Yongji Wang

Department of Mathematics, New York University
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EDUCATION

Massachusetts Institute of Technology Cambridge, MA
Ph.D. in Civil and Environmental Engineering 09/2014 –01/2021

- GPA: 5.0/5.0 (full A/A+)
- Advisor: Lydia Bourouiba
- Thesis: "Fundamentals in unsteady fluid fragmentation from drop impact"

University of Cambridge Cambridge, UK
M.A.St in Applied Mathematics (Part III Tripos of Applied Mathematics) 09/2012 –07/2013

- GPA: 3.78/4.00 (79.12/100)   **Distinction** (First class)   Ranking: 22/115
- Advisor: Edward J. Brambley
- Thesis: "The transmission of shock waves in curved tubes"

University of Hong Kong Hong Kong
B.S. in Mechanical Engineering 09/2010 –06/2012

- GPA: 3.9/4.0   **First class honor**   Ranking: 3/77
- Advisor: Kwok Wing Chow
- Thesis: "Nonlinear shallow water waves on running water"

Shanghai Jiao Tong University Shanghai, CN
B.S. in Mechanical Engineering (dual degree with the University of Hong Kong) 09/2008 –06/2010

- GPA: 3.74/4.0   **Top 10%**   Ranking: 6/106

RESEARCH EXPERIENCE

New York University New York, NY
Postdoctoral Associate in the *Courant Institute of Mathematics*   Mentor: Tristan Buckmaster

- Investigation of viscoelastic properties of Antarctica Ice Shelves via deep learning 10/2023 - present
- Discovery of self-similar blow-up solution to 3-D Euler equations via PINNs 10/2023 - present

Princeton University Princeton, NJ
Postdoctoral research associate in the *Department of Geosciences*   Mentor: Ching-Yao Lai

- Data-driven discovery of flow laws of ice shelves 02/2021 - 10/2023
- Coupled observations with physics model to reveal the rheology of Antarctic Ice Shelves.
- Leveraged the remote-sensing observations of ice velocity and thickness and physics-informed neural network to infer two-dimensional effective ice viscosity, strain rate and deviatoric stress of Antarctic Ice Shelves.
- Discovered the substantial difference of ice-shelf rheology between the compression zone, where the ice rheology closely obeys power laws, and extension zones, where ice performs complex rheological behaviors.

Adjunct postdoctoral associate in the *Department of Mathematics*   Co-mentor: Tristan Buckmaster

- Discovery of self-similar blow-up solution via physics-informed neural network 08/2021 - 08/2023

- Established new numerical approach, leveraging physics-informed deep learning and multi-stage training scheme to search for self-similar blow-up solutions to nonlinear fluid equations with high accuracy and efficiency.

- Discovered, for the first time, the self-similar blow-up solution for the 3-dimensional axisymmetric Euler equations in the presence of cylindrical boundary, which sheds new light to the field of mathematical fluid dynamics.

- Discovered, for the first time, the *unstable* self-similar blow-up solutions for the Córdoba-Córdoba-Fontelos (CCF) equations, a milestone towards the solution to the Millennium Prize Navier-Stokes problem.

Massachusetts Institute of Technology   Cambridge, MA
Ph.D student in the *Civil and Environmental Engineering*   Advisor: Lydia Bourouiba

- Persistence of respiratory cloud in shaping disease transmissions   03/2020 - 09/2020
  - Innovated integrated experimental platform, combining Schlieren Imaging, Interferometry Particle Imaging, and Particle Tracking Imaging to capture both gas and droplet phases of human respiratory clouds.
  - Developed hybrid particle tracking algorithms that link Interferometry Particle Imaging with Particle Tracking Velocimetry to measure both size and speed distributions of droplets in respiratory clouds with high precision.

- Fundamentals in unsteady fluid fragmentation on drop impact   09/2015 - 01/2021
  - Innovated fully-automated integrated platform that enables reproduction of complex fragmentation experiments with high efficiency and accuracy, combined with systematic flow visualization and measurement techniques.
  - Developed multi-step Advanced Image-Processing algorithms to capture spatio-temporal evolution of key physical quantities of unsteady fragmentation with unprecedented accuracy.
  - Established a theoretical framework to elucidate fundamental physics underlying unsteady fragmentation that enables the prediction of both size and speed distributions of droplets generated during fragmentation.

- Drop-on-drop interactions on rigid surfaces   09/2014 - 01/2016
  - Discovered four types of interactions upon drop impact in the vicinity of another sessile drop on the surface.
  - Rationalized and predicted the boundaries between different types of drop-on-drop interactions.

Massachusetts Institute of Technology   Cambridge, MA
Principal graduate researcher at *change:WATER Labs* (Clean tech. startup)

- Dignified sanitation solutions for non-sewered communities   09/2015 - 06/2018
  - Invented low-price, compact, standalone and dignified non-sewered toilet, made of specific-designed membrane that enables rapidly shrinking of urban sewage accumulations by evaporation.
  - Designed precise and well-controlled fluid dynamics experiments for measuring the evaporation rate of the toilet under different environmental conditions, including humidity, temperature and pressure.
  - Developed advanced data-processing algorithms that enable systematic analysis of measured experimental data for validating and improving toilet performance.
  - Configured the ventilation system and internal structure of the non-sewered toilet based on systematic tests to maximize its efficiency to shrink liquid sewage by evaporation.

University of Hong Kong   Hong Kong
Research assistant at the *Aerodynamics and Acoustics Laboratory*   Advisor: Lixi Huang

- High-order wave propagation and noise attenuation control in cylindrical ducts   07/2013 - 07/2014
  - Innovated sophisticated experimental setups to mimic the fan noise of aircraft engine.
  - Wrote computational program for simulating superposition of acoustic pressure field from point sources with different phase angles and amplitudes at any positions in cylindrical tubes.

- Introduced new approach of producing rotating sound in a cylindrical tube with single high-order azimuthal mode and designed the duct lining made of micro-perforated panels for high-frequency noise attenuation.

University of Cambridge   Cambridge, UK
Graduate researcher at the *Waves group* of DAMTP   Advisor: Edward J. Brambley

- Transmission of shock waves in curved tubes   12/2012 - 05/2013
  - Researched Whitham's geometrical shock dynamics.
  - Implemented a simple method to derive the geometrical and dynamical relations between the cross-sectional area of the ray tube and the velocity of the shock front.
  - Wrote computational program for simulating the transmission of shock waves in a rectangular tube based on Whitham's geometrical shock dynamics.

University of Hong Kong   Hong Kong
Undergraduate researcher in the department of *Mechanical Engineering*   Advisor: Kwok Wing Chow

- Nonlinear shallow water waves on running water   12/2012 - 05/2013
  - Studied asymptotic expansion and perturbation theory.
  - Mastered the way of deriving the Korteweg-de Vries (KdV) and Kadomtsev-Petviashvili (KP)-type II equations in the case of small-amplitude perturbation and no mean flow.
  - Investigated the problem of uniform flow or shear flow, with focus on the conditions of production of lump solitary wave production at the surface, and its compatibility with the first kind of KP equations.

PUBLICATIONS

Under Review

Y, Wang, C. Y. Lai, D. J. Prior and C. Breen-Cowen, "Deep learning the flow laws of Antarctic Ice Shelves" (2024)

Y, Wang, C. Y. Lai, "DIFFICE-jax: Differentiable neural-network solver for data assimilation of ice shelves in JAX" (2024)

X. Si, **Y, Wang**, and L. Bourouiba, "A light absorption method for dynamic measurement of thin liquid sheet thickness and concentration fields ," (2024).

Journal Articles

1. N. B. Coffey, C. Y. Lai, **Y. Wang**, W. R. Buck, T. Surawy-Stepney, A. E. Hogg., "Theoretical stability of ice shelf basal crevasses with a vertical temperature profile," *Journal of Glaciology*, (2024).

2. **Y, Wang**, and C. Y. Lai, "Multi-stage Neural Networks: Function Approximator of Machine Precision," *Journal of Computational Physics*, **504**, 112865 (2024).

3. **Y, Wang**, C. Y. Lai, J. Gómez-Serrano, and T. Buckmaster. "Asymptotic self-similar blow up profile for 3-D axisymmetric Euler equation via neural networks," *Physical Review Letters*, **130**, 244002 (2023)

4. **Y. Wang** and L. Bourouiba, "Non-Galilean Taylor-Culick law governs sheet dynamics in unsteady fragmentation," *Journal of Fluid Mechanics*, **969**, A19 (2023)

5. **Y. Wang** and L. Bourouiba, "Mass, momentum and energy partitioning of unsteady fragmentation," *Journal of Fluid Mechanics*, **935**, A29 (2022)

6. **Y. Wang** and L. Bourouiba, "Growth and breakup of ligaments in unsteady fragmentation," *Journal of Fluid Mechanics*, **910**, A39 (2021)

7. **Y. Wang** and L. Bourouiba, "Unsteady sheet fragmentation: droplet sizes and speeds," *Journal of Fluid Mechanics*, **848**, 946-967 (2018)

8. **Y. Wang**, R. Dandekar, N. Bustos, S. Poulain and L. Bourouiba, "Universal rim thickness in unsteady sheet fragmentation", *Physical Review Letters*, **120**, 204503 (2018)

9. **Y. Wang** and L. Bourouiba, "Non-isolated drop impacts on surfaces," *Journal of Fluid Mechanics*, **835**, 24-44 (2018)

10. **Y. Wang** and L. Bourouiba, "Drop impact on small surfaces: thickness and velocity profiles of the expanding sheet in the air," *Journal of Fluid Mechanics*, **814**, 510-534 (2017)

Conference Papers

1. J. Ng, **Y. Wang**, C. Y. Lai, "Spectrum-informed multistage neural network: Multiscale function approximator of machine precision," *ICML Workshop*, (2024).

2. C. Cowen-Breen, **Y. Wang**, C. Y. Lai, "Euler operators for mis-specified physics-informed neural networks," *ICML Workshop*, (2024).

Google Scholar link: Yongji Wang

Teaching experience

Princeton University

- Guest lecturer of *Deep learning in Geophysical Fluid Dynamics (AOS551)*   Fall 2021 & 2022
  Graduate-level course   Class size: 20-30 students
  – Taught students two lectures on fundamental principles and techniques of physics-informed neural networks.
  – Prepared code examples for students to study TensorFlow and learn to write basic algorithms using physics-informed neural network.

Massachusetts Institute of Technology

- Teaching Assistant of *Nonlinear Dynamics and Turbulence (1.686/18.358/2.033)*   Spring 2017 & 2020
  Graduate-level course   Class size: 10-15 students   Twice
  – Held and led office hours, tutorials, and graded problem sets.
  – Assisted students to understand lecture materials and illustrate problem sets.

- Teaching Assistant of *Fluids and Diseases (1.063/1.631/2.250/HST.537)*   Spring 2017 – 2019
  Graduate-level course   Class size: 10-15 students   Three times
  – Improved teaching materials including problem sets and their solutions.
  – Prepared equipment for in-class demonstration.
  – Taught students recitations and lectures on fundamental fluid dynamics.

- Created teaching demonstration GUIs to illustrate how spatial information affects disease transmission.

- Teaching Assistant of *Nonlinear Dynamics: Continuum Systems (1.062/18.354)*   Spring 2016 & 2018
  Graduate-level course   Class size: 10-15 students   Twice
  - Improved teaching materials including problem sets and their solutions.
  - Prepared equipment of the lab session for students to conduct experiments.
  - Taught recitations of the course for students to prepare quizzes and mid-term exams.

- Assistant of *Innovation and Technology in Agriculture and the Environment*   Summer 2017
  MIT Professional Education Short Program   Class size: 10-15 participants
  - Prepared equipment and notes for the laboratory demonstration.

Mentoring experience

New York University

- Josh Rhines   Ph.D student   05/2023 - present
  Topic: Stress perturbation of the Greenland Ice Sheet in response to its basal lubrication
  - prepared the manuscript for the submission to the Journal of Fluid Mechanics

- Charlie Cowen-Breen   Ph.D student   01/2024 - 07/2024
  Topic: Over-constraint and cheating effect of physics-informed neural networks (PINNs)
  - published a conference paper in the ICML (2024) Workshop: AI for Science

- Jakin Ng   Undergraduate student   07/2023 - 05/2024
  Topic: Specturm information multi-stage neural networks for machine precision
  - published a conference paper in the ICML (2024) Workshop: AI for Science

Princeton University

- Evans Chandran   Undergraduate student   01/2023 - 05/2023
  Junior Project (JP): Investigating glacial ice flow regimes via physics-informed neural networks

- Charlie Cowen-Breen   Undergraduate student   02/2021 - 05/2022
  Thesis: Investigating glacial ice flow regimes via physics-informed neural networks
  - Received the Sigma Xi Book Award in the Math Department for his senior thesis research
  - Received the Peter A. Greenberg '77 Prize in the Math department for junior undergraduates

Massachusetts Institute of Technology

- Xinyu Si   Master student   05/2019 - 12/2019
  Project: Developing light-absorption method for the measurement of interfacial phenomena
  - Submitted a paper to the *Experiments in Fluids*

- Tyler J. Pleasant   Undergraduate student   01/2016 - 05/2016
  Project: Developing image-processing algorithm to analyze drop fragmentation processes

- Budmonde Duinkhar   Undergraduate student   11/2014 - 02/2015
  Project: Quantifying the fragmentation phenomenon of drop-on-drop interactions

PRESENTATIONS

Invited Talks

- *"Multi-stage neural networks achieving machine precision,"* Department Seminar of Mathematical Science, Korea Advanced Institute of Science & Technology, Daejeon, Korean (May 2024)

- *"Multi-stage neural networks achieving machine precision,"* FRG conference of PDEs of incompressible fluid flows, computer assisted proofs and nueral networks, Minneapolis, MN (April 2024)

- *"Application of fundamental fluid mechanics in disease transmissions,"* Feilan Environmental and Health Seminar, Chinese Society for Environmental Science, Beijing, China (Oct. 2023)

- *"Physics informed neural networks for self-similar blow-up solutions,"* PDE & Applied Math Seminar, University of Maryland, College Park, MD (Nov. 2022)

- *"Physics informed neural networks for blow-up solutions of Euler equations,"* PDE & Applied Math Seminar, University of California, Davis, CA (Oct. 2022)

- *"Physics informed neural networks for self-similar blow-up solutions,"* Scientific Machine Learning Webinar, Carnegie Mellon University, Pittsburgh, PA (Oct. 2022)

- *"Physics-informed neural netowrk for fluid mechanics,"* Challenges and Prospects of ML for the Physical Sciences, Simons Fundation, New York, NY (June 2022)

- *"Physics-informed neural netowrk for blow-up solutions of Euler equation,"* Mathematics, Physics & Machine Learning webinar, Lisbon, Portugal (May 2022)

- *"Physics-informed neural netowrk for self-similar blow-up solutions,"* PDE and Applications Seminar, Uppsala, Sweden (May 2022)

Seminar Talks

- *"Discovering self-similar blow-up solutions using physics-informed neural networks,"* M2lines ML meeting, New York University, NY (May 2024)

- *"Assessing ice rheology using physics-informed deep learning,"* West Antarctic Ice Sheet Workshop, University of Minnesota , MN (Sep. 2023)

- *"Discovering ice-shelf rheology via physics-informed neural network,"* GEO Climate Seminar, Princeton University, NJ (Oct. 2022)

- *"Inferring flow law of ice shelves using physics-informed neural network,"* Soft Matter Coffee Hour, Princeton University, NJ (April 2022)

Conference Talks

- **Y. Wang**, C. Y. Lai, D. Prior and C. Cowen-Breen *"Assessing ice rheology using physics-informed deep learning,"* American Geophysical Union Fall Meeting, San Francisco, CA (December 2023)

- **Y, Wang**, C. Y. Lai, J. Gómez-Serrano, and T. Buckmaster *"Discovering self-similar blow-up solutions using physics-informed neural networks,"* 76th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Washington DC (November 2023)

- **Y. Wang**, C. Cowen-Breen, and C. Y. Lai *"Discovery of ice shelf rheology via physics-informed neural network,"* American Geophysical Union Fall Meeting, Chicago, IL (December 2022)

- **Y. Wang**, C. Cowen-Breen, and C. Y. Lai *"Discovery of ice shelf rheology via physics-informed neural network,"* 75th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Indianapolis, IN (November 2022)

- **Y. Wang**, E. Pomerantz, C. Cowen-Breen, R. Chou and C. Y. Lai *"Inferring flow law of ice shelves using physics-informed neural network,"* 74th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Phoenix, AZ (November 2021)

- **Y. Wang** and L. Bourouiba *"Unsteady fragmentation upon drop impact: Sheet dynamics,"* 72th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Seattle, WA (November 2019)

- L. Bourouiba and **Y. Wang** *"Unsteady fragmentation upon drop impact: prediction of droplet size and speed distributions,"* 72th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Seattle, WA (November 2019)

- **Y. Wang** and Bourouiba *"Pathogen transmission via droplets during unsteady fragmentation,"* 1st Fluid and Health Conference, Cargése, Corsica (August 2019)

- **Y. Wang** and L. Bourouiba *"Ligament dynamics along unsteady rims"*, 71th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Atlanta, GA (November 2018)

- L. Bourouiba and **Y. Wang** *"Rim thickness evolution in unsteady sheet fragmentation,"* 71th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Atlanta, GA (November 2018)

- **Y. Wang** and L. Bourouiba *"Rim destabilization in unsteady sheet expansion in the air from drop impact on small surfaces,"* 70th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Denver, CO (November 2017)

- L. Bourouiba and **Y. Wang** *"Role of unsteadiness and local dynamics in the selection of secondary droplet sizes in drop impact fragmentation,"* 70th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Denver, CO (November 2017)

- **Y. Wang** and L. Bourouiba *"Unified thickness profile of radially expanding sheets in the air,"* 69th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Portland, OR (November 2016)

- L. Bourouiba and **Y. Wang** *"Binary drop interaction on surfaces: onset and bounding ligaments of Crescent-Moon fragmentation,"* 69th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Portland, OR (November 2016)

Competition and Pitch Talks

- **Y. Wang**, C. Smith, H. Elasaad and Y. Cao *"Dignified sanitation solutions for non-sewered communities"* (Third Prize and Audience-Choice Award), MIT $100k Entrepreneurship Competition, Cambridge, MA (May 2017)

- **Y. Wang**, C. Smith, H. Elasaad and Y. Cao *"Dignified sanitation solutions for non-sewered communities"* (Finalist), Hultz Prize regional competition, Boston, MA (March 2017)

- **Y. Wang** and L. Bourouiba *"Drop fragmentation in shaping disease transmissions"* (Winner), Research Speed Dating Event, Department of Civil and Environmental Engineering, MIT (February 2017)

- **Y. Wang**, C. Smith, H. Elasaad and Y. Cao *"Dignified sanitation solutions for non-sewered communities"* (Winner), Hult Prize competition@MIT, Cambridge, MA (November 2016)

Poster Presentations

- **Y. Wang** and C. Y. Lai *"Inferring viscosity of ice shelves using physics-informed neural network,"* Ice-Ocean Interactions on Icy Moons in the Solar System Workshop, Princeton Center for Theoretical Science, Princeton, NJ (April 2022)

- **Y. Wang** and L. Bourouiba *"Fundamentals in unsteady fluid fragmentation,"* Research Speed Dating Event, Department of Civil and Environmental Engineering, MIT (February 2020)

- **Y. Wang** and . Bourouiba *"Fundamentals in unsteady fluid fragmentation with applications to disease transmissions,"* Industrial Group Symposium of Institute for Medical Engineering and Science, MIT (October 2019)

HONORS AND AWARDS

Academic Awards

- John S. Hennessy OGE Fellowship   2017

  Competitive institutional fellowship (one per year) awarded to graduate students with strong academic and research performance by the Office of Graduate Education, Massachusetts Institute of Technology.

- MIT GSC Travel Grant   2017 & 2019

  Competitive institutional travel grant awarded by the Graduate Student Council, Massachusetts Institute of Technology, in support of travel expenses for graduate students who present talks in academic-related conferences.

- Best Talk Award of MIT CEE Research Speed Dating Event   2017

  The first prize of the graduate student presentation competition at the Research Speed Dating Event hosted by the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology.

- Berger Fellowship   2015

  Honorific fellowship awarded to newly-enrolled graduate students with strong academic and research background by the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology

- Cambridge Darwin College Prize   2013

  Honorific prize awarded to the students in Darwin College who achieve Distinction for their degrees by Darwin College, the University of Cambridge.

- Dean's Honor List of the Faculty of Engineering, HKU   2011 & 2012

  Highest academic prize awarded to the top 5% undergraduate students with the best academic performance by the Faculty of Engineering, the University of Hong Kong.

- CEDES Scholarship   2008-2012

  Competitive institutional 4-year scholarship (two per year) awarded to undergraduate students of Shanghai Jiao Tong University with strong academic performance by the CEDES Corporation.

- Merit Student of Shanghai Jiao Tong University   2010

  Highest individual prize awarded to undergraduate students with the best comprehensive qualities including academic, research and social activities by Shanghai Jiao Tong University.

- Top Ten learning pacesetter of the Faculty of Engineering, SJTU   2010

  Highest academic prize awarded to undergraduate students with with the best academic performance by the Faculty of Engineering, Shanghai Jiao Tong University.

- Scholarship of Shanghai Jiao Tong University   2009 & 2010

  Competitive institutional scholarship awarded to the top 10% undergraduate students with the best academic performance by Shanghai Jiao Tong University.

- The Third Prize of Applied Mathematics contest of Shanghai City   2008

- The First Prize of Physics contest of Shanghai City   2008

Entrepreneurship Awards (*change:WATER Labs*)

- MIT Water Innovation Prize Winner   2017

  The first prize of MIT Water Innovation Competition, a startup competition focused on water innovation, with $10k grant awarded by the MIT Water Club.

- MIT $100k Entrepreneurship Competition Audience-Choice-Award   2017

  The third prize of MIT $100k Entrepreneurship Competition, one of the largest and world famous business plan competitions, with $10k grant awarded by the MIT Entrepreneurship Center.

- Hult Prize@MIT Winner   2017

  The first prize of Hult Prize Competition at MIT, one of the world famous social entrepreneurship awards.

- Harvard Arab Weekend 5th Start-Up Pitch Competition Winner   2016

  The first prize of Harvard Arab Weekend 5th Start-Up Pitch Competition, with $10k grant awarded by the Harvard Business School MENA club and the Harvard Arab Alumni Association.

- Tamer Social Impact Fund   2016

  Winner of the seed grants of $25k to nonprofit, for-profit, and hybrid early-stage social and environmental ventures awarded by Columbia University.

- MIT Enterprise Forum PanArab Innovation for Refugees Competition Winner   2016

  The first prize of a global competition for the best tech-driven solutions addressing the challenges faced by refugees across the globe, with $10k grant awarded by MIT Enterprise Forum PanArab Innovation for Refugees.

- Mass Clean Energy Council Catalyst Award   2016

  Winner of the seed grants of $50k to researchers and early-stage companies looking to demonstrate initial prototypes of their clean energy technologies awarded by the Mass Clean Energy Council.

- MIT IDEAS Global Challenge: Grant Winner   2015

  The first prize of the MIT IDEAS Global Challenge competition, an annual innovation and social entrepreneurship competition for MIT students, with $5K grant awarded by the MIT Innovation Initiative.