Patrick Murphy

Contact Information

San Jose State University
Department of Mathematics
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Research Interests

Emergent behavior of complex systems and their robustness, kinetic models of collective behavior, data-driven agent-based simulations, machine learning frameworks for cell state detection and collective behavior, stochastic processes and applications in cellular biology.

Education

Department of Mathematics, University of Utah

Ph.D. in Mathematics, May 2020

- Dissertation Topic: Cellular Diffusion in Heterogeneous and Age-structured Switching Environments
- Advisor: Paul C. Bressloff

Department of Mathematical Sciences, Montana State University

M.S. in Mathematics, May 2015

- Advisor: Tomáš Gedeon

B.S. in Mathematics, May 2014

Professional Appointments

Department of Mathematics and Statistics, San José State University

Assistant Professor, July 2023 - present

Department of Bioengineering, Rice University

Postdoctoral Research Associate, July 2020 - June 2023

Center for Theoretical Biological Physics, Rice University

Postdoctoral Research Associate, July 2020 - June 2023

Additional Experience

UC San Diego Visiting Graduate Student in Biophysics	Summer 2019

Honors and Awards

SJSU Woordward Fund Award ($6,000)	Summer 2025
San José State Universiy Grants Academy	Spring 2023
NSF Research Training Grant (RTG) Fellowship	2018-2019
Outstanding Graduating Seniors with Distinction	Fall 2014
Montana INBRE Undergraduate Student Research Program Award	Spring 2014

Teaching

Instructor of Record, Mathematical Modeling (SJSU)	Spring 2025
Instructor of Record, Statistics for Bioinformatics (SJSU)	Fall 2024 & Fall 2025

Instructor of Record, Linear Algebra (SJSU)	Fall 2024
Instructor of Record, Mathematical Modeling for the Life Sciences (SJSU)	Spring 2024 & Spring 2025
Instructor of Record, Calculus III (SJSU)	Spring 2024
Instructor of Record, Calculus III (SJSU)	Fall 2023
Instructor of Record, Calculus I (SJSU)	Fall 2023
Instructor of Record, Calculus I (University of Utah)	Fall 2019
Lab Instructor, Mathematics in Medicine (University of Utah)	Spring 2019
Lab Instructor, Mathematical Biology I (University of Utah)	Fall 2018
Instructor of Record, Precalculus (University of Utah)	Spring 2017 & Fall 2017
Instructor of Record, Intermediate Algebra (University of Utah)	Fall 2016
Lab Instructor, Differential Equations and Linear Algebra (University of Utah)	Spring 2016
Lab Instructor, Calculus for Engineers I (University of Utah)	Fall 2015
Instructor of Record, College Algebra (Montana State)	Fall 2014

Mentorship of Student Research

Undergraduate Research in Applied Mathematics, San Jose State University — 2023-present

- Surabhi Bage (Spring 2025). Multilinear regression for household power consumption.
- Dexter Allen (Fall 2024-Spring 2025). Modeling interactions between myxobacterial rippling and surface roughness.
- Adan Amer (Fall 2024-Spring 2025). Statistical analysis of bacterial motility decisions.

Masters Students in Applied Mathematics, San Jose State University — 2023-present

- Kevin Lopez (current). Modeling the spread of infection diseases among cities.
- Isaac Heller (current). A PDE model for bacterial aggregate dispersal.
- Keitel Del Rosario (current). Agent-based models of streams and rippling patterns in myxobacteria.

	Undergraduate Research in Biophysics, Rice University	2020-2021
	- Brandon Islas (Rice University, class of 2022). Numerical solutions of rippling patterns in the bacteria *Myxococcus xanthus* (co-mentor Oleg Igoshin). - Matan Lieber-Kotz (Rice University, class of 2022). Accuracy of Boltzmann models for cell collisions (co-mentor Oleg Igoshin).	
Conferences and Talks	Short presentation on data-driven methods in bacterial cooperative behavior, Annual West Coast Bacterial Physiologist Conference	December 2024
	Applied Math seminar on data-driven methods in emergent behavior, University of Cincinnati	November 2024
	Minisymposium talk on Emergent Collective Behaviors in Biology (session organizer and speaker), SIAM Life Sciences	June 2024
	Contributing talk, Annual International Myxomeeting on Myxobacteria	June 2024
	Colloquium, San Jose State University Department of Mathematics and Statistics	March 2023
	Contributing talk, Banff BIRS Workshop on Emergent Behavior	May 2022
	Virtual seminar, University of Pennsylvania Simons Center for Mathematical Biology	February 2022
	Virtual seminar, University of Pittsburgh Department of Mathematics	January 2022
	Contributing talk, Annual International Myxomeeting on Myxobacteria	October 2021
	Virtual seminar, UC San Diego Department of Mathematics	October 2020
	Virtual seminar, New Jersey Institute of Technology Department of Mathematics	September 2020
	SIAM Conference on the Life Sciences (Poster) Minneapolis, MN	August 2018
	Montana State University Student Research Celebration (Poster) Bozeman, MT	April 2014
Professional memberships	Society for Industrial and Applied Mathematics (SIAM)	
Publications	(*co-first authors, **primary author)	
	15. J Zhang, E Caro, P Chen, T Khan, **P Murphy**, L Shimketsh, A Patel, R Welch, O Igoshin. *A Deep Learning Framework for Quantifying Dynamic Self-Organization in Myxococcus xanthus.* [Submitted]	

14. T Khan, **P Murphy**, J Zhang, O Igoshin, and R Welch. *Genetic and environmental determinants of streaming and aggregation in Myxococcus xanthus.* [Accepted] Sci. Rep. (2025)

13. I Timofeyev, M Batista, **P Murphy**, O Igoshin, M Perepelitsa. *Role of Non-Exponential Reversal times in Aggregation Models of Bacterial Populations.* Math Biosci. 383:109418. doi: 10.1016/j.mbs.2025.109418 (2025)

12. M Perepelitsa, and I Timofeyev, **P Murphy**, and O Igoshin. *The existence of weak solutions for the kinetic models of motion of myxobacteria with alignment and reversals.* Kinetic and Related Models. doi: 10.3934/krm.2025001 (2024)

11. **P Murphy***, M A Perepelitsa*, I Timofeyev, B Islas, M Lieber-Kotz, and O Igoshin. *Breakdown of Boltzmann-type Models for the Alignment of Self-propelled Rods.* Math. Biosci. 376, 109266 (2024)

10. T Tyree, **P Murphy**, and WJ Rappel. *Annihilation dynamics during spiral defect chaos revealed by particle models.* Chaos 34, 053131 (2024)

9. **P Murphy***, J A Comstock*, J Zhang, R Welch, and O Igoshin. *Cell behaviors underlying Myxococcus xanthus aggregate dispersal.* mSystems 00425-23 (2023)

8. M A Perepelitsa*, I Timofeyev*, **P Murphy***, and O Igoshin. *Mean-field model for nematic alignment of self-propelled rods.* Phys. Rev. E. 106, 034613 (2022)

7. J Zhang, J A Comstock, C R Cotter, **P A Murphy**, W Nie, R D Welch, A B Patel, O A Igoshin. *Quantification of Myxococcus xanthus Aggregation and Rippling Behaviors: Deep-Learning Transformation of Phase-Contrast into Fluorescence Microscopy Images.* Microorganisms (2021), 9, 1954

6. P C Bressloff, S D Lawley, and **P Murphy****. *Interaction Between Switching Diffusivities and Cellular Microstructure.* Multiscale Model. Simul. 18 572-588 (2020)

5. P C Bressloff*, S D Lawley*, and **P Murphy***. *Effective Permeability of Gap Junctions with Age-structured Switching.* SIAM J. Appl. Math. 80 312-337 (2020)

4. P C Bressloff*, S D Lawley*, and **P Murphy***. *Protein Concentration Gradients and Switching Diffusions.* Phys. Rev. E. 99, 032409 (2019)

3. P C Bressloff*, S D Lawley*, and **P Murphy***. *Diffusion in an Age-structured Randomly Switching Environment.* J. Phys. A 51, 315001 (2018)

2. C Xia, C Cochrane, J DeGuire, G Fan, E Holmes, M McGuirl, **P Murphy**, J Palmer, P Carter, L Slivinski, and B Sandstede, *Lagrangian Data Assimilation in Traffic-flow Models*, Physica D 346, (2017) 59-72

1. T Gedeon* and **P Murphy***, *Dynamics of Simple Food Webs*, Bull. Math. Biol. (2015) 77: 1833