:10.1088/1361-6544/ac5096, arXiv:1907.04370.

*Global bifurcation of anti-plane shear fronts*, (with R. M. Chen and M. H. Wheeler), J. Nonlinear Sci., vol. **31**(28) (2021).

DOI:10.1007/s00332-021-09684-7, arXiv:2008.09453.

*Large-amplitude internal fronts in two-fluid systems*, (with R. M. Chen and M. H. Wheeler), Comptes Rendus. Mathématique, vol. **358**(9–10) (2020), pp. 1073–1083.

DOI:10.5802/crmath.128, arXiv:2007.16055.

*On the stability of solitary water waves with a point vortex*, (with K. Varholm and E. Wahlén), Commun. Pure Appl. Math., vol. **73**(12) (2020), pp. 2634–2684.

DOI:10.1002/cpa.21891, arXiv:1811.08024.

*Existence, nonexistence, and asymptotics of deep water solitary waves with localized vorticity*, (with R. M. Chen and M. H. Wheeler), Arch. Rational Mech. Anal., vol. **234**(2) (2019), pp. 595–633.

DOI:10.1007/s00205-019-01399-0, arXiv:1706.00147.

*Solitary water waves with discontinuous vorticity*, (with A. Akers), J. Math. Pures Appl., vol. **124** (2019), pp. 220–272.

DOI:10.1016/j.matpur.2018.06.008, arXiv:1709.09918.

*Existence and qualitative theory for stratified solitary water waves*, (with R. M. Chen and M. H. Wheeler), Ann. Inst. H. Poincaré Anal. Non Linéaire, vol. **25**(2) (2018), pp. 517–576.

DOI:10.1016/j.anihpc.2017.06.003, arXiv:1601.05130.

*Unique determination of stratified steady water waves from pressure*, (with R. M. Chen), J. Differential Equations, vol. **264**(1) (2018), pp. 115–133.

DOI:10.1016/j.jde.2017.09.002, arXiv:1502.07775.

*Pressure transfer functions for interfacial fluid problems*, (with R. M. Chen and V. M. Hur), J. Math. Fluid Mech., vol. **19**(1) (2017), pp. 59–76.

DOI:10.1007/s00021-016-0265-6, arXiv:1511.05550.

*On the wind generation of water waves*, (with O. Bühler, J. Shatah, and C. Zeng), Arch. Rational Mech. Anal., vol. **222**(2) (2016), pp. 827–878.

DOI:10.1007/s00205-016-1012-0, arXiv:1505.02032.

*On the existence and qualitative theory for stratified solitary water waves*, (with R. M. Chen and M. H. Wheeler), C. R. Acad. Sci. Paris, Ser. I., vol. **354**(6) (2016), pp. 601–605.

DOI:10.1016/j.crma.2016.03.004.

*Continuous dependence on the density for stratified steady water waves*, (with R. M. Chen), Arch. Rational Mech. Anal., vol. **219**(2) (2016), pp. 741–792.

DOI:[10.1007/s00205-015-0906-6](https://doi.org/10.1007/s00205-015-0906-6), [arXiv:1408.5030](https://arxiv.org/abs/1408.5030).

*Nonlinear resonances with a potential: Multilinear estimates and an application to NLS*, (with P. Germain and Z. Hani), Internat. Math. Res. Notices, vol. **2015**(18) (2015), pp. 8484–8544.

DOI:[10.1093/imrn/rnu195](https://doi.org/10.1093/imrn/rnu195), [arXiv:1303.4354](https://arxiv.org/abs/1303.4354).

*Steady stratified periodic gravity waves with surface tension I: Local bifurcation*, Discrete Cont. Dyn. Syst. Ser. A, **8** (2014), pp. 3241–3285.

DOI:[10.3934/dcds.2014.34.3241](https://doi.org/10.3934/dcds.2014.34.3241).

*Steady stratified periodic gravity waves with surface tension II: Global bifurcation*, Discrete Cont. Dyn. Syst. Ser. A, **8** (2014), pp. 3287–3315.

DOI:[10.3934/dcds.2014.34.3287](https://doi.org/10.3934/dcds.2014.34.3287).

*Travelling water waves with compactly supported vorticity*, (with J. Shatah and C. Zeng), Nonlinearity, **26** (2013), pp. 1529–1564.

DOI:[10.1088/0951-7715/26/6/1529](https://doi.org/10.1088/0951-7715/26/6/1529), [arXiv:1211.3314](https://arxiv.org/abs/1211.3314).

*Steady water waves in the presence of wind*, (with O. Bühler and J. Shatah), SIAM J. Math. Anal., **45** (2013), pp. 2182–2227.

DOI:[10.1137/120880124](https://doi.org/10.1137/120880124), [arXiv:1211.3308](https://arxiv.org/abs/1211.3308).

*Some criteria for the symmetry of stratified water waves*, Wave Motion, **46** (2009), pp. 350–362.

DOI:[10.1016/j.wavemoti.2009.06.008](https://doi.org/10.1016/j.wavemoti.2009.06.008), [arXiv:0903.0908](https://arxiv.org/abs/0903.0908).

*Stratified steady periodic water waves*, SIAM J. Math. Anal., **41** (2009), pp. 1054–1105.

DOI:[10.1137/080721583](https://doi.org/10.1137/080721583), [arXiv:0807.0474v3](https://arxiv.org/abs/0807.0474v3).

#### INTERDISCIPLINARY WORKS

S. Balkissoon, N. Fox, A. Lupo, S. E. Haupt, Y. C. Li, P. Market, S. Walsh, *Determining chaotic characteristics and forecasting tall tower wind speeds in Missouri using Empirical Dynamical Modeling (EDM)*, Renewable Energy, vol. **170** (2021), pp. 1292–1307.

DOI:[10.1016/j.renene.2021.01.108](https://doi.org/10.1016/j.renene.2021.01.108).

## Honors, research awards, and visiting appointments

2020 Richard F. and Sharon A. Kiester Faculty Enhancement Award, University of Missouri.

2019 Research-in-Teams Grant, “Global bifurcation techniques for traveling waves on non-compact domains”, Erwin Schrödinger Institute, Vienna, Austria.

US Junior Oberwolfach Fellow.

NSF DMS-1844731, conference grant to support the 2019 KUMUNU Conference on PDE, Dynamical Systems, and Application.

2018-2022 NSF DMS-1812436, “Existence and energetic stability of traveling waves in the presence of symmetry.”

- 2017 Longterm Visitor, Institute for Computational and Experimental Research Mathematics, Providence, RI.  
  
Richard F. and Sharon A. Kiester Faculty Enhancement Award, University of Missouri.
- 2016 NSF DMS-1549934, conference grant to support the 2016 KUMU Conference on PDE, Dynamical Systems, and Applications.
- 2015-2018 NSF DMS-1514910, “Existence, stability, and qualitative theory of traveling water waves.”
- 2013 *Travelling water waves with compactly supported vorticity* officially recognized as a ‘Highlight of 2013’ by the journal Nonlinearity.
- 2010 Recipient of the Dunmu Ji Award, recognizing a doctoral thesis as particularly original and independent.

## Selected invited talks

- Mar. 2022 *Global bifurcation of hydrodynamic bores*, Continuum Mechanics Seminar, University of Nebraska–Lincoln, Online.
- Nov. 2021 *Global bifurcation for monotone fronts of elliptic equations*, Computational and Applied Mathematics Seminar, University of Kansas, Lawrence, KS.
- Oct. 2021 *Global bifurcation for monotone fronts of elliptic equations*, Special Session on Progress in Nonlinear Waves, AMS Central Virtual Sectional Meeting, Online.  
  
*Global bifurcation of hydrodynamic bores*, Seminar on Analysis, Geometry, and PDEs, Lund University, Online.
- May 2021 *Orbital stability of internal waves*, Differential Equations and Numerical Analysis Seminar, Norwegian University of Science and Technology, Online.
- Apr. 2021 *Orbital stability of internal waves*, Analysis Seminar, University of Kansas, Online.
- Feb. 2021 *Large fronts in hydrodynamics and nonlinear elasticity*, Analysis and PDE Seminar, University of Pittsburgh, Online.
- Oct. 2020 *Global bifurcation for monotone fronts of elliptic equations*, Analysis Seminar, University of Oklahoma, Online.  
  
*Water waves with density stratification or localized vorticity*, ONEPAS Seminar, Online.
- Sep. 2020 *Global bifurcation for monotone fronts of elliptic equations*, PDE Seminar, Brown University, Online.
- Mar. 2020 *Global bifurcation for monotone fronts of elliptic equations*, Analysis and PDE Seminar, University of Pittsburgh, Pittsburgh, PA.

- Oct. 2019 *Center manifolds without a phase space for quasilinear PDE from elasticity, biology, and hydrodynamics*, Analysis and PDE Seminar, University of Pittsburgh, Pittsburgh, PA.
- Sep. 2019 *Capillary-gravity water waves with exponentially localized vorticity*, Mathematics Colloquium, Missouri S&T, Rolla, MO.
- Center manifolds without a phase space for quasilinear PDE from elasticity, biology, and hydrodynamics*, Analysis in Missouri: A Midwestern Symposium, Columbia, MO.
- Jul. 2019 *Orbital stability and instability of fractional KdV solitary waves*, Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany.
- May 2019 *Water waves with localized vorticity*, Mathematical Colloquium, University of Vienna, Austria.
- Mar. 2019 *Capillary-gravity water waves with exponentially localized vorticity*, Midwest Partial Differential Equations Seminar, Indiana University, Bloomington, IN.
- Nov. 2018 *Capillary-gravity water waves with exponentially localized vorticity*, Applied Math/PDE Seminar, Drexel University, Philadelphia, PA.
- Oct. 2018 *Capillary-gravity water waves with exponentially localized vorticity*, Workshop on Nonlinear Differential Equations, Dynamical Systems and Applications, University of Kansas, Lawrence, KS.
- Jun. 2018 *Capillary-gravity water waves with exponentially localized vorticity*, Lund Workshop on Fluid Dynamics and Dispersive Equations, Lund, Sweden.
- Dec. 2017 *Existence, nonexistence, and asymptotics of deep water solitary waves with localized vorticity*, “Nonlinear water waves - an interdisciplinary interface” workshop, Erwin Schrödinger Institute, Vienna, Austria.
- Oct. 2017 *Stability of traveling waves with a point vortex*, Analysis, Dynamics, and Applications Seminar, University of Arizona, Tucson, AZ.
- Aug. 2017 *Stability of traveling waves with a point vortex*, Nonlinear Water Waves Workshop, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK.
- Apr. 2017 *Stability of traveling waves with a point vortex*, Water Waves Workshop, ICERM, Providence, RI.
- Mar. 2017 *Water waves with localized vorticity*, Conference on Nonlinear Waves: Analysis and Applications, University of Pittsburgh, Pittsburgh, PA.
- Oct. 2016 *Existence and qualitative theory for solitary stratified water waves*, Theoretical and Computational Aspects of Nonlinear Surface Waves, Banff International Research Station for Mathematical Innovation and Discovery, Banf, Alberta, Canada.
- Oct. 2016 *Existence and qualitative theory for solitary stratified water waves*, 2nd Annual Meeting of SIAM Central States Section, Little Rock, AR.

- Jul. 2016 *Existence and qualitative theory for solitary stratified water waves*, 11th AIMS Conference on Dynamical Systems, Differential Equations and Applications, Orlando, FL.
- Dec. 2015 *Existence and qualitative theory for solitary stratified water waves*, SIAM Conference on Analysis of Partial Differential Equations, Scottsdale, AZ.
- Jun. 2015 *Mathematical theory of wind-generated water waves*, Differential Equations and Numerical Analysis Seminar, Norwegian University of Science and Technology (NTNU), Trondheim, Norway.
- Apr. 2015 *Continuous dependence on the density for stratified steady water waves*, Workshop on Mathematical Theory of Water Waves, Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany.
- Apr. 2015 *Continuous dependence on density for stratified steady water waves*, IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory, Athens, GA.
- Mar. 2015 *Instability of traveling water waves with a point vortex*, Conference on PDEs and Free Boundary Problems, University of Pittsburgh, Pittsburgh, PA.
- Nov. 2014 *On the wind-generation of water waves*, Harmonic Analysis and Differential Equations Seminar, University of Illinois Urbana-Champaign, Urbana-Champaign, IL.
- Jul. 2014 *On the wind-generation of water waves*, AIMS Conference on Dynamical Systems, Differential Equations and Applications, Madrid, Spain.
- Dec. 2013 *Mathematical theory of wind-generated water waves*, SIAM Conference on Analysis of PDEs, Orlando, FL.
- Nov. 2013 *Resonance for nonlinear dispersive equations with a potential*, Computational and Applied Mathematics Seminar, University of Kansas, Lawrence, KS.
- Oct. 2013 *Resonance for nonlinear dispersive equations with a potential*, PDE and Analysis Seminar, University of Pittsburgh, Pittsburgh, PA.
- Jun. 2013 *Resonance for nonlinear dispersive equations with a potential*, Chinese–Norwegian Mathematics Workshop, Trondheim, Norway.
- Jun. 2013 *Resonance for nonlinear dispersive equations with a potential*, 26th Nordic and 1st European–Nordic Congress of Mathematicians, Lund, Sweden.
- Mar. 2013 *Resonance for nonlinear dispersive equations with a potential*, IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, Athens, GA.
- Jan. 2013 *Steady water waves with compactly supported vorticity*, Joint Mathematics Meetings, San Diego, CA.
- Nov. 2012 *Steady waves with compactly supported vorticity*, Applied Mathematics Seminar, University of Maryland, College Park, MD.
- Jun. 2012 *Steady water waves with compactly supported vorticity*, Nonlinear Waves and Interface Problems Workshop, University of Lund.

- Apr. 2012 *Steady water waves in the presence of wind*, Georgia Institute of Technology, Atlanta, GA.
- Apr. 2011 *Theory of steady stratified water waves*, IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena, Athens, GA.
- Nov. 2010 *Traveling waves in stratified water*, Applied Mathematics Seminar, Courant Institute, NYU, New York, NY.
- Apr. 2010 *An existence theory for steady stratified water waves*, Analysis Seminar, University of Pennsylvania, Philadelphia, PA.
- Dec. 2009 *Stratified steady water waves*, SIAM Conference on Analysis of PDEs, Miami, FL.
- Feb. 2009 *Stratified steady water waves*, Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany.

## Service

Current students: Daniel Sinambela (PhD expected 2022), Thomas Hogancamp (PhD expected 2023).

Past students: Hung Le (PhD, 2019), Max Highsmith (MS, 2018), Adelaide Akers (PhD, 2017), Jessie Bleile (MS, 2016), Evan Datz (MS, 2016).

Undergraduate research advising: Elijah Good (Discovery Research Fellow, MU, 2021–); Michael Dotzel (Undergraduate Thesis, MU, 2016); Yungjoo Lee, Timothy Mok, and Haochuan Wang (S.U.R.E. Program, NYU, 2012).

Reviewer for AMS Mathematical Reviews.

Served as referee for Simons Foundation.

Refereed submitted articles for: *Advances in Mathematics*, *Archive Rational Mechanics and Analysis*; *Communications in Mathematical Physics*; *Communications on Pure and Applied Mathematics*; *Discrete and Continuous Dynamical Systems A*; *Fluid Dynamics Research*; *Journal of Differential Equations*; *Journal of Fluid Mechanics*; *Journal of Mathematics Analysis and Applications*; *Nonlinearity*; *Philosophical Transactions of the Royal Society A*; *Proceedings of the Royal Society of Edinburgh, Section A*; *SIAM Journal on Mathematical Analysis*; *Studies in Applied Mathematics*; and the *Transactions of the AMS*.

2020 Invited talk for Mathematics Honors Society at Hickman High school.

Co-organizer of the MU-MST Joint Analysis Seminar.

Served as organizer of the MU Differential Equations Seminar.

Served as Math Competition Advisor for MU and faculty advisor to the undergraduate Math Club.

- Served on Awards Committee.
- 2019 Co-organizer of the 2019 KUMUNU Conference on Partial Differential Equations, Dynamical Systems, and Applications.
- Co-organizer of mini-symposium “Stability and traveling waves” at the 11th IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory.
- Served as organizer of the MU Differential Equations Seminar.
- Served as Math Competition Advisor for MU and faculty advisor to the undergraduate Math Club.
- Served on Awards Committee.
- 2018 Served as Math Competition Advisor for MU and faculty advisor to the undergraduate Math Club.
- Served as organizer for the MU Differential Equations Seminar.
- Served on Library Committee.
- Served on Awards Committee.
- 2017 Served as Math Competition Advisor for MU and faculty advisor to the undergraduate Math Club.
- Served as organizer for the MU Differential Equations Seminar.
- Served on Workload Policy Committee.
- Co-organizer of mini-symposium “Traveling waves and spectral theory” at the 10th IMACS International Conference on Nonlinear Evolutions Equations and Wave Phenomena: Computation and Theory.
- 2016 Co-organizer of the KUMU Conference on PDE, Dynamical Systems, and Applications.
- Served as Math Competition Advisor for MU and faculty advisor to the undergraduate Mathematics Club.
- Served on Library Committee.
- 2015 Co-organizer of mini-symposium “Water waves” at the SIAM Conference on Analysis of Partial Differential Equations.
- 2014 External sensor evaluating the master’s thesis for a student (K. Varholm) at NTNU (Norwegian University of Science and Technology)
- Served on Analysis Qualification Exam Committee.
- Referee for Missouri Research Board grant application.



- 2013 Speaker at [cSplash](#), an annual one-day festival of mathematics and computer science talks aimed at high school students
- 2012 Faculty advisor to three participants in the Courant Institute [Summer Undergraduate Research Experience](#) (S.U.R.E.) program, Summer 2012.
- 2011 Speaker at [cSplash](#).
- 2008-2010 Organizer, Brown University Working Seminar in PDEs.

## Teaching experience

### 2013- University of Missouri

#### *Calculus III*

Introduction to multivariate calculus, with topics spanning the geometry of three-dimensional space to Stokes' Theorem.

#### *Differential Equations*

Introductory undergraduate course on ordinary differential equations: explicit solution methods for first- and second-order ODEs, numerical methods, phase plane analysis, and applications.

#### *Numerical Linear Algebra*

Advanced undergraduate/beginning graduate course on numerical methods for linear algebra.

#### *Mathematical Modeling*

Advanced undergraduate/beginning graduate course introducing methods of mathematical modeling and applied mathematics.

#### *Topics in Applied Math: Bifurcation Theory*

Advanced graduate-level topics course on applications of local and global bifurcation theory to problems in hydrodynamics and elliptic PDE.

#### *Topics in Applied Math: Nonlinear Dispersive Equation*

Advanced graduate-level topics course on nonlinear dispersive PDEs.

#### *Topics in Applied Math: Nonlinear Dispersive Equation II*

Continuation of Topics in Applied Math: Nonlinear Dispersive Equation.

#### *Topics in Applied Math: Mathematical Theory of Water Waves*

Advanced graduate-level topics course in theoretical fluid mechanics and water waves.

#### *Topics in Applied Math: Advanced Topics in Partial Differential Equations*

Advanced graduate-level topics covering Schauder theory, variational methods for PDEs, and semi-groups.

#### *Partial Differential Equations I*

Graduate-level introductory course on partial differential equations.

#### *Partial Differential Equations II*

Second semester graduate-level course on partial differential equations.

#### *Advance Ordinary Differential Equations*

Graduate-level introductory course on ODEs and dynamical systems.

2010–2013 **Courant Institute**

*Analysis I*

Introductory undergraduate course in real analysis: limits, point-set topology, compactness, metric spaces.

*Discrete Mathematics*

Introduction to proof-based mathematics, with material drawn from a survey of Discrete Mathematics topics.

*Partial Differential Equations*

Advanced undergraduate course in PDEs covering the highlights of linear theory, as well as some topics in nonlinear PDE.

*Linear Algebra*

Introduction to basic tools of Linear Algebra: vector and matrix manipulation, eigenvalues, vector spaces.

*Calculus III*

Introduction to multivariate calculus, with topics spanning the geometry of three-dimensional space to Stokes' Theorem.

2006–2009 **Brown University**

PRIMARY INSTRUCTOR

*Intermediate Calculus (Physics/Engineering)*

Introduction to multivariate calculus with emphasis on applications in electrostatics and fluid mechanics.

TEACHING ASSISTANT

*Essential Statistics*

First course in statistics, giving introductory treatment of probability, data analysis and common statistical methods.

*Methods of Applied Mathematics I*

Theory of first- and second-order ordinary differential equations, including analytic and numerical methods.

*Methods of Applied Mathematics II*

Systems of ODEs, stability analysis, introduction to partial differential equations.

2004–2005 **Carnegie Mellon University**

TEACHING ASSISTANT

*Concepts of Mathematics*

Introduction to proof-based mathematics with material drawn from number theory and discrete mathematics.

*Integration, Differential Equations, and Approximation*

Second course in differential and integral calculus, covering methods of integration, sequences and

series and basic theory of ODEs.

## Related skills

Python, C/C++/Objective-C, Lisp/Scheme, Matlab, Maple, OpenGL.