Brendan **Keith**

Numerical Analysis · Computational Science & Engineering · Applied Mathematics

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Research Interests

In order to bridge the gaps between observation, theory, and prediction, modern science relies heavily on sophisticated computational methods. From simulating star formation to proton transport, from climate change and sea level rise to turbulence and combustion, and from optimized structural design to the development of personalized treatment pathways in state-of-the-art medical practice, complex computer simulations are indispensable, regardless of scale. By studying the mathematics behind computer simulations, I try to bring clarity and insight to otherwise intractable problems like these.

I am currently interested in applying my work to problems at the frontiers of science and engineering research by expanding on state-of-the-art techniques in optimal control, uncertainty quantification, and high performance computing.

Appointments

Chair of Numerical Mathematics
Technische Universität München — *Garching, Germany*

Postdoctoral Researcher — *Sept. 2018 - present*

- 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, Ontatio*

B.Math Honours Applied Mathematics with Physics Option — *2011*

B.Math Honours Pure Mathematics — *2011*

Teaching and Supervision Experience

TU Munich — *Garching, Germany*

Postdoctoral mentor — *2018 - present*

- Work alongside and offer advice to Ph.D. students in the chair.
- Co-supervise and direct Master's students' six-month research projects.

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

Authorship

Preprints

1. Drzisga, D., Keith, B., and Wohlmuth, B. (2019). *The surrogate matrix methodology: Accelerating isogeometric structural mechanics*. (Submitted.)
2. Drzisga, D., Keith, B., and Wohlmuth, B. (2019). *The surrogate matrix methodology: A reference implementation for low-cost assembly in isogeometric analysis*. (Submitted.)
3. *Drzisga, D., Keith, B., and Wohlmuth, B. (2019). *The surrogate matrix methodology: Low-cost assembly for isogeometric analysis*. arXiv:1904.06971 [math.NA].
4. Drzisga, D., Keith, B., and Wohlmuth, B. (2019). *The surrogate matrix methodology: a priori error estimation*. arXiv:1902.07333 [math.NA].
5. *Demkowicz, L., Gopalakrishnan, J., and Keith, B. (2018). *The DPG-star method*. arXiv:1809.03153 [math.NA].

Peer-Reviewed Journal Articles

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[1], B. K. (2011). *The Wave Equation and Multi-Dimensional Time*. The Waterloo Mathematics Review, **1**(1), 32–42.

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

Selected Conference Presentations and Invited Talks

Presented at well over 20 scientific meetings since 2015

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	**MRLSFEM2**, Minimum Residual & Least-Squares Finite Element Methods	*Portland, OR*
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	**POEMs**, Polytopal Element Methods in Mathematics and Engineering	*Atlanta, GA*
2015	**Oberwolfach**, Workshop on Computational Engineering	*Oberwolfach, DE*
2015	**USNCCM13**, US National Congress on Computational Mechanics	*San Diego, CA*

Selected Seminars and Training Programs

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

Academic Service

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 Organizing

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)
Graduate Student Assembly Representative: UT Austin (09/2016 - 08/2017)
Graduate Student Council Member: McGill University (09/2012 - 08/2013)

Societal Membership

Society for Industrial and Applied Mathematics (SIAM)
United States Association for Computational Mechanics (USACM)

Selected Honors & Awards

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*