

# Prashant K. Jha

## Research Associate

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[Google Scholar](#); [LinkedIn](#); [GitHub](#)

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## SUMMARY

My research focuses on using mechanics, applied mathematics, and computational science to understand and represent the complex behavior of materials, e.g., crack propagation and multiphysics effects in materials and particle breakage and interlocking in granular media. My research expertise and interests include mechanics of solids and granular media, multiphysics and multiscale modeling of engineering and biomedical systems, uncertainty quantification, and applications and advancement of neural networks to engineering problems.

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## POSITIONS

### Research Associate

Dec 2020 – present

Oden Institute for Computational Engineering and Sciences

*The University of Texas at Austin, Austin, TX 78712, USA*

PI: Prof. J. Tinsley Oden

### ▷ PAST POSITIONS

#### Adjunct Faculty

Aug 2021 – Dec 2021

Department of Aerospace Engineering and Engineering Mechanics

*The University of Texas at Austin, Austin, TX 78712, USA*

#### Adjunct Faculty

Aug 2021 – Dec 2021

Department of Biomedical Engineering

*The University of Texas at Austin, Austin, TX 78712, USA*

#### Peter O'Donnell

Postdoctoral Fellow

Aug 2019 – Nov 2020

Oden Institute for Computational Engineering and Sciences

*The University of Texas at Austin, Austin, TX 78712, USA*

PI: Prof. J. Tinsley Oden

#### Postdoctoral Fellow

Oct 2016 – Jul 2019

Department of Mathematics

*Louisiana State University, Baton Rouge, LA 70803, USA*

PI: Prof. Robert Lipton

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## EDUCATION

### Ph.D.

2012 – 2016

Civil and Environmental Engineering

*Carnegie Mellon University, Pittsburgh, PA 15213, USA*

Adviser: Prof. Kaushik Dayal

Thesis: Coarse graining of electric field interactions with materials

### M.E.

2010 – 2012

Mechanical Engineering

*Indian Institute of Science, Bengaluru, KA 560012, India*

Adviser: Prof. Chandrashekhara S. Jog

Thesis: A monolithic strategy for fluid-structure interaction in compressible flow

### B.E.

2006 – 2010

Mechanical Engineering

*Govt. Engineering College, Raipur, CG 492001, India*

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## TEACHING EXPERIENCES

### COE 311K

Fall 2021

Engineering Computation

Department of Aerospace Engineering and Engineering Mechanics

*The University of Texas at Austin, Austin, TX 78712, USA*

### BME 313L

Fall 2021

Introduction to Numerical Methods in Biomedical Engineering

Department of Biomedical Engineering

*The University of Texas at Austin, Austin, TX 78712, USA*

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## JOURNAL RESPONSIBILITIES

### ▷ JOURNAL EDITING

#### Associate Editor

Jul 2021 – present

Journal of Peridynamics and Nonlocal Modeling (JPER) ([link](#))

#### Topic Editor

Aug 2021 – present

Journal of Open Source Software (JOSS) ([link](#))

### ▷ JOURNAL REVIEWS

CMAME (15+ reviews), JMPS, SINUM, M3AS, MMS, JALCOM, IJMST, BMJ Open, Mathematical Reviews (AMS), PHYSICA

## EXPERTISE

### ▷ SKILLS

Continuum Mechanics; Multiphysics Modeling and Simulation; Numerical Methods for Differential Equations, Optimization, Algebraic System of Equations; Finite Element Analysis; Fracture Mechanics; Constitutive Modeling; Phase-field Methods; Continuum Mixture Theory; Uncertainty Quantification; Bayesian Inference; Optimal Experimental Design; Machine Learning

### ▷ PROGRAMMING LANGUAGES AND TOOLS

C and C++; MATLAB and OCTAVE; Python; Shell; Git; Docker

## GRANTS

- |                           |                                                            |
|---------------------------|------------------------------------------------------------|
| 1. <b>MDACC-Oden-TACC</b> | A mechanistic tumor growth model for HP MRI                |
| Sep 2020 – Mar 2022       | PI: Fuentes (MD Anderson Cancer Center), co-PI: <b>Jha</b> |
| \$50k                     |                                                            |

## MAJOR PROJECTS (\* – ONGOING, \*\* – COMPLETED)

- **\*Bayesian calibration and inverse problems in mechanics** (at UT Austin)
  - Proposed a Bayesian inference method for the calibration of PDE-based models; the method employs goal-oriented a-posteriori estimates of modeling error [JhaOden-JCP-2022](#)
  - Faster MCMC parameter sampling by utilizing computationally cheaper approximations of the error in QoIs
  - Enhancing the application of the neural operator to Bayesian inverse problems by computing correction to neural operator prediction [CaoRoseberryJha-Residual-2022](#)
  - Significantly improved performance when correcting the neural operator predictions (examples include nonlinear Poisson equation and hyperelasticity)
- **\*Multiphysics modeling of tissue-scale tumor growth** (at UT Austin)
  - Developed a 3D-1D model of tumor growth and angiogenesis, coupling the evolution of tumors with the flow in tissue and vascular network [Nonlin-2021](#), [CMAME-2021](#)
  - 1D Poiseuille flow model and Darcy's law to simulate the flow in a vascular network and tissue domain, respectively
  - Evolution of tumors, proteins, and drugs based on continuum mixture theory and phase-field method
- **\*Optimal experimental design for Hyperpolarized (HP) MRI** (at UT Austin)
  - Determining HP scan parameters (design parameters) such as flip angles and repetition times is non-trivial due to the signal decay and instantaneous signal loss during a scan
  - Proposed a method based on mutual information to determine the optimal design parameters that increase the information content of data [JhaFuentes-MRM-2022](#)
  - Received a grant of \$50k as a co-PI (D. Fuentes as PI) for the duration of Sep 2020 – Mar 2022
- **\*High-fidelity mechanics model for granular media** (at UT Austin)
  - Discrete Element Method (DEM) based models are restricted to spherical particles and can not simulate particle breakage
  - Combined peridynamics (nonlocal theory of fracture) and DEM and proposed a novel high-fidelity model called PeriDEM that overcomes the limitations of DEM-based models [JMPS-2021](#)
  - Open-source software available on GitHub ([PeriDEM](#))
- **\*Relating peridynamics and classical linear elastic fracture mechanics (LEFM)** (at UT Austin and LSU, Baton Rouge)
  - Connecting LEFM and peridynamics is of great interest for the validation and broader integration of peridynamics
  - We showed that peridynamics satisfies the LEFM energy relation [JhaLipton-IJFrac-2021](#), [LiptonJha-Nonlin-2021](#) [LiptonJha-JPER-2019](#)
  - In the absence of fracture, peridynamics approximates elastodynamics [JhaLipton-IJNME-2018](#)
  - Obtained a CFL-like stability condition for an explicit time discretization of peridynamics [JhaLipton-IJNME-2018](#)
- **\*\*Numerical method and analysis of peridynamics theory of fracture in solids** (at LSU, Baton Rouge)
  - Implemented and studied numerical methods such as finite difference and finite element for peridynamics [JhaLipton-SINUM-2018](#), [JhaLipton-DCDSB-2021](#), [JhaLipton-CMAME-2019](#)
  - Showed that the numerical solution converges to the exact solution as expected (an important contribution as such results were not clearly established before our work)
- **\*\*Multiscale modeling of electrical interaction in ionic solids** (at CMU, Pittsburgh)
  - Coulombic interactions are long-ranged, and it is challenging to integrate them with multiscale methods, e.g., Quasicontinuum (QC) method
  - Obtained a continuum limit approximation of Coulombic (electrostatic) interaction and utilized the limiting energy to develop a QC method with electrostatic interaction [JhaMarshallKnapDayal-Multiscale](#), [JhaDayal-ContinuumLimit](#), [Jha-PhDThesis-2016](#)
- **\*\*Discrete-to-continuum limit of electrostatic interaction in nanostructures** (at CMU, Pittsburgh)
  - Performed a rigorous derivation of continuum limit of electrostatic interaction in nanostructures with rotational and translational symmetries [JhaDayal-ContinuumLimit](#)
  - Unlike in the case of 3D crystal structures, the limiting electrostatic energy in nanostructures is local

- The limiting energy includes contributions from both the tangential and normal components of the dipole moment field; tangential components not present in the limiting energy obtained through dimensional reduction techniques
- **\*\*Monolithic fluid-structure interaction (FSI) formulation** (at IISc, Bangalore)
  - Developed a monolithic arbitrary Lagrangian-Eulerian (ALE) formulation for FSI problems
  - Compressible fluid and nonlinear solid undergoing large deformation
  - Mapped the Navier-Stokes equations for compressible fluid to the reference configuration
  - Developed energy-conserving time discretization and finite element spatial discretization of nonlinear coupled partial differential equations

## PUBLICATIONS [[GOOGLE SCHOLAR](#)]

### ▷ PUBLISHED

1. P. K. **Jha** and R. Lipton, "Numerical analysis of nonlocal fracture models in holder space," *SIAM Journal on Numerical Analysis*, vol. 56, no. 2, pp. 906–941, 2018.
2. P. K. **Jha** and R. Lipton, "Numerical convergence of nonlinear nonlocal continuum models to local elastodynamics," *International Journal for Numerical Methods in Engineering*, vol. 114, no. 13, pp. 1389–1410, 2018.
3. R. Lipton, E. Said, and P. K. **Jha**, "Free damage propagation with memory," *Journal of Elasticity*, vol. 133, no. 2, pp. 129–153, 2018.
4. R. P. Lipton, R. B. Lehoucq, and P. K. **Jha**, "Complex fracture nucleation and evolution with nonlocal elastodynamics," *Journal of Peridynamics and Nonlocal Modeling*, vol. 1, no. 2, pp. 122–130, 2019.
5. P. K. **Jha** and R. Lipton, "Numerical convergence of finite difference approximations for state based peridynamic fracture models," *Computer Methods in Applied Mechanics and Engineering*, vol. 351, pp. 184–225, 2019.
6. P. Diehl, P. K. **Jha**, H. Kaiser, R. Lipton, and M. Lévesque, "An asynchronous and task-based implementation of peridynamics utilizing hpx—the c++ standard library for parallelism and concurrency," *SN Applied Sciences*, vol. 2, no. 12, pp. 1–21, 2020.
7. P. K. **Jha** and R. Lipton, "Finite element convergence for state-based peridynamic fracture models," *Communications on Applied Mathematics and Computation*, vol. 2, no. 1, pp. 93–128, 2020.
8. P. K. **Jha** and R. P. Lipton, "Kinetic relations and local energy balance for lefm from a nonlocal peridynamic model," *International Journal of Fracture*, vol. 226, no. 1, pp. 81–95, 2020.
9. P. K. **Jha**, L. Cao, and J. T. Oden, "Bayesian-based predictions of covid-19 evolution in texas using multispecies mixture-theoretic continuum models," *Computational Mechanics*, vol. 66, no. 5, pp. 1055–1068, 2020.
10. P. K. **Jha**, P. S. Desai, D. Bhattacharya, and R. Lipton, "Peridynamics-based discrete element method (peridem) model of granular systems involving breakage of arbitrarily shaped particles," *Journal of the Mechanics and Physics of Solids*, vol. 151, p. 104376, 2021.
11. R. P. Lipton and P. K. **Jha**, "Nonlocal elastodynamics and fracture," *Nonlinear Differ. Equ. Appl.*, vol. 23, 2021.
12. P. K. **Jha** and R. Lipton, "Finite element approximation of nonlocal dynamic fracture models," *Discrete & Continuous Dynamical Systems-B*, vol. 26, no. 3, p. 1675, 2021.
13. M. Fritz, P. K. **Jha**, T. Köppl, J. T. Oden, and B. Wohlmuth, "Analysis of a new multispecies tumor growth model coupling 3d phase-fields with a 1d vascular network," *Nonlinear Analysis: Real World Applications*, vol. 61, p. 103331, 2021.
14. M. Fritz, P. K. **Jha**, T. Köppl, J. T. Oden, A. Wagner, and B. Wohlmuth, "Modeling and simulation of vascular tumors embedded in evolving capillary networks," *Computer Methods in Applied Mechanics and Engineering*, vol. 384, p. 113975, 2021.
15. D. A. Hormuth, C. M. Phillips, C. Wu, E. A. B. F. Lima, G. Lorenzo, P. K. **Jha**, A. M. Jarrett, J. T. Oden, and T. E. Yankeelov, "Biologically-based mathematical modeling of tumor vasculature and angiogenesis via time-resolved imaging data," *Cancers*, vol. 13, no. 12, 2021.
16. P. Gadikar, P. Diehl, and P. K. **Jha**, "Load balancing for distributed nonlocal models within asynchronous many-task systems," in *2021 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, (Los Alamitos, CA, USA), pp. 669–678, IEEE Computer Society, jun 2021.
17. P. K. **Jha** and P. Diehl, "Nlmech: Implementation of finite difference/meshfree discretization of nonlocal fracture models," *Journal of Open Source Software*, vol. 6, no. 65, p. 3020, 2021.
18. P. K. **Jha** and J. T. Oden, "Goal-oriented a-posteriori estimation of model error as an aid to parameter estimation," *Journal of Computational Physics*, vol. 470, p. 111575, 2022.
19. P. K. **Jha**, J. Marshall, J. Knap, and K. Dayal, "Atomic-to-continuum multiscale modeling of defects in crystals with nonlocal electrostatic interactions," *Journal of Applied Mechanics*, vol. 90, 11 2022.

### ▷ UNDER REVIEW

20. P. K. **Jha**, T. Breitzman, and K. Dayal, "Discrete-to-continuum limits of long-range electrical interactions in nanostructures," Preprint: <https://www.math.cmu.edu/cna/Publications/publications2020/papers/20-CNA-020.pdf>, 2020.
21. P. K. **Jha**, C. Walker, D. Mitchell, J. T. Oden, D. Schellingerhout, J. A. Bankson, and D. T. Fuentes, "Mutual-

information based optimal experimental design for hyperpolarized  $^{13}\text{C}$ -pyruvate mri,” Submitted for review. Preprint: <https://arxiv.org/abs/2206.12509>, June 2022.

22. L. Cao, T. O’Leary-Roseberry, P. K. **Jha**, J. T. Oden, and O. Ghattas, “Residual-based error correction for neural operator accelerated infinite-dimensional bayesian inverse problems,” [arXiv preprint arXiv:2210.03008](https://arxiv.org/abs/2210.03008), 2022.

#### ▷ BOOK CHAPTERS AND REPORTS

23. P. K. **Jha** and R. Lipton, Well-Posed Nonlinear Nonlocal Fracture Models Associated with Double-Well Potentials, pp. 1417–1456. Cham: Springer International Publishing, 2019.
24. P. K. **Jha** and R. Lipton, Finite Differences and Finite Elements in Nonlocal Fracture Modeling: A Priori Convergence Rates, pp. 1457–1494. Cham: Springer International Publishing, 2019.
25. R. Lipton, E. Said, and P. K. **Jha**, Dynamic Brittle Fracture from Nonlocal Double-Well Potentials: A State-Based Model, pp. 1265–1291. Cham: Springer International Publishing, 2019.
26. R. Lipton, E. Said, and P. K. **Jha**, Dynamic Damage Propagation with Memory: A State-Based Model, pp. 1495–1523. Cham: Springer International Publishing, 2019.

#### PROFESSIONAL ACTIVITIES

##### ▷ CONFERENCE ORGANIZATION

- With colleagues, organized (as the main organizer) a USACM thematic conference on computational oncology. Jan 2022. [Conference site](#).
- Co-organized a minisymposium M19 on "Nonlocal models in mathematics and computation" at the SIAM TX-LA 3rd Annual Meeting. Oct 2020.

##### ▷ MENTORING

- Co-mentored a student working on the development of distributed solver for a nonlocal diffusion equation. Google Summer of Code 2020. [Related github repository](#). Summer 2020.

#### OPEN-SOURCED SOFTWARE

- **PeriDEM**. Implementation of high-fidelity model (PeriDEM, JMPS 2021) of granular media.
- **NLMech**. Peridynamics simulation library. (With P. Diehl).
- **BayesForSEIRD**. Bayesian calibration and validation of the SEIRD epidemic model. (With L. Cao).
- **Angiogenesis3D1D**. Angiogenesis and tumor growth using 3D-1D model. (With T. Köppl, A. Wagner, M. Fritz).

#### AWARDS AND ACHIEVEMENTS

- |                                  |                                                                                                                                                      |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <b>GATE exam</b><br>May 2010  | All India rank 31 (957/1000 score) in GATE-2010 exam<br><i>India</i>                                                                                 |
| 2. <b>TA Award</b><br>May 2013   | Best Teaching Assistant award for the graduate level finite-element course<br><i>Carnegie Mellon University, Pittsburgh, PA 15213, USA</i>           |
| 3. <b>Fellowship</b><br>Aug 2019 | Peter O’Donnell Postdoctoral Fellowship (competitive, about 4 fellowships a year)<br><i>The University of Texas at Austin, Austin, TX 78712, USA</i> |

#### TRAVEL

- |                                        |                                                                                                                          |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1. <b>Visit</b><br>Feb 2017 – May 2017 | Institute for Mathematics and its Applications<br><i>University of Minnesota Twin Cities, Minneapolis, MN 55455, USA</i> |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------|

#### TALKS

1. Seminar: *Coarse graining of electric field interactions with materials*. Mechanical Engineering Seminar, Indian Institute of Science, Bengaluru, India. Aug 2016.
2. Seminar: *Coarse graining of electric field interactions with materials*. Mechanical Engineering Seminar, Indian Institute of Technology, Chennai, India. Aug 2016.
3. Seminar: *Coarse graining of electric field interactions with materials*. AEM Mechanics Research Seminar, University of Minnesota Twin Cities, Minneapolis, USA. Mar 2017.
4. Seminar: *Numerical analysis of nonlocal fracture models*. IMA Postdoctoral Seminar, University of Minnesota Twin Cities, Minneapolis, USA. Apr 2017.
5. Conference: *Numerical analysis of nonlocal fracture models*. US National Congress on Computational Mechanics USNCCM14, Montreal, Canada. Jul 2017.
6. Seminar: *Finite element approximation of nonlocal fracture models*. Mathematics Department Applied Analysis Seminar, Louisiana State University, Baton Rouge, USA. Mar 2018.
7. Seminar: *Well-posedness of nonlocal fracture models and apriori error estimates of numerical approximations*. Mathematics Department Seminar, Indian Institute of Science, Bengaluru, India. May 2018.
8. Conference: *Free damage propagation with memory*. 13th World Congress in Computational Mechanics, New York, USA. Jul 2018.
9. Conference: *Convergence results for finite element and finite difference approximation of nonlocal fracture models*. SIAM TX-LA Annual Meeting, Baton Rouge, USA. Oct 2018.

10. Seminar: *Modelling fracture in solids using nonlocal interaction: A brief overview of Peridynamics*. Mechanical Engineering Seminar, Indian Institute of Technology, Delhi, India. Apr 2019.
11. Conference: *Convergence results for finite element and finite difference approximation of nonlocal fracture*. ICIAM 2019, Valencia, Spain. Presented by Dr. R. Lipton. Jul 2019.
12. Conference: *Numerical fracture experiments using nonlinear nonlocal models*. US National Congress on Computational Mechanics USNCCM15, Austin, USA. Jul 2019.
13. Informal seminar: *Numerical fracture experiments using nonlinear nonlocal models*. Oden Institute, The University of Texas at Austin, Austin, USA. Aug 2019.
14. Seminar: *A mechanistic tumor growth model for HP MRI*. Center for Computational Oncology Seminar, The University of Texas at Austin, Austin, USA. Sep 2020.
15. Seminar: *A mechanistic tumor growth model for HP MRI*. Civil and Environmental Engineering Seminar, Carnegie Mellon University, Pittsburgh, USA. Oct 2020.
16. Seminar: *Application of peridynamics to fracture in solids and granular media*. Special Mechanics Seminar, University of Houston, Houston, USA. Oct 2020.
17. Conference: *Application of peridynamics to fracture in solids and granular media*. SIAM TX-LA Annual Meeting 2020, USA. Oct 2020.
18. Seminar: *Application of peridynamics to fracture in solids and granular media*. MAE Seminar Series, University at Buffalo, Buffalo, USA. Oct 2020.
19. Seminar: *Modeling failure in solids and tissue-scale tumour growth via high-fidelity computational methodologies*. Department Seminar, Department of Computational and Data Science, Indian Institute of Science, Bengaluru, India. May 2021.
20. Conference: *Analysis and Application of Peridynamics to Fracture in Solids and Granular Media*. EMI 2021, USA. May 2021.
21. Conference: *Analysis and Application of Peridynamics to Fracture in Solids and Granular Media*. USNCCM 16, USA. Jul 2021.
22. Seminar: *High-fidelity mechanistic modeling of tumor growth at the tissue scale*. Babuška Forum, Oden Institute, The University of Texas at Austin, Austin, USA. Sep 2021.

#### KEY REFERENCES

##### **Prof. Kaushik Dayal**

E: [Kaushik.Dayal@cmu.edu](mailto:Kaushik.Dayal@cmu.edu)

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##### **Prof. Robert Lipton**

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##### **Prof. J. Tinsley Oden**

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##### **Prof. David T. Fuentes**

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##### **Prof. Chandrashekhar S. Jog**

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##### **Professor**

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##### **Professor**

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##### **Associate Professor**

*MD Anderson Cancer Center*

Department of Imaging Physics

Houston, TX 77094, USA

##### **Professor**

*Indian Institute of Science*

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