

# Brendan Keith

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## Appointments

### Division of Applied Mathematics Brown University

MORTON E. GURTIN ASSISTANT PROFESSOR OF APPLIED MATHEMATICS  
ASSISTANT PROFESSOR OF APPLIED MATHEMATICS

Providence, Rhode Island

July 2024 – present

July 2022 – June 2024

### Center for Applied Scientific Computing Lawrence Livermore National Laboratory

POSTDOCTORAL RESEARCHER

Livermore, California

Feb. 2021 – June 2022

### Institute for Computational and Experimental Research in Mathematics (ICERM) Brown University

POSTDOCTORAL FELLOW

Providence, Rhode Island

Sept. 2020 – Dec. 2020

### Chair of Numerical Mathematics Technische Universität München

POSTDOCTORAL RESEARCHER

Garching, Germany

Sept. 2018 – Aug. 2020

## Education

### Oden Institute for Computational Engineering and Sciences University of Texas at Austin

PH.D. COMPUTATIONAL SCIENCE, ENGINEERING, & MATHEMATICS

Austin, Texas

2018

### Department of Mathematics and Statistics McGill University

M.SC. APPLIED MATHEMATICS

Montréal, Quebec

2013

### Departments of Applied Mathematics, Pure Mathematics, and Physics University of Waterloo

B.MATH HONOURS APPLIED MATHEMATICS WITH PHYSICS OPTION

B.MATH HONOURS PURE MATHEMATICS

Waterloo, Ontario

2011

2011

## Teaching Experience

APMA 1160 An Introduction to Numerical Optimization

APMA 2560 Numerical Solution of Partial Differential Equations II

APMA 2570B Numerical Solution of Partial Differential Equations III

## Selected Honors & Awards

2025 **Sloan**, Alfred P. Sloan Research Fellow in Mathematics

2023 **Popular Science**, Member of Popular Science Magazine's 10 Brilliant Early Career Researchers

2023 **DOE**, DOE Office of Science Early Career Research Program Award

2020 **ICERM**, ICERM Postdoctoral Fellowship for the program "Advances in Computational Relativity"

2017 **SIAM**, SIAM Student Certificate of Recognition for 2017

## Current Research Funding as Lead PI

2023–'28 **DOE SC ECRP**, REASON-3D: Randomized, Entropic, Adaptive, and Scalable Optimization for Non-Intrusive Data-Driven Design \$875k

2024–'27 **NSF CDS&E**, Data-Driven Discovery of Neural ODE Dynamics, Astrophysical Models, and Orbits (Neural ODE DynAMO) \$376k

## Preprints

1. Dokken, J. S., Farrell, P. E., Keith, B., Papadopoulos, I. P., and Surowiec, T. M. (2025). *The latent variable proximal point algorithm for variational problems with inequality constraints*. arXiv: 2503.05672 [math.OC].
2. Fu, G., Keith, B., and Masri, R. (2024). *A locally-conservative proximal Galerkin method for pointwise bound constraints*. arXiv: 2412.21039 [math.NA].
3. Kim, D., Lazarov, B. S., Surowiec, T. M., and Keith, B. (2024). *A simple introduction to the SiMPL method for density-based topology optimization*. arXiv: 2411.19421 [math.OC].

## Scientific Journal Articles

4. Keith, B., Kim, D., Lazarov, B. S., and Surowiec, T. M. (2025). *Analysis of the SiMPL method for density-based topology optimization*. SIAM J. Optim., (to appear).
5. Keith, B. and Surowiec, T. M. (2024). *Proximal Galerkin: A structure-preserving finite element method for pointwise bound constraints*. Found. Comput. Math., 1–97. DOI: 10.1007/s10208-024-09681-8.
6. Duswald, T., Keith, B., Lazarov, B., Petrides, S., and Wohlmuth, B. (2024). *Finite elements for Matérn-type random fields: Uncertainty in computational mechanics and design optimization*. Comput. Methods Appl. Mech. Engrg., **429**, 117146. DOI: 10.1016/j.cma.2024.117146.
7. Andrej, J., Atallah, N., Bäcker, J.-P., Camier, J., Copeland, D., Dobrev, V., Dudouit, Y., Duswald, T., Keith, B., Kim, D., Kolev, T., Lazarov, B., Mittal, K., Pazner, W., Petrides, S., Shiraiwa, S., Stowell, M., and Tomov, V. (2024). *High-performance finite elements with MFEM*. Int. J. High Perform. Comput. Appl., **38** (5), 447–467. DOI: 10.1177/10943420241261981.
8. Dzanic, T., Mittal, K., Kim, D., Yang, J., Petrides, S., Keith, B., and Anderson, R. (2024). *DynAMO: Multi-agent reinforcement learning for dynamic anticipatory mesh optimization with applications to hyperbolic conservation laws*. J. Comput. Phys., 112924. DOI: <https://doi.org/10.1016/j.jcp.2024.112924>.
9. Gillette, A., Keith, B., and Petrides, S. (2024). *Learning robust marking policies for adaptive mesh refinement*. SIAM J. Sci. Comput., **46** (1), A264–A289. DOI: 10.1137/22M1510613.
10. Bollapragada, R., Karamanli, C., Keith, B., Lazarov, B., Petrides, S., and Wang, J. (2023). *An Adaptive Sampling Augmented Lagrangian Method for Stochastic Optimization with Deterministic Constraints*. Comput. Math. Appl., **149**, 239–258. DOI: 10.1016/j.camwa.2023.09.014.
11. Beiser, F., Keith, B., Urbainczyk, S., and Wohlmuth, B. (2023). *Adaptive sampling strategies for risk-averse stochastic optimization with constraints*. IMA J. Numer. Anal. drac083. DOI: 10.1093/imanum/drac083.
12. Kodakkal, A., Keith, B., Khristenko, U., Apostolatos, A., Bletzinger, K.-U., Wohlmuth, B., and Wuechner, R. (2022). *Risk-averse design of tall buildings for uncertain wind conditions*. Comput. Methods Appl. Mech. Engrg., **402**, 115371. DOI: 10.1016/j.cma.2022.115371.
13. Keith, B., Khadse, A., and Field, S. E. (2021). *Learning orbital dynamics of binary black hole systems from gravitational wave measurements*. Phys. Rev. Res., **3** (4), 043101. DOI: 10.1103/PhysRevResearch.3.043101.
14. Keith, B. (2021). *A priori error analysis of high-order  $LL^*$  (FOSLL\*) finite element methods*. Comput. Math. Appl., **103**, 12–18. DOI: 10.1016/j.camwa.2021.10.015.
15. Keith, B., Khristenko, U., and Wohlmuth, B. (2021). *Learning the structure of wind: A data-driven nonlocal turbulence model for the atmospheric boundary layer*. Phys. Fluids., **33**(9), 095110. DOI: 10.1063/5.0064394.
16. Keith, B., Khristenko, U., and Wohlmuth, B. (2021). *A fractional PDE model for turbulent velocity fields near solid walls*. J. Fluid Mech., **916**, A21. DOI: 10.1017/jfm.2021.182.
17. Drzisga, D., Keith, B., and Wohlmuth, B. (2020). *The surrogate matrix methodology: Accelerating isogeometric analysis of waves*. Comput. Methods Appl. Mech. Engrg., **372**, 113322. DOI: 10.1016/j.cma.2020.113322.
18. Drzisga, D., Keith, B., and Wohlmuth, B. (2020). *The surrogate matrix methodology: A reference implementation for low-cost assembly in isogeometric analysis*. MethodsX, **7**, 100813. DOI: 10.1016/j.mex.2020.100813.
19. Demkowicz, L., Gopalakrishnan, J., and Keith, B. (2020). *The DPG-star method*. Comput. Math. Appl., **79**(11), 3092–3116. DOI: 10.1016/j.camwa.2020.01.012.
20. Drzisga, D., Keith, B., and Wohlmuth, B. (2020). *The surrogate matrix methodology: Low-cost assembly for isogeometric analysis*. Comput. Methods Appl. Mech. Engrg., **361**, 112776. DOI: 10.1016/j.cma.2019.112776.
21. Drzisga, D., Keith, B., and Wohlmuth, B. (2019). *The surrogate matrix methodology: a priori error estimation*. SIAM J. Sci. Comput., **41**(6), A3806–A3838. DOI: 10.1137/18M1226580.
22. Keith, B., Vaziri Astaneh, A., and Demkowicz, L. (2019). *Goal-oriented adaptive mesh refinement for discontinuous Petrov–Galerkin methods*. SIAM J. Numer. Anal., **57**(4), 1649–1676. DOI: 10.1137/18M1181754.
23. Vaziri Astaneh, A., Keith, B., and Demkowicz, L. (2019). *On perfectly matched layers for discontinuous Petrov–Galerkin methods*. Comput. Mech., **63**(6), 1131–1145. DOI: 10.1007/s00466-018-1640-3.

24. Keith, B., Petrides, S., Fuentes, F., and Demkowicz, L. (2017). *Discrete least-squares finite element methods*. Comput. Methods Appl. Mech. Engrg., **327**, 226–255. DOI: 10.1016/j.cma.2017.08.043.
25. Keith, B., Knechtges, P., Roberts, N., Elgeti, S., Behr, M., and Demkowicz, L. (2017). *An ultraweak DPG method for viscoelastic fluids*. J. Non-Newton. Fluid Mech., **247**, 107–122. DOI: 10.1016/j.jnnfm.2017.06.006.
26. Fuentes, F., Keith, B., Demkowicz, L., and Le Tallec, P. (2017). *Coupled variational formulations of linear elasticity and the DPG methodology*. J. Comput. Phys., **348**, 715–731. DOI: 10.1016/j.jcp.2017.07.051.
27. Keith, B., Fuentes, F., and Demkowicz, L. (2016). *The DPG methodology applied to different variational formulations of linear elasticity*. Comput. Methods Appl. Mech. Engrg., **309**, 579–609. DOI: 10.1016/j.cma.2016.05.034.
28. Fuentes, F., Keith, B., Demkowicz, L., and Nagaraj, S. (2015). *Orientation embedded high order shape functions for the exact sequence elements of all shapes*. Comput. Math. Appl., **70**(4), 353–458. DOI: 10.1016/j.camwa.2015.04.027.

## Scientific Software

29. Izmailov, A., Meeker, M., Deskos, G., and Keith, B. (2024). *DRDMannTurb: A python package for scalable, data-driven synthetic turbulence*. J. Open Source Softw. DOI: 10.21105/joss.06838. URL: <https://github.com/METHODS-Group/DRDMannTurb>.

## Conference Proceedings

30. Sit, H., Keith, B., and Bergen, K. (2024). *Improving explainability of softmax classifiers using a prototype-based joint embedding method*. Workshop on Explainable AI at International Joint Conference on Artificial Intelligence (IJCAI). arXiv: 2407.02271 [cs.LG].
31. Yang, J., Mittal, K., Dzanic, T., Petrides, S., Keith, B., Petersen, B., Faissol, D., and Anderson, R. (2023). *Multi-Agent Reinforcement Learning for Adaptive Mesh Refinement*. Proceedings of the 22nd International Conference on Autonomous Agents and Multiagent Systems (AAMAS-2023), 14–22. URL: <https://www.southampton.ac.uk/~eg/AAMAS2023/pdfs/p14.pdf>.
32. Tosi, R., Nuñez, M., Keith, B., Pons-Prats, J., Wohlmuth, B., and Rossi, R. (2021). *Scalable dynamic asynchronous Monte Carlo framework applied to wind engineering problems*. Advances in Uncertainty Quantification and Optimization Under Uncertainty with Aerospace Applications. Proceedings of the 2020 UQOP International Conference. Ed. by Vasile, M. and Quagliarella, D. Vol. 8. Space Technology Proceedings. Springer, 55–68. DOI: 10.1007/978-3-030-80542-5\_4.

## Technical Reports

33. Keith, B., Demkowicz, L., and Gopalakrishnan, J. (2017). *DPG\* method*. ICES Report 17-25. The University of Texas at Austin.

## Theses

34. Keith, B. (2018). *New ideas in adjoint methods for PDEs: A saddle-point paradigm for finite element analysis and its role in the DPG methodology*. PhD thesis. Austin, Texas: University of Texas at Austin.
35. Keith, B. (2014). *Lagrangian Coherent Structures in Three-dimensional Steady Flows*. Master’s Thesis. Montreal, Quebec: McGill University.

## Other Writings

36. Keith, B., O’Leary-Roseberry, T., Sanderse, B., Scheichl, R., and Bloemen Waanders, B. van (2025). *Scientific machine learning: A symbiosis*. Found. Data Sci., **7** (1), i–x. DOI: 10.3934/fods.2024051.
37. Keith, B., O’Leary-Roseberry, T., Lu, L., Mishra, S., and Mao, Z. (2023). *BIRS Workshop Report 23w5129 Scientific Machine Learning*. URL: <http://stats.birs.ca/workshops/2023/23w5129/report23w5129.pdf>.
38. Keith, B. (2023). *The technique that can find a system’s state through data alone*. Nature, **622** (7982), 246–247. DOI: 10.1038/d41586-023-03070-x.
39. Robison<sup>1</sup>, B. K. (2011). *The Wave Equation and Multi-Dimensional Time*. The Waterloo Mathematics Review, **1**(1), 32–42.

<sup>1</sup>Personal name legally changed by the Government of Ontario to Brendan Keith on February 22, 2012.

## Selected Conference Presentations and Invited Talks

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2024	<b>ICTAM26</b> , International Congress on Theoretical and Applied Mechanics	Daegu, KR
2024	<b>Yonsei</b> , CSE Department Seminar (two talks)	Seoul, KR
2024	<b>WCCM16</b> , World Congress on Computational Mechanics	Vancouver, BC
2024	<b>ECCOMAS9</b> , European Congress on Computational Methods in Applied Sciences and Engineering	Lisbon, PT
2024	<b>CMAI</b> , Center for Mathematics and Artificial Intelligence Colloquium	Fairfax, VA
2024	<b>Stony Brook</b> , Optimization Workshop	Stony Brook, NY
2024	<b>Cornell</b> , Center for Applied Mathematics Colloquium	Ithaca, NY
2024	<b>U of Utah</b> , Applied Math Seminar	Salt Lake City, UT
2024	<b>Sandia</b> , Center for Computing Research Seminar	Albuquerque, NM
2024	<b>WONAPDE</b> , Workshop on Numerical Analysis of Partial Differential Equations	Concepcion, Chile
2024	<b>UPC</b> , Instituto de Ingeniería Matemática y Computacional Seminar	Santiago, Chile
2023	<b>Oxford</b> , Numerical Analysis Group Internal Seminar	Oxford, UK
2023	<b>ACM</b> , Advances in Computational Mechanics Workshop in Honor of the 80th birthday of Thomas J.R. Hughes	Austin, TX
2023	<b>USNCCM17</b> , US National Congress on Computational Mechanics	Albuquerque, NM
2023	<b>HOFEIM</b> , International Workshop on High-Order Finite Element and Isogeometric Methods	Larnaca, CY
2023	<b>WIAS</b> , Weierstrass Institute Mathematical Optimization Seminar	Berlin, DE
2023	<b>UT Austin</b> , Workshop in Honor of Leszek F. Demkowicz's 70th Birthday	Austin, TX
2023	<b>UT Austin</b> , Oden Institute Seminar	Austin, TX
2023	<b>JMM</b> , Joint Mathematics Meeting	Boston, MA
2022	<b>Simula RL</b> , Optimization in Oslo	Oslo, NO
2022	<b>EPFL</b> , Mathematics in Computational Science and Engineering Seminar	Lausanne, CH
2022	<b>USACM</b> , Large-Scale TTA Early-Career Colloquium	Virtual
2022	<b>NC State</b> , Numerical Analysis Seminar	Virtual
2022	<b>ICCOPT</b> , International Conference on Continuous Optimization	Bethlehem, PA
2022	<b>SIAM UQ22</b> , SIAM Conference on Uncertainty Quantification	Atlanta, GA
2021	<b>USNCCM16</b> , US National Congress on Computational Mechanics	Virtual
2021	<b>SIAM OP21</b> , SIAM Conference on Optimization	Virtual
2021	<b>SIAM DS21</b> , SIAM Conference on Applications of Dynamical Systems	Virtual
2021	<b>ECOM</b> , East Coast Optimization Meeting	Virtual
2021	<b>SIAM CSE21</b> , SIAM Conference on Computational Science and Engineering	Virtual
2019	<b>SSDSS</b> , AICES School for Simulation and Data Science Seminar	Aachen, DE
2019	<b>IGA2019</b> , International Conference on Isogeometric Analysis	München, DE
2019	<b>FrontUQ19</b> , Workshop on Frontiers of Uncertainty Quantification in Fluid Dynamics	Pisa, ITL
2019	<b>USNCCM15</b> , US National Congress on Computational Mechanics	Austin, TX
2018	<b>Oberwolfach</b> , Workshop on Computational Engineering	Oberwolfach, DE
2018	<b>WCCM13</b> , World Congress on Computational Mechanics	New York, NY
2018	<b>SIAM AN18</b> , SIAM Annual Meeting	Portland, OR
2018	<b>ETAMM2</b> , Emerging Trends in Applied Mathematics and Mechanics	Kraków, PL
2017	<b>MRLSFEM2</b> , Minimum Residual & Least-Squares Finite Element Methods	Portland, OR
2017	<b>USNCCM14</b> , US National Congress on Computational Mechanics	Montréal, QC
2017	<b>Oberwolfach</b> , Seminar on Discontinuous Petrov–Galerkin Methods	Oberwolfach, DE
2017	<b>ACSE</b> , Advances in Computational Science and Engineering (in honor of the 80th birthday of Prof. J.T. Oden)	Austin, TX
2017	<b>SIAM CSE17</b> , SIAM Conference on Computational Science and Engineering	Atlanta, GA
2016	<b>MAFELAP 2016</b> , Mathematics of Finite Elements and Applications	Uxbridge, UK
2016	<b>AMFE</b> , Advances in Mathematics for Finite Elements (in honor of the 90th birthday of Prof. Ivo Babuška)	Austin, TX
2015	<b>POEMs</b> , Polytopal Element Methods in Mathematics and Engineering	Atlanta, GA
2015	<b>Oberwolfach</b> , Workshop on Computational Engineering	Oberwolfach, DE
2015	<b>USNCCM13</b> , US National Congress on Computational Mechanics	San Diego, CA

## Academic Service

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### Departmental Service

Faculty Advisor to Brown University's SIAM Chapter (2024 – present)

Faculty Advisor to the Student Groups of the Division of Applied Mathematics (2022 – 2024)

**Peer Review (Journals)**

(Five to ten manuscripts per year)

Computational Methods in Applied Mathematics (CMAM), Computer Methods in Applied Mechanics and Engineering (CMAME), Computers and Mathematics with Applications (CAMWA), IMA Journal of Numerical Analysis (IMAJNA), Mathematical Models and Methods in Applied Sciences (M3AS), Mathematics of Computation (Math. Comp.), Nature, Numerische Mathematik, SIAM Journal on Scientific Computing (SISC), SIAM Review

**Peer Review (Funding Agencies)**Agence Nationale de la Recherche, Army Research Office (ARO), Department of Energy (DOE), National Science Center, Poland (Panel ST8)

**Conference Organization**  
Banff International Research Station (BIRS) Workshop on Scientific Machine Learning (2023)  
Workshop in Honor of Leszek F. Demkowicz's 70th Birthday (2023)  
Texas Applied Mathematics and Engineering Symposium (2017)

**Campus Government**  
Vice-President: UT Austin SIAM chapter. (01/2018 – 08/2018)  
President: UT Austin SIAM chapter. (09/2015 – 12/2017)  
Treasurer: UT Austin SIAM chapter. (09/2013 – 08/2015)

**Research Community Membership**  
Society for Industrial and Applied Mathematics (SIAM)  
United States Association for Computational Mechanics (USACM)

Research Supervision

Postdocs	Ph.D. students	Master's students	Undergraduate students
<ul style="list-style-type: none"><li>• Peter Sentz (2022 – present)</li><li>• Dohyun Kim (2023 – present)</li><li>• Rami Masri (2024 – present)</li></ul>	<ul style="list-style-type: none"><li>• Noe Reyes Rivas (2024 – present)</li></ul>	<ul style="list-style-type: none"><li>• Summan Sohail (2020)</li><li>• Jonas Kipfstuhl (2020)</li><li>• Simon Urbainczyk (2020)</li><li>• Refath Bari (2025 – present)</li></ul>	<ul style="list-style-type: none"><li>• Alexey Izmailov (2023 – 2024)</li><li>• Matthew Meeker (2023)</li><li>• Yuechuan Yang (2023 – 2024)</li><li>• Rohit Panse (2023 – 2024)</li><li>• Lucas Chan (2024 – present)</li></ul>

Expired Research Funding as Lead PI

2023 –'24	<b>OVPR Seed Award (Brown Internal)</b> , Data-Driven High-Order Accurate Fail-Safe Neural Topology Optimization for Plastic Deformation and Fracture	\$100k
2022–'24	<b>LLNL LDRD</b> , Adaptive Sampling for Risk-Averse Design and Optimization	\$1.4m