## Debdeep Bhattacharya


CONTACT INFORMATION

Department of Mathematics
Louisiana State University
303 Lockett Hall
Baton Rouge, LA 70803-4918

Email:
debdeepbh@lsu.edu
Website:
http://debdeepbh.github.io


RESEARCH INTERESTS

Granular media, high-performance computing, peridynamics, analysis and theory of partial differential equations, especially of nonlocal and nonlinear dispersive type, signal processing, machine learning.

EMPLOYMENT

**Louisiana State University**

Postdoctoral Researcher, May 2020 - present
**Mentor:** Prof. Robert Lipton

EDUCATION

**The George Washington University**

Ph.D. in Mathematics, May 2020
**Advisor:** Prof. Frank Baginski
**Thesis title:** Harmonic Analysis Techniques in Nonlinear Dispersive Equations and Signal Processing

**Tata Institute of Fundamental Research Centre for Applicable Mathematics, Bengaluru, India**

Master of Science (MSc) in Mathematics, May 2014

**Indian Statistical Institute, Bengaluru, India**

Bachelor in Mathematics, May 2012

SUMMER RESEARCH VISITS

**Oak Ridge National Laboratory**

Mathematical Sciences Graduate Internship (MSGI), National Science Foundation (NSF), Summer 2019
**Supervisor:** Dr. Pablo Seleson

**University of Hawai'i at Manoa**

Visiting Scholar, Summer 2018
**Supervisor:** Prof. Peter Gorham

PUBLICATIONS AND PREPRINTS

1. **Simulating grain shape effects and damage in granular media using PeriDEM.** Debdeep Bhattacharya, Robert P. Lipton. (To appear in SIAM Journal on Scientific Computing) (arXiv:2108.07212)
2. **Peridynamics-based discrete element method (PeriDEM) model of granular systems involving breakage of arbitrarily shaped particles.** Prashant K Jha, Prathamesh S Desai, Debdeep Bhattacharya, Robert P Lipton. Journal of the Mechanics and Physics of Solids, 2020. doi (arXiv:2010.07218)
3. **Peridynamics for Quasistatic Fracture Modeling.** Debdeep Bhattacharya, Patrick Diehl, Robert P. Lipton. Proceedings of the ASME 2021 International Mechanical Engineering Congress and Exposition. doi (arXiv:2107.14665)

4. **Mass concentration of $H^s$ blowup solution to 2D modified Zakharov-Kuznetsov equation** Partial Differential Equations and Applications, 2021. doi (arXiv:2007.15773)
5. **Unusual Near-Horizon Cosmic-Ray-like Events Observed by ANITA-IV.** P. W. Gorham et al. Physical Review Letters, 2021. doi (arXiv:2008.05690)
6. **Global well-posedness of the mZK equation in 2 dimensions for low-regularity data.** Debdeep Bhattacharya, Luiz Gustavo Farah, and Svetlana Roudenko. Journal of Differential Equations, 2019. doi (arXiv: 1906.05822)
7. **Quasistatic Evolution with Unstable Forces.** Debdeep Bhattacharya and Robert Lipton (Submitted) (arXiv:2204.04571)
8. **Modeling The Launch Dynamics of a Large Scientific Balloon.** Frank Baginski and Debdeep Bhattacharya, 43rd COSPAR Scientific Assembly, 2021. doi
9. **Harmonic Analysis Techniques in Nonlinear Dispersive Equations and Signal Processing.** Ph.D Dissertation, May 2020. ProQuest: 27831360

## In prepartion

1. **Peridynamic simulation of hopper flow: role of stiffness and breakage** with Rigoberto Moncada Lopez (In preparation)
2. **Reduction of three-dimensional axisymmetric problems to two dimensions in Peridynamics** with Pablo Seleson and Jeremy Trageser (In preparation)
3. **Generalized ForWaRD algorithm for multi-antenna model** with Frank Baginski (In preparation)
4. **Quasistatic J-integral for a nonlocal continuum model.** with Robert Lipton and Patrick Diehl (In preparation)

## Technical reports

1. **Deconvolution problem and application to ANITA signals**, Report, submitted to ANITA collaboration at University of Hawai'i at Manoa (link)
2. **Reduction of three-dimensional axisymmetric problems to two dimensions in Peridynamics**, submitted to the NSF as part of MSGI program (link)

## Honors and Achievements

- Dean's Graduate Conference Travel Grant, The George Washington University, 2017
- Columbian College of Arts of Sciences Fellowship, The George Washington University, 2015 – present
- Junior Research Fellowship from Tata Institute of Fundamental Research, India, 2012–2014
- INSPIRE Scholarship from Department of Science and Technology, Government of India, 2010-2012
- Student Fellowship from Indian Statistical Institute, 2009-2012
- Secured an all-India rank 31 in National Eligibility Test (NET) jointly conducted by Council of Scientific and Industrial Research and University Grant Commission, Government of India, 2013

## Invited talks

- 19th U.S. National Congress on Theoretical and Applied Mechanics June 19, 2022, University of Texas at Austin, Austin, USA
- University of Nebraska-Lincoln, February 24, 2022, Lincoln, USA
- Applied Math Seminar, George Washington University, October 1, 2021, Washington, D.C., USA
- 16th U.S. National Congress on Computational Mechanics (USCNNM16), July 25, 2021, Chicago, USA (Virtual)
- ALOP Workshop on Nonlocal Models, July 13, 2021, Universität Trier, Germany (Virtual)
- MURI seminar series, California Institute of Technology, March 16, 2021, Pasadena, CA (Virtual)
- 3rd Annual Meeting of the SIAM Texas-Louisiana Section, October 16-18, 2020, College Station, TX, USA (Virtual)
- MURI seminar series, California Institute of Technology, September 9, 2020, Pasadena, CA (Virtual)
- 13th AIMS Conference on Dynamical Systems, Differential Equations and Applications, June 5-9, 2020, Atlanta, USA
- Computational and Applied Math (CAM) seminar, Computer Science and Mathematics Division, Oak Ridge National Laboratory, August 8, 2019
- RIT in Applied Harmonic Analysis, Norbert Weiner Center, University of Maryland, May 13, 2019
- Spring 2019 conference on Applied Mathematics, George Washington University, May 4, 2019
- Antarctic Impulse Transient Anetann (ANITA) collaboration, December 10, 2018
- Department of Physics, University of Hawai'i at Manoa, June 28, 2018
- Graduate Student Seminar, The George Washington University, October 27, 2017

## Poster Presentations

- *Fracture modeling in axisymmetric problems using peridynamics*, Workshop on Experimental and Computational Fracture Mechanics: Validating peridynamics and phase field models for fracture prediction and experimental design, February 26-28, 2020
- *Fracture modeling in axisymmetric problems using peridynamics*, Oak Ridge Postdoctoral Association (ORPA) Research Symposium, Oak Ridge National Laboratory, August 6, 2019
- *Global Well-posedness of 2d Modified Zakharov-Kuznetsov Equation for Low-regularity Data*, 2019 Workshop on Nonlinear Dispersive Partial Differential Equations and Inverse Scattering, The Fields Institute, Toronto, Canada, May 21 - 24, 2019
- *Global Well-posedness of 2d Modified Zakharov-Kuznetsov Equation for Low-regularity Data*, GW Research Days, George Washington University, April 9, 2019

## Teaching Experience

**Instructor**

- Fall 2022: Mathematical Methods in Engineering
- Summer 2017: Linear Algebra I
- Summer 2016: Calculus with Pre-calculus I

**Teaching Assistant**

- 2015 - 2020: Calculus I, II, III, Calculus with Pre-calculus, Calculus for the Social and Management Sciences, Partial Differential Equations

## Programming Experience

**Languages:** C/C++, Python, R, MATLAB

- High performance computing: `MPI`, `openmp`, `CUDA`, `CuPy`, `mpi4py`
- Machine learning: `PyTorch`, `Tensorflow`, `scikit-learn`, `Keras`
- Data manipulation: `Pandas`, `SQL`, `Excel`

- Visualization: `matplotlib`, `ggplot2`, `seaborn`, `VisPy`, `VisIt`, `gmsh`, `meshio`
- Other tools: BASH, LaTeX, Git, Vim

**GitHub profile:** https://github.com/debdeepbh

**Coding Projects**

- `perigrain`: A high-fidelity granular media simulation and analysis platform with deformation and fracture in arbitrary grain shapes using peridynamics and discrete element method. Applications include vehicle mobility on gravels of different shapes, hopper flow of deformable particles, among others.
- Balloon launch dynamics: 3D simulation and analysis of the launch dynamics of high altitude balloons in python with MPI Parallelization
- `libWTools`: Signal processing library using Fourier and wavelet-based tools
- `deconvolution`: Recovering electromagnetic signals from blurred and noisy observations from array antennas using Fourier and wavelet analysis techniques, and by solving regularized optimization problems
- `crack`: Numerical simulations of crack branching in sodalime glass using peridynamics
- `rexpense`: Generating complex expense reports and statistics in a multi-user setup
- `ml`: Machine learning projects with mathematical explanations
- `mathabotface`: Automated theorem and lemma twitting bot

## Professional Service

- Co-organized seminars and symposia:
  - Minisymposium on *Theoretical and computational aspects of nonlocal operators* at the 7th SIAM Central States Annual Meeting, Oklahoma State University, October 1-2, 2022
  - Minisymposium on *Peridynamic Theory and Multiscale Methods for Complex Material Behavior* at the 9th GACM Colloquium on Computational Mechanics for Young Scientists from Academia and Industry in Essen, Germany, September 21-23, 2022
  - Spring 2019 Conference on Applied Mathematics, George Washington University, Washington, D.C., May 4, 2019
  - GWU-SIAM conference on Applied Mathematics, George Washington University, Washington, D.C., April 29, 2017
- Reviewer for
  - Journal of Open Source Software
  - Computational Geoscience
- Volunteered at the National Math Festival in the SIAM booth to demonstrate mathematical concepts to high-school level students, Washington, D.C., 2017, 2018
- Served as the vice president of the SIAM chapter at the George Washington University, January 2016 - 2018

## Conference and workshop participation

- Workshop on *Experimental and Computational Fracture Mechanics: Validating peridynamics and phase field models for fracture prediction and experimental design*, February 26-28, 2020, Baton Rouge, Louisiana, USA
- 2019 *Workshop on Nonlinear Dispersive Partial Differential Equations and Inverse Scattering*, The Fields Institute, Toronto, Canada, May 21 - 24, 2019
- *February Fourier Talks*, February 21-22, 2019, University of Maryland, USA
- *IAS/PCMI 2018 Summer Graduate School on Harmonic Analysis*, July 1-21, 2018, Park City, Utah, USA
- *February Fourier Talks*, February 15-16, 2018, University of Maryland, USA
- Workshop on *Dispersive Equations, Solitons, and Blow-up*, September 4-8, 2017, Hausdorff Center of Mathematica, Bonn, Germany

- *French-American Conference on Nonlinear Dispersive PDEs*, June 12-16, 2017, Centre International de Rencontres Mathematiques (CIRM), Luminy, Marseille, France
- Research School on *Random Structures in Statistical Mechanics and Mathematical Physics*, March 6 -10, 2017, Centre International de Rencontres Mathematiques (CIRM), Luminy, Marseille, France
- PDE/Analysis Mini School on *Dynamics of the energy critical wave equations* by Thomas Duyckaerts, University of North Carolina, Chapel Hill, 13-15 February, 2017
- PDE/Analysis Mini School on *Random Schrödinger operators: Basic properties, localization, and spectral statistics* by Peter Hislop, University of North Carolina, Chapel Hill, 27-28 October 2016
- Workshop on *Getting Started with PDEs*, The Hebrew University, Jerusalem, Israel, September 11 - September 15, 2016
- *Third Chicago Summer School In Analysis*, University of Chicago, June 13 - June 24, 2016
- PIRE-CNA 2016 Summer School on *New Frontiers in Nonlinear Analysis for Materials*, Carnegie Mellon University, Pittsburgh, June 2-10, 2016

READING PROJECTS

- **Spring 2015:** Algebraic Topology at Indian Statistical Institute, Kolkata, course taught by Prof. Goutam Mukherjee
- **Summer 2011:** Differential Geometry at Indian Institute of Science Education and Research, Mohali, under the guidance of Prof. Kapil Hari Paranjape
- **Winter 2010:** Measure Theory at Indian Statistical Institute, Bangalore with Prof. K. Ramamurthy
- **Summer 2010:** Point Set Topology at Indian Statistical Institute, Kolkata with Prof. S. M. Srivastava

LANGUAGES

English, Bengali, Hindi, Marathi