

# Xiaoxiao (Catherine) Ding

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## EDUCATION

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### Harvard University

Cambridge, Massachusetts, USA

*Ph.D. in Applied Mathematics GPA: 4.0/4.0*

*Aug 2018 – May 2024*

*M.Sc. en route in Computational Science and Engineering GPA: 4.0/4.0*

*Aug 2018 – May 2022*

### Lawrence Berkeley National Laboratory

Berkeley, California, USA

*Visiting Graduate Student Researcher at the Computing Sciences Research Division*

*June 2019 and August 2023*

### Imperial College London

London, UK

*Integrated B.Eng. and M.Eng. in Civil Engineering First Class Honours*

*Oct 2014 – Aug 2018*

## RESEARCH INTERESTS

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**Broadly:** multiscale mechanics, mechanical metamaterials, integrated design and manufacturing

**Specifically:** numerical methods for nonlinear elasticity, parallel computation and coupled analysis for study of textiles, knots, polymers across length scales and dimensions; scientific data analysis, integration of experiment and simulation, data-driven methods for accelerated design and augmented material characterization; computational geometry for packing of complex materials, mechanisms from hierarchical assembly, computer vision, geometric deep learning, and topology optimization

## JOURNAL PUBLICATIONS AND THESES

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- **Ding X.**, Sanchez V., Bertoldi K. and Rycroft C.H., “Unravelling the Mechanics of Knitted Fabrics Through Hierarchical Geometric Representation”, *arXiv:2307.12360*, 2023.
- Deng B., Zareei A., **Ding X.**, Weaver J.C., Rycroft C.H. and Bertoldi K., “Inverse Design of Mechanical Metamaterials with Target Nonlinear Response via a Neural Accelerated Evolution Strategy” *Advanced Materials (Cover)*, 2022.
- Artigaut M., Sufian A., **Ding X.**, Shire T. and O’Sullivan C., “Influence of Stress Anisotropy on Stress Distributions in Gap-Graded Soils” *Proceedings of the 7th International Symposium on Deformation Characteristics of Geomaterials*, 2019.
- **Ding X.**, “Effect of Shearing on Stress Transfer Within Gap-Graded Soils” (M.Eng. Thesis), Department of Civil and Environmental Engineering, Imperial College London, 2018.
- Deng F., **Ding X.**, Chi Y., Xu L. and Wang L., “The Pull-Out Behavior of Straight and Hooked-End Steel Fiber from Hybrid Fiber Reinforced Cementitious Composite: Experimental Study and Analytical Modelling” *Composite Structures*, 2018.
- Xu L., Li B., **Ding X.**, Chi Y., Li C., Huang B. and Shi Y., “Experimental Investigation on Damage Behavior of Polypropylene Fiber Reinforced Concrete Under Compression” *International Journal of Concrete Structures and Materials*, 2018.

## SELECTED CONFERENCE PRESENTATIONS AND INVITED SEMINARS

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- **Ding X.**, *A unified framework for learning energy landscapes of textile metamaterials (Invited)*, SIAM Conference on Mathematical Aspects of Materials Science, Pittsburgh, USA, May 20th 2024.
- **Ding X.**, *Unravelling the mechanics of knitted fabrics for mechanical programmability (Invited)*, Northwestern Initiative for Manufacturing Science and Innovation, Evanston, USA, Oct 16th 2023.
- **Ding X.**, *Exploration of the energy landscape of knitted fabrics for mechanical programmability*, 17th U.S. National Congress on Computational Mechanics, Albuquerque, USA, July 26th 2023.
- **Ding X.**, *Geometric nonlinearity for mechanical programmability (Invited)*, Flexible Structures Lab, EPFL Lausanne, Switzerland, March 14th 2023.
- **Ding X.**, *Unravelling the mechanics of knitted fabrics for mechanical programmability (Invited)*, Harvard University Applied Math Graduate Student Seminar, Cambridge, USA, March 1st 2023.
- **Ding X.** and Rycroft C.H., *Designing knitted fabrics with programmable properties*, APS March Meeting, Virtual, March 15th 2021.

## SELECTED RESEARCH EXPERIENCES

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### MIT: 3D Reconstruction and Physical Inference

Cambridge, MA, USA

March 2022 – May 2022

*Cross-Registered Student*

- Designed a deep learning model incorporating D-NeRF (a novel computer vision technique) to augment unobserved frames from experimental setup and use limited dataset to infer physics from deformation dynamics.
- Generated synthetic datasets from Blender and wrote Python scripts to output camera information.
- Trained D-NeRF model and multi-ResNet model on GPU environment and obtained results compatible to state-of-the-art methods on data augmentation and preliminary learning of physical parameter from video input.

### Harvard University: Inverse Design of Mechanical Metamaterials

Cambridge, MA, USA

May 2020 – Oct 2022

*Graduate Research Assistant*

- Proposed the original research idea and initiated collaboration to use neural networks to speed up the search through design space of mechanical metamaterials consisting of rotational squares.
- Coded and trained the neural network to perform forward mapping from structure to functionality.
- Contributed to the design and execution of experiments.

### Harvard University: Mechanics-Based Simulation of Knitted Fabrics

Cambridge, MA, USA

Sep 2018 – present

*Graduate Research Assistant*

- Derived formulation for numerical simulation of textiles from first principles, taking topology, elasticity, friction, and collision detection into account.
- Developed a computational tool based on nonlinear dynamics to simulate the deformation of textiles (knitted, woven and knots) at yarn level with parallel computing capacity.
- Rendered high-quality images and videos for the simulation tests.
- Performed comprehensive analysis of collected data from inhomogeneous mechanical fields and provided insights on cross-scale mechanisms.
- Designed innovative experimental apparatuses to perform uniaxial tensile tests on textiles and performed material characterization tests using UTM and custom bending stiffness test specimen.
- Used DIC in experiments to track the evolution of inhomogeneous mechanical fields.

## TEACHING ACTIVITIES

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### Harvard University ES120: Introduction to Mechanics

Cambridge, MA, USA

Jan 2023 – May 2023

*Teaching Fellow and worked with Professor Joost Vlassak*

- Proactively involved in syllabus design with the course instructor and a team of 4 teaching fellows.
- Led weekly sections and office hours and two learning labs for a class of 50 undergraduate students.
- Designed questions for weekly homework, two midterms and one final exam.
- Proactively mentored students from underrepresented groups beyond teaching responsibility and particularly encouraged women and international students in group design projects.

### Harvard University AM105: Introduction to ODE and PDE

Cambridge, MA, USA

Jan 2022 – May 2022

*Teaching Fellow and worked with Professor Zhigang Suo*

- Proactively involved in syllabus design with the course instructor and a team of 5 teaching fellows.
- Led weekly sections and office hours for a class of 80 undergraduate students.
- Designed questions for weekly homework.

### Harvard University AM205: Advanced Scientific Computing

Cambridge, MA, USA

Aug 2021 – Dec 2021

*Teaching Fellow and worked with Professor Chris Rycroft*

- Led weekly office hours for a class of 100 graduate students.
- Independently / collaboratively designed and delivered 5 group activities, covering introduction to Python, the Linux system, using SVD for image processing, differential-algebraic solvers and numerics with neural networks.
- Proactively mentored students on individual and group class projects.

### Harvard University ES181: Engineering Thermodynamics

Cambridge, MA, USA

Jan 2019 – May 2019

*Teaching Fellow and worked with Professor Zhigang Suo*

- Proactively involved in weekly homework design with the course instructor and a team of 4 teaching fellows.
- Led weekly sections and office hours for a class of 40 undergraduate students.
- Created a teaching paradigm, using 3D printed model to demonstrate the P-vT curve interactively in class, which continues to be used in the course in following years.

## AWARDS AND MEDIA COVERAGE

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- Awarded the Best Female Presentation (Graduate Student Entry) at the 17th U.S. National Congress on Computational Mechanics by IACM Female Researchers Chapter, July 2023.
- Awarded the 17th U. S. National Congress on Computational Mechanics Travel Award of USD 385, April 2023.
- Awarded the Braslau Family Travel Grant of USD 1000, March 2023.
- Awarded the Harvard University Professional Development Award of USD 2500, October 2022.
- Awarded the Harvard University Certificate of Distinction in Teaching, October 2021.
- Covered in the APS News "Unraveling the Possibilities of Knitted Materials", June 2021.
- Awarded Institution of Civil Engineers (ICE) Kenneth Watson Travel Award of GBP 1000, June 2016.

## PROFESSIONAL ACTIVITIES AND OUTREACH

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- Meccanica: An International Journal of Theoretical and Applied Mechanics: **Reviewer**, 2019-present.
- United States Association for Computational Mechanics (USACM): **Student Member**, 2021-present.
- Society of Engineering Sciences (SES): **Student Member**, 2021-present.
- Society for Industrial and Applied Mathematics (SIAM): **Student Member**, 2018-present.
- American Physical Society (APS): **Student Member**, 2018-present.
- American Physical Society (APS): **Selected Student Member** to participate in nationwide Advancing Graduate Leadership Mentor Training Workshop proactively obtaining research mentor training, December 2022.
- Women in Data Science Cambridge (WiDS): **Mentor** of 50+ participants at the one-day workshop on machine learning, February 2020.
- Harvard University School of Engineering and Applied Sciences: **Selected Graduate Student Representative** to join departmental panel discussion on promoting diversity, inclusion and equity to create a cohesive student body, September 2021.
- Harvard Science in the News (SITN): **Graphic Designer** communicating science to the general public, 2020-present.
- Harvard Graduate Women in Science and Engineering (HGWISE): **Graduate Student Mentor**, 2019-present.
- Imperial College London: **Selected Departmental Student Industrial Liaison Officer**, raising sustainable funding and organizing career development events, 2015-2016.
- British Royal Academy of Engineering: **STEM Ambassador**, voluntarily organizing nationwide workshops to support underrepresented groups from high schools to study STEM, 2014-2018.

## KEY SKILLS

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**Experimental:** Material characterization using UTM (Instron) and SEM, fabrication of knitted fabrics using home and industrial machines, fabrication of flexible mechanical metamaterials, 3D printer (Ultimaker and Formlabs), laser cutter

**Computational:** C++, Python, MATLAB, Git, Linux, Abaqus, COMSOL, SolidWorks, Autodesk Illustrator, Sketchbook, Blender, Pov-Ray, OpenCV, CNN, RNN, PCA, DIC, differential rendering, parallel computing

**Analytical Analysis:** Computational geometry, statistical analysis, feature extraction, inverse optimization

**Languages:** Mandarin Chinese, English, French, German

## REFERENCES

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**Chris Rycroft** (Primary advisor for doctoral research):

Professor of Mathematics

Department of Mathematics

University of Wisconsin–Madison

725 Van Vleck Hall

480 Lincoln Dr, Madison, WI 53706

and

Associate in Materials Science and Mechanical Engineering

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**Katia Bertoldi** (Committee advisor for doctoral research):

William and Ami Kuan Danoff Professor of Applied Mechanics

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**Joost Vlassak**(Course instructor of ES120 Introduction to Mechanics):

Abbott and James Lawrence Professor of Materials Engineering

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