Zachary Gao Sun

Curriculum Vitae

Department of Physics
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Education

2019–2025 **Ph.D., Physics**, *Yale University*, New Haven, CT.
Thesis Title: Mechanics and Energetics of Cytoskeletal Assembly. Ph.D. Advisor: Michael Murrell

2024.8–2025.1 **IvyExchange Ph.D. student**, *Harvard University*, Cambridge, MA.
Advisor: Joost Vlassak

2019–2022 : **Certificate in Yale Physical Engineering & Biology (PEB) program**, *Yale University*, New Haven, CT.

2019–2021 : **M.S.**, *Yale University*, New Haven, CT.

2019–2021 : **M.Phil.**, *Yale University*, New Haven, CT.

2015–2019 : **B.S. Physics Departmental Honors with Great Distinction**, *University of Massachusetts at Amherst*, Amherst, MA.

2015–2019 : **B.S. Astronomy Honors, Concentration in Astrophysics with Great Distinction**, *University of Massachusetts at Amherst*, Amherst, MA.

2015–2019 : **B.A. Linguistics and Psychology Honors, concentration in Phonology, Cognitive Psychology and Neuroscience with Great Distinction**, *University of Massachusetts at Amherst*, Amherst, MA.

2015–2019 : **Certificate in Integrative Concentration of Natural Science, concentration in Renewable Energy**, *University of Massachusetts at Amherst*, Amherst, MA.

Publications

Main areas of research

Physics of Living Systems, Cytoskeleton, Complex Systems, Active Matter, Rheology
Google Scholar: https://scholar.google.com/citations?user=DkDwpcsAAAAJ&hl=en&oi=ao

Journal Articles

2026.02 **Zachary Gao Sun**, Juanjuan Zheng, A. Pasha Tabatabai, Joost J. Vlassak, and Michael Murrell†. Mechanical organization yields degenerate dissipation beyond linear response. ***(In Review at Nature Communications)***, 2026.02.

2026.02 Ryota Sakamoto, **Zachary Gao Sun**, and Michael Murrell†. Crosslinked F-actin networks regulate load-dependent energy conversion. ***(Accepted, Communications Biology)***, 2026.02.

2026.02 Sheng Chen†, Matthew Ricci, A. Pasha Tabatabai, **Zachary Gao Sun**, Suraj Shankar, Mor Nitzan, and Michael P Murrell†. Topological control of spontaneous failure in active nematic solids. ***Nature Materials***, 2026.02.

2025.8 **Zachary Gao Sun**, Juanjuan Zheng, Joost Vlassak, and Michael Murrell†. Non-monotonicity in actomyosin network heat dissipation via F-actin architecture regulation. ***(In Prep)***, 2025.8.

2025.8 **Zachary Gao Sun**, Beatrice Nettuno, Davide Toffenetti, Priyanka Dutta, Bruce Goode, Erwin Frey†, and Michael Murrell†. Synergistic feedback and regulation by cofilin-srv2/cap-profilin cycle creates in vitro actin waves and active nematic solid. ***(In Prep)***, 2025.8.

2025.12 **Zachary Gao Sun**, Mehrzad Sasanpour, Megan T. Valentine, Jennifer L. Ross, Michael Murrell, Ryan McGorty, and Rae M. Robertson-Anderson†. active motion of microtubules in interpenetrating cytoskeleton composites is driven by extensile shearing and suppressed by contractile dynamics. ***(In Submission for Soft Matter)***, 2025.12.

2025.06 **Zachary Gao Sun**, Nathan Zimmerberg, Patrick Kelly, Carlos Floyd, Garegin Papoian, and Michael Murrell†. Feedback between F-actin organization and active stress govern criticality and energy localization in the cell cytoskeleton. ***Nature Physics***, volume 21, page 1290–1302, 2025.06.

2024.11 **Zachary Gao Sun** and Michael Murrell†. Cofilin-mediated filament softening and crosslinking counterbalance to enhance actin network flexibility. ***Physical Review Letters***, volume 133, page 218402. American Physical Society, 2024.11.

2024.10 Srishti Dar, Rubén Tesoro Moreno, Ivan Palaia, Anusha B. Gopalan, **Zachary Gao Sun**, Léanne Strauss, Richard R. Sprenger, Julio M. Belmonte, Sarah K. Foster, Michael Murrell, Christer S. Ejsing, Anđela Šarić, Maria Leptin, and Alba Diz-Muñoz†. Caging of membrane-to-cortex attachment proteins can trigger cellular symmetry breaking. ***(In review at Cell)***, ***BioArxiv***: *https://doi.org/10.1101/2024.10.14.618153*, 2024.10.

2024.05 MS Yousafzai, S Amiri, **ZG Sun**, AA Pahlavan†, and M Murrell†. Confinement induces internal flows in adherent cell aggregates. ***Journal of the Royal Society Interface***, volume 21, page 20240105. The Royal Society, 2024.05.

2024.03 **Zachary Gao Sun**, Vikrant Yadav, Sorosh Amiri, Wenxiang Cao, Enrique M. De La Cruz, and Michael Murrell†. Cofilin-mediated actin filament network flexibility facilitates 2d to 3d actomyosin shape change. ***European Journal of Cell Biology***, volume 103, page 151379. Urban & Fischer, 2024.03.

2022.11 Camelia G. Muresan*, **Zachary Gao Sun***, Vikrant Yadav, A. Pasha Tabatabai, Laura Lanier, June Hyung Kim, Taeyoon Kim, and Michael P. Murrell†. F-actin architecture determines constraints on myosin thick filament motion. ***Nature Communications***, volume 13 (7008). Nature Publishing Group, **F1000 article**, 2022.11.

2022.08 Sheng Chen, **Zachary Gao Sun**, and Michael P Murrell. In vitro reconstitution of the actin cytoskeleton inside giant unilamellar vesicles. ***JoVE (Journal of Visualized Experiments)***, volume 186, page e64026. MyJove Corp, 2022.08.

*: Equal contribution †: Corresponding author

Research Experience

Institute of Science and Technology Austria (ISTA)

January,2026 – present ***Heisenberg and Hannezo Lab: Embryonic Morphogenesis***, *Postdoctoral Fellow*.
In vivo experiments and computational modeling on zebrafish and ascidian embryonic morphogenesis.

Advisor : **Carl-Philipp Heisenberg**, (*Lab Web-page*)

co-Advisor : **Edouard Hannezo**, (*Lab Web-page*)

Harvard University

August,2025 – December, 2025 ***Weitz lab: The origin of Liquid-Liquid phase separation in vimentin***, *Visiting Postdoc*.
In vivo cell experiments on concentration-dependent LLPS and network properties of vimentin.

Advisor : **David A. Weitz**, (*Lab Web-page*)

Santa Fe Institute

June,2025 – July,2025 ***Santa Fe Institute Complexity Science Summer School***, Project 1.Collective Memory in Biological and Social Networks; Project 2:Entropy production and Criticality in Neuro-linguistics (manuscripts in prep).

Harvard University

August,2024 – January,2025 ***Vlassak lab: Measuring energy dissipation in active matter***, *IvyExchange/Collaboration*.
Measure heat/energy dissipation in non-equilibrium systems.

Advisor : **Joost J. Vlassak**, *Abbott and James Lawrence Professor of Materials Engineering*, Harvard University (*Lab Web-page*)

Yale University

June,2019 – May,2025 ***Murrell lab: In vitro Active Matter & Non-equilibrium Dynamics***.
In vitro reconstituted cytoskeletal systems.

Advisor : **Michael P. Murrell**, *Associate Professor, Department of Biomedical Engineering & Physics*, Yale University (*Lab Web-page*)

UMass Amherst

February,2018 – May, 2019 ***Tuominen's Physics lab on Self-organization***.
Formation patterns and non-equilibrium dynamical dissipative system.

Advisor : **Mark Tuominen**, *Professor, Department of Physics & Associate Dean of College of Natural Science*, UMass Amherst

Conferences & Talks

July 2025 ***Q-BIO 2025 Conference: Emergent Orders in Living Systems Across Scales, Peking University, Beijing, China*** Selected Contributed Talk: Feedback between F-actin organization and active stress govern criticality and energy localization in the cell cytoskeleton

March 2025 ***Institute of Physics Physics of Life conference, UK*** Early Career Talk: Feedback between F-actin organization and active stress govern criticality and energy localization in the cell cytoskeleton

March 2025 ***American Physical Society (APS) Global Physics Summit*** ESME invited Talk: Feedback between F-actin organization and active stress govern criticality and energy localization in the cell cytoskeleton

February 2025 ***Biophysical Society Annual Meeting*** PCB invited Talk: Feedback between F-actin organization and active stress govern criticality and energy localization in the cell cytoskeleton

December 2024 ***Yale PEB Discussion*** Talk: Active Mechanics of the Cell Cytoskeleton

December 2024 ***Yale PEB Retreat*** Invited Talk: Active Mechanics of the Cell Cytoskeleton

November 2024 ***MIT PLS Short Talk*** Talk: Active Mechanics of the Cell Cytoskeleton

April 2024 ***Max Planck Institute Dresden: Physics of Life (IntCha24 Active Matter Workshop)*** Poster: Cytoskeletal geometry and active stress orchestrate self-organized criticality in the cytoskeleton

March 2024 ***American Physical Society (APS) March Meeting*** Contributed Talk: Cofilin concentration controls cofilactin gel stress response

July 2023 ***International Physics of Living System conference (iPoLS) Georgia Tech, Atlanta, GA, USA*** Contributed Talk: F-actin architecture governs self-organized criticality in the cytoskeleton

March 2023 ***American Physical Society (APS) March Meeting*** Contributed Talk: F-actin architecture governs self-organized criticality in the cytoskeleton

November 2022 ***Yale PEB Discussion*** Talk: Self-organized criticality in the cytoskeleton

April 2019 ***National Undergraduate Physics Conference*** Behavior of a Non-equilibrium Self-Organizing System: A Potential Means to Enhance Energy Efficiency in Systems with Functional Intelligence

March 2019 ***American Physical Society (APS) March Meeting*** Poster: Behavior of a Non-equilibrium Self-Organizing System: A Potential Means to Enhance Energy Efficiency in Systems with Functional Intelligence

Fellowships & Awards

March 2025 ***American Physical Society Emerging Soft Matter Excellence Award*** Selected to be one of the finalists for the Emerging Soft Matter Excellence (ESME) Award and give invited talk

March 2025 ***American Physical Society GSNP Junior Speaker Award (Declined)***

February 2025 ***Biophysical Society Physical Cell Biology Student Award*** Selected to be the recipient for the Physical Cell Biology Student Award at BPS and give invited talk

March 2024 ***APS DBIO Travel Award*** Selected to be one of the four students to receive funding for attending APS conference to present talks

May 2019 ***iCons Honorary Lecture Award*** Selected to be one of the four students to give lecture on Honors Thesis

2015-2019 ***Chancellors Award, UMass Amherst*** Awarded to International students with excellent academic standings

Fall 2017 ***Commonwealth Honors College Research Fellowship Award***(with maximum grant)5% Honors students who applied receive full grant

2018-2019 ***Commonwealth Honors Research Grant*** 5% Honors students who applied receive grant, but prioritizes students who work on Honors Thesis

Computer skills

Programming Languages: Python, MATLAB, R, JAVA

Teaching fellowship

Spring, 2022, 2021 & 2020 : **PHY182: Electromagnetism**, Yale University.

Fall, 2020 &2019 : **PHY181: Classical Mechanics**, Yale University.