

# Debdeep Bhattacharya

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## CONTACT INFORMATION

Department of Mathematics  
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## RESEARCH INTERESTS

I study analysis and the theory of partial differential equations, in particular, of nonlocal and nonlinear dispersive type and their application to continuum mechanics (classical and peridynamics). I use high-performance computing to simulate inter- and intra-particle interaction in granular media to extract and predict bulk behavior. I am also interested in signal processing and machine learning.

## EMPLOYMENT

### Louisiana State University

Postdoctoral Researcher, May 2020 - present  
**Host:** 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 EXPERIENCE

### 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

1. **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)
2. **Simulating grain shape effects and damage in granular media using PeriDEM.** Debdeep Bhattacharya, Robert P. Lipton. (Submitted) (arXiv:2108.07212)
3. **Peridynamics for Quasistatic Fracture Modeling.** Debdeep Bhattacharya, Patrick Diehl, Robert P. Lipton. (Submitted) (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)

#### OTHER WRITINGS

1. **Harmonic Analysis Techniques in Nonlinear Dispersive Equations and Signal Processing.** Ph.D Dissertation, May 2020. ProQuest: 27831360
2. **Deconvolution problem and application to ANITA signals,** Report, submitted to ANITA collaboration at University of Hawai'i at Manoa (link)
3. **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

- *Effect of particle shapes on bulk behavior of granular assembly using a peridynamics-based discrete element method*, February 24, 2022, University of Nebraska-Lincoln, Lincoln, USA
- *Multichannel deconvolution with Fourier and wavelet regularization*, Applied Math Seminar, George Washington University, October 1, 2021, Washington, D.C., USA
- *Simulating grain shape effects and damage in granular media using PeriDEM*, 16th U.S. National Congress on Computational Mechanics (USCNCM16), July 25, 2021, Chicago, USA (Virtual)
- *Effect of particle shapes on particle bulk using a Peridynamics-based discrete element method*, ALOP Workshop on Nonlocal Models, July 13, 2021, Universität Trier, Germany (Virtual)
- *Modeling particle beds with arbitrary particle shapes with peridynamics and short-range contact forces*, MURI seminar series, March 16, 2020 (Virtual)
- *Modeling particle beds using Peridynamics*, The 3rd Annual Meeting of the SIAM Texas-Louisiana Section, October 16-18, 2020, College Station, TX, USA (Virtual)
- *Modeling granular media with Peridynamics and short-range contact forces*, MURI seminar, September 9, 2020 (Virtual)
- (Postponed due to COVID-19) *On low regularity solutions to the 2D modified Zakharov-Kuznetsov equation*, 13th AIMS Conference on Dynamical Systems, Differential Equations and Applications, June 5-9, 2020, Atlanta, USA

- *Reduction of 3D axisymmetric models to 2D in peridynamics*, Computational and Applied Math (CAM) seminar, Computer Science and Mathematics Division, Oak Ridge National Laboratory, August 8, 2019
- *Fourier-Wavelet Regularized deconvolution (ForWaRD) in multi-antenna setup*, RIT in Applied Harmonic Analysis, Norbert Weiner Center, University of Maryland, May 13, 2019
- *Global Well-posedness of 2d Modified Zakharov-Kuznetsov Equation for Low-regularity Data*, Spring 2019 conference on Applied Mathematics, George Washington University, May 4, 2019
- *Deconvolution in a multi-antenna setup and application to ANITA data*, Antarctic Impulse Transient Anetann (ANITA) collaboration, December 10, 2018
- *Deconvolution problem and its application to ANITA data*, University of Hawai'i at Manoa, June 28, 2018
- *The I-method and its applications*, 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

**GitHub:**  
debdeepbh

**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, L<sup>A</sup>T<sub>E</sub>X, Git, Vim

##### Coding Projects

- **periwheel**: Analysis and prediction of vehicle mobility on loosely packed dry gravel beds using a massively parallel implementation of a mesoscale computational model
- **perigrain**: Modeling and analysis of deformable granular media to extract and predict bulk behavior dependent on particle shape
- **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 • <b>crack</b> : Numerical simulations of crack branching in sodalime glass using peridynamics • <b>rexpense</b> : Generating complex expense reports and statistics in a multi-user setup • <b>mathabotface</b> : Automated theorem and lemma twitting bot
RESPONSIBILITIES	• Co-organizer of minisymposium on <i>Peridynamic Theory and Multiscale Methods for Complex Material Behavior</i> at the 9th GACM Colloquium on Computational Mechanics for Young Scientists from Academia and Industry in Essen, Germany, September 21-23, 2022 • Co-organizer of GWU-SIAM conference on Applied Mathematics, April 29, 2017 with Eric Shehadi and Chong Wang • Vice president of the SIAM chapter at the George Washington University, January 2016 - 2018
READING PROJECTS	• <b>Spring 2015</b> : Algebraic Topology at Indian Statistical Institute, Kolkata, course taught by Prof. Goutam Mukherjee • <b>Summer 2011</b> : Differential Geometry at Indian Institute of Science Education and Research, Mohali, under the guidance of Prof. Kapil Hari Paranjape • <b>Winter 2010</b> : Measure Theory at Indian Statistical Institute, Bangalore with Prof. K. Ramamurthy • <b>Summer 2010</b> : Point Set Topology at Indian Statistical Institute, Kolkata with Prof. S. M. Srivastava
CONFERENCES AND WORKSHOPS ATTENDED	• Workshop on <i>Experimental and Computational Fracture Mechanics: Validating peridynamics and phase field models for fracture prediction and experimental design</i> , February 26-28, 2020, Baton Rouge, Louisiana, USA • 2019 <i>Workshop on Nonlinear Dispersive Partial Differential Equations and Inverse Scattering</i> , The Fields Institute, Toronto, Canada, May 21 - 24, 2019 • <i>February Fourier Talks</i> , February 21-22, 2019, University of Maryland, USA • <i>IAS/PCMI 2018 Summer Graduate School on Harmonic Analysis</i> , July 1-21, 2018, Park City, Utah, USA • <i>February Fourier Talks</i> , February 15-16, 2018, University of Maryland, USA • Workshop on <i>Dispersive Equations, Solitons, and Blow-up</i> , September 4-8, 2017, Hausdorff Center of Mathematics, Bonn, Germany • <i>French-American Conference on Nonlinear Dispersive PDEs</i> , June 12-16, 2017, Centre International de Rencontres Mathématiques (CIRM), Luminy, Marseille, France • Research School on <i>Random Structures in Statistical Mechanics and Mathematical Physics</i> , March 6 -10, 2017, Centre International de Rencontres Mathématiques (CIRM), Luminy, Marseille, France • PDE/Analysis Mini School on <i>Dynamics of the energy critical wave equations</i> by Thomas Duyckaerts, University of North Carolina, Chapel Hill, 13-15 February, 2017 • PDE/Analysis Mini School on <i>Random Schrödinger operators: Basic properties, localization, and spectral statistics</i> by Peter Hislop, University of North Carolina, Chapel Hill, 27-28 October 2016 • Workshop on <i>Getting Started with PDEs</i> , The Hebrew University, Jerusalem, Israel, September 11 - September 15, 2016 • <i>Third Chicago Summer School In Analysis</i> , University of Chicago, June 13 - June 24, 2016 • PIRE-CNA 2016 Summer School on <i>New Frontiers in Nonlinear Analysis for Materials</i> , Carnegie Mellon University, Pittsburgh, June 2-10, 2016