Casey O. Barkan

PhD Candidate @ UCLA Physics

[GitHub]   [Google scholar]   [LinkedIn]   [Email]

Education

Ph.D. Physics, University of California, Los Angeles (GPA: 3.98/4.00)   Expected: Spring 2025
M.S. Physics, University of Pennsylvania (GPA: 3.93/4.00)   2019
B.S.E. Chemical and Biomolecular Engineering, University of Pennsylvania (GPA: 3.83/4.00)   2018
- Minors in Economics, Mathematics. 2nd Major in Physics. *Summa Cum Laude.*

Experience

Research Scholar, MATS, Berkeley, CA   Winter 2025
- Building AI Safety Evaluations for UK AI Safety Institute.

Doctoral Researcher in Theoretical Physics, UCLA   2019-Present
- Led multiple research collaborations in statistical physics and mathematical biology.
  - Topics: Protein-ligand interactions, Evolutionary dynamics, Dynamics of tissue development, Foundations of statistical mechanics.
- 6 first-author papers including a single-author paper.
- Communicated research in 9 conference presentations (4 oral, 5 poster).
- Coded simulations, optimizations, statistical analyses, and visualizations in Python.
- Led summer tutoring and mentorship program.

Teaching Assistant, Univ. of Penn. & UCLA   2016-2017 & 2019-2022
- Courses: Quantum computation, Electrodynamics, Electronic circuits, + 5 more.
- Received Outstanding Teaching Award and excellent teaching evaluations.

Researcher in Computational and Quantum Chemistry, Univ. of Penn.   2016-2018
- Designed and implemented optimization tools for quantum materials computations.
- Wrote successful grant to fund team of 5 undergraduate researchers.

Research Intern in Neurobiology, University of Chile   2013-2014
- Performed electrophysiology experiments studying olfaction.

Independent Projects with Machine Learning & Economics

Neural networks for high-dimensional partial differential equations.
- Implemented ML method useful for optimization and quantum mechanics.
- https://github.com/cbarkan1/physics-informed-neural-networks

Economic modeling of AI automation impacts.
- Developed economic model to explore counterintuitive labor market impacts of AI automation.
- https://cbarkan1.github.io/AI_productivity_in_noncompetitive_markets.pdf

Steering a large language model with a pre-trained sparse autoencoder.
- Utilized mechanistic interpretability method to steer the behavior of an LLM.
- https://github.com/cbarkan1/steering-GPT2-with-an-SAE

Computational Skills

Python (PyTorch, Numpy, Scipy, Matplotlib), Inspect AI, Deep Learning, Transformers, Game Theory, Optimization & Optimal Control, Economic modeling, Stochastic Calculus, ODEs/PDEs.

Publications

IN REVIEW: Barkan, C.O. & Chou, T. (2025). Incorporating stochastic gene expression, signaling-mediated intercellular interactions, and regulated cell proliferation in models of coordinated tissue development.
https://arxiv.org/abs/2501.11271

Barkan, C.O. & Wang, S. (2025). Migration feedback induces emergent ecotypes and abrupt transitions in evolving populations. *Physical Review E (In Press)*.
https://arxiv.org/abs/2309.10884

Barkan, C.O. (2024). On the convergence of phase space distributions to microcanonical equilibrium: dynamical isometry and generalized coarse-graining. *Journal of Physics A: Mathematical and Theoretical*.
https://doi.org/10.1088/1751-8121/ad7c9e

Barkan, C.O. & Bruinsma, R.F. (2024). Topology of molecular deformations induces triphasic catch bonding in selectin–ligand bonds. *Proceedings of the National Academy of Sciences*.
https://doi.org/10.1073/pnas.2315866121

Barkan, C.O. & Wang, S. (2023). Multiple phase transitions shape biodiversity of a migrating population. *Physical Review E*.
https://doi.org/10.1103/PhysRevE.107.034405

Barkan, C.O. & Bruinsma, R.F. (2023). Catch-slip bonding, pathway switching, and singularities in the flow of molecular deformation. *Physical Review Research*.
https://doi.org/10.1103/PhysRevResearch.5.023161

Awards

• UCLA Dissertation Year Award	2024
• Outstanding Teaching Award, UCLA Physics	2021
• NSF Graduate Research Fellowship	2019
• 1st Place Prize for best chemical engineering design project, Penn CBE	2018
• 1st Place Prize for best chemical engineering laboratory project, Penn CBE	2018
• American Chemical Society Scholastic Achievement Award	2018
• Tau Beta Pi Engineering Honors Society	2017

Conference Presentations

(Note: I was the presenter for all listed presentations)

Oral presentations:
- Barkan, C.O. (March 2024). Modeling the structural mechanism of TCR-pMHC catch bonding. APS March Meeting, Minneapolis, MN.
- Barkan, C.O. & Wang, S. (Sept 2023). Migration feedback yields novel critical transitions and emergent ecotypes in connected populations. UCLA QCBio Retreat, Los Angeles, CA.
- Barkan, C.O. & Bruinsma, R.F. (March 2023). Geometric Signatures of Switching Behavior in Mechanobiology. APS March Meeting, Las Vegas, NV.
- Barkan, C.O. (March 2023). Theory of force-sensitive bonds: complex behavior from simple mechanisms. APS March Meeting, Las Vegas, NV.

Poster presentations:
- Barkan, C.O. (Nov 2023). Mechanical Allostery Induces Tunable Catch Bonding. 5th course on multi-scale integration in biological systems, Curie Institute, Paris.

- Barkan, C.O. & Bruinsma, R.F. (Feb 2023). Geometric Signatures of Switching Behavior in Mechanobiology. Biophysical Society Meeting, San Diego, CA.
- Barkan, C.O. & Bruinsma, R.F. (Sept 2022). Geometric Signatures of Switching Behavior in Mechanobiology. EMBO Physics of Cells, Ein Gedi, Israel.
- Barkan, C.O. & Wang, S. (March 2022) Phase Transitions Shape Biodiversity of a Migrating Population. APS March Meeting, Chicago, IL.
- Barkan, C.O. & Wang, S. (Sept 2021). Emergent Ecological Phenomena in an Evolving and Migrating Population. UCLA QCBio Retreat, Los Angeles, CA.