

Lianghao Cao

Ph.D. candidate

Oden Institute for Computational Engineering & Sciences

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Education

2017–2022	Ph.D. in Computational Science, Engineering & Mathematics
The University of Texas at Austin	Supervisor: J. Tinsley Oden
	Co-supervisor: Omar Ghattas
	Thesis: <i>Predictive modeling and uncertainty quantification for diblock copolymer self-assembly</i>
2013–2017	B.S. in Engineering Mechanics
University of Illinois at Urbana-Champaign	Minor in Computational Science and Engineering

Research Interests

Topics:

Uncertainty quantification, predictive modeling, PDE-constrained optimization, scientific machine learning.

Recent work:

1. Uncertainty quantification for model-based predictions of material self-assembly.
2. Fast minimization solvers for phase-field models of material self-assembly.
3. Neural network surrogates and error analysis for many-query applications of parametric PDEs.

Publications

Peer-reviewed

1. **Lianghao Cao**, Omar Ghattas, and J. Tinsley Oden. “A globally convergent modified Newton method for the direct minimization of the Ohta–Kawasaki energy with application to the directed self-assembly of diblock copolymers”. In: *SIAM Journal on Scientific Computing* 44.1 (2022), B51–B79. DOI: 10.1137/20M1378119.
2. Prashant K. Jha, **Lianghao Cao**, and J. Tinsley Oden. “Bayesian-based predictions of COVID-19 evolution in Texas using multispecies mixture-theoretic continuum models”. In: *Computational Mechanics* 66.5 (2020), pp. 1055–1068. ISSN: 14320924. DOI: 10.1007/s00466-020-01889-z.

In pre-print (submitted for peer-review)

1. Ricardo Baptista*, **Lianghao Cao***, Joshua Chen*, Omar Ghattas, Fengyi Li*, Youssef M. Marzouk, and J. Tinsley Oden. *Bayesian model calibration for block copolymer self-assembly: Likelihood-free inference and expected information gain computation via measure transport*. *Equal contribution. 2022. DOI: 10.48550/ARXIV.2206.11343.
2. **Lianghao Cao**, Thomas O’Leary-Roseberry, Prashant K. Jha, J. Tinsley Oden, and Omar Ghattas. *Residual-based error correction for neural operator accelerated infinite-dimensional Bayesian inverse problems*. 2022. DOI: 10.48550/ARXIV.2210.03008.
3. Dingcheng Luo, **Lianghao Cao**, Peng Chen, Omar Ghattas, and J. Tinsley Oden. *Optimal design of chemoepitaxial guideposts for directed self-assembly of block copolymer systems using an inexact-Newton algorithm*. 2022. DOI: 10.48550/ARXIV.2208.01193.

In preparation for submission (share upon request)

1. **Lianghao Cao**, Daniil Bochkov, Omar Ghattas, and J. Tinsley Oden. “Self-consistent field calculations of diblock copolymers: Hessian approximation and a real-space semi-implicit Seidel scheme”.
2. **Lianghao Cao**, Keyi Wu, Peng Chen, J. Tinsley Oden, and Omar Ghattas. “Fast Bayesian model calibration for diblock copolymer self-assembly using the power spectrum of microscopy image data”. Full results presented at EMI Conference 2022.
3. Pratyush K. Singh, **Lianghao Cao**, Jingye Tan, and Danial Faghihi. “A nonlocal theory of heat transfer and microphase separation of nanostructured copolymers”.

Presentations

Invited talks:

1. “Residual-based error correction for neural operator accelerated infinite-dimensional Bayesian inverse problems”
5th Annual Meeting of SIAM Texas–Louisiana Section, Houston, TX, USA, 11/02/2022.
Mini-symposium: Recent advances in learning
2. “Bayesian model calibration for diblock copolymer self-assembly: Likelihood-free inference and expected information gain via measure transport”
The American Physical Society’s March Meeting, Las Vegas, NV, USA, 03/06/2023 (exp.)
Focus session: Uncertainty quantification for soft matter physics

Conference talks:

1. “A Globally Convergent Modified Newton Method for the Direct Minimization of the Ohta–Kawasaki Energy”
19th U.S. National Congress on Theoretical and Applied Mechanics, Austin, TX, USA, 06/24/2022.
Session: Phase Field Study of Microstructures and Behaviours of Advanced Materials
2. “Bayesian Calibration of Models for Diblock Copolymers Self-Assembly with Power Spectrum of Microscopy Image Data”
The Engineering Mechanics Institute Conference 2022, Baltimore, MD, USA, 06/02/2022.
Session: Physics-Based Data-Driven Modeling and Uncertainty Quantification in Computational Materials Science and Engineering
3. “Bayesian Calibration of Models for the Self-Assembly of Diblock Copolymers: Likelihood-Free Inference and Expected Information Gain Computation via Measure Transport”,
16th U.S. National Congress on Computational Mechanics, virtual, 07/26/2021.
Session: Physics-Based Data-Driven Modeling and Uncertainty Quantification in Computational Materials Science and Engineering

Professional Activities

Teaching/Mentoring

Sep. 2021–	Mentor	SIAM Applied Mathematics Mentorship	UT Austin
Sep. 2020–	Mentor	Oden Institute Student Mentorship	UT Austin
Aug. 2018–Dec. 2018	Teaching assistant	M 408 K: Calculus I	UT Austin
Aug. 2016–Dec. 2016	Course assistant	ME 370: Mechanical Design I	UIUC
Mar. 2015–Jun. 2017	NetMath mentor	MATH 415: Applied Linear Algebra	UIUC

Journal peer review

Computer Methods in Applied Mechanics and Engineering (10 reviews); Journal of Peridynamics and Nonlocal Modeling (1 review)

Membership

American Institute for Chemical Engineers (AIChE); American Physical Society (APS); Society for Industrial and Applied Mathematics (SIAM); U.S. Association for Computational Mechanics (USACM)

Awards and Recognitions

2022	SIAM Travel Award	Society for Industrial and Applied Mechanics
2021	USNCCM16 Conference Award	U.S. Association for Computational Mechanics
2017	O'Donnell Fellowship (1 year)	Institute for Comput. Eng. & Sci., UT Austin
2017	James Scholar Honors	The College of Engineering, UIUC
2016	NetMath Award for Best Student Retention	NetMath Program, UIUC

References

1. Dr. J. Tinsley Oden
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2. Dr. Omar Ghattas
Professor, Walker Department of Mechanical Engineering, Oden Institute for Computational Engineering & Sciences, The University of Texas at Austin.
Email: omar@oden.utexas.edu
3. Dr. Youssef M. Marzouk
Professor, Department of Aeronautics & Astronautics, Massachusetts Institute of Technology.
Email: ymarz@mit.edu
4. Dr. Danial Faghihi
Assistant professor, Department of Mechanical and Aerospace Engineering, University at Buffalo.
Email: danialfa@buffalo.edu