Casey O. Barkan

PhD Candidate @ UCLA Physics

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

Summary: Transitioning from theoretical physics to AI Governance research. Current MATS scholar building evaluations of AI capabilities. Soon-to-begin full-time position at RAND in technical governance research, including AI governance. Strong interest and skillset in mathematical economics, aiming to contribute to economic policy research as part of my upcoming role.

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 collaborations on topics in statistical physics and mathematical biology.
  - Topics: Protein-ligand interactions, Evolutionary dynamics, Dynamics of tissue development, Foundations of statistical mechanics.
- Published single-author paper + 5 other first-author papers (including 2 under review.
- Communicated research in 9 conference presentations (4 oral, 5 poster).
- Coded simulations, visualizations, optimizations, and statistical analyses 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 cutting-edge ML method for optimization and quantum mechanics.
- https://github.com/cbarkan1/physics-informed-neural-networks

Economic modeling of AI automation impacts.
- Developed macroeconomic model to explore counterintuitive labor market impacts of AI automation technology.
- 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

Selected Advanced Courses

• AI Safety Fundamentals: AI Alignment (BlueDot Impact)	Fall 2024-Winter 2025
• AI Safety Fundamentals: AI Governance (BlueDot Impact)	Summer 2024-Fall 2024
• Financial Economics (PhD course, UCLA Anderson)	Fall 2024
• Mathematical Statistics (PhD course, Wharton)	Spring 2017

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

IN REVISION: Barkan, C.O. & Wang, S. (2024). Migration feedback induces emergent ecotypes and abrupt transitions in evolving populations. *In revision at Physical Review E*.
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,* 57(47), 5001.
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*, 121(6), e2315866121.
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*, 107(3), 034405.
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*, *5*(2), 023161.
https://doi.org/10.1103/PhysRevResearch.5.023161

Conference 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.

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