

Brendan Keith

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Research Interests

High-order finite element methods, scientific machine learning, optimal design, and uncertainty quantification.

Research Grants

LDRD **\$450,000/year**, Adaptive Sampling for Risk-Averse Design and Optimization 2022, 2023, 2024

Appointments

Division of Applied Mathematics
Brown University

Providence, Rhode Island

ASSISTANT PROFESSOR

July 2022 – present

Center for Applied Scientific Computing
Lawrence Livermore National Laboratory

Livermore, California

POSTDOCTORAL RESEARCHER

Feb. 2021 – June 2022

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

Providence, Rhode Island

POSTDOCTORAL FELLOW

Sept. 2020 – Dec. 2020

Chair of Numerical Mathematics
Technische Universität München

Garching, Germany

POSTDOCTORAL RESEARCHER

Sept. 2018 – Aug. 2020

Supervisor: Barbara Wohlmuth

Education

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

Austin, Texas

PH.D. COMPUTATIONAL SCIENCE, ENGINEERING, & MATHEMATICS

2018

Supervisor: Leszek Demkowicz

Dissertation: A saddle-point paradigm for finite element analysis and its role in the DPG methodology

Department of Mathematics and Statistics
McGill University

Montréal, Quebec

M.SC. APPLIED MATHEMATICS

2013

Supervisor: George Haller

Thesis: Lagrangian coherent structures in three-dimensional steady flows

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

Waterloo, Ontario

B.MATH HONOURS APPLIED MATHEMATICS WITH PHYSICS OPTION

2011

B.MATH HONOURS PURE MATHEMATICS

2011

Publications

Preprints

1. Gillette, A., Keith, B., and Petrides, S. (2022). *Learning robust marking policies for adaptive mesh refinement*. arXiv: 2207.06339 [math.NA].
2. Beiser, F., Keith, B., Urbainczyk, S., and Wohlmuth, B. (2020). *Adaptive sampling strategies for risk-averse stochastic optimization with constraints*. arXiv: 2012.03844 [math.OC].

Scientific Journal Articles

3. 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., 115371. DOI: 10.1016/j.cma.2022.115371.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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: <https://doi.org/10.1016/j.cma.2020.113322>.
9. 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.
10. 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.
11. 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.
12. 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.
13. 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.
14. 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.
15. 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.
16. 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.
17. 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.
18. 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.
19. 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.

Other

20. 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: https://doi.org/10.1007/978-3-030-80542-5_4.
21. 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.
22. Keith, B., Demkowicz, L., and Gopalakrishnan, J. (2017). *DPG* method*. ICES Report 17-25. The University of Texas at Austin.
23. Keith, B., Fuentes, F., and Demkowicz, L. (2015). *The Exact Sequence for Elements of All Shapes (ESEAS) software library*. URL: <https://github.com/libESEAS/ESEAS>.
24. Keith, B. (2014). *Lagrangian Coherent Structures in Three-dimensional Steady Flows*. Master's Thesis. Montreal, Quebec: McGill University.
25. Robison¹, B. K. (2011). *The Wave Equation and Multi-Dimensional Time*. The Waterloo Mathematics Review, **1**(1), 32–42.

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

Selected Conference Presentations and Invited Talks

Presented at over 25 scientific meetings since 2015

2022	SIAM UQ22 , SIAM Conference on Uncertainty Quantification	Atlanta, GA
2021	USNCCM16 , US National Congress on Computational Mechanics	Virtual
2021	SIAM OP21 , SIAM Conference on Optimization	Virtual
2021	SIAM DS21 , SIAM Conference on Applications of Dynamical Systems	Virtual
2021	ECOM , East Coast Optimization Meeting	Virtual
2021	SIAM CSE21 , SIAM Conference on Computational Science and Engineering	Virtual
2019	IGA2019 , International Conference on Isogeometric Analysis	München, DE
2019	FrontUQ19 , Workshop on Frontiers of Uncertainty Quantification in Fluid Dynamics	Pisa, ITL
2019	USNCCM15 , US National Congress on Computational Mechanics	Austin, TX
2018	Oberwolfach , Workshop on Computational Engineering	Oberwolfach, DE
2018	WCCM13 , World Congress on Computational Mechanics	New York, NY
2018	SIAM AN18 , SIAM Annual Meeting	Portland, OR
2018	ETAMM2 , Emerging Trends in Applied Mathematics and Mechanics	Kraków, PL
2017	USNCCM14 , US National Congress on Computational Mechanics	Montréal, QC
2017	ACSE , Advances in Computational Science and Engineering (in honor of the 80th birthday of Prof. J.T. Oden)	Austin, TX
2017	SIAM CSE17 , SIAM Conference on Computational Science and Engineering	Atlanta, GA
2016	MAFELAP 2016 , Mathematics of Finite Elements and Applications	Uxbridge, UK
2016	AMFE , Advances in Mathematics for Finite Elements (in honor of the 90th birthday of Prof. Ivo Babuška)	Austin, TX
2015	Oberwolfach , Workshop on Computational Engineering	Oberwolfach, DE
2015	USNCCM13 , US National Congress on Computational Mechanics	San Diego, CA

Selected Seminars and Training Programs

2020	ICERM , Semester Program: Advances in Computational Relativity	Providence, RI
2018	ATPESC , Argonne Training Program on Extreme-Scale Computing	Chicago, IL
2017	Oberwolfach , Seminar on Discontinuous Petrov–Galerkin Methods	Oberwolfach, DE
2016	GPDE , Winter school on geometric PDEs and their approximations	College Station, TX

Academic Service

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), Mathematics of Computation (Math. Comp.), SIAM Journal on Scientific Computing (SISC)

Peer Review (Funding Agencies)

National Science Center, Poland (Panel ST8)

Conference Organization

Texas Applied Mathematics and Engineering Symposium

Student 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)

Membership

Society for Industrial and Applied Mathematics (SIAM)

United States Association for Computational Mechanics (USACM)

Selected Honors & Awards

2020	Fellowship , ICERM postdoctoral fellowship for the program “Advances in Computational Relativity”	Providence, RI
2018	Finalist , Student Poster Competition for the 13th World Congress on Computational Mechanics	New York, NY
2017	Recognition of service , SIAM Student Certificate of Recognition for 2017	Austin, TX
2017	2nd Place , Best Mathematically Oriented Poster at USNCCM14	Montréal, QC
2017	Fellowship , University of Texas at Austin University Graduate Continuing Fellowship	Austin, TX
2013	Award , University of Texas at Austin College Recruitment Fellowship Award	Austin, TX
2011	USRA , Undergraduate student research award. Supervisor: Ray McLenaghan	Waterloo, ON
2010	USRA , Undergraduate student research award. Supervisor: David Siegel	Waterloo, ON