Sarah Harvey, Ph.D.

✉ sharvey@flatironinstitute.org   🌐 sarahharvey.github.io   SarahHarvey   in SarahHarvey11   iD

RESEARCH AND EMPLOYMENT

Oct 2022 - Present	**Flatiron Institute - Center for Computational Neuroscience**
	Flatiron Research Fellow
	Developing theoretically well-motivated methods for the analysis of neural datasets and neural networks. Currently studying the mathematical basis for neural manifold estimation and measuring similarity between biological and artificial neural networks [1, 2, 3, 4, 5].
	ADVISOR: Alex Williams
	LAB WEBSITE: http://neurostatslab.org/

Sept 2015 - Sept 2022	**Stanford University - Department of Applied Physics**
	PhD Candidate
	Research on understanding the relationship between thermodynamics, information theory, and biological computation using the techniques of nonequilibrium statistical mechanics. Projects centered around applying methods from theoretical physics to biophysics [6], neuroscience [7] and reinforcement learning [8].
	ADVISOR: Surya Ganguli
	LAB WEBSITE: https://ganguli-gang.stanford.edu

Summer 2015	**Los Alamos National Laboratory - Intelligence & Space Research Division**
	Computational Physics Intern
	Worked in the Space Sciences and Applications group studying the space radiation environment and its effect on satellites. Created a Monte Carlo simulation to study microchannel plate detector responses to heavy ion radiation fluxes from extraterrestrial sources.
	ADVISOR: Alexei Klimenko

Jan 2014 - Jun 2015	**University of Washington - Optical Spintronics and Sensing Lab**
	Undergraduate Researcher
	Designed and constructed a scanning confocal microscope, which was used to perform photoluminescence confocal microscopy to investigate excitonic properties of novel 2D stacking fault structures in GaAs [9].
	ADVISOR: Kai-Mei Fu

Summer 2013	**Boeing Research and Technology - Boeing Radiation Effects Laboratory**
	Physics Intern
	Performed materials radiation effects testing and troubleshooting with Boeing particle accelerators. Headed factory spectrophotometry testing for new customers and ran a solar simulator UV effects test. Improved neutron dosimetry calculation accuracy using numerical methods in MATLAB.

Oct 2012 - Jun 2013	**University of Washington - Winglee Advanced Propulsion Lab**
	Undergraduate Researcher
	Plasma physics and plasma propulsion research.

Jun 2012 - Sept 2012	**Boeing Research and Technology - Applied Physics Laboratory**
	Physics Intern
	Composite materials research and development.

Jun 2011 - Dec 2011	**Eagle Harbor Technologies**
	Physics Intern
	Experimental plasma propulsion system design.

Jun 2010 - Sept 2010	**University of Washington - Torii Biology Lab**
	Undergraduate Researcher
	Assisted with RNA silencing experiments in *Arabidopsis thaliana* (model organism in plant biology).

EDUCATION

June 2022   **Stanford University**
Doctor of Philosophy in Applied Physics
SUPPORT: National Defense Science and Engineering Graduate Fellowship (NDSEG) & Stanford Graduate Fellowship
COURSEWORK: graduate-level physics curriculum including statistical physics, quantum information theory, general relativity and differential geometry, quantum field theory, laboratory electronics, advanced optical imaging laboratory, theoretical neuroscience, deep learning.
THESIS: *Combating noise and uncertainty in biophysical models* [8].

Mar 2015   **University of Washington, Seattle**
Bachelor of Science with honors in physics, summa cum laude
MAJORS: Physics and Astronomy | MINORS: Applied Mathematics and Music
GPA: 3.97/4 cumulative, 3.96/4 physics courses, 4.00/4 astronomy courses
Phi Beta Kappa Honors Society, Sigma Pi Sigma physics honors society

PUBLICATIONS

[1] Joao Barbosa, Amin Nejatbakhsh, Lyndon Duong, **Sarah E. Harvey**, Scott L. Brincat, Markus Siegel, Earl K. Miller, and Alex H. Williams. "Quantifying Differences in Neural Population Activity With Shape Metrics". *bioRxiv* (2025). URL: https://www.biorxiv.org/content/early/2025/01/11/2025.01.10.632411.

[2] **Sarah E. Harvey**, David Lipshutz, and Alex H. Williams. "What Representational Similarity Measures Imply about Decodable Information". *Proceedings of Machine Learning Research* (2024). arXiv: 2411.08197 [stat.ML]. URL: https://arxiv.org/abs/2411.08197.

[3] Jenelle Feather, David Lipshutz, **Sarah E. Harvey**, Alex H. Williams, and Eero P. Simoncelli. "Discriminating image representations with principal distortions". *International Conference on Learning Representations (ICLR)* (2024). arXiv: 2410.15433 [q-bio.NC].

[4] **Sarah E. Harvey**, Brett W. Larsen, and Alex H. Williams. "Duality of Bures and Shape Distances with Implications for Comparing Neural Representations". *Proceedings of Machine Learning Research* (2024). arXiv: 2311.11436 [stat.ML]. URL: https://proceedings.mlr.press/v243/harvey24a.

[5] Dean A Pospisil, Brett W Larsen, **Sarah E. Harvey**, and Alex H Williams. "Estimating Shape Distances on Neural Representations with Limited Samples". *International Conference on Learning Representations (ICLR)* (2024). arXiv: 2310.05742 [stat.ML]. URL: https://openreview.net/forum?id=kvByNnMERu.

[6] **Sarah E. Harvey**, Subhaneil Lahiri, and Surya Ganguli. "Universal energy-accuracy tradeoffs in nonequilibrium cellular sensing". *Phys. Rev. E* 108 (1 July 2023), p. 014403. URL: https://link.aps.org/doi/10.1103/PhysRevE.108.014403.

[7] Christopher H. Stock, **Sarah E. Harvey**, Samuel A. Ocko, and Surya Ganguli. "Synaptic balancing: A biologically plausible local learning rule that provably increases neural network noise robustness without sacrificing task performance". *PLOS Computational Biology* 18.9 (Sept. 2022), pp. 1–27. URL: https://doi.org/10.1371/journal.pcbi.1010418.

[8] **Sarah E. Harvey**. "Combating noise and uncertainty in biophysical models". Available at https://searchworks.stanford.edu/view/14423017. PhD thesis. Stanford, CA: Stanford University, Sept. 2022.

[9] Todd Karin, Xiayu Linpeng, M. M. Glazov, M. V. Durnev, E. L. Ivchenko, **Sarah Harvey**, Ashish K. Rai, Arne Ludwig, Andreas D. Wieck, and Kai-Mei C. Fu. "Giant permanent dipole moment of two-dimensional excitons bound to a single stacking fault". *Phys. Rev. B* 94 (4 July 2016), p. 041201. URL: https://link.aps.org/doi/10.1103/PhysRevB.94.041201.

MANUSCRIPTS IN PREPARATION OR UNDER REVIEW

⋆ **Sarah E. Harvey**, Alex H. Williams. "Interpretable comparison of neural representations through decoded signal geometry".

⋆ Tianxiao He, Alex H. Williams, **Sarah E. Harvey**. "How data augmentation shapes neural representations".

⋆ **Sarah E. Harvey**, Surya Ganguli, Subhaneil Lahiri. "A large deviation theory approach to risk-aware policy gradients in Markov decision processes".

Presentations

- SAND: Statistical Analysis of Neural Data, June 2025 (contributed, selected for oral)
  TITLE: "What Representational Similarity Measures Imply about Decodable Information".

- UniReps: Unifying Representations in Neural Models NeurIPS workshop, December 2024 (contributed, selected for best paper award and oral).
  TITLE: "What Representational Similarity Measures Imply about Decodable Information".

- Cognitive Computational Neuroscience (CCN) 2024 (contributed, selected for oral and poster).
  TITLE: "Duality of Bures and Shape Distances with Implications for Comparing Neural Representations".

- ICLR Workshop on Representational Alignment (Re-Align), May 2024 (panelist).

- Computational and Systems Neuroscience (COSYNE) 2024 (reviewed poster).
  TITLE: "Duality of Bures and Shape Distances with Implications for Comparing Neural Representations".

- UniReps: Unifying Representations in Neural Models NeurIPS workshop, December 2023 (contributed, selected for oral).
  TITLE: "Duality of Bures and Shape Distances with Implications for Comparing Neural Representations".

- Towards a theory of artificial and biological neural networks, a Les Houches workshop, February 2023 (contributed, selected for oral).
  TITLE: "Synaptic balancing".

- Banff International Research Station workshop, *Mathematical Models in Biology: from Information Theory to Thermodynamics*, 26 July 2020 (invited, oral).
  TITLE: "An energy-accuracy tradeoff for nonequilibrium receptors".

- APS March Meeting 2020: *Inference, Information, and Learning in Biophysics* virtual session (oral).
  TITLE: An energy-accuracy tradeoff for nonequilibrium receptors. Abstract and presentation slides:
  https://meetings.aps.org/Meeting/MAR20/Session/A25.6

- Bernstein Conference 2019: (poster)
  TITLE: A local synaptic balancing rule for homeostatic plasticity.

- Computational and Systems Neuroscience (COSYNE) 2017 and APS March Meeting 2017 (posters)
  TITLE: An energy-accuracy tradeoff in subneuronal molecular sensing.

Teaching

July 2022	**Stanford Program for Inspiring the Next Generation of Women in Physics**
	Virtual program
	Counselor for a group of high school girls from all over the world who are interested in physics. Taught tutorials on python programming, quantum mechanics, astronomy and astrophysics.
Aug 2021	**Methods in Computational Neuroscience Summer School**
	Marine Biological Laboratory, Woods Hole, MA
	Research facilitator (previously known as teaching assistant). Helped advise student projects, teach tutorials, administer homework assignments, and manage other course events.
Jan 2019 - Mar 2019	**NBIO 228: Mathematical Tools for Neuroscience**
	Stanford University
	Developed curriculum, lectures, and homework assignments for the core mathematical methods class required for first year neuroscience PhD students at Stanford.

Honors, Awards and Special Programs

Dec 2024	UniReps Workshop Best Paper Award. Paper: [2].
Dec 2023	UniReps Workshop Best Proceeding Honorable Mention. Paper: [4].
June 2021	Beg Rohu Summer School Participant
Sept 2018	Center for Mind, Brain, Computation and Technology Graduate Trainee
Aug 2017	Methods in Computational Neuroscience Summer School Participant
Sept 2016	National Defense Science and Engineering Graduate Fellowship
Sept 2015	Stanford Graduate Fellowship, William R. Hewlett Fellow
Jun 2014	Mary L. Boas Endowed Scholarship in Physics
2010 - 2014	University of Washington Annual Dean's List
Sept 2010 - Jun 2014	Washington NASA Space Grant Scholar
Sept 2010 - Jun 2014	Mary Gates Endowment for Students
Sept 2010 - 2014	Elks National Foundation Legacy Scholarship recipient
Sept 2010 - 2014	Nellie Martin Carmen Scholarship recipient
2013	Barry Goldwater Scholarship Honorable Mention
2009	Washington Aerospace Scholar
2009	American Association of University Women award for mathematics