Dr. Sabina Jehan Haque

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Overview

I am an applied mathematician broadly compelled by explaining the cell with pure and applied math. I am currently a Van Loo Postdoctoral Research Fellow jointly affiliated with the Center for Applied and Interdisciplinary Mathematics and Center for the Study of Complex Systems at the University of Michigan Ann Arbor. In my postdoc, I have been exploring avenues to extend my background in graph theory to both abstract mathematical ideas in algebraic and Riemannian geometry and applications in parameter identifiability and the thermodynamics of biochemical oscillations. I recently completed my PhD in Systems Biology at Harvard University advised by Dr. Jeremy Gunawardena. My doctoral research involves using graph theory and stochastic processes to understand how cellular information processing tasks, such as those in eukaryotic gene regulation, depart from thermodynamic equilibrium.

Employment	**University of Michigan Ann Arbor**	Jul 2024 - present
	Van Loo Postdoctoral Research Fellow	
	Harvard Medical School	May 2024 - Jun 2024
	Postdoctoral Research Fellow	
	Advisor: Jeremy Gunawardena	
Education	**Harvard University**	Sep 2018 - Apr 2024
	PhD in Systems Biology	
	Advisor: Jeremy Gunawardena	
	Dissertation title: Graph-theoretic approaches to biochemical reaction networks	
	Middlebury College	Sep 2014 - May 2018
	B.A. in Mathematics (high honors), Molecular Biology & Biochemistry	

Research Interests

Algebraic graph theory	Non-equilibrium biophysics
Geometry and topology	Chemical reaction network theory
Continuous time Markov processes	Pattern formation in biology
Spectra of Laplacian matrices	Topological data analysis

Publications

1. **Haque, S. J.**, Satriano, M., Sorea, M. & Yu, P. Y. The Disguised Toric Locus and Affine Equivalence of Reaction Networks. *SIAM J. Appl. Dyn. Syst.* **22**, 1423–1444 (2023)

2. Chavez, A., Tuttle M, Pruitt B. W., Ewen-Campen B., Chari R., Ter-Ovanesyan D., **Haque S. J.** *et al.* Comparison of Cas9 activators in multiple species. *Nat. Methods* **13**, 563–567 (2016)

In Preparation

3. **Haque S. J.**, Cetiner U., Gunawardena J. Anomalous behaviour of the Steinberg signature for detecting departure from thermodynamic equilibrium. (In preparation).

4. **Haque S. J.**, Nam K.-M., Gunawardena J. A graph construction for analysing the parametric asymptotics of Markov processes (In preparation).

Fellowships and Awards

Junior Scientists Board Research Grant Challenge ($10K funding)   2024 - 2025
Center for Complex Particle Systems (COMPASS), University of Michigan Ann Arbor

Lynch Foundation PhD Fellowship   2023 - 2024
Department of Systems Biology, Harvard University

NSF-Simons QBio PhD Fellowship   2021 - 2022
NSF-Simons Center for Mathematical & Statistical Analysis of Biology, Harvard University

Lynch Foundation PhD Fellowship   2019 - 2021
Department of Systems Biology, Harvard University

Graduation with high honors   2018
Department of Mathematics, Middlebury College

Outstanding Oral Presentation   2017
Graduate Program in Physical and Engineering Biology, Yale University

Selected Talks

The linear framework: graph-theoretic approach to Markov processes with applications in biochemical reaction networks.   Oct 3 2023
Mathematics Department, University of Michigan, Ann Arbor MI

Following the energy: graph-theoretic models of broken detailed balance with biochemical applications.   Oct 17 2023
Barcelona Collaboratorium for Modelling and Predictive Biology, UPF, Barcelona Spain

A graph-theoretic approach to Markov processes with applications in biochemical reaction networks.   Oct 3 2023
Mathematics Department Colloquium, Middlebury College, Middlebury VT

Following the energy: graph-theoretic models of broken detailed balance with biochemical applications.
NSF-Simons QBio Seminar, Harvard University, Cambridge MA

Apr 25 2023

Following the energy: graph-theoretic models of broken detailed balance with biochemical applications.
Systems Biology Department Seminar, Harvard University, Cambridge MA

Mar 26 2023

Graph-theoretic models of detecting broken detailed balance in molecular information processing.
2022 SIAM Annual Meeting MS 26: Trends and New Results in Deterministic Models of Biochemical Interaction Networks, Pittsburgh PA

Jul 11 2022

Graph-theoretic models of non-equilibrium conditions in molecular information processing.
Systems Biology PhD Program retreat, Harvard University, Cambridge MA

May 17 2022

Investigating mathematical properties of non-equilibrium signatures in biological information processing systems.
Poster at 2022 American Physical Society Annual March Meeting, Chicago IL

Mar 16 2022

Graph-theoretic models of non-equilibrium conditions in molecular information processing.
NSF-Simons QBio Seminar, Harvard University, Cambridge MA

Nov 10 2021

Using the linear framework to analyze non-equilibrium behavior in biological systems.
Systems, Synthetic, and Quantitative Biology G2 Symposium, Harvard University, Cambridge MA

Dec 03 2019

Stochasticity and magnetoreception in models of magneto-aerotaxis: an idea in-progress.
Poster at NSF-Simons Quantitative Biology Initiative Symposium, Harvard University, Cambridge MA

May 15 2019

Dynamics and perturbations in laminar flows: an analytical approach.
Mathematics Department senior thesis talk, Middlebury College, Middlebury VT

May 09 2018

Analysis of endocytic protein dynamics by stochastic modeling of fluorescent signal lifetimes.
Mathematics Department seminar, Middlebury College, Middlebury VT

Sep 09 2017

Analysis of endocytic protein dynamics by stochastic modeling of fluorescent signal lifetimes.
Physical and Engineering Biology (PEB) REU Symposium, Yale University, New Haven CT

July 18 2017

Modeling neurodegenerative diseases in S. cerevisiae
Church lab meeting, Harvard University, Cambridge MA

Aug 01 2016

Teaching

University of Michigan Ann Arbor
MATH 404: Intermediate Differential Equations (Nonlinear Dynamics & Chaos)   Winter 2025

Harvard University
AM 50: Introduction to Applied Mathematics   Spring 2020

Middlebury College (STEM Peer Tutor)
MATH 0223: Multivariable Calculus   Spring 2018
CHEM 0322: Biochemistry of Macromolecules   Spring 2018
MATH 0122: Calculus II   Fall 2017
MATH 0121: Calculus I   Fall 2017
MATH 0200: Linear Algebra   Spring 2017
Precalculus (private tutoring)   Spring 2016

Middlebury College (Peer Writing Tutor for First Year Writing Seminars)
Head First Year Seminar Mentor   2017 - 2018
FYSE 1259: Science and Science Fiction   Fall 2017
FYSE 1483: The Magic of Numbers   Fall 2016
FYSE 1167: Shakespeare's Characters   Fall 2015

Conferences and workshops attended

Simons-NSF MathBioSys Annual Meeting 2023   Apr 2023
Simons Foundation, New York NY

2022 SIAM Annual Meeting   Jul 2022
David L. Lawrence Convention Center, Pittsburgh PA

APS Annual March Meeting 2022   Mar 2022
McCormick Place - West Building, Chicago IL

Quantitative Approaches in Biology (virtual)   Nov 2020
Northwestern University NSF-Simons Center

Mathematical Models in Biology: From Information Theory to   Jul 2020
Thermodynamics (virtual)
Banff International Research Station (BIRS)

Workshop on Dynamics, Randomness, and Control in Molecular   Nov 2019
and Cellular Networks
Center for Mathematical Sciences and Applications, Harvard University, Cambridge MA

Quantitative Biology Initiative Symposium   May 2019
Harvard University, Cambridge MA

Outreach

Guest speaker for summer class on Physics of Biological Function   Jun 2023
Wentworth Institute of Technology, Boston MA

Cambridge Science Festival volunteer   Oct 2022
Cambridge, MA

Graduate research assistant in Quantitative Biology grant preparation   May-Jul 2022
NSF-Simons Center for Quantitive Biology, Harvard University, Cambridge MA

Diversity, equity, and inclusion contributor, recruiter, and mentor   2020-present
Systems Biology Department/PhD Program, Harvard University, Cambridge MA

"What is Systems Biology?" outreach event creator/coordinator   Apr 2019
Cambridge Science Festival, Cambridge MA

Guest speaker at Teen Cafe in Biotechnology   Apr 2019
MIT Museum, Cambridge MA

Writing

Cellular mathematics: how does math enhance our understanding of life at the molecular level?   2022-present
https://sabinahaque.substack.com/

Graph Theory 101   Jun-Aug 2021
Science in the News Special Edition: Networks, Harvard University, Cambridge MA
https://sitn.hms.harvard.edu/flash/2021/graph-theory-101/

Challenging an epidemic of systemic racism in America   Jun 2020
https://medium.com/@sjhaque14/challenging-an-epidemic-of-systemic-racism-in-america-26c419744fb9

References

References made available upon request.