Takumi Matsuzawa

CONTACT INFORMATION

Laboratory of Atomic and Solid State Physics
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EDUCATION

University of Chicago, Chicago, IL 2016 - 2023
Ph.D., Physics, Dissertation: *Life, death, and propagation of turbulence*
Committee: William T. M. Irvine (Chair), Sidney R. Nagel, Fausto Cattaneo, Stephanie Palmer
M.S., Physics, Project title: *Splashing of low-viscosity fluid* 2016 - 2017
Mentor: Sidney R. Nagel

Kalamazoo College, Kalamazoo, MI 2013 - 2016
B.A., Physics and Chemistry, *summa cum laude with distinction*
Mentor: Jan Tobochnik

RESEARCH APPOINTMENTS

Nanyang Technological University, School of Mechanical and Aerospace Engineering
Nanyang Assistant Professor Starting in 2027

Cornell University, Laboratory of Atomic and Solid State Physics
Schmidt Science Postdoctoral Fellow 2024 - present
Postdoctoral Associate 2023 - 2024
Mentor: Eric R. Dufresne

FELLOWSHIPS AND AWARDS

Science as Art Competition, 1st Prize, University of Chicago 2026
BPS 2026 Travel Award, Biophysical Society 2026
Schmidt Science Fellowship, Schmidt Sciences in partnership with the Rhodes Trust 2024 - 2026
Grainger Foundation Fellowship, University of Chicago 2022 - 2023
Gallery of Fluid Motion Award, APS Division of Fluid Dynamics 2022
Sidney Nagel Prize for Creativity in Research, University of Chicago 2020
Robert G. Sachs Fellowship, University of Chicago 2016
John Wesley Hornbeck Prize for Excellence in Physics, Kalamazoo College 2016
Senior Leadership Recognition Award for Excellence in Teaching, Kalamazoo College 2016
Lee Teng Undergraduate Fellowship in Accelerator Science and Engineering, Fermilab 2015
39th Lower Michigan Mathematics Competition, 2nd Place 2015
AWS Fellowship for Science, Kalamazoo College 2014 - 2016

RESEARCH INTERESTS

Soft condensed matter physics; fluid mechanics; biophysics; biomolecular condensates; liquid–liquid phase separation; complex fluids; turbulence

PUBLICATIONS

Key publications are marked with ★.
Journals:

Partition Coefficients Reveal Changes in Properties of Low-Contrast Biomolecular Condensates
K. Varma, D. Matthias, C. B. Shapiro, S. Bailey-Darland, **T. Matsuzawa**, C. Lorenz, T. Bate, S. J. Thornton, S. Duraivel, R. W. Style, J. P. Sethna, E. R. Dufresne, *bioRxiv* 10.64898/2026.02.20.707107 (2026). [Link]; Accepted in *Nature Communications*.

Phase behavior of solvent-nematogen mixtures
S. Bailey-Darland, **T. Matsuzawa**, Eric R. Dufresne, ***Soft Matter***, **123**, 34: 5745–5755, (2026). [Link]

★Susceptibility and Regulation of Biomolecular Condensates by Solutes
T. Matsuzawa, K. Varma, T. Bate, C. Lorenz, K. Larina, J. Bauermann, D. Matthias, T. Grubić, R. W. Style, M. O. Steinmetz, E. R. Dufresne, ***Proc. Natl. Acad. Sci.***, **123**, 31, e2604434123, (2026). [Link]
Media coverage (selected):
Phys.org (2026), Cell biochemistry beyond membranes [Link]
Cornell Chronicle (2026), Cell biochemistry beyond membranes [Link]

★Nonlinear diffusion and decay of a blob of turbulence spreading into a quiescent fluid
T. Matsuzawa, M. Zhu, N. Goldenfeld, W. T. M. Irvine, ***Proc. Natl. Acad. Sci.***, **123**, 7, e2526858123, (2026). [Link]; selected for cover image.

Media coverage (selected):

Phys.org (2026), A 'blob' in a tank is helping scientists tease out the secrets of turbulence[Link]

The University of Chicago (2026): UChicago Science as Art Competition, 1st Prize [Link]

★Self-propulsion, flocking and chiral active phases from particles spinning at intermediate Reynolds numbers

P. Chen, S. Weady, S. Atis, **T. Matsuzawa**, M. Shelley, W. T. M. Irvine, ***Nature Physics***, **21**, 146–154 (2025). [Link]; selected for cover image.

Media coverage (selected):

Nature Physics, News & Views (2024): "Spinning into new regimes" [Link]

Phys.org (2024): "Tiny rotating particles create vorticity in viscous fluids, yielding fascinating new behaviors" [Link]

★Creation of an isolated turbulent blob fed by vortex rings

T. Matsuzawa, N. P. Mitchell, S. Perrard, W. T. M. Irvine, ***Nature Physics***, **19**, 1193–1200 (2023). [Link]; selected for cover image.

Research Briefing:

Turbulence can be sustained and controlled using coherent vortex rings,
T. Matsuzawa, W. T. M. Irvine, ***Nature Physics***, **19**, 1088–1089 (2023). [Link]

Media coverage (selected):

Nature, Research Highlight (2023): "Smash-ups make a tame blob of turbulence." [Link]

Quanta Magazine (2020): "An unexpected twist lights up the secrets of turbulence." [Link]

Turbulence through sustained vortex ring collisions

T. Matsuzawa, N. P. Mitchell, S. Perrard, W. T. M. Irvine, ***Physical Review Fluids***, **8**, 11507 (2023). [Link]

Multi-scale modeling of altered synaptic plasticity related to amyloid β effects

T. Matsuzawa, L. Zalányi, T. Kiss, and P. Érdi, ***Neural Networks***, **93**, 230-239 (2017). [Link]

Book chapters:

Connecting epilepsy and Alzheimer's disease: Modeling of normal and pathological rhythmicity and synaptic plasticity related to amyloid β effects

P. Érdi, **T. Matsuzawa**, T. John, T. Kiss, and L. Zalányi. In *Computational Neurology and Psychiatry*, pp. 93-120. Springer, Cham. (2017). [Link]

Workshop papers (peer-reviewed):

Evaluating machine learning models with NERO: non-equivariance revealed on orbits

Z. Zhao, **T. Matsuzawa**, W. T. M. Irvine, M. Maire, G. L. Kindlmann, ***NeurIPS Workshop on Interpretable AI*** (2024). [Link]

Commentary:

Wetting beyond equilibrium

T. Matsuzawa, ***Nature Physics***, (2026). DOI: 10.1038/s41567-026-03252-0; *invited*. [Link]

In preparation:

Liquid FUS protein condensates exhibit a gas-like structure

C. Lorenz, N. Hess, S. Bailey-Darland, **T. Matsuzawa**, T. Bate, G. Wang, K. Varma, D. Matthias, H. Koganti, L. Pollack, B. Schuler, J. Joseph, and E. R. Dufresne.

Small-angle X-ray scattering from phase-separated mixtures

S. Bailey-Darland, C. Lorenz, **T. Matsuzawa**, T. Bate, U. Wiesner, V. Elser, B. Schuler, and E. R. Dufresne.

Talks

2026 Northeast Regional Disordered Proteins Workshop: Function Without Form, Syracuse, NY Sep 2026

"Susceptibility and Regulation of Biomolecular Condensates by Solutes"

Stony Brook University, Simons Center for Geometry and Physics, Stony Brook, NY Sep 2026

"Nonlinear diffusion and decay of a turbulent blob" *(invited)*

Kyushu University, Fukuoka, Japan — May 2026

"Susceptibility and Regulation of Biomolecular Condensates by Solutes" *(invited; Japanese)*

Nanyang Technological University, The School of Mechanical and Aerospace Engineering, online

"Propagation and Decay of a Turbulent Blob" *(invited)* — May 2026

Kalamazoo College Physics Department Seminar, Kalamazoo, MI — Apr 2026

"From smoke rings to turbulence" *(invited)*

Biophysical Society Annual Meetings, San Francisco, CA — Feb 2026

"Designing enzymatic regulation of biomolecular condensates"

- Won **BPS Travel Award** to attend

Simons Seminars on Turbulence, Simons Foundation, online — Dec 2025

"Nonlinear diffusion and decay of an expanding turbulent blob" *(invited)*

2025 Interdisciplinary Science Summit, Pasadena, CA — Jul 2025

"Liquid machinery in cells: A physicist's pivot" *(invited)*

Syracuse University Soft Matter and Biological Physics Seminar, Syracuse, NY — May 2025

"Expanding into quiescence: how turbulence spreads and decays" *(invited)*

APS March Meeting, Minneapolis, MN — Mar 2024

"Decay and nonlinear diffusion of turbulence"

APS Division of Fluid Dynamics, Washington D.C. — Nov 2023

"Decay and propagation of an isolated turbulent blob"

APS March Meeting, Las Vegas, NV — Mar 2023

"Life, death, and propagation of an isolated turbulent blob fed by vortex loops"

APS Division of Fluid Dynamics, Indianapolis, IN — Nov 2022

"Creation of an isolated turbulent blob sustained by vortex ring injection"

Okinawa Institute of Science and Technology, Okinawa, Japan — Dec 2022

"Creation of an isolated turbulent blob fed by vortex rings" *(invited)*

APS March Meeting, Chicago, IL — Mar 2022

"Creation of an isolated turbulent blob sustained by vortex ring injection"

University of Chicago JFI Friday Seminar, Chicago, IL — Jan 2022

"From vortex reconnections to turbulence" *(invited)*

APS March Meeting (virtual) — Mar 2021

"Confined turbulence through multiple vortex ring collision"

APS Division of Fluid Dynamics (virtual) — Nov 2020

"Realization of confined turbulence through multiple vortex ring collision"

University of Chicago JFI Friday Seminar, Chicago, IL — May 2019

"How does nature cook and eat up a turbulent puff?"

APS March Meeting, Boston, MA — Mar 2018

"Realization of confined turbulence through multiple vortex ring collision"

University of Chicago JFI Friday Seminar, Chicago, IL — Apr 2017

"Confinement of turbulence" *(invited)*

Complex Systems Conference, Kalamazoo, MI — Dec 2017

"Multi-scale modeling of altered synaptic plasticity related to amyloid-β effects"

Research Expo, Fermi National Accelerator Laboratory, Batavia, IL — Aug 2016

"Targeting studies of the second-generation Mu2e experiment" [Link]

Research Expo, KEK (High Energy Accelerator Research Organization), Japan — Aug 2014

"Laser break-down spectroscopy on alloys"

Poster Presentations

Gordon Research Seminar & Conference: Soft Condensed Matter Physics — Aug 2025

"Local probes of high-dimensional phase equilibria for Biomolecular Condensates" [PDF]

The 12th Liquid Matter Conference, Mainz, Germany — Sep 2024

"Solutes shift phase equilibria of biomolecular condensates" [PDF]

Simons Foundation Workshop: Turbulence Across Vast Scales, New York, NY — Dec 2019

"Realization of confined turbulence through multiple vortex ring collision" [PDF]

Annual Meeting of Society for Neuroscience, Chicago, IL — Mar 2016

"Modeling altered synaptic plasticity due to amyloid-β"

Annual Users Meeting, Fermi National Accelerator Laboratory, Batavia, IL — Jun 2015

"Targeting studies of the second-generation Mu2e experiment"

Research Symposium, KEK (High Energy Accelerator Research Organization), Japan Jul 2014
"Laser break-down spectroscopy on alloys"

Workshops

2026 Northeast Regional Disordered Proteins Workshop: Function Without Form, Syracuse, NY, Sep 17–18, 2026. *Speaker*.
Simons Center for Geometry and Physics: Physics and mathematics of turbulence in different media, New York, NY, Aug 24–Oct 9, 2026. *Speaker*. (*invited*)
Gordon Research Seminar & Conference: Soft Condensed Matter Physics, New London, NH, Aug 10–15, 2025. *Discussion Leader* at Gordon Research Seminar.
Schmidt Science Leadership Program, 2024 – 2025, Oxford, UK; Palo Alto, CA; Pasadena, CA; three weeks total. *Invited Speaker* at 2025 Interdisciplinary Science Summit.
Finding Your Research Voice Workshop, Cornell University, Ithaca, NY, May 8 – 9, 2025.
Aspen Center for Physics Winter Conference: Computing with Physical Systems, Aspen, CO, Jan 7–12, 2024.
Simons Foundation Workshop: Turbulence Across Vast Scales, New York, NY, Dec 2 – 9, 2019.

Teaching Experience

Teaching Assistant — Department of Physics, University of Chicago, USA

Experimental Physics (PHYS 211)	Winter 2019
Computational Physics (PHYS 250)	Fall 2018
Honors Waves, Optics, & Heat (PHYS 143)	Spring 2018
Waves, Optics, and Heat (PHYS 133)	Spring 2017
Electricity and Magnetism (PHYS 132)	Winter 2017
Mechanics (PHYS 131)	Fall 2016

Teaching Assistant — Department of Physics, Kalamazoo College, USA

Thermal Physics (PHYS 360)	Winter 2016
Quantum Mechanics (PHYS 420)	Fall 2016
Astrophysics (PHYS 480)	Fall 2016
Modern Physics (PHYS 220)	Fall 2014
Optics and Waves (PHYS 152)	Spring 2014
Electricity and Magnetism (PHYS 150)	Winter 2014

Student Instructor — Kalamazoo College, USA
Tutored calculus, linear algebra, and the introductory physics sequence Apr 2014 – Mar 2016

Students Mentored

Cornell University
Kaarthik Varma, Graduate researcher 2023 - present
Jen Jang, Graduate researcher, 2024 - present
Sully Robert Bailey-Darland, Graduate researcher, 2024 - present
Katia Larina, Graduate researcher, 2025 - present
Allison Dew, Undergraduate researcher, 2025 - 2026
Blue Shapiro, Graduate researcher, 2024 - 2025 *After:* Materials Scientist at Vandstrom
Dana Matthias, Undergraduate researcher, 2024 - 2025 *After:* Master's program, ETH Zürich

University of Chicago
Matteo Sabato, Graduate researcher, 2020 - 2023
Yaocheng Li, Graduate researcher, 2020 - 2023
Diego Padilla, Undergraduate researcher, 2021 *After:* Ph.D. program, UCLA

Service and Outreach

Reviewer: *Science; Nature Physics; Proceedings of the National Academy of Sciences; Biophysical Journal; Matter; European Journal of Mechanics B: Fluids*
Editorial writing: News & Views article for *Nature Physics* Jan 2026
Discussion leader: Gordon Research Conference: Soft Condensed Matter Physics Aug 2025
Session chair: 12th Liquid Matter Conference, Mainz, Germany Sep 2024
Instructor:
- Special Education Aide (weekly) Sep 2021 – Jun 2024
  Provided individualized educational support for children with autism spectrum disorder and trauma-related challenges.

- Mentor for Science and Technology Outreach Program (biweekly) Sep 2014 – Apr 2016
  Designed and taught courses about coding, electronics, and robotics for middle school students.

Demonstrator/Volunteer:
- Physics With a Bang!, MRSEC at the University of Chicago (annual) 2019 – 2023
- SMART Science Outreach Program, MRSEC at the University of Chicago Jul 2020
- Beyond the Naked Eye, Marwen Art School and the University of Chicago Jun 2017
  Exhibited science-inspired art and photography on pattern formation and fluid instabilities.

Speaker and Panelist:
- Career panel, Society of Physics Students, Kalamazoo College Chapter Apr 2026
- Research symposium, Consulate-General of Japan in Chicago Jun 2018

Mentor: Organization for underrepresented students in STEM, Kalamazoo College 2015 – 2016

References

Professor William T. M. Irvine
Department of Physics, University of Chicago
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Professor Eric R. Dufresne
Department of Physics and Department of Materials Science and Engineering, Cornell University
erd43@cornell.edu

Professor Nigel Goldenfeld
Department of Physics, University of California, San Diego
nigelg@ucsd.edu