Sanket Biswas

Curriculum Vitae

Ph.D. Student
Chemical and Biomolecular Engineering
University of California, Berkeley
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Research Statement: I use tools from applied mathematics, continuum mechanics, and statistical physics to develop theoretical and computational models that elucidate how microscale transport processes in soft and active matter systems give rise to emergent macroscale behavior.

Education

University of California, Berkeley, CA, USA **Aug. 2025 – Present**
Ph.D. in Chemical Engineering
- **Advisors:** Prof. Kranthi K. Mandadapu and Prof. Karthik Shekhar.
- **Research focus:** Analytical and numerical modeling of microscale electrochemical transport processes across biomembranes.

University of British Columbia, Vancouver, BC, Canada **Sep. 2023 – Aug. 2025**
M.A.Sc. in Chemical and Biological Engineering ***GPA:*** *94.2%*
- **Advisors:** Prof. John M. Frostad and Prof. Gwynn J. Elfring.
- **Thesis:** Dynamics of microdroplets under oscillatory and quasi-static deformation. [Slides]

Sant Longowal Institute of Engineering and Technology, PB, India **Aug. 2019 – May 2023**
B.E. (Hons.) in Chemical Engineering ***GPA:*** *9.39/10*
- **Advisor:** Prof. Shubhadeep Mandal (Indian Institute of Science, Bengaluru).
- **Thesis:** Dynamics of inertial active Brownian particles in a microchannel with Poiseuille flow.
- **Honors project:** Numerical simulation of a 2D squirmer in a rectangular microchannel.

Publications

In preparation

[1] **S. Biswas**, J. M. Frostad, and G. J. Elfring. "A second-order asymptotic theory for the nonlinear quasi-static deformation of axisymmetric capillary bridges". (2026).

[2] **S. Biswas**, J. M. Frostad, and G. J. Elfring. "A theory for characterizing the bulk rheology and interfacial tension of viscoelastic microdroplets under oscillatory deformation". (2026).

Preprints

[3] **S. Biswas**, H. Tiwari, S. Verma, and K. Kumari. "High Accuracy Determination of Rheological Properties of Drilling Fluids Using the Marsh Funnel". *arXiv preprint* (2023). arXiv: 2308.04975 [physics.flu-dyn]. [PDF]

[4] F. Abney-McPeek, **S. Biswas**, S. Dutta, Y. Huang, D. Li, and N. Xu. "Ehrhart-Equivalence, Equidecomposability, and Unimodular Equivalence of Integral Polytopes". *arXiv preprint* (2021). arXiv: 2101.08771 [math.CO]. [PDF]

Thesis

[5] **S. Biswas**. "Dynamics of microdroplets under oscillatory and quasi-static deformation". *M.A.Sc. thesis, University of British Columbia* (2025). [PDF]

Research Experience

M.A.Sc. Thesis (funded by Tri-Agency and Mitacs GGF) Sep. 2023 – Aug. 2025
Advisors: Prof. John M. Frostad and Prof. Gwynn J. Elfring **University of British Columbia**

Topic: Dynamics of microdroplets under oscillatory and quasi-static deformation. [PDF] [Slides]

– **Project 1:** Developed an asymptotic model for the leading-order nonlinear quasi-static force response and shape of an axisymmetric Newtonian microdroplet pinned between coaxial capillaries in the cantilevered capillary force apparatus (CCFA), enabling accurate interfacial tension measurements from the force response over a wider range of deformations than was possible with earlier analytical models.

– **Project 2:** Developed an asymptotic model for the leading-order small-strain, thin-gap oscillatory deformation of a Maxwell viscoelastic microdroplet pinned between coaxial capillaries in the CCFA, enabling extraction of interfacial tension and frequency-dependent storage and loss moduli from the measured force response.

Undergraduate Thesis (funded by JNCASR SRFP) Jan. 2023 – May 2023
Advisor: Prof. Shubhadeep Mandal **Indian Institute of Science**

Topic: Dynamics of inertial active Brownian particles (ABPs) in a microchannel with Poiseuille flow. [PDF] [Slides]

– Derived the governing stochastic differential equations for the 2D trajectories of inertial ABPs in a rectangular microchannel with Poiseuille flow using Langevin dynamics, and designed and implemented a second-order accurate stochastic finite difference scheme with reflective boundaries in MATLAB to solve them.

– Analyzed ABP trajectories and phase spaces using statistical mechanical tools (e.g., correlation and fluctuation measures) to assess the influence of particle inertia, local fluid temperature, flow speed, and initial conditions.

Undergraduate Honors Project Jan. 2023 – May 2023
Advisor: Prof. Shubhadeep Mandal **Indian Institute of Science**

Topic: Numerical simulation of a 2D squirmer in a rectangular microchannel. [PDF] [Slides]

– Designed and validated a COMSOL framework to study how channel height affects the dynamics of a 2D squirmer in a quiescent Newtonian fluid confined to a rectangular microchannel.

Undergraduate Minor Project (funded by IIChE Research Award) Sep. 2022 – Dec. 2022
Advisor: Prof. Kamlesh Kumari **SLIET**

Topic: Rheological analysis of drilling fluids using the Marsh funnel. [PDF] [Slides]

– Used the Herschel-Bulkley model to derive analytical expressions for the flow rate, exit velocity, and rheological properties of drilling fluids flowing through a Marsh funnel under the influence of gravity.

– Applied this model to experimentally determine the rheological properties of 12 drilling fluids, achieving an average error of less than 5%, a level of accuracy not previously reported.

Mitacs Globalink Research Internship Jun. 2022 – Aug. 2022
Advisor: Prof. Benoit Charbonneau **University of Waterloo**

Topic: Packing of n-dimensional space with n-dimensional non-spherical symmetric convex bodies. [Conference slides] [Seminar slides]

– Performed an extensive literature review on optimal packings and coverings of n-dimensional Euclidean space with spheres, polyhedra, and ellipsoids.

– Designed and implemented an exact nonlinear programming model based on Monte Carlo methods in Maple to determine tight bounds for the densest packing of n-dimensional Euclidean space with congruent n-dimensional ellipsoids, and presented the results at the 2022 Canadian Undergraduate Mathematics Conference.

Semester Project 3 [Virtual] Jan. 2022 – May 2022
Advisor: Prof. Sumesh Thampi **Indian Institute of Technology Madras**

Topic: Confinement-induced 3D trajectories of microswimmers in rectangular microchannels. [Report] [Seminar write-up] [Slides]

– Modeled the microswimmer as a squirmer and derived analytical expressions for its 3D trajectories in rectangular microchannels using far-field approximations and the method of images. Investigated how the trajectories varied with squirmer strength and size, confinement dimensions, and initial conditions.

– Validated the analytical findings by designing and implementing a lattice-Boltzmann method (LBM)-based numerical framework in MATLAB, incorporating a mid-grid bounce-back scheme for the squirmer's surface velocity.

Semester Project 2 [Virtual] Sep. 2021 – Dec. 2021
Advisors: Prof. Sergei Chernyshenko and Prof. Giovanni Fantuzzi **Imperial College London**

Topic: Nonlinear stability analysis of fluid flows using semi-algebraic optimization.

– Implemented sum-of-squares optimization to construct Lyapunov functions in MATLAB and established nonlinear stability of rotating Couette flow at Reynolds numbers higher than those achievable with standard energy stability methods.

Summer Internship [Virtual] Jun. 2021 – Aug. 2021
Advisor: Prof. Juliette Bruce **University of California, Berkeley**

Topic: Abelian varieties and subcomplexes of perfect chain complexes.

– Investigated the perfect chain complex of polyhedral cones by analyzing the subcomplexes associated with graphic and co-graphic matroids, contributing to a deeper understanding of their topological properties.

Semester Project 1 [Virtual] Jan. 2021 – May 2021
Advisor: Prof. Nishad Kothari **Indian Institute of Technology Madras**

Topic: Strengthening Petersen's Theorem: Investigating perfect matchings in bridgeless cubic graphs. [PDF]

– Strengthened Petersen's theorem on perfect matchings in bridgeless cubic graphs by proving that every edge lies in at least two distinct perfect matchings, except in certain special graphs and infinite families.

PROMYS Research Lab [Virtual] Jun. 2020 – Aug. 2020
Advisor: Prof. Kiran S. Kedlaya **Boston University**

Topic: Ehrhart-equivalence, equidecomposability, and unimodular equivalence of integral polytopes. [PDF] [Slides]

– Established 6 theorems characterizing Ehrhart-equivalence between two integral n-polytopes in $\mathbb{R}^n$.

Contributed Presentations

‡ denotes invited presentations.

[1] **S. Biswas**. "Rheology of Viscoelastic Microdroplets under Oscillatory Compression". *CHBE Graduate Seminar, University of British Columbia; Vancouver, BC, Canada* (Mar. 2025). [Slides]

[2] **S. Biswas**, J. M. Frostad, and G. J. Elfring. "Dynamics and Rheology of Viscoelastic Microparticles under Oscillatory and Quasi-Static Compression". *APS March Meeting; Anaheim, CA, USA* (Mar. 2025).

[3] **S. Biswas**, J. M. Frostad, and G. J. Elfring. "Dynamics and Rheology of Complex Droplets under Oscillatory Squeeze Flow". *APS 77th Annual Meeting of the Division of Fluid Dynamics; Salt Lake City, UT, USA* (Nov. 2024).

[4] **S. Biswas**. "Dynamics of Inertial Active Brownian Particles in a Rectangular Microchannel with Poiseuille Flow". *Microfluidics Seminar, Indian Institute of Science; Bengaluru, KA, India* (May 2023). [Slides]

‡ [5] **S. Biswas**. "3D Trajectories of Microswimmers in Rectangular Microchannels". *Henry Shum Group Meeting, University of Waterloo; Waterloo, ON, Canada* (Jul. 2022). [Slides]

‡ [6] **S. Biswas**. "3D Trajectories of Microswimmers in Rectangular Microchannels". *Biological Physics Group Meeting, Max Planck Institute for the Physics of Complex Systems, Dresden; Virtual* (Jul. 2022). [Slides]

[7] **S. Biswas** and C. Q. Martínez. "Packing Ellipsoids in an Optimized Cylinder". *Differential Geometry Seminar, University of Waterloo; Waterloo, ON, Canada* (Aug. 2022).

[8] **S. Biswas** and C. Q. Martínez. "Packings and Coverings in $\mathbb{R}^n$". *Canadian Undergraduate Mathematics Conference; Quebec City, QC, Canada* (Jul. 2022). [Slides]

[9] F. Abney-McPeek, **S. Biswas**, S. Dutta, Y. Huang, D. Li, and N. Xu. "Ehrhart-Equivalence and $\mathrm{GL}_4(\mathbb{Z})$-Equidecomposability in Dimension 4". *Research Lab Seminar, Program in Mathematics for Young Scientists, Boston University; Virtual* (Aug. 2020). [Slides]

Poster Presentation

[1] **S. Biswas**. "Rheology of Viscoelastic Microdroplets under Oscillatory Compression". *CHBE Research Day, University of British Columbia; Vancouver, BC, Canada* (Feb. 2025). [Poster]

Awards and Honors

Aug. 2025–Jul. 2026 **Berkeley Fellowship for Graduate Study**, *Department of Chemical and Biomolecular Engineering, University of California, Berkeley.*

Aug. 2023–Dec. 2025 **International Tuition Award**, *Department of Graduate and Postdoctoral Studies, University of British Columbia, Vancouver.*

Jan. 2024–Dec. 2024 **Mitacs Globalink Graduate Fellowship Award**, *Mitacs.*

Aug. 2023–Dec. 2023 **Faculty of Applied Science Graduate Award**, *Department of Chemical and Biological Engineering, University of British Columbia, Vancouver.*

May 2023 **Biophysics Summer Internship**, *Department of Biological Physics, Max Planck Institute for the Physics of Complex Systems, Dresden.*

Jan. 2023–May 2023 **Summer Research Fellowship Programme (SRFP)**, *Jawaharlal Nehru Centre for Advanced Scientific Research and Indian Institute of Science, Bengaluru.*

Aug. 2022 **IIChE Research Award (best undergraduate thesis)**, *Indian Institute of Chemical Engineers.*

Jun. 2022–Aug. 2022 **Mitacs Globalink Research Internship**, *Mitacs and University of Waterloo.*

Jun. 2019, Jun. 2020 **Mehta Fellowship**, *Program in Mathematics for Young Scientists, Boston University.*

Jul. 2018 **Mathematics Summer Program**, *École normale supérieure, Paris.*

Dec. 2016 Qualified for **Indian National Mathematical Olympiad**, *Homi Bhabha Centre For Science Education, Tata Institute of Fundamental Research.*

Nov. 2016 High Distinction in the **Australian Mathematics Competition**, *Australian Maths Trust.*

Teaching Experience

UC Berkeley || Chemical and Biomolecular Engineering

Fa. 2025 **Graduate Student Instructor, CHMENG 130: Mathematics and Statistics in Chemical Engineering**

University of British Columbia || Chemical and Biological Engineering

Sp. 2025 **Graduate Teaching Assistant, CHBE 230: Computational Methods**

"Sanket was always helpful when I had questions. He answered them clearly and walked me through the approach to each problem."

Fa. 2024 **Graduate Teaching Assistant, CHBE 352: Transport Phenomena II**

"Sanket is very helpful when students ask questions. He is clearly knowledgeable about the subject matter, explains topics and concepts effectively, and is patient when students are struggling. He also cares about what students should get out of the course. Although it would be nice to have set office hours for in-person questions, I really appreciate how promptly he responds to emails. Overall, Sanket has been a tremendous resource whenever I have been stuck on practice problems or needed help studying for exams. Thanks so much, Sanket!"

Skills & Technologies

- **Programming & Scripting:** Python, MATLAB, C/C++, Haskell
- **Scientific Computing:** Wolfram Mathematica, FEniCS, COMSOL Multiphysics, Maple, SageMath
- **Visualization & Figure Preparation:** Matplotlib, PowerPoint (IguanaTeX), Inkscape, TikZ/LaTeX
- **Typesetting & Writing:** LaTeX, Overleaf, TeXShop
- **Development & Reproducibility:** JupyterLab, Git, GitHub

Professional Service

Aug. 2023–Jul. 2025 **Captain, CHBE Graduate Student Committee mixed-gender soccer/futsal team:** Led the department's mixed-gender team to a championship in the UBC intramural outdoor soccer league and a runner-up finish in the UBC futsal league, *University of British Columbia, Vancouver.*

Jul. 2023–Aug. 2023 **Mitacs Globalink Ambassador:** Supported incoming Globalink Research Internship fellows with questions about host institutions, cities, and research projects, *Mitacs.*

Apr. 2021–Aug. 2025 **Advisor and Coordinator, IIChE Student Chapter:** Co-founded and coordinate the IIChE Lecture Series, an online seminar series introducing undergraduate students across India to current research in Chemical Engineering and related fields, *Sant Longowal Institute of Engineering and Technology.*

Apr. 2020–Aug. 2024 **Mentor, Student Mentor Scheme:** Mentored 12 undergraduate students on coursework planning and applications for competitive research internships in India and abroad, *Sant Longowal Institute of Engineering and Technology.*

Jun. 2020–Aug. 2020 **Junior Counselor:** Graded daily problem sets, provided academic mentoring, and helped organize cohort activities for approximately 60 high-achieving high-school students, *Program in Mathematics for Young Scientists, Boston University.*