

# Brendan Keith

Numerical Analysis · Computational Science & Engineering · Applied Mathematics

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## Research

I specialize in high-order finite element and isogeometric methods. I am also interested in scientific machine learning, uncertainty quantification, non-local physics, numerical relativity, and high performance computing.

## Appointments

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

Providence, Rhode Island

Postdoctoral Fellow

Sept. 2020 - present

**Mentor:** Mark Ainsworth

Supported by a fellowship for the semester program “Advances in Computational Relativity.”

### Chair of Numerical Mathematics Technische Universität München

Garching, Germany

Postdoctoral Researcher

Sept. 2018 - Aug. 2020

**Supervisor:** Barbara Wohlmuth

Supported by the European Union's Horizon 2020 research and innovation program under grant agreement No 800898: Exascale Quantification of Uncertainties for Technology and Science Simulation (ExaQUte).

## 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:** New ideas in adjoint methods for PDEs: 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

## Teaching

### UT Austin

Austin, Texas

Graduate Teaching Assistant

2014–2016

- CSE 386M, Functional Analysis in Theoretical Mechanics (graduate course)
- CSE 380, Tools and Techniques for Computational Science (graduate course)
- M 408N, Differential Calculus for Science

### McGill University

Montréal, Québec

Graduate Teaching Assistant

2012

- Math 376, Honours Nonlinear Dynamics

### University of Waterloo

Waterloo, Ontario

Undergraduate Teaching Assistant

2009–2011

- Math 124, Calculus and Vector Algebra for Kinesiology
- Math 135, Algebra for Honours Mathematics
- Math 136, Linear Algebra for Honours Mathematics
- Math 137, Calculus 1 for Honours Mathematics
- Math 138, Calculus 2 for Honours Mathematics
- Math 239, Introduction to Combinatorics

## Preprints

1. Keith, B. (2020). *A priori error analysis of high-order  $LL^*$  (FOSLL\*) finite element methods*. arXiv preprint arXiv:2012.09594.
2. Beiser, F., Keith, B., Urbainczyk, S., and Wohlmuth, B. (2020). *Adaptive sampling strategies for risk-averse stochastic optimization with constraints*. arXiv preprint arXiv:2012.03844.
3. Keith, B., Khristenko, U., and Wohlmuth, B. (2020). *A fractional PDE model for turbulent velocity fields near solid walls*. arXiv preprint arXiv:2008.03957.

## Scientific Journal Articles

4. 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>.
5. 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](https://doi.org/10.1016/j.mex.2020.100813).
6. 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](https://doi.org/10.1016/j.camwa.2020.01.012).
7. 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](https://doi.org/10.1016/j.cma.2019.112776).
8. 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](https://doi.org/10.1137/18M1226580).
9. 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](https://doi.org/10.1137/18M1181754).
10. 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](https://doi.org/10.1007/s00466-018-1640-3).
11. 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](https://doi.org/10.1016/j.cma.2017.08.043).
12. 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](https://doi.org/10.1016/j.jnnfm.2017.06.006).
13. 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](https://doi.org/10.1016/j.jcp.2017.07.051).
14. 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](https://doi.org/10.1016/j.cma.2016.05.034).
15. 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](https://doi.org/10.1016/j.camwa.2015.04.027).

## Other

16. Tosi, R., Nuñez, M., Keith, B., Pons-Prats, J., Wohlmuth, B., and Rossi, R. (2020). *Scalable dynamic asynchronous Monte Carlo framework applied to wind engineering problems*. Proceedings of UQOP2020, (To appear.)
17. 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.
18. Keith, B., Demkowicz, L., and Gopalakrishnan, J. (2017). *DPG\* method*. ICES Report 17-25. The University of Texas at Austin.
19. 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>.
20. Keith, B. (2014). *Lagrangian Coherent Structures in Three-dimensional Steady Flows*. Master's Thesis. Montreal, Quebec: McGill University.
21. Robison<sup>1</sup>, B. K. (2011). *The Wave Equation and Multi-Dimensional Time*. The Waterloo Mathematics Review, **1**(1), 32–42.

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<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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Presented at well over 20 scientific meetings since 2015

2019	<b>SSDSS</b> , AICES School for Simulation and Data Science Seminar Series	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>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

## Selected Seminars and Training Programs

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2018	<b>ATPESC2018</b> , Argonne Training Program on Extreme-Scale Computing	Chicago, IL
2017	<b>Oberwolfach</b> , Seminar on Discontinuous Petrov–Galerkin Methods	Oberwolfach, DE
2016	<b>GPDE2016</b> , Winter school on geometric PDEs and their approximations	College Station, TX

## Academic Service

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### Peer Review (Journals)

(Five to ten manuscripts per year)

Computer Methods in Applied Mechanics and Engineering  
Computers and Mathematics with Applications  
IMA Journal of Numerical Analysis  
Mathematics of Computation

### 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

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