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A 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

A.i 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

B 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. Chandrashekhar 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

C TEACHING EXPERIENCES

1. **COE 311K**
   Fall 2021
   Engineering Computation
   Department of Aerospace Engineering and Engineering Mechanics
   The University of Texas at Austin, Austin, TX 78712, USA

2. **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

D JOURNAL RESPONSIBILITIES

D.i JOURNAL EDITING

Associate Editor — Journal of Peridynamics and Nonlocal Modeling (JPER) (link)
Jul 2021 – present

Topic Editor — Journal of Open Source Software (JOSS) (link)
Aug 2021 – present

D.ii JOURNAL REVIEWS

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

E EXPERTISE

E.i 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

E.ii PROGRAMMING LANGUAGES AND TOOLS

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

F GRANTS

1. **MDACC-Oden-TACC** — A mechanistic tumor growth model for HP MRI
   Sep 2020 – Aug 2021 — PI: Fuentes (MD Anderson Cancer Center), co-PI: **Jha**
   $50,000

G MAJOR PROJECTS (* – Ongoing, ** – Completed)

- *__Bayesian calibration and uncertainty quantification__ (at UT Austin)
  - Proposed a Bayesian inference scheme for the calibration of PDE-based models utilizing goal-oriented a-posteriori estimates JhaOden-JCP-2022
  - Faster MCMC parameter sampling by utilizing computationally faster approximations of the error in QoIs
  - Modeling “model inadequacy" (correction) in a Bayesian inference in which the high-fidelity model is replaced with surrogate models (manuscript in preparation)
  - Correction is designed to enhance the application of neural network surrogates in Bayesian inference (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 evolution of tumors with the flow in tissue and vascular network Nonlin-2021, CMAME-2021
  - 1D Poiseuille model and Darcy’s law to simulate the flow in a vascular network and tissue domain
  - 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 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 co-PI (D. Fuentes as PI) from Sep 2020 – March 2022

- *__High fidelity model for granular media__ (at UT Austin)
  - Existing models based on the Discrete Element Method (DEM) are restricted to spherical particles, and can not handle 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)
  - Establishing a connection between LEFM and peridynamics is of great interest; we showed that peridynamics satisfies the LEFM energy relation JhaLipton-IJFrac-2021, LiptonJha-Nonlin-2021
  - Showed that peridynamics satisfies Griffith's fracture energy relation 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 theory JhaLipton-SINUM-2018, JhaLipton-DCDSB-2021, JhaLipton-CMAME-2019
  - Showed that the numerical solution converges to the exact solution as expected (important contribution as such results were not clearly established prior to our work)
- **__Multiscale modeling of electrical interactions in ionic solids__ (at CMU, Pittsburgh)
  - Coulombic interactions are long-ranged and existing multiscale methods are suitable for only short-range interactions
  - Obtained a continuum-limit approximation of electrostatic interactions and combined it with the Quasicontinuum multiscale framework JhaDayal-ContinuumLimit, Jha-PhDThesis-2016
- **__Discrete-to-continuum limit of electrostatic interactions in nanostructures__ (at CMU, Pittsburgh)
  - Performed a rigorous derivation of continuum limit of electrostatic interactions in nanostructures with rotational and translational symmetries JhaDayal-ContinuumLimit
  - Unlike in the case of 3D crystal structures, limiting electrostatic energy 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 the 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 deformations
  - Mapped Navier-Stokes equations for compressible fluid to the reference configuration
  - Developed energy conserving time discretization with finite element discretization of nonlinear coupled partial differential equations

H PUBLICATIONS [GOOGLE SCHOLAR]

H.i PUBLISHED

1. 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.
2. 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.
3. 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.
4. R. Lipton, E. Said, and P. K. **Jha**, "Free damage propagation with memory," Journal of Elasticity, vol. 133, no. 2, pp. 129–153, 2018.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. R. P. Lipton and P. K. **Jha**, "Nonlocal elastodynamics and fracture," Nonlinear Differ. Equ. Appl. 28, vol. 23, 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. Tinsley Oden, "Goal-oriented a-posteriori estimation of model error as an aid to parameter estimation," Journal of Computational Physics, p. 111575, 2022.

H.ii UNDER REVIEW

19. 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.

20. 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 13c-pyruvate mri," Submitted for review. Preprint: https://arxiv.org/abs/2206.12509, June 2022.

H.iii BOOK CHAPTERS AND REPORTS

21. 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.

22. P. K. **Jha** and R. Lipton, Finite differences and finite elements in nonlocal fracture modeling: A priori convergence rates, pp. 1–38. Cham: Springer International Publishing, 2018.

23. R. Lipton, E. Said, and P. K. **Jha**, Dynamic brittle fracture from nonlocal double-well potentials: A state-based model, pp. 1–27. Cham: Springer International Publishing, 2018.

24. R. Lipton, E. Said, and P. K. **Jha**, Dynamic damage propagation with memory: A state-based model, pp. 1–29. Cham: Springer International Publishing, 2018.

I PROFESSIONAL ACTIVITIES AND SERVICE

I.i CONFERENCE ORGANIZATION

1. With colleagues, organized (as the main organizer) a USACM thematic conference on computational oncology. Jan 2022. Conference site.

2. Co-organized minisymposium M19 on "Nonlocal models in mathematics and computation" at SIAM TX-LA 3rd Annual Meeting. Oct 2020.

3. One of the nominated candidate for the election of members-at-large for USACM TTA on Mathematical Methods. Jun 2021.

I.ii 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.

J OPEN-SOURCED SOFTWARE

1. **PeriDEM.** Implementation of high-fidelity model (PeriDEM, JMPS 2021) of granular media.

2. **NLMech.** Peridynamics simulation library. (With P. Diehl).

3. **BayesForSEIRD.** Bayesian calibration and validation of the SEIRD epidemic model. (With L. Cao).

4. **Angiogenesis3D1D.** Angiogenesis and tumor growth using 3D-1D model. (With T. Köppl, A. Wagner, M. Fritz).

K AWARDS AND ACHIEVEMENTS

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

L TRAVEL

1.	**Visit** Feb 2017 – May 2017	Visited Institute for Mathematics and its Applications *University of Minnesota Twin Cities, Minneapolis, MN 55455*

M 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.

N KEY REFERENCES

Prof. Kaushik Dayal
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Carnegie Mellon University
123J Porter Hall
Pittsburgh, PA 15213

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P: +1-225-578-1569
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Professor
Louisiana State University
258 Lockett Hall
Baton Rouge, LA 70803

Prof. J. Tinsley Oden
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Professor
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Austin, TX 78712

Prof. David T. Fuentes
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Associate Professor
MD Anderson Cancer Center
Department of Imaging Physics
Houston, TX 77094

Prof. Chandrashekhar S. Jog
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