

# Casey O. Barkan

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## Education

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**University of California, Los Angeles** (2019-Present; Expected graduation: September 2024)

- PhD Candidate, Physics (GPA: 3.98/4.00)
- Advisor: Robijn F. Bruinsma

**University of Pennsylvania** (2014-2019)

- MS, Physics (GPA: 3.93/4.00)
- BSE, Chemical and Biomolecular Engineering (GPA: 3.83/4.00)
  - Second major: Physics
  - Minors: Mathematics, Economics
  - *Summa Cum Laude*

## Current Research Focus

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My current research has two emphases. First, at the molecular level, I am working on theories of mechanically sensitive receptor-ligand interactions. I developed a mathematical theory of catch bonding, showing how the catch-to-slip switch results from singularities in the *flow field* of force-induced molecular deformation. With this theory, I addressed a long-standing challenge in mechanobiology: to explain how selectin proteins can convert between slip, catch-slip, and slip-catch-slip behavior through minor structural changes. I am now working to apply this theory to TCR-pMHC catch bonding. Second, at the population level, I investigated the effects of migration patterns on evolving populations in spatially-structured environments using minimal models. This work uncovered counterintuitive phase transitions and emergent effects, and it motivates specific experiments that may be able to investigate these behaviors.

An interesting intersection of molecular-scale and population-scale phenomena occurs in the adaptive immune system, where TCR-pMHC interactions trigger T cell activation which triggers broader immune response. Catch bonding has been observed in TCR-pMHC for some peptides, and it is an open question what role this plays in peptide discrimination. Investigating this question is an exciting area for future study.

## Publications

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

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

C. Barkan and R. Bruinsma, *Topology of molecular deformation induces triphasic catch bonding in selectin-ligand bonds*. Under review at PNAS. (<https://www.biorxiv.org/content/10.1101/2023.09.08.556954v1>).

C. Barkan and S. Wang, *Migration feedback yields novel critical transitions and emergent ecotypes in connected populations*. Under review at PNAS. (<https://arxiv.org/abs/2309.10884>).

## **Conference Presentations**

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### Oral presentations:

UCLA QCBio Retreat 2023, *Migration feedback yields novel critical transitions and emergent ecotypes in connected populations*.

APS March Meeting 2023, *Geometric Signatures of Switching Behavior in Mechanobiology*.

APS March Meeting 2023, *Theory of force-sensitive bonds: complex behavior from simple mechanisms*.

### Poster presentations:

Biophysical Society Meeting 2023, *Geometric Signatures of Switching Behavior in Mechanobiology*.

EMBO Physics of Cells 2022, *Geometric Signatures of Switching Behavior in Mechanobiology*.

APS March Meeting 2022, *Phase Transitions Shape Biodiversity of a Migrating Population*.

UCLA QCBio Retreat 2021, *Emergent Ecological Phenomena in an Evolving and Migrating Population*.

## **Teaching Experience (as a TA)**

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Quantum Computation, *graduate level course* (Fall 2022)

Electronics laboratory, *upper division course* (Spring 2021)

Thermodynamics for Life Sciences (Winter 2021)

Electrodynamics, *upper division course* (Fall 2020)

Thermodynamics for Life Sciences, Laboratory (Summer 2020)

Introductory Mechanics (Fall 2019)

Honors Introductory Chemistry (Fall 2017, as an undergraduate)

Introductory Calculus (Fall 2016, as an undergraduate)

## **Honors and Awards**

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Outstanding Teaching Assistant Award, UCLA Physics (2021)

NSF Graduate Research Fellowship (2019)

American Chemical Society Scholastic Achievement Award (2018)

Melvin C. Molstad Prize for best Chemical Engineering design project, Penn CBE (2018)

A. Norman Hixson Laboratory Report Prize in Chemical Engineering, Penn CBE (2018)

Tau Beta Pi Engineering Honors Society (2017)

## **Outreach**

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YEE STEM Tutoring and Mentorship program (UCLA student group)

- Lead organizer (2022): Wrote a grant to provide funding for background checks for 27 tutors/mentors. Worked with community partner (Innovate Public Schools) to organize summer tutoring and mentoring.
- Volunteer tutor/mentor (2020-Present).

West Philadelphia Tutoring Project (Penn student group)

- Volunteer tutor for underprivileged youth in Philadelphia (2018-2019).