Stanford

Ching-Yao Lai

Assistant Professor of Geophysics

Bio

BIO

My group attacks fundamental questions in ice-dynamics, geophysics, and fluid dynamics by integrating mathematical and machine-learned models with observational data. We use our findings to address challenges facing the world, such as advancing our scientific knowledge of ice dynamics under climate change. The length scale of the systems we are interested in varies broadly from a few microns to thousands of kilometers, because the governing physical principles are often universal across a range of length and time scales. We use mathematical models, simulations, and machine learning to study the complex interactions between fluids and elasticity and their interfacial dynamics, such as multiphase flows, flows in deformable structures, and cracks. We extend our findings to tackle emerging topics in climate science and geophysics, such as understand the missing physics that governs the flow of ice sheets in a warming climate. We welcome collaborations across disciplinary lines, from geophysics, engineering, physics, applied math to computer science, since we believe combining expertise and methodologies across fields is crucial for new discoveries.

ACADEMIC APPOINTMENTS

- Assistant Professor, Geophysics
- Member, Institute for Computational and Mathematical Engineering (ICME)

ADMINISTRATIVE APPOINTMENTS

- Executive Committee Member, Topical Group on the Physics of Climate, American Physical Society (APS), (2021-2023)

HONORS AND AWARDS

- Sloan Research Fellowship, Alfred P. Sloan Foundation (2024-2026)
- Research Scholar Award, Google Research (2023-2024)
- Lamont Postdoctoral Fellowship, Lamont-Doherty Earth Observatory, Columbia University (2018-2019)

PROFESSIONAL EDUCATION

- Ph.D., Princeton University , Mechanical and Aerospace Engineering (2018)
- B.S., National Taiwan University , Physics (2013)

LINKS

- Lai Research Group Website: https://icyphysics.stanford.edu/
- Google Scholar: https://scholar.google.com/citations?user=e1kTy34AAAAJ&hl=en

Teaching

COURSES

2023-24

- Icy Geophysics: GEOPHYS 385I (Aut, Win, Spr, Sum)
- Machine Learning and the Physical Sciences: CME 215, GEOPHYS 148, GEOPHYS 248 (Spr)
- Scientific Machine Learning: GEOPHYS 385M (Win)

STANFORD ADVISEES

Postdoctoral Faculty Sponsor

Olivia MENG, Facu Sapienza

Postdoctoral Research Mentor

Stephanie Olinger

Publications

PUBLICATIONS

- **Multi-stage neural networks: Function approximator of machine precision** *JOURNAL OF COMPUTATIONAL PHYSICS*
  Wang, Y., Lai, C.
  2024; 504
- **Realistic tropical cyclone wind and pressure fields can be reconstructed from sparse data using deep learning** *COMMUNICATIONS EARTH & ENVIRONMENT*
  Eusebi, R., Vecchi, G. A., Lai, C., Tong, M.
  2024; 5 (1)
- **One-dimensional ice shelf hardness inversion: Clustering behavior and collocation resampling in physics-informed neural networks** *JOURNAL OF COMPUTATIONAL PHYSICS*
  Iwasaki, Y., Lai, C.
  2023; 492
- **Asymptotic Self-Similar Blow-Up Profile for Three-Dimensional Axisymmetric Euler Equations Using Neural Networks.** *Physical review letters*
  Wang, Y., Lai, C. Y., Gómez-Serrano, J., Buckmaster, T.
  2023; 130 (24): 244002
- **Hydraulic transmissivity inferred from ice-sheet relaxation following Greenland supraglacial lake drainages.** *Nature communications*
  Lai, C. Y., Stevens, L. A., Chase, D. L., Creyts, T. T., Behn, M. D., Das, S. B., Stone, H. A.
  2021; 12 (1): 3955
- **Vulnerability of Antarctica's ice shelves to meltwater-driven fracture.** *Nature*
  Lai, C. Y., Kingslake, J., Wearing, M. G., Chen, P. C., Gentine, P., Li, H., Spergel, J. J., van Wessem, J. M.
  2020; 584 (7822): 574-578
- **Bubble Bursting: Universal Cavity and Jet Profiles.** *Physical review letters*
  Lai, C. Y., Eggers, J., Deike, L.
  2018; 121 (14): 144501
- **Foam-driven fracture.** *Proceedings of the National Academy of Sciences of the United States of America*
  Lai, C. Y., Rallabandi, B., Perazzo, A., Zheng, Z., Smiddy, S. E., Stone, H. A.
  2018; 115 (32): 8082-8086
- **Suppressing viscous fingering in structured porous media.** *Proceedings of the National Academy of Sciences of the United States of America*
  Rabbani, H. S., Or, D., Liu, Y., Lai, C. Y., Lu, N. B., Datta, S. S., Stone, H. A., Shokri, N.

2018; 115 (19): 4833-4838

- **Elastic Relaxation of Fluid-Driven Cracks and the Resulting Backflow.** *Physical review letters*
  Lai, C. Y., Zheng, Z., Dressaire, E., Ramon, G. Z., Huppert, H. E., Stone, H. A.
  2016; 117 (26): 268001