

Aniruddha Bora

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Research Interests

Scientific machine learning; physics-informed and physics-grounded AI; neural operators and operator learning; generative modeling of physical systems; reinforcement learning and autonomous decision-making; agentic AI for scientific discovery; numerical analysis and scientific computing; climate and fluid dynamics; multiphysics and thermal modeling.

Academic Appointments and Research Fellowships

Assistant Professor, Department of Computer Science Texas State University, San Marcos, Texas	Aug. 2025–Present
J. Tinsley Oden Faculty Fellow Oden Institute for Computational Engineering and Sciences, University of Texas at Austin	Summer 2026
Postdoctoral Research Associate, Department of Applied Mathematics Brown University, Providence, Rhode Island	2022–2025

Education

Ph.D., Computational Analysis & Modelling Louisiana Tech University, Ruston, Louisiana	Nov. 2021
Dissertation: Gradient Preserved Method and Neural Network Method for Solving Heat Conduction Equation with Variable Thermal Conductivity in Double Layered Structures. Advisor: Prof. Weizhong Dai.	
M.S., Applied Mathematics South Asian University, New Delhi, India	May 2015
B.Sc., Mathematics Cotton College, Guwahati, Assam, India	May 2013

Research Leadership and Student Mentoring

Independent faculty research, Texas State University (2025–Present).

Develop research in scientific machine learning, neural operators, physics-grounded modeling, and reinforcement learning for scientific and engineering applications; lead funded projects and interdisciplinary collaborations.

- **Doctoral advising (primary advisor):**
 - Chris Coorvey — Physics-Aware Latent Scientific Machine Learning.
 - Collins Reismann — DOE Earth-System AI and Quantum Computing.
 - Keerthana Sunil — Uncertainty-Aware Agentic Reinforcement Learning for Scientific Systems.
- **Undergraduate research:** Mentor undergraduate students on scientific machine learning and interdisciplinary AI projects.
- **Research collaborations:** Climate modeling and scientific AI collaborations with university and national-laboratory researchers; see funded projects below.

Prior mentoring, Brown University. Mentored Imperial College London student Sotos Lois (June 2022–July 2023) on mathematical foundations of scientific machine learning and physics-informed/operator-learning approaches to mathematical finance. Served as a mentor in the Applied Mathematics Directed Reading Program (Spring 2023).

Research Funding and Computational Allocations

Externally funded research

- **Co-PI; Texas State subaward PI.** DOE Genesis, Phase I: *Drift-Aware Initialization of Coupled Earth System Models for Scalable Subseasonal-to-Seasonal Prediction Using Agentic AI*. Prime institution: Pacific Northwest National Laboratory. Total collaborative project funding: \$750,000; Texas State subaward: \$110,000.

Institutional and innovation funding

- **PI.** BobCatalyst HealthTech Ignition Grant, Noema Laser, \$25,000.
- **PI.** BobCatalyst Proof of Concept (POC) Grant, Trashformer, \$22,450.
- **PI.** BobCatalyst Innovation Accelerator Program (BIAP) Award, \$5,000 (2026).
- **PI.** *PIER: Physics-Informed, Energy-efficient, Risk-aware Routing*. Texas State University, \$12,000; funded Jan. 2026–Present.

Competitive computational resource allocations (non-cash)

- **PI.** Argonne Leadership Computing Facility (ALCF) Director’s Discretionary Allocation for Physics-Informed Generative AI. Estimated commercial-cloud-equivalent value: \$190,000 (non-cash computational allocation).
- **Co-PI.** ALCF Director’s Discretionary Allocation for quantification of extreme weather based on neural operator approximation (2022).

Collaborative proposal contributions

- **Proposal development contributor, Brown University.** *Machine Learning Methods for Phase Change Heat Transfer Modeling and Design*; Multidisciplinary University Research Initiative (MURI), Office of Naval Research (2024). Collaborative proposal amount: \$7.3 million.

Peer-Reviewed Journal Articles

1. **Aniruddha Bora**, Shixuan Zhang, Khemraj Shukla, Ruby Leung, and George Em Karniadakis. “Inception UNet (IUNet) and Multi-scale Multi-branch (M&M) UNet Plug-In Neural Operators for Online Bias Correction in E3SM.” *Journal of Computational Physics*, 2026. DOI
2. Ramona Rubini, Siavash Khodakarami, **Aniruddha Bora**, George Em Karniadakis, and Michele Dassiti. “Process-informed forecasting of complex thermal dynamics in pharmaceutical manufacturing.” Under review at *Neural Networks*, 2026. DOI.
3. Vivek Oommen, Siavash Khodakarami, **Aniruddha Bora**, Zicheng Wang, and George Em Karniadakis. “Learning Turbulent Flows with Generative Models: Super-resolution, Forecasting, and Sparse Flow Reconstruction.” *Nature Communications*, 2026. DOI
4. Shixuan Zhang, Ruby Leung, Bryce Harrop, **Aniruddha Bora**, Khemraj Shukla, and George Em Karniadakis. “Improved nudging strategy for constraining humidity and temperature fields in the E3SM Atmosphere Model.” *Geoscientific Model Development*, 2026. DOI
5. Siavash Khodakarami, Vivek Oommen, **Aniruddha Bora**, and George Em Karniadakis. “Mitigating Spectral Bias in Neural Operators via High-Frequency Scaling for Physical Systems.” *Neural Networks*, 2025. DOI
6. Hanxun Jin, Boyu Zhang, Qianying Cao, Enrui Zhang, **Aniruddha Bora**, Sridhar Krishnaswamy, George Em Karniadakis, and Horacio D. Espinosa. “Characterization and Inverse Design of Stochastic Mechanical Metamaterials Using Neural Operators.” *Advanced Materials*, 2025. DOI
7. Vivek Oommen, **Aniruddha Bora**, Zhen Zhang, and George Em Karniadakis. “Integrating Neural Operators with Diffusion Models Improves Spectral Representation in Turbulence Modeling.” *Proceedings of the Royal Society A*, 2025. Preprint
8. Farnaz Rezaei, Weizhong Dai, Shayan Davani, and **Aniruddha Bora**. “A physics-informed neural network method for thermal analysis in laser-irradiated 3D skin tissues with embedded vasculature, tumor and gold nanorods.” *International Journal of Heat and Mass Transfer*, 245 (2025), 126980. DOI

9. Laurence Finch, Weizhong Dai, and **Aniruddha Bora**. “An Artificial Neural Network Method for Simulation of Wave Propagation Based on the Rosenau-KdV-RLW Equation on Unbounded Domain.” *Mathematics*, 13(7) (2025), 1036. DOI
10. Alan John Varghese, **Aniruddha Bora**, Mengjia Xu, and George Em Karniadakis. “TransformerG2G: Learning temporal graph embeddings with long-range historical information.” *Neural Networks*, 172 (2024), 106086. Preprint
11. Joshua P. Wilson, Weizhong Dai, **Aniruddha Bora**, and Jacob C. Boyt. “A new artificial neural network method for solving Schrödinger equations on unbounded domains.” *Communications in Computational Physics*, 32 (2022), 1039–1060. DOI
12. **Aniruddha Bora**, Weizhong Dai, Joshua P. Wilson, Jacob C. Boyt, and Sergey L. Sobolev. “Neural network method for solving nonlocal two-temperature nanoscale heat conduction in gold films exposed to ultrashort-pulsed lasers.” *International Journal of Heat and Mass Transfer*, 190 (2022), 122791. DOI
13. **Aniruddha Bora**, Weizhong Dai, Joshua P. Wilson, and Jacob C. Boyt. “Neural network method for solving parabolic two-temperature microscale heat conduction in double-layer thin films exposed to ultrashort-pulsed lasers.” *International Journal of Heat and Mass Transfer*, 178 (2021), 121616. DOI
14. **Aniruddha Bora** and Weizhong Dai. “Gradient preserved method for solving heat conduction equation with variable coefficients in double layers.” *Applied Mathematics and Computation*, 386 (2020), 125516. Article

Peer-Reviewed Conference and Workshop Papers

1. **Aniruddha Bora**, Khemraj Shukla, Shixuan Zhang, Ruby Leung, and George Em Karniadakis. “Learning bias corrections for climate models using deep neural operators.” AAAI Spring Symposium Series, 2023. Preprint
2. Jiawen Wei, **Aniruddha Bora**, Vivek Oommen, Chenyu Dong, Juntao Yang, George Em Karniadakis, and Gianmarco Mengaldo. “XAI4Climate: Attributing the role of climate change on extreme-weather precursors via interpretable machine learning.” *Tackling Climate Change with Machine Learning*, ICLR Workshop, 2025. Preprint

Book Chapter

Somdatta Goswami, **Aniruddha Bora**, Yue Yu, and George Em Karniadakis. “Physics-informed deep neural operator networks.” In *Machine Learning in Modeling and Simulation: Methods and Applications*, pp. 219–254, Springer, 2023. Preprint

Submitted Manuscripts and Preprints

1. Zahra Farazpay and **Aniruddha Bora**. “When Known Physics Helps Neural PDE Models: Residual Constraints Out-Regularize Generic Priors for Nonlinear Dynamics.” Submitted to *ICLR 2027*. Preprint
2. **Aniruddha Bora**, Julie Chalfant, and Chrysostomos Chrysostomidis. “Physics-informed offline reinforcement learning eliminates catastrophic fuel waste in maritime routing.” Submitted to *Scientific Reports*. Preprint
3. **Aniruddha Bora**, Isabel K. Alvarez, Julie Chalfant, and Chrysostomos Chrysostomidis. “Enhancing Heat Sink Efficiency in MOSFETs using Physics-Informed Neural Networks: A Systematic Study on Coolant Velocity Estimation.” Submitted to *International Journal of Heat and Mass Transfer*. Preprint

Manuscript in preparation. **Aniruddha Bora** and Weizhong Dai. “Artificial Neural Network Method for Solving Phase Lagging Heat Transport Equation.”

Software and Formal Verification

Aniruddha Bora. *HeatEnergyDecay: Lean 4 proof of energy decay for linear heat-type flows*. Zenodo record.

Teaching and Course Development

Texas State University — Instructor of Record

- CS 5325: Reinforcement Learning (Fall 2025; Fall 2026).
- CS 4379G: Data Analysis & Visualization with Python (Spring 2026).

Brown University — Teaching Assistant

- Deep Learning for Scientists & Engineers (2022–2025). Prepared course materials and analyzed optimization methods and mathematical formulations.

Louisiana Tech University — Teaching

- PHYS 209 (Fall 2021): Delivered physics instruction to a class of 64 students, held office hours, and administered assessments.
- PHYS 261/262 (Sept. 2016–Aug. 2021): Led weekly computing laboratories and office hours; developed instructional videos for remote laboratory instruction.

Pedagogical development: Sheridan Teaching Seminar, Reflective Teaching (Certificate I), Brown University, Sept.–Dec. 2022.

Selected Invited Talks and Research Presentations

- HydroML 2026, “PIER (Physics-Informed, Energy-efficient, Risk-aware Routing),” May 19, 2026.
- Oden Institute Seminar, UT Austin, “PIER: Toward Practical, Risk-Aware Voyage Planning,” Mar. 10, 2026.
- Rice AI Seminar Series, Rice University, “Mathematically Diverse Multiscale Neural Operators: From Bias Correction to Inverse Forcings,” Oct. 10, 2025.
- Scientific Machine Learning for Differential Equations, Oden Institute, “Enhancing Heat Sink Efficiency in MOSFETs using Physics-Informed Neural Networks” (poster), Sept. 25–26, 2025.
- East Coast Optimization Meeting, George Mason University, “Enhancing Heat Sink Efficiency in MOSFETs using Physics-Informed Neural Networks,” Apr. 17–18, 2025.
- Applied Mathematics Symposium: Artificial Intelligence Meets Fluid Dynamics, “Learning bias corrections for climate models using deep neural operators,” July 7, 2023.
- AAI Spring Symposium Series, “Learning bias corrections for climate models using deep neural operators,” Mar. 27–29, 2023.
- Computational Mathematics and Machine Learning Workshop, Lorentz Centre, Netherlands, “Neural Network Method for Solving Parabolic Two-Step Microscale Heat Conduction in Double-Layer Thin Films Exposed to Ultrashort-Pulsed Lasers,” Nov. 1, 2021.
- Machine Learning + X, Crunch Seminar, Brown University, “Combining Differentiable PDE Solvers and Graph Neural Networks for Fluid Flow Prediction” (paper review), Apr. 22, 2022.
- Machine Learning + X, Crunch Seminar, Brown University, “Neural Network Method for Solving Parabolic Two-Step Microscale Heat Conduction in Double-Layer Thin Films Exposed to Ultrashort-Pulsed Lasers,” July 23, 2021.
- Science Seminar, Louisiana Tech University, Nov. 28, 2021
- Workshop on Applications on Riemann Integration and Metric Space, Assam Don Bosco University, Dec. 23, 2021

Innovation presentation: Global Innovation Rodeo at Texas House, SXSW 2026, Mar. 12, 2026.

Honors, Fellowships, and Innovation Awards

- J. Tinsley Oden Faculty Fellow, Oden Institute, UT Austin (Summer 2026; also listed under Academic Appointments).
- Winner, BioNTX Tech Transfer Showcase, iC³ Life Science & Healthcare Innovation Summit (2026).
- Popular Choice Award (Noema-Laser), Nucleate Texas Demo Day (2026).
- Second Place, Bobcat Innovation Challenge pitch competition (\$1,500), Apr. 11, 2026.
- Nucleate Activator Finalist, 2026 cohort.
- Harry J. Gaston, Jr. Memorial Scholarship in Engineering, Louisiana Tech University (2020–2021).
- College of Engineering and Science Scholarship, Louisiana Tech University (2018–2019; 2019–2020).
- Teaching Assistant of the Year, Louisiana Tech University (2018–2019).
- Mercedes-Benz Endowed Scholarship, Louisiana Tech University (2017–2018).
- Highest Cumulative Grade Point Average, South Asian University (2013–2014).

Intellectual Property

- “NoemaLaser Digital-twin guided, constraint-safe laser“ Provisional patent application filed Sep. 22, 2026. Application No. 64/159,789 (Patent Pending).
- “Hierarchical Multi-Agent Reinforcement Learning for Scalable Adaptive Traffic Signal Control.” Provisional patent application filed Apr. 28, 2026.
- “Physics-informed offline reinforcement learning eliminates catastrophic fuel waste in maritime routing.” Provisional patent application filed Mar. 10, 2026. Application No. 63/996,145 (Patent Pending).
- “Reinforcement Learning-Based Adaptive Collection Scheduling System for IoT-Enabled Waste Bins.” Application No. 64/033,319 (Patent Pending).

Academic and Professional Service

Conference and minisymposium organization (forthcoming)

- Co-organizer, minisymposium, SIAM Texas–Louisiana Sectional Meeting, Southern Methodist University, Dallas, TX, Oct. 30–Nov. 1, 2026.
- Co-organizer, minisymposium, SIAM Conference on Computational Science and Engineering (CSE27), Pittsburgh, PA, Feb. 22–26, 2027.

Peer reviewer: *Nature Machine Intelligence*; *Journal of Computational Physics*; *Engineering Applications of Artificial Intelligence*; *Neural Computation*; *International Journal of Applied Mechanics and Engineering*; *Neurocomputing*.

University service: Reviewer, SPRINT UTRA Scholarship Applications, Brown University (Oct. 2023).

Technical Skills and Specialized Training

Scientific programming and ML: Python, JAX, PyTorch, Fortran, FEniCS, MATLAB, Octave; R, SAS.

High-performance computing: Brown OSCAR; ALCF Theta, Polaris, Aurora; Slurm, Cobalt.

Specialized training: Argonne Training Program on Extreme-Scale Computing (ATPESC), 2022.