

# EMRE R. ALCA

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## EXPERIENCE

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### Ph.D student in Physics, University of Pennsylvania

Philadelphia, PA.

*Supervisor: Prof. Andrea Liu*

*September 2025 - present*

- Began analytically and computationally investigating the dynamic instability of microtubules as a mechanism by which the microtubule spindle explores a combinatorial search space to solve spatial positioning optimization problems, working in close collaboration with Dr. Reza Farhadifar and Prof. Michael Shelly (Flatiron Institute).

### Associate of Systems Biology, Harvard Medical School

Boston, MA.

*Supervisor: Prof. Jeremy Gunawardena; funded by the [NITMB](#)*

*January 2024 - May 2025*

- Analytically proved new, qualitatively different, bounds and trade-offs on error correction performance in kinetic proofreading at and away from thermodynamic equilibrium (publication in preparation).
- Developed [linearframework.py](#), a Python package for the symbolic calculation of closed-form expressions for the steady-state and transient quantities of continuous-time Markov processes.
- Used the Harvard O2 cluster to perform numerical experiments to support analytic predictions.
- Supervised an undergraduate student numerically exploring, and finding, new conjectures for structural constraints on hidden Markov models using the Harvard Orchestra 2 cluster and [linearframework.py](#).

### Visiting Research Student, California Institute of Technology

Pasadena, CA.

*Supervisor: Prof. Erik Winfree*

*May 2023 - August 2023*

- Investigated an analogy between Ising models, Hopfield networks, and liquid-liquid phase separation.
- Applied this analogy to the design of phase-separating droplets.
- Developed differentially optimizable simulations of partial differential equations's (Cahn-Hilliard equations in Python) accelerated using spectral differentiation.

### Research Assistant, University of Toronto

Toronto, On.

*Supervisor: Prof. Alan Aspuru-Guzik*

*November 2020 - February 2022*

- Developed Python wrappers for the control of multiple proprietary robotic chemistry platforms, making previously incompatible machines interoperable and implemented fully automated experimental workflows with machine learning recommended conditions ([published in Digital Discovery](#)).

## EDUCATION

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### University of Pennsylvania

*September 2025 - Present*

Ph.D Student in Physics; Supervisor: Prof. Andrea Liu

### University of Toronto

*September 2019 - November 2023*

H.B.Sc. Physics Major & Cognitive Science Major with Distinction

## TECHNICAL STRENGTHS

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### Math & Physics

Stochastic Processes, Thermodynamics, Graph Theory, Neural Networks, Dynamical Systems & Chaos

### Programming Languages

Python, Java, JavaScript

### Software

NumPy, Matplotlib, SciPy, Git, PyTorch, Tensorflow, Excel

### Design

LaTeX, Illustrator, Photoshop, Fusion360