

# Brendan Keith

Numerical Analysis · Computational Science & Engineering · Applied Mathematics

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## Research

Currently interested in applications in optimal control, machine learning, uncertainty quantification, and high performance computing.

## Appointments

### Chair of Numerical Mathematics Technische Universität München

Garching, Germany

Postdoctoral Researcher

Sept. 2018 - present

**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

### TU Munich

Garching, Germany

Postdoctoral mentor

2018 - present

- Co-supervise and direct Master's students' thesis research projects.
- Work alongside and offer advice to Ph.D. students.

### UT Austin

Austin, Texas

Graduate Teaching Assistant

2014–2016

*Some grading responsibilities and teaching of tutorials.*

- 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

*Grading responsibilities and exam supervision.*

- Math 376, Honours Nonlinear Dynamics

### University of Waterloo

Waterloo, Ontario

Undergraduate Teaching Assistant

2009–2011

*Solely grading responsibilities.*

- 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

# Publications

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## Preprints

1. Drzisga, D., Keith, B., and Wohlmuth, B. (2020). *The surrogate matrix methodology: Accelerating isogeometric analysis of waves*. arXiv:2004.05197 [math.NA].

## Scientific Journal Articles

2. 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.
3. Demkowicz, L., Gopalakrishnan, J., and Keith, B. (2020). *The DPG-star method*. *Comput. Math. Appl.* DOI: 10.1016/j.camwa.2020.01.012.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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

13. 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.
14. Keith, B., Demkowicz, L., and Gopalakrishnan, J. (2017). *DPG\* method*. ICES Report 17-25. The University of Texas at Austin.
15. 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>.
16. Keith, B. (2014). *Lagrangian Coherent Structures in Three-dimensional Steady Flows*. Master's Thesis. Montreal, Quebec: McGill University.
17. 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)  
Gesellschaft für Angewandte Mathematik und Mechanik (GAMM)

## Selected Honors & Awards

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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