Gideon Simpson

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Citizenship

USA

Current Position

Associate Professor, Drexel University, Department of Mathematics, September 2018 – Present

Previous Positions

- Visitor, University of Pennsylvania, MEAM, January 2020 – June 2020 (Sabbatical)
- Assistant Professor, Drexel University, Department of Mathematics, September 2013 – August 2018
- Visitor, IPAM, UCLA, September 2017 – December 2017
- PIRE/DOE Postdoctoral Fellow, University of Minnesota, School of Mathematics, August 2011 – August 2013
- Visitor, University of Warwick, Mathematics Institute, September 2012 – December 2012
- Postdoctoral Fellow, University of Toronto, Department of Mathematics, July 2008 – June 2011

Research Interests

- Nonlinear Wave Equations – Solitary Waves, Stability, Singularity Formation
- Multiscale Methods – Homogenization, Accelerated Dynamics
- Scientific Computing – Direct Numerical Simulation, Algorithms
- Applications – Fluid Mechanics, Geophysics, Nonlinear Optics, Materials Science

Education

- Columbia University, Graduate School of Arts and Sciences (GSAS)
  Ph.D., Applied Mathematics, October 2008
  Thesis Advisors: Marc Spiegelman & Michael I. Weinstein
  Thesis Title: *The Mathematics of Magma Migration*
- Columbia University, GSAS
  M. Phil., Applied Physics, May 2006
- Columbia University, School of Engineering and Applied Science (SEAS)
  M.S., Applied Physics, May 2004
- Cornell University, College of Arts and Sciences
  B.A., Summa Cum Laude, Mathematics, May 2003

External Support

- **Title** Collaborative Research: Particles and Proxies for Sampling and Optimization
  Agency NSF
  Role Co-PI; Other Co-PI – D. Aristoff, Colorado State University
  Duration 8/01/2021-7/31/2024
  Award Amount $149,687 (Drexel)
- **Title** Collaborative Research: Stochastic Methods for Complex Systems
  Agency NSF
  Role Co-PI; Other Co-PI – D. Aristoff, Colorado State University
  Duration 8/01/2018-7/31/2021
  Award Amount $98,134 (Drexel)
- **Title** Uncertainty Quantification for statistical models in dynamic environments
  Agency ARO
  Role Senior Personnel; PI – P. Plecháč (University of Delaware)
  Duration 10/1/2019-9/31/2020
  Award Amount N/A
- **Title** Gene Golub Summer School on Stochastic Differential Equations and Wave Propagation at Drexel University
  Agency SIAM
  Role Co-PI; Lead PI – D. Ambrose, Drexel University
  Duration 06/01/2016 – 09/30/2016
  Award Amount $94,120
- **Title** Computational and Analytical Challenges in Nonlinear Dispersive Wave Equations
  Agency National Science Foundation (NSF)
  Role PI
  Duration 09/01/2014 – 07/31/2018
  Initial Award Amount $146,118
  Supplementary Award Amount $5,000 for REU support
- **Title** Theory and Computation for Mesoscopic Materials Modeling
  Agency US Department of Energy (DOE), Subcontract from University of Minnesota
  Role Co-PI; Lead PI – M. Luskin, School of Mathematics, University of Minnesota
  Duration 08/01/2014 – 08/14/2018
  Award Amount Total/ Drexel $549,513 / $88,715

Honors & Awards

- Simon Prize Recipient, Columbia University, 2009
- NSF Graduate Research Fellowship Honorable Mention, 2005
- NSF IGERT Fellow, Columbia University, 2003
- Phi Beta Kappa, Cornell University, 2003

Peer Reviewed Publications

1. F.G. Jones, G. Simpson. Iterate averaging, the Kalman filter, and 3DVAR for linear inverse problems. *Numerical Algorithms* , 2022.
2. G. Medvedev, G. Simpson. A Numerical Method for a Nonlocal Diffusion Equation with Additive Noise. *Stochastics and Partial Differential Equations: Analysis and Computations*, 2022.
3. R.J. Webber, D. Aristoff, G. Simpson. A splitting method to reduce MCMC variance. *Under revision*, arXiv:2011.13899.
4. P. Plecháč, G. Simpson. Sampling from Rough Energy Landscapes. *Communications in Mathematical Sciences*, 18(8), 2271–2303, 2020.
5. T.D. Swinburne, J. Janssen, M. Todorova, G. Simpson, P. Plecháč, M. Luskin, J. Neugebauer. Anharmonic free energy of lattice vibrations in fcc crystals from a mean-field bond. *Physical Review B*, 102, 100101, 2020.
6. J. Copperman, D. Aristoff, D. Makarov, G. Simpson, D. Zuckerman. Transient probability currents provide upper and lower bounds on non-equilibrium steady-state currents in the Smoluchowski picture. *Journal of Chemical Physics*, 151, 174108, 2019.
7. S. Woloszynek, J.C. Mell, Z. Zhao, G. Simpson, M.P. O'Connorm, G.L. Rosen. Exploring thematic structure and predicted functionality of 16S rRNA amplicon data. *PLoS ONE*, 14(12): e0219235, 2019.
8. D. Ambrose, E. Das Gupta, S. Moskow, V. Ozornina, G. Simpson. Detection of thin high contrast dielectrics from boundary measurements. *Journal of Physics Communications*, 3 (11), 115016, 2019.
9. G. Simpson, D. Watkins. Relative entropy minimization over Hilbert spaces via Robbins-Monro. *AIMS Mathematics*, 4(3), 359-383, 2019.
10. D.M. Ambrose, G.R. Simpson, J.D. Wright, D.G. Yang. Existence theory for magma equations in dimension two and higher. *Nonlinearity*, 21(10), 4724, 2018.
11. B. Farmer, M. Luskin, P. Plecháč, G. Simpson. Spin-Diffusions and Diffusive Molecular Dynamics, *Modelling and Simulation in Materials Science and Engineering*, 25(8), 2017.
12. J.L. Marzuola, S.G. Raynor, G. Simpson. Nonlinear Bound States in a Schrödinger–Poisson System with External Potential, *SIAM Journal on Applied Dynamical Systems*, 16(1), 2017.
13. A.D. Jones, G. Simpson, W. Wilson. Conservative Integrators for a Toy Model of Weak Turbulence, *Journal of Computational and Applied Mathematics*, 325, 113-124, 2017
14. Y. Cher, G. Simpson, C. Sulem. Local Structure of Singular Profiles for a Derivative Nonlinear Schrödinger Equation, *SIAM Journal on Applied Dynamical Systems*, 16(1), 514-545, 2017
15. D. Aristoff, S.T. Chill, G. Simpson. Analysis of estimators for adaptive Kinetic Monte Carlo,*Communications in Applied Mathematics and Computational Science*, 11(2), 171-186, 2016.
16. R. Côte, C. Muñoz, D. Pilod, G. Simpson. Asymptotic Stability of high-dimensional Zakharov-Kuznetsov solitons. *Archive for Rational Mechanics and Analysis*, 220(2), 639-710, 2016.
17. M. Luskin, G. Simpson, D.J. Srolovitz. A Theoretical Examination of Diffusive Molecular Dynamics,*SIAM Journal on Applied Mathematics*, 76(6), 2176-2196, 2016.
18. D. Olson, S. Shukla, G. Simpson, D. Spirn. Petviashvilli's Method for the Dirichlet Problem. *Journal of Scientific Computing*, 66(1), 297-320, 2016.
19. F.J. Pinski, G. Simpson, A.M. Stuart, H. Weber. Algorithms for Kullback-Leibler Approximation of Probability Measures in Infinite Dimensions. *SIAM Journal on Scientific Computing*, 37(6), A2733-A2757, 2015.

20. F.J. Pinski, G. Simpson, A.M. Stuart, H. Weber. Kullback-Leibler approximation for probability measures on infinite dimensional spaces. *SIAM Journal on Mathematical Analysis*, 47(6), 4091-4122, 2015.
21. D.M. Ambrose, G. Simpson. Local Existence Theory for Derivative Nonlinear Schrödinger Equations with Non-Integer Power Nonlinearities. *SIAM Journal on Mathematical Analysis*, 47(3), 2241-2264,2015.
22. A. Binder, T. Lelièvre, G. Simpson. A Generalized Parallel Replica Dynamics. *Journal of Computational Physics*, 284, 595-616, 2015.
23. D. Aristoff, T. Lelièvre, G. Simpson. The parallel replica method for simulating long trajectories of markov chains. *AMRX*, 2014(2), 332-352, 2014.
24. J.L. Marzuola, S. Raynor, G. Simpson. Dynamics near a minimal mass soliton of a generalized Korteweg-de Vries equation. *Dynamical Systems* , 29 (2), 285-299, 2014.
25. D. Ginsberg, G. Simpson. Analytical and Numerical Results on the Positivity of Steady State Solutions of a Thin Film Equation. *Discrete and Continuous Dynamics Systems-B*, 18(5):1305-1321, 2013.
26. G. Simpson, M. Luskin. Numerical Analysis of Parallel Replica Dynamics. *ESAIM:M2AN*, 47:1287-1314, 2013.
27. X. Liu, G. Simpson, C. Sulem. Stability of solitary waves for a generalized derivative nonlinear Schödinger equation. *Journal of Nonlinear Science*, 23:557-583, 2013.
28. X. Liu, G. Simpson, C. Sulem. Focusing singularity in a derivative nonlinear Schrödinger equation. *Physica D*, 262:48-58, 2013.
29. J.E. Colliander, J.L. Marzuola, T. Oh, G. Simpson. Behavior of a model dynamical system with applications to weak turbulence. *Experimental Mathematics*, 22(3):250-264, 2013.
30. D.M. Ambrose, G. Simpson, J.D. Wright, D.G. Yang. Ill-Posedness of Degenerate Dispersive Equations. *Nonlinearity*, 25(9): 2655–2680, 2012.
31. D.E. Pelinovsky, G. Simpson, M.I. Weinstein. Polychromatic Solitary Waves in a Periodic and Nonlinear Maxwell System. *SIAM Journal on Applied Dynamical Systems*, 11(1):478–506, 2012.
32. G. Simpson, M.I. Weinstein. Coherent Structures and Carrier Shocks in the Nonlinear Periodic Maxwell Equations. *Multiscale Modeling & Simulation*, 9(3):955–990, 2011.
33. G. Simpson, I. Zwiers. Vortex Collapse for the L2-Critical Nonlinear Schrödinger Equation. *Journal of Mathematical Physics*, 52(8):083503, 2011.
34. R. Asad, G. Simpson. Embedded Eigenvalues and the Nonlinear Schrödinger Equation. *Journal of Mathematical Physics*, 52(3):033511, 2011.
35. G. Simpson, M. Spiegelman. Solitary Wave Benchmarks in Magma Dynamics. *Journal of Scientific Computing*, 49(3):268–290, 2011.
36. J.L. Marzuola, G. Simpson. Spectral Analysis for Matrix Hamiltonian Operators. *Nonlinearity*, 24:389-429, 2011.
37. J. Colliander, G. Simpson, and C. Sulem. Numerical simulations of the energy-supercritical nonlinear Schrödinger equation. *Journal of Hyperbolic Differential Equations* , 7:279–296, 2010.
38. J.L. Marzuola, S. Raynor, and G. Simpson. A System of ODEs for a Perturbation of a Minimal Mass Soliton. *Journal of Nonlinear Science*, 20:425–461, 2010.
39. G. Simpson, M. Spiegelman, and M.I. Weinstein. A Multiscale Model of Partial Melts 2: Numerical Results. *Journal of Geophysical Research – Solid Earth*, 115, B04411, 2010.
40. G. Simpson, M. Spiegelman, and M.I. Weinstein. A Multiscale Model of Partial Melts 1: Effective Equations. *Journal of Geophysical Research – Solid Earth*, 115, B04410, 2010.

41. G. Simpson, C. Sulem, and P.L. Sulem. Arrest of Langmuir wave collapse by quantum effects. *Physical Review E*, 80:5, 056405, 2009.
42. G. Simpson and M.I. Weinstein. Asymptotic stability of ascending solitary magma waves. *SIAM Journal on Mathematical Analysis* , 40:1337–1391, 2008.
43. G. Simpson, M.I. Weinstein and P. Rosenau. On a Hamiltonian PDE arising in magma dynamics. *Discrete and Continuous Dynamics Systems-B* , 10:903–924, 2008.
44. G. Simpson, M. Spiegelman, and M.I. Weinstein. Degenerate dispersive equations arising in the study of magma dynamics. *Nonlinearity*, 20:21–49, 2007.

Conference Proceedings

1. R.O. Weber, P. Goel, S. Amiri, G. Simpson. Longitudinal Distance: Towards Accountable Instance Attribution. *ICCBR*, arXiv:2108.10437.
2. J.D. Russo, D. Aristoff, G. Simpson, J.T. Copperman, D.M. Zuckerman. Unbiased Trajectory-Based Estimation of Stationary Distributions and Splitting Probabilities. *APS March Meeting*, arXiv:2105.13402.

Software

WeightedEnsemble.jl Open source Julia implementation of the Weighted Ensemble algorithm, `https://github.com/gideonsimpson/WeightedEnsemble.jl`

BasicMD.jl Open source Julia implementation of some common molecular dynamics algorithms, `https://github.com/gideonsimpson/BasicMD.jl`

TestLandscapes.jl Open source Julia implementation of some elementary test energy landscapes, `https://github.com/gideonsimpson/TestLandscapes.jl`

Invited Presentations

2021 Oregon State University, October 2021

2020 Utah State/BYU, October 2020

2019 MRS, Boston, December 2019
ICIAM, Valencia, Spain, July 2019
DelMar, University of Maryland, May 2019
University of Illinois at Chicago, March 2019
Tulane University, February 2019

2018 CIRM (Luminy), September 2018
Drexel Waves Conference, May 2018
Tulane University, January 2018
Temple University, November 2018

2017 IPAM, UCLA, October 2017
University of British Columbia, July 2017
University of Edinburgh, June 2017
George Washington University, April 2017
University of Massachusetts, February 2017

2016 MIT, December 2016
Gene Golub Summer School, Drexel University, July 2016
London Mathematical Society Workshop, Durham University, July 2016
Frontiers in Applied and Computational Mathematics Conference, NJIT, June 2016
INI Workshop, Cambridge University, April 2016
University of Pennsylvania, March 2016
University of Cincinnati, January 2016

2015 Fordham University, November, 2015
Workshop on Multiscale Modeling and Analysis in Materials Science Shanghai Jiao Tong University, August 2015
University of Chicago, April, 2105
SIAM Workshop on Dimension Reduction, Penn State, March 2015
University of Cincinnati, January 2015

2014 Wake Forest University, December 2014
Colorado State University, October 2014
BIRS Workshop on Multiscale Models of Crystal Defects, September 2014

2013 Warwick University Maths Institute Workshop, December 2013
University of Delaware, November 2013
Binghamton University, October 2013
Midwest Partial Differential Equations Seminar, May 2013
University of New Mexico, February 2013
Drexel University, February 2013
University of California, San Diego, January 2013
Warwick University, January 2013
Miami University, January 2013

2012 University of Maryland, December 2012
Sandia National Laboratories, CSRI, August 2012
Warwick University, June 2012
Georgia Southern University, March 2012
NJIT, February 2012
Columbia University, February 2012

2011 Drexel University, October 2011
OxMOS Meeting, Oxford University, September 2011
CNA Workshop on Macroscopic Modeling of Materials with Fine Structure, Carnegie Mellon University, may 2011
AMS Spring Southeastern Section Meeting, Georgia Southern University, March 2011
Florida International University, March 2011
Wayne State University, March 2011
Oregon State University, February 2011
Claremont McKenna College, February 2011
Michigan State University, February 2011
Ohio River Analysis Meeting, University of Cincinnati, January 2011

2010 Fields Institute, November 2010
University of North Carolina–Chapel Hill, October 2010
Drexel University, April 2010

2009 McMaster University, March 2009

2008 NJIT, April 2009
University of Toronto, February 2009
University of Chicago, February 2009

Other Presentations

2021 USNCCM16 Conference, August 2021
SIAM CSE Conference, March 2021

2018 SIAM Conference on Materials Science, July 2018 AIMS Conference on Dynamical Systems, July 2018

2017 IMACS Conference on Nonlinear Evolution Equations and Wave Phenomena, University of Georgia, March 2017
AMS Spring Sectional Meeting, College of Charleston, March 2017

2016 Multiscale Materials Modeling Conference, October 2016
SIAM Conference on Nonlinear Waves, August 2016
SIAM Conference on Materials Science, May 2016

2015 DelMar, US Naval Academy, May 2015
SIAM Workshop on Dimension Reduction, Penn State, March 2015
AMS Spring Sectional Meeting, Michigan State University, March 2015

2014 AMS Fall Western Sectional Meeting, San Francisco State University, October 2014
American Institute of Mathematical Conferences the 10th AIMS Conference on Dynamical Systems, Differential Equations and Applications, Madrid, Spain, July 2014
DelMar, University of Maryland, Baltimore County, May 2014

2013 SIAM Conference on Partial Differential Equations, December 2013
SIAM Conference on Materials Science, June 2013
Midwest Partial Differential Equations Seminar, May 2013

2012 SIAM Annual Meeting, July 2012

2011 CMS Winter Meeting, Ryerson University, December 2011
AMS Fall Southeastern Section Meeting, Wake Forest University, September 2011
IMACS Conference on Nonlinear Evolution Equations and Wave Phenomena, March 2011
AMS Spring Southeastern Section Meeting, Georgia Southern University, March 2011

2010 SIAM Conference on Nonlinear Waves and Coherent Structures, August 2010
Canadian Math Society(CMS) Summer Meeting, University of New Brunswick, June 2010
Frontiers in Applied and Computational Mathematics Conference, NJIT, May 2010

2009 American Geophysical Union(AGU) Fall Meeting, December 2009
BIRS Workshop on analysis of nonlinear wave equations and applications in engineering, August 2009
SIAM Snowbird Conference on Applications of Dynamical Systems, May 2009
American Math Society(AMS) Eastern Sectional Metting, Worcester Polytechnic Institute , April 2009

2006 SIAM Conference on Nonlinear Waves and Coherent Structures, University of Central Florida, September 2006
Recent advances in nonlinear partial differential equations and applications: A workshop in honor of Peter D. Lax and Louis Nirenberg, June 2006

2005 NSF IGERT Project Meeting, May 2005

Teaching

- Calculus 1 (Math 121), Fall 2020
- Mathematical and Statistical Software (Math 318), Winter 2018, Winter 2019
- Probability and Statistics (Math 311), Spring 2018
- Differential Equations (Math 210), Fall 2016, Winter 2018
- Graduate Numerical Analysis (Math 520) , Fall 2016, Winter 2019, Fall 2020
- Graduate Numerical Analysis (Math 521) , Winter 2017, Spring 2019, Winter 2021
- Numerical Analysis (Math 301), Winter 2016, Winter 2018
- Numerical Analysis (Math 300), Fall 2015, Fall 2021
- Numerical Mathematics (Math 540), Spring 2015, Fall 2019, Fall 2021
- Numerical Analysis (Math 301), Winter 2015

- Partial Differential Equations (Math 323), Winter 2014
- Discrete Event Simulation (Math 483), Spring 2019
- Vector and Complex Analysis for Engineers (Math 291), Spring 2021

Undergraduate Research Students

- Zachary Lee, Summer REU 2020, Drexel University.
- Nicholas DeFillipis, Summer REU 2020, Drexel University.
- Nick Livolsi, STAR Summer Scholar 2020, Drexel University.
- Aquil Jones, Summer REU, BS student at Drexel University, 2017
- William Wilson, Summer REU, BS student at Drexel University, 2016
- Soumitra Shukla, Summer REU, BA student at University of Minnesota, 2015
- Reza Asad, Summer REU, BA student at University of Toronto, 2013
- Daniel Ginsberg, Summer REU, BA student at University of Toronto, 2013

Graduate & Postgraduate Students

- Brittan Farmer, Postdoctoral Researcher at Drexel University, 2016
- Felix Jones, PhD student at Drexel University, 2020
- Daniel Watkins, MS student at Drexel University, 2015
- Liam Doherty, PhD student at Drexel University

Departmental & University Service

2021 – 2022 Departmental Service:

- Head of Grants Committee
- Member of the Tenure Track Search Committee

University Service:

- University Research Computing Facility – Board Member

2020 – 2021 Departmental Service:

- Head of Graduate Admissions Committee

University Service:

- University Research Computing Facility – Board Member

2019 – 2020 University Service:

- University Research Computing Facility – Board Member

2018 – 2019 Departmental Service:

- Graduate Admissions Committee

University Service:

- University Research Computing Facility – Board Member
- Accepted undergraduate students open house

2017 – 2018 Departmental Service:

- Graduate Admissions Committee

University Service:

- University Research Computing Facility – Board Member

2016 – 2017 Departmental Service:

- Graduate Admissions Committee
- PDE & Applied Mathematics Seminar Organizer

University Service:

- Admitted Undergraduate Student Open House
- Commencement
- University Research Computing Facility – Board Member

2015 – 2016 Departmental Service:

- Graduate Admissions Committee
- PDE & Applied Mathematics Seminar Organizer

University Service:

- Convocation

2014 – 2015 Departmental Service:

- Graduate Admissions Committee
- PDE & Applied Mathematics Seminar Organizer
- Strategic Hiring Committee

University Service:

- Admitted Undergraduate Students Open House
- Convocation

2013 – 2014 Departmental Service:

- Graduate Admissions Committee
- PDE & Applied Mathematics Seminar Organizer
- Library Liaison

University Service:

- Admitted Undergraduate Students Open House
- Convocation

Conference & Seminar Organization

- Minisymposium co-organizer at MRS Fall Meeting 2021, Boston
- Minisymposium co-organizer at USNCCM16, 2021, Chicago
- Minisymposium co-organizer at MRS Fall Meeting 2019, Boston
- Minisymposium co-organizer at ICIAM 2019, Valencia, Spain
- Gene Golub Summer School co-organizer, Drexel University, 2016: Stochastic Differential equations and Wave Propagation
- Frontiers in Applied and Computational Mathematics Conference co-organizer, NJIT, 2016.
- Isaac Newton Institute Workshop co-organizer, Cambridge University, 2016: From the Grain to the Continuum: Two Phase Dynamics of a Partially Molten, Polycrystalline Aggregate
- Minisymposia co-organizer, SIAM Conference on Partial Differential Equations, 2015: Coherent Structures in Hamiltonian PDE

- Workshop co-organizer, Waves, Spectral Theory, and Applications: A workshop celebrating the research of Michael Weinstein, 2015
- Minisymposia co-organizer, SIAM Conference on Partial Differential Equations, 2013: Recent Advances in Nonlinear Dispersive Partial Differential Equations
- Minisymposia co-organizer, SIAM Conference on Mathematical Aspects of Materials Science, 2013: Computational Tools for Metastable Systems
- Special Session co-organizer, AMS Fall 2011 Southeastern Section Meeting, Special Session on Nonlinear Dispersive Equations
- Minisymposia co-organizer, SIAM Conference on Nonlinear Waves and Coherent Structures, 2010:
  - Modulation of Nonlinear Solutions of in Dispersive Partial Differential Equations
  - Patterns and Coherent Structures in the Solid Earth: Magma Dynamics
- Applied Math & Analysis Seminar co-organizer, University of Toronto, 2009–2010

Review Service

Proposals NSERC, NSF

Peer Reviewed Journals Journal of Computational Physics, Journal of Fluid Mechanics, Journal of Mathematical Physics A, Nonlinearity, Nonlinear Analysis, Numerische Mathematik, Revista Matemática Complutense, Physica D, SINUM, Multiscale Modeling & Simulation, Journal of Uncertainty Quantification, SIAM Review, Journal of Differential Equations, AIMS Mathematics, Artificial Intelligence, Proceedings of the American Mathematical Society