

# Dr. Sabina Jehan Haque

*James Van Loo Independent Postdoctoral Research Fellow  
University of Michigan, Department of Mathematics*

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## Overview

I am an applied mathematician working at the intersection of graph theory, dynamical systems, and algebraic geometry with applications in chemical reaction networks and structural identifiability. I am currently a [Van Loo Postdoctoral Research Fellow](#) jointly affiliated with the [Department of Mathematics](#) and [Center for the Study of Complex Systems](#) at the University of Michigan Ann Arbor. I completed my PhD in [Systems Biology](#) at Harvard University advised by [Jeremy Gunawardena](#). My doctoral research focused on using the linear framework, a graph-theoretic approach to continuous-time Markov processes, to characterize the interplay between network topology and system dynamics in biochemical reaction networks. My postdoctoral work has expanded this program toward structural identifiability, model reduction, and convex optimization, while developing new connections between network topology and active biological systems.

**Research interests:** algebraic graph theory, chemical reaction network theory, structural identifiability, real algebraic geometry, continuous-time Markov processes, non-equilibrium biophysics, dynamical systems theory, fast-slow dynamics and model reduction

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

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## 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., Yordanov P., Gunawardena J. A graph construction for analysing the parametric asymptotics of Markov processes (In preparation).
4. **Haque S. J.**, Eisenberg, M. \_\_\_\_\_. (In preparation).

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## Fellowships and Awards

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| <b>James Van Loo Independent Postdoctoral Fellowship</b><br>Michigan Center for Applied and Interdisciplinary Mathematics (MCAIM), University of Michigan Ann Arbor | 2024 - 2027                 |
| <b>Junior Scientists Board Research Grant Challenge (\$10K funding)</b><br>Center for Complex Particle Systems (COMPASS), University of Michigan Ann Arbor          | 2024 - 2025                 |
| <b>Lynch Foundation PhD Fellowship</b><br>Department of Systems Biology, Harvard University   | 2019 - 2021,<br>2023 - 2024 |
| <b>NSF-Simons QBio PhD Fellowship</b><br>NSF-Simons Center for Mathematical & Statistical Analysis of Biology, Harvard University                                   | 2021 - 2022                 |

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## Selected Talks

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| <b>Graph-theoretic approaches to biochemical reaction networks and structural identifiability</b><br>Applied Algebra Group, Department of Mathematics, University of Copenhagen, Copenhagen Denmark | Feb 05 2025 |
| <b>Graph-theoretic and algebraic geometric approaches to biochemical reaction networks</b><br>Mathematics of Reaction Networks (MoRN) Seminar, virtual  | Nov 11 2025 |
| <b>Graph-theoretic and algebraic geometric approaches to biochemical reaction networks</b><br>Mathematics Seminar, Algebraic Systems Biology Group, MPI-CBG, Dresden Germany                        | Oct 03 2025 |

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|---|-------------|
| <p><b>A graph construction for analyzing the parametric asymptotic of Markov processes</b></p> <p>2025 SIAM Conference on Applied Algebraic Geometry, 4th Madison Workshop on Mathematics of Reaction Networks, Madison WI</p>                          | Jul 12 2025 |
| <p><b>The linear framework: graph-theoretic approach to Markov processes with applications in biochemical reaction networks.</b></p> <p>Mathematics Department, University of Michigan, Ann Arbor MI</p>  | Oct 03 2024 |
| <p><b>Following the energy: graph-theoretic models of broken detailed balance with biochemical applications.</b></p> <p>National Institute for Theoretical and Mathematical Biology, Chicago IL</p>   | Jan 12 2024 |
| <p><b>Following the energy: graph-theoretic models of broken detailed balance with biochemical applications.</b></p> <p>Barcelona Collaboratorium for Modelling and Predictive Biology, UPF, Barcelona Spain</p>  | Oct 17 2023 |
| <p><b>A graph-theoretic approach to Markov processes with applications in biochemical reaction networks.</b></p> <p>Mathematics Department Colloquium, Middlebury College, Middlebury VT</p>  | Oct 03 2023 |
| <p><b>Following the energy: graph-theoretic models of broken detailed balance with biochemical applications.</b></p> <p>NSF-Simons QBio Seminar, Harvard University, Cambridge MA</p>   | Apr 25 2023 |
| <p><b>Following the energy: graph-theoretic models of broken detailed balance with biochemical applications.</b></p> <p>Systems Biology Department Seminar, Harvard University, Cambridge MA</p>  | Mar 26 2023 |
| <p><b>Graph-theoretic models of detecting broken detailed balance in molecular information processing.</b></p> <p>2022 SIAM Annual Meeting MS 26: Trends and New Results in Deterministic Models of Biochemical Interaction Networks, Pittsburgh PA</p> | Jul 11 2022 |
| <p><b>Graph-theoretic models of non-equilibrium conditions in molecular information processing.</b></p> <p>Systems Biology PhD Program retreat, Harvard University, Cambridge MA</p>  | May 17 2022 |
| <p><b>Investigating mathematical properties of non-equilibrium signatures in biological information processing systems.</b></p> <p>Poster at 2022 American Physical Society Annual March Meeting, Chicago IL</p>  | Mar 16 2022 |
| <p><b>Graph-theoretic models of non-equilibrium conditions in molecular information processing.</b></p> <p>NSF-Simons QBio Seminar, Harvard University, Cambridge MA</p>  | Nov 10 2021 |

## University of Michigan Ann Arbor

### Instructor of record:

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| MATH 404: Intermediate Differential Equations (Nonlinear Dynamics & Chaos) | Winter 2025 |
| MATH 404: Intermediate Differential Equations (Nonlinear Dynamics & Chaos) | Fall 2025   |
| MATH 404: Intermediate Differential Equations (Nonlinear Dynamics & Chaos) | Fall 2026   |

### Undergraduate students mentored:

- Joe Bogdan (University of Michigan, Independent Research Study, Summer 2025)
- Daniel Le (Colby College, Math REU, Summer 2026)
- George Simmons (University of Michigan, Math REU, Summer 2026)

## Harvard University

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| AM 50: Introduction to Applied Mathematics | Spring 2020 |
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## Conferences and workshops attended

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| <b>*14th European Conference on Mathematical &amp; Theoretical Biology</b><br>University of Graz, Austria                                 | Jul 2026 |
| <b>*Chemical Reaction Networks Workshop in Hawai'i 2026</b><br>University of Hawai'i at Mānoa, Honolulu, HI                               | May 2026 |
| <b>*4th Madison Workshop on Mathematics of Reaction Networks</b><br>University of Wisconsin-Madison, Madison WI                           | Jul 2025 |
| <b>2025 SIAM Conference on Applied Algebraic Geometry Meeting</b><br>University of Wisconsin-Madison, Madison WI                          | Jul 2025 |
| <b>Simons-NSF MathBioSys Annual Meeting 2023</b><br>Simons Foundation, New York NY  | Apr 2023 |
| <b>*2022 SIAM Annual Meeting</b><br>David L. Lawrence Convention Center, Pittsburgh PA  | Jul 2022 |
| <b>*APS Annual March Meeting 2022</b><br>McCormick Place - West Building, Chicago IL  | Mar 2022 |
| <b>Quantitative Approaches in Biology (virtual)</b><br>Northwestern University NSF-Simons Center  | Nov 2020 |
| <b>Mathematical Models in Biology: From Information Theory to Thermodynamics (virtual)</b><br>Banff International Research Station (BIRS) | Jul 2020 |
| <b>Workshop on Dynamics, Randomness, and Control in Molecular and Cellular Networks</b>   | Nov 2019 |

Center for Mathematical Sciences and Applications (CMSA), Harvard University, Cambridge MA

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## Outreach

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| <b>MCAIM Colloquium organizer</b><br>University of Michigan, Ann Arbor MI  | 2026-present |
| <b>American Women in Mathematics peer mentor</b><br>University of Michigan, Ann Arbor MI   | 2024-present |
| <b>Guest speaker for summer class on Physics of Biological Function</b><br>Wentworth Institute of Technology, Boston MA                                      | Jun 2023     |
| <b>Cambridge Science Festival volunteer</b><br>Cambridge, MA   | Oct 2022     |
| <b>Graduate research assistant in Quantitative Biology grant preparation</b><br>NSF-Simons Center for Quantitative Biology, Harvard University, Cambridge MA | May-Jul 2022 |
| <b>Diversity, equity, and inclusion contributor, recruiter, and mentor</b><br>Systems Biology Department/PhD Program, Harvard University, Cambridge MA       | 2020-2024    |
| <b>“What is Systems Biology?” outreach event creator/coordinator</b><br>Cambridge Science Festival, Cambridge MA   | Apr 2019     |

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## Science communication

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| <b>Cellular mathematics: how does math enhance our understanding of life at the molecular level?</b><br><a href="https://sabinahaque.substack.com/">https://sabinahaque.substack.com/</a>   | 2022-present |
| <b>Graph Theory 101</b><br>Science in the News Special Edition: Networks, Harvard University, Cambridge MA<br><a href="https://sitn.hms.harvard.edu/flash/2021/graph-theory-101/">https://sitn.hms.harvard.edu/flash/2021/graph-theory-101/</a> | Jun-Aug 2021 |

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## References

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References made available upon request.