

Xinyu Si

Postdoctoral Associate, Department of Mechanical Engineering, University of Rochester

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Research Profile

I am an experimental fluid mechanician studying how forcing, boundaries, and dispersed or active matter reshape momentum, mass, and heat transport in turbulent flows, from thin-layer turbulence to rotating thermal convection. I combine laboratory experiments with advanced flow diagnostics to identify the physical mechanisms that make transport predictable and controllable.

Research Appointments

University of Rochester	2025–Present
<i>Postdoctoral Associate, Mechanical Engineering</i>	<i>Rochester, NY</i>

Douglas H. Kelley Group

- Investigate heat and momentum transport, flow regimes, and coherent structures in rotating thermal convection.
- Lead the development of ToRoCo, including apparatus design, thermal diagnostics, volumetric 3D PTV, and student training.

Johns Hopkins University	2024
<i>Visiting Researcher, Mechanical Engineering</i>	<i>Baltimore, MD</i>

Rui Ni Group

- Collaborated on turbulence-generation system design and installation for the Fish Aquarium with a Turbulent Environment (FATE) project.
- Implemented and calibrated a 3D PTV system for turbulence measurements in the FATE facility.

Massachusetts Institute of Technology	2019
<i>Visiting Researcher, Mechanical Engineering</i>	<i>Cambridge, MA</i>

Lydia Bourouiba Group

- Worked on a light-absorption method for time-resolved measurement of thin liquid-sheet thickness and concentration fields during drop impact.

Education

University of Pittsburgh	2020–2025
Ph.D., Civil and Environmental Engineering; Minor: Mathematics	

Dissertation: *The Two-Way Coupling Between Active Matter and Transport Barriers in Turbulent Flows*. Advisor: Lei Fang.

Stanford University	2018–2020
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M.S., Civil and Environmental Engineering

Tongji University	2014–2018
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B.S., Environmental Engineering

Additional study: University of California, Berkeley, concurrent enrollment, Civil and Environmental Engineering, 2017–2018.

Peer-Reviewed Publications

1. Ziyue Yu, **Xinyu Si**, Lei Fang. “Tensor-geometry-activated spectral energy transfer at Reynolds numbers of order unity in two-dimensional flows.” *Journal of Fluid Mechanics* **1044**, A32 (2026).
2. **Xinyu Si**, Filippo De Lillo, Guido Boffetta, Lei Fang. “Manipulating the direction of turbulent energy flux via tensor geometry in a two-dimensional flow.” *Science Advances* **11**, eadv0956 (2025).
3. **Xinyu Si**, Lei Fang. “Interaction between swarming active matter and flow: the impact on Lagrangian coherent structures.” *Physical Review Fluids* **9**, 033101 (2024). **Editor’s Suggestion; Physical Review Fluids’ Top Papers of 2024.**
4. **Xinyu Si**, Lei Fang. “Biologically generated turbulent energy flux in shear flow depends on tensor geometry.” *PNAS Nexus* **3**, pgae056 (2024).
5. **Xinyu Si**, Lei Fang. “Preferential transport of swimmers in heterogeneous two-dimensional turbulent flow.” *Physical Review Fluids* **7**, 094501 (2022).

6. **Xinyu Si**, Lei Fang. “Preferential alignment and heterogeneous distribution of active non-spherical swimmers near Lagrangian coherent structures.” *Physics of Fluids* **33**, 073303 (2021). **Editor’s Pick.**
7. **Xinyu Si**, Lei Fang. “A novel social distance model reveals the sidewall effect at bottlenecks.” *Scientific Reports* **11**, 20982 (2021).

Manuscripts Under Review and Submitted

- **Xinyu Si**, Filippo De Lillo, Guido Boffetta, Lei Fang. “Disrupting giant ocean transport barriers with small perturbations.” *Science Advances*. **Under revision.**
- **Xinyu Si**, Mohammad Y. Abdelshafy, Amirhooshang Zeraatkardevin, Athena Summers, Christopher Muir, Jonathan Cheng, Douglas Kelley. “ToRoCo: Rotating convection device with three-dimensional velocity measurements and boundary topography.” *Review of Scientific Instruments*. **Submitted.**

Media Coverage

Quanta Magazine

October 2, 2026

Stephen Ornes. “Sea Monkeys Show Scientists How To Rewrite a Rule of Turbulence.”

Feature article covering my research on tensor geometry and turbulent energy transfer, including our *PNAS Nexus* (2024) and *Science Advances* (2025) studies.

Honors and Recognition

- Second Place, CEE Research Day Research Presentation Competition, University of Pittsburgh 2025
- First Place, CEE Research Day Research Presentation Competition, University of Pittsburgh 2024
- EGSO / CEE Travel Grant, University of Pittsburgh 2022
- Golden West Section A&WMA Scholarship, Stanford University 2019
- First Prize, Tongji Scholarship for Excellence (top 10%) 2017, 2016

Selected Conference Presentations

- **APS Division of Fluid Dynamics, 2026**, Orlando, FL (upcoming). “Lagrangian transport, coherent structures, and helicity in turbulent rotating Rayleigh–Bénard convection experiments.”
- **APS Division of Fluid Dynamics, 2025**, Houston, TX. “Helicity in rotating convection with topography: 3D Lagrangian particle tracking in ToRoCo.”
- **AGU Annual Meeting, 2025**, New Orleans, LA (poster). “Helicity in rotating convection with boundary topography: experimental insights from ToRoCo and implications for core dynamics.”
- **APS Division of Fluid Dynamics, 2024**, Salt Lake City, UT. “Manipulating the direction of spectral energy flux in a thin-layer flow.”
- **APS March Meeting, 2024**, Minneapolis, MN; **APS Division of Fluid Dynamics, 2023**, Washington, DC. “Interaction between swarming active matter and flow: the impact on Lagrangian coherent structures.”
- **APS Division of Fluid Dynamics, 2022**, Indianapolis, IN. “Preferential transport of swimmers in heterogeneous two-dimensional turbulent flow.”
- **AGU Annual Meeting, 2021**, New Orleans, LA (poster). “Preferential alignment and heterogeneous distribution of non-spherical swimmers near Lagrangian coherent structures.”

Service

- **Journal reviewer:** *Physics of Fluids* (6 reviews), *Water Science* (1 review) 2025–Present
- Session Chair, Geophysical Fluid Dynamics: Rotating Flows, APS Division of Fluid Dynamics Annual Meeting, Orlando, FL 2026

Student Mentoring

- **Ariane Yedidia**, undergraduate, University of Rochester (2026–Present). PTV data analysis and Lagrangian statistics.
- **Amirhooshang Zeraatkardevin**, Ph.D. student, University of Rochester (2025–Present). ToRoCo design and construction, 3D PTV operation, and data analysis.
- **Brandon Scortino**, undergraduate, University of Rochester (2025–Present). 3D PTV operation, camera calibration, and image processing.
- **Ziyue Yu**, Ph.D. student, University of Pittsburgh (2024). Electromagnetically driven thin-layer flows, image processing, 2D PTV, and flow analysis.

- **Hao Yu**, Ph.D. student, University of Pittsburgh (2021). Particle-tracking algorithms and step-frequency filtering.
- **Jamison Beveridge**, undergraduate, University of Pittsburgh (2021). Swimmer transport in turbulence, particle-advection schemes, and the Vicsek model.

Teaching Experience

University of Pittsburgh

- **CEE 1410: Hydrologic Analysis and Design**. Teaching assistant and laboratory instructor, Fall 2024.
- **CEE 1402: Fluid Mechanics**. Teaching assistant and laboratory instructor, Spring 2022.
- **CEE 1105: Materials of Construction**. Teaching assistant and laboratory instructor, Spring 2021.
- **CEE 1412: Introduction to Water Resources Engineering**. Teaching assistant and grader, Fall 2020, Fall 2021, and Spring 2025.