Anthony Gruber, Ph.D.

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Education

Ph.D., Mathematics, Texas Tech University, Lubbock, TX 2019

M.S., Mathematics, Texas Tech University, Lubbock, TX 2017

B.G.S., Music Performance/Chemistry/Mathematics,
Texas Tech University, Lubbock, TX 2015

Research Funding

PI, "Learning Operators for Structure-Informed Surrogate Modeling", Sandia LDRD. 2022-present

Team Member, "M2dt: Multifaceted Mathematics for Predictive Digital Twins", ASCR MMICC, Sandia PI Irina Tezaur. 2022-present

Team Member, "SEA-CROGS: Scalable, Efficient and Accelerated Causal Reasoning Operators, Graphs and Spikes for Earth and Embedded Systems", ASCR MMICC, Sandia PI Nat Trask. 2023-present

Postdoc, "Efficient and Scalable Time-Stepping Algorithms and Reduced-Order Modeling for Ocean System Simulations", DOE SciDAC, PI Max Gunzburger. 2021-2022

Recipient, NSF Mathematical Sciences Graduate Internship 2018

Recipient, NSF REU Internship 2014

Professional Experience

Sandia National Laboratories Sep 2022–present
John von Neumann Fellow *Albuquerque, NM*

- Funded half-time for self-directed research on structure-informed surrogate modeling with emphasis on nonintrusive and variationally consistent methods.
- Remaining time funded by the DOE Early Career Program (PI Nat Trask) on projects related to scientific machine learning and data-driven exterior calculus on graphs.
- JvN Fellowship funded by the DOE ASCR applied mathematics research program in conjunction with the Sandia LDRD program.

Florida State University Jan 2021–Aug 2022
Postdoctoral Research Associate *Tallahassee, FL: stationed in Columbia, SC*

- Advised by Prof. Max Gunzburger on the design of algorithms for function approximation and reduced-order modeling related to the simulation of ocean dynamics.
- Further advised on related work by Prof. Lili Ju and Prof. Zhu Wang at the University of South Carolina.
- Funded by DOE grant DE-SC0020418: Efficient and Scalable Time-Stepping Algorithms and Reduced-Order Modeling for Ocean System Simulations.

Texas Tech University Aug 2019–Dec 2020*
Assistant Professor of Practice *Lubbock, TX: stationed in San José, Costa Rica*

- Mathematics program director at the TTU satellite campus in San José.
- Taught a 2-2 load of mathematics courses, conducted research, and coordinated with TTU faculty and administration state-side to further the University mission in Costa Rica.
- (*) Remained employed on unpaid leave until August 2022.

Oak Ridge National Laboratory June 2018–Aug 2018
NSF Graduate Research Fellow *Oak Ridge, TN*

- Advised by Dr. Robert Bridges on a project called Active Manifolds (see publications below) applying geometric methods to data science problems involving high-dimensional function approximation.
- Produced mathematical and computational results specially selected for presentation to the leaders of the Computing and Computational Sciences Division at ORNL.
- Funded through the NSF Mathematical Sciences Graduate Internship (MSGI) program.

Texas Tech University Aug 2015–Aug 2019
Graduate Part-Time Instructor *Lubbock, TX*

- Served as instructor of record for a 2-2 load of mathematics courses each year.
- Responsible for all aspects of instruction, including writing/delivering lectures and assigning homework, as well as writing and grading exams.
- Funded through scholarships/endowments at TTU.

University of Texas at Dallas May 2014–Aug 2014
NSF Research Intern *Richardson, TX*

- Worked under Prof. Manuel Quevedo to design, construct, and characterize TiSi and CrB2-Si-SiC thin-film resistors (TFRs) using a combination of lithography, x-ray photoelectron spectrometry, and Hall-effect measurements.
- Generated data that facilitated the identification of a superior ratio of Ti:Si, thereby improving resistivity of previous TFRs by 30%.
- Funded through the NSF Research Experiences for Undergraduates (REU) program.

Publications

Journal Articles

15. A. Gruber and I. Tezaur, "Canonical and noncanonical Hamiltonian operator inference," *Compututer Methods in Applied Mechanics and Engineering*, (in press)

14. A. Gruber, Á. Pámpano, and M. Toda, "Instability of closed p-elastic curves in $\mathbb{S}^2$," *Analysis and Applications*, (in press)

13. A. Gruber, "Parallel Codazzi tensors with submanifold applications," *Mathematische Nachrichten*, vol. 00, pp. 1–11, 2023.

12. A. Gruber, M. Gunzburger, L. Ju, R. Lan, and Z. Wang, "Multifidelity Monte Carlo estimation for efficient uncertainty quantification in climate-related modeling," *Geoscientific Model Development*, vol. 16, no. 4, pp. 1213–1229, 2023.

11. A. Gruber, M. Gunzburger, L. Ju, and Z. Wang, "Energetically consistent model reduction for metriplectic systems," *Computer Methods in Applied Mechanics and Engineering*, vol. 404, p. 115709, 2023.

10. Y. Teng, Z. Wang, L. Ju, A. Gruber, and G. Zhang, "Level set learning with pseudoreversible neural networks for nonlinear dimension reduction in function approximation," *SIAM Journal on Scientific Computing*, vol. 45, no. 3, pp. A1148–A1171, 2023.

9. A. Gruber, Á. Pámpano, and M. Toda, "On p-Willmore disks with boundary energies," *Differential Geometry and its Applications*, vol. 86, p. 101971, 2023.

8. A. Gruber, M. Gunzburger, L. Ju, and Z. Wang, "A multifidelity Monte Carlo method for realistic computational budgets," *Journal of Scientific Computing*, vol. 94, no. 1, 2022.

7. A. Gruber, M. Toda, and H. Tran, "Stationary surfaces with boundaries," *Annals of Global Analysis and Geometry*, vol. 62, no. 2, pp. 305–328, 2022.

6. A. Gruber, M. Gunzburger, L. Ju, and Z. Wang, "A comparison of neural network architectures for data-driven reduced-order modeling," *Computer Methods in Applied Mechanics and Engineering*, vol. 393, p. 114764, 2022.

5. A. Gruber, "Planar immersions with prescribed curl and Jacobian determinant are unique," *Bulletin of the Australian Mathematical Society*, vol. 106, no. 1, pp. 126–131, 2022.

4. A. Gruber, M. Gunzburger, L. Ju, Y. Teng, and Z. Wang, "Nonlinear level set learning for function approximation on sparse data with applications to parametric differential equations," *Numerical Mathematics: Theory, Methods and Applications*, vol. 14, no. 4, pp. 839–861, 2021.

3. A. Gruber, Á. Pámpano, and M. Toda, "Regarding the Euler–Plateau problem with elastic modulus," *Annali di Matematica Pura ed Applicata*, vol. 200, no. 5, pp. 2263–2283, 2021.

2. A. Gruber and E. Aulisa, "Computational p-Willmore flow with conformal penalty," *ACM Transactions on Graphics (TOG)*, vol. 39, aug 2020.

1. A. Gruber, M. Toda, and H. Tran, "On the variation of curvature functionals in a space form with application to a generalized Willmore energy," *Annals of Global Analysis and Geometry*, vol. 56, no. 1, pp. 147–165, 2019.

Articles in Refereed Conference Proceedings

4. A. Gruber and E. Aulisa, "Quaternionic remeshing during surface evolution," *AIP Conference Proceedings*, vol. 2425, no. 1, p. 330003, 2022.

3. A. Gruber, M. Toda, and H. Tran, "Willmore-stable minimal surfaces," *AIP Conference Proceedings*, vol. 2425, no. 1, p. 330004, 2022.

2. E. Aulisa, A. Gruber, M. Toda, and H. Tran, "New developments on the p-Willmore energy of surfaces," in *Proceedings of the Twenty-First International Conference on Geometry, Integrability and Quantization*, vol. 21, pp. 57–66, Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences, 2020.

1. R. Bridges, A. Gruber, C. Felder, M. Verma, and C. Hoff, "Active manifolds: A non-linear analogue to active subspaces," in *Proceedings of the 36th International Conference on Machine Learning* (K. Chaudhuri and R. Salakhutdinov, eds.), vol. 97 of *Proceedings of Machine Learning Research*, pp. 764–772, PMLR, 09–15 Jun 2019.

Submitted Articles

2. A. Gruber, K. Lee, and N. Trask, "Reversible and irreversible bracket-based dynamics for deep graph neural networks," (under review)

1. A. Gruber and E. Aulisa, "Quasiconformal mappings with surface domains," (under review).

Other

1. A. Gruber, *Curvature Functionals and p-Willmore Energy.* PhD thesis, Texas Tech University, 2019.

Professional Activities

Conferences/Minisymposia Organized

2. Organizer, Minisymposium on geometric mechanics formulations and structure-preserving discretizations, 17^{th} U.S. National Congress on Computational Mechanics, July 26-30, 2023.

1. Organizer, session #54, "Elastic curves and surfaces with applications and numerical representations", 18th International Conference of Numerical Analysis and Applied Mathematics, Sep 17-23, 2020.

Journals Reviewed

- *Computer Methods in Applied Mechanics and Engineering*
- *Journal of Computational Physics*
- *Journal für die reine und angewandte Mathematik*
- *Geoscientific Model Development*
- *Numerical Methods for Partial Differential Equations*
- *Journal of Geometry and Physics*
- *Electronic Journal of Statistics*
- *SIAM Journal on Scientific Computing*

Other Service

- Panel Member, NSF-MSGI Alumni Panel (virtual), 2023 NSF-MSGI Virtual Symposium. (Aug. 23, 2023)
- Panel Member, Early Career Panel (virtual), Association of Women in Mathematics, Texas Tech University, Lubbock, TX. (Apr. 21, 2022)

Teaching & Mentoring

Courses Taught	**Dates:**
- "Intro to Data Analytics", (general knowledge, TTU-CR)	short course, Fall 2020
- "College Algebra", (100 level, TTU)	one section, Summer 2015
- "Calculus III with Applications", (200 level, TTU)	large section, Fall 2016 two sections, Fall 2017 virtual section, Summer 2019
- "Calculus III with Applications", (200 level, TTU-CR)	one section, Fall 2019 one section, Spring 2019 one section, Fall 2020
- "Higher Math for Engineers and Scientists I", (300 level, TTU)	two sections, Spring 2017 large section, Spring 2018 virtual section, Fall 2018
- "Higher Math for Engineers and Scientists I", (300 level, TTU-CR)	one section, Spring 2020
- "Intro to Critical Reasoning and Proof", (300 level, TTU-CR)	one section, Fall 2019
- "Higher Math for Engineers and Scientists II", (300 level, TTU)	one section, Spring 2019
- "Foundations of Algebra I, (300 level, TTU-CR)	one section, Fall 2020
- "Advanced Calculus I, (400 level, TTU-CR)	one section, Fall 2020

Research Mentoring

- Ph.D. thesis committee member, Madusha Atampalage, "Topics of Minimal Surfaces

and Applications", defended Apr. 2021 (graduated Aug. 2021), Texas Tech University.

Technical Expertise

Computer Languages

- Python (expert)
- C++ (some experience)
- MATLAB (some experience)
- Mathematica (limited experience)
- Java (minimal experience)

Laboratory Experience

- Chromatography: TLC, HPLC, GC, column.
- Deposition: CSS, PL.
- Acid/base titration; chemical distillation/recrystalization.
- Bomb calorimetry; lithography; Hall voltage measurement.
- Class 1000 cleanroom experience.

Professional Presentations

Invited Talks

11. "Data-driven surrogate models for bracket-based dynamical systems", 2^{nd} IACM Mechanistic Machine Learning and Digital Engineering for Computational Science Engineering and Technology, El Paso, TX (Sep. 24-27, 2023)
10. "Property-preserving model reduction for Hamiltonian and metriplectic Systems" (virtual), Chair for Dynamics, Control, and Numerics, FAU Erlangen-Nürnberg, Bavaria, Germany. (May 31, 2023)
9. "Mathematics in different settings" (virtual), Hong Duc University, Thanh Hòa, Vietnam. (May 20, 2023)
8. "Energetically consistent model reduction for Hamiltonian and metriplectic systems", CRUNCH webinar (virtual), Brown University, Providence, RI. (60 min; Dec. 9, 2022)
7. "Convolutional neural networks for data compression and reduced-order modeling", Minisymposium on machine learning for large-scale scientific data analytics, SIAM Mathematics of Data Science, San Diego, CA. (25 min; Sep. 28, 2022)
6. "Computing quasiconformal mappings between immersed surfaces", AMS Fall Central Sectional, University of Texas at El Paso, El Paso, TX. (20 min; Sep. 17, 2022)
5. "Calculus in computer graphics and data science" (virtual), Mathematics Seminar Series, Cameron University, Lawton, OK. (50 min; Oct 19, 2021)
4. "Some nonlinear PDEs in computer graphics and data science", Mathematics Colloquium Series, Texas Tech University, Lubbock, TX. (50 min; Sep 29, 2021).

3. "Convolutional neural networks for data compression and reduced order modeling", SIAM SEAS special session on Deep Learning Methods for Data Driven Models, Auburn University, Auburn, AL. (30 min; Sep 18, 2021)

2. "Codazzi tensors with parallel mean curvature" (virtual), AMS special session #1159, Geometry of Submanifolds and Integrable Systems, University of Texas at El Paso, El Paso, TX. (25 min; Sep. 12, 2020.)

1. "Stationary surfaces for curvature functionals", 63rd Texas Geometry and Topology Conference (virtual), Texas Tech University, Lubbock, TX. (50 min; April 23, 2020)

Seminar and Contributed Talks

13. "Variationally consistent model reduction", Sandia Fellows Day, Albuquerque, NM. (20 min; Aug 29, 2023)

12. "Canonical and Noncanonical Hamiltonian Operator Inference", Minisymposium on Geometric Mechanics Formulations and Structure-Preserving Discretizations, 17^{th} U.S. National Congress on Computational Mechanics, Albuquerque, NM. (25 min; July 26-30, 2023)

11. "Canonical and Noncanonical Hamiltonian Model Reduction", Workshop on Establishing Benchmarks for Data-Driven Modeling of Physical Systems, University of Southern California, Los Angeles, CA. (30 min; April 6-7, 2023)

10. "Artificial neural networks for dimension reduction and reduced-order modeling", Applied Mathematics group, Texas Tech University, Lubbock, TX. (50 min; Sep 30, 2021)

9. "Optimal quasiconformal mappings with prescribed boundary" (virtual), Probability, Geometry, and Mathematical Physics group, Texas Tech University, Lubbock, TX. (50 min; April 7, 2021)

8. "Geometric flows via finite element methods" (virtual), Elasticity group, Texas Tech University, Lubbock, TX. (50 min; Dec 2, 2020)

7. "Quaternionic remeshing during surface evolution" (virtual), 18^{th} International Conference of Numerical Analysis and Applied Mathematics, Rhodes, Greece. (30 min; Sep 17, 2020)

6. "Willmore-stable minimal surfaces" (virtual), 18^{th} International Conference of Numerical Analysis and Applied Mathematics, Rhodes, Greece. (30 min; Sep 17, 2020)

5. "Variational Aspects of Curvature Functionals", Elasticity group, Texas Tech University, Lubbock, TX. (50 min; Sep 2, 2020)

4. "Computing stationary solutions to p-Willmore flow", Applied Mathematics group, Texas Tech University, TX. (50 min; April 22, 2020.)

3. "A conformally-adjusted Willmore flow of closed surfaces", Applied Mathematics group, Texas Tech University, Lubbock, TX. (50 min; May 8, 2019)

2. "Curvature functionals and p-Willmore energy", Analysis group, Texas Tech University, Lubbock, TX. (50 min; April 29, 2019)

1. "Active Manifolds: A geometric approach to dimension reduction for sensitivity analysis", Computational and Applied Mathematics group, Oak Ridge National Laboratory, Oak Ridge, TN. (50 min; August 1, 2018)