Binan Gu

Personal Information

Affiliation	Worcester Polytechnic Institute (WPI), Department of Mathematical Sciences
Status	Postdoctoral Scholar
Address	100 Institute Rd, Worcester, MA 01609
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Research Interests

- Mathematical and Network Modeling
- Fluid Dynamics
- Partial Differential Equations
- Stochastic Processes and Applications

Current work: pore dynamics through carbonate-reaction kinetics in high-temperature aquifer storage applications, reduced ODE model for pore networks with advective, diffusive and reactive transport, simultaneous adsorption and sieving fouling mechanism on membrane pore networks, persistence homology in membrane pore networks with varying radii, exclusion processes in statistical mechanics.

Education

Sep 2016–Aug 2022
New Jersey Institute of Technology (NJIT). Ph.D. Candidate, Mathematical Sciences.
Ph.D. thesis: *Stochastic Modeling of Flow through Complex Geometries.*
Advisors: Prof. Linda J. Cummings, Prof. Lou Kondic.

Aug 2014–May 2016
New York University (NYU). Master of Science, Mathematics.
Master thesis: *Branching Markov Chains and Random Walks in Random Environments.*
Advisor: Prof. Chiranjib Mukherjee.

Aug 2009–Dec 2013
University of Southern California (USC).
Bachelor of Science, Mathematics.
Bachelor of Arts, Economics.

Publications and Work in Progress

[1] On the Influence of Pore Connectivity on Performance of Membrane Filters.
B. Gu, D.R. Renaud, P. Sanaei, L. Kondic, L.J. Cummings, *Journal of Fluid Mechanics*, **902**, A5 (2020).

[2] A Graphical Representation of Membrane Filtration with Adsorption.
B. Gu, L. Kondic, L.J. Cummings, *SIAM Journal of Applied Mathematics*, **82**, 3, (2022).

[3] Network-based membrane filters: Influence of network and pore size variability on filtration performance.
B. Gu, L. Kondic, L.J. Cummings, *Journal of Membrane Science*, **657**, 120668 (2022).

[4] Flow through Pore-Size Graded Membrane Networks.
B. Gu, L. Kondic, L.J. Cummings, *Physical Review Fluids*, **8**, 044502 (2023).

[5] Modeling and Simulating Shear-Thinning Viscous Flow in a Hele-Shaw Cell.
B. Gu, J. Adriazola, L. Kondic, L.J. Cummings (final stage of manuscript preparation).

[6] Stochastic Modeling of Sieving in Membrane Pore Networks.
B. Gu, P. Sanaei, L. Kondic, L.J. Cummings (final stage of manuscript preparation).

[7] Persistent Homology of Membrane Pore Networks.
M. Illingworth, **B. Gu**, L. Kondic, L.J. Cummings (In progress).

[8] Long-term impact of nonlinear pore dynamics on species and thermal transport under temporally periodic far-field forcing.
B. S. Tilley, **B. Gu**, T. Baumann (In progress).

[9] A Reduced ODE Model for Nonlinear Pore Dynamics and its Network Adaptations
B. S. Tilley, **B. Gu**, (In progress).

Technical Reports

[1] On Temperature Effects in Reacting Porous Media Applications.
R.H. Allaire, A.G. Odu, **B. Gu**, W. Lu, A. Newell, P.J. Paranamana, T. Phan, H. Ruzayqat, DOI: 10.13140/RG.2.2.32155.62246 (2017).

[2] Finding the Limits of Machine Learning in Optimization
D.A. Edwards, **B. Gu**, K. Johnson, M. Wichman, M. Zyskin, Mathematics in Industry Reports, DOI: 10.33774/miir-2022-q537t (2022).

Presentations, Talks and Workshops

Conference Abstracts

Nov 2023 American Physical Society Division of Fluid Dynamics
Long-term impact of nonlinear pore dynamics on species and thermal transport under temporally periodic far-field forcing
Washington, D. C., USA.

Oct 2023 Society of Industrial and Applied Mathematics NY-NJ-PA Sectional Meeting
A General Model for Pore Dynamics on Species and Thermal Transport under Temporally Periodic Far-field Forcings.
Newark, New Jersey, USA.

Mar 2023 American Physical Society March Meeting
Stochastic Modeling of Sieving in Membrane Filters.
Las Vegas, Nevada, USA.

Nov 2022 American Physical Society Division of Fluid Dynamics
On Pore-size Graded Membrane Networks.
Indianapolis, Indiana, USA.

Jan 2022 16th Northeast Complex Fluids and Soft Matter Workshop (NCS16)
A Graphical Representation of Membrane Filtration.
Princeton University, Princeton, New Jersey, USA.

Nov 2021 American Physical Society Division of Fluid Dynamics
A Graphical Representation of Membrane Filtration.
Phoenix, Arizona, USA.

May 2021 InterPore 2021-13th International Conference on Porous Media & Annual Meeting (virtual)
A Graphical Representation of Membrane Filtration with Adsorption.

Aug 2020 InterPore 2020-12th International Conference on Porous Media & Annual Meeting (virtual)
Stochastic Modelling of Adsorption and Sieving in a Pore Network.

Nov 2019 American Physical Society Division of Fluid Dynamics.
Stochastic Modelling of Sieving in Membrane Filters with Complex Pore Morphology.
Seattle, Washington, USA.

July 2019 Fluid Mechanics of Cleaning and Decontamination, Special Interest Group
Stochastic Modelling of Sieving.
Mathematical Institute, Oxford University, Oxford, United Kingdom.

Jan 2019 10th Northeast Complex Fluids and Soft Matter Workshop (NCS10)
Modeling Connectivity and Asymmetry in Membrane Filters.
Rutgers University, New Brunswick, New Jersey, USA.

Jan 2019 Transport in Disordered Systems.
Modeling Connectivity and Asymmetry in Membrane Filters.
Princeton University, Princeton, New Jersey, USA.

Nov 2018 American Physical Society Division of Fluid Dynamics.
Modeling Connectivity and Asymmetry in Membrane Filters.
Georgia Institute of Technology, Atlanta, Georgia, USA.

May 2018 9th Northeast Complex Fluids and Soft Matter Workshop (NCS9)
Modeling Asymmetry of Membrane Filters with Complex Morphology.
University of Pennsylvania, Philadelphia, Pennsylvania, USA.

Contributed Conference Presentations

Nov 2023 American Physical Society Division of Fluid Dynamics
*Network modeling of membrane filtration with multiple fouling modes*Co-authors: L. J. Cummings, P. Sanaei, L. Kondic
Washington, D. C., USA.

Nov 2023 American Physical Society Division of Fluid Dynamics
*On correlating topology and performance of pore networks in membrane filters*Co-authors: M. Illingworth, L. J. Cummings, L. Kondic
Washington, D. C., USA.

July 2019 27th Congress on Statistical Physics
Stochastic Modeling of Flow Through Complex Geometries.
Buenos Aires, Argentina.

May 2018 Interpore 2018-10th International Conference on Porous Media & Annual Meeting.
Mathematical Modeling of Microstructured Membrane Filters: A Stochastic Approach.
New Orleans, Louisiana, USA.

Jan 2018 8th Northeast Complex Fluids and Soft Matter Workshop
Stochastic Approach to Model Fouling in Membrane Filters.
New York, New York, USA.

Nov 2017 American Physical Society Division of Fluid Dynamics.
Stochastic Approach to Model Fouling in Membrane Filters with Complex Pore Morphology.
Denver, Colorado, USA.

Invited Talks

Apr 2024 Fluid Mechanics and Waves Seminar
A General Model for Pore Dynamics on Species and Thermal Transport under Temporally Periodic Far-field Forcings.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Feb 2024 Institute of Applied Mathematics, Fluids Seminar
A Reduced ODE Model for Nonlinear Pore Dynamics and its Network Adaptations.
University of British Columbia, Vancouver, British Columbia, Canada.

Feb 2023 Applied Math Group Lunch Meeting
Graphical Representation of Membrane Filtration.
Georgia State University, Atlanta, Georgia, USA.

Sep 2022 Mathematical Sciences Department, Colloquium
Graphical Representation of Membrane Filtration.
Worcester Polytechnic Institute, Worcester, Massachussetts, USA.

Dec 2021 Applied Mathematics and Mathematical Medicine and Biology Seminar
Graphical Representation of Membrane Filtration.
University of Delaware, Newark, Delaware, USA.

Sep 2021 NJIT Optimization and Machine Learning Talks
PageRank, its related centrality measures and diffusion on large graphs..
New Jersey Institute of Technology, Newark, New Jersey, USA.

Oct 2021 Complex Fluids and Soft Matter Group
Graphical Representations of Membrane Networks.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Sep 2021 NJIT Optimization and Machine Learning Talks
Stochastic Temporal Networks.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Apr 2021 NJIT Optimization and Machine Learning Talks
On Diffusion Approximations of Stochastic Gradient Descent.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Feb 2021 NJIT Optimization and Machine Learning Talks
On the Energy Landscape of Deep Networks.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Oct 2020 NJIT Optimization and Machine Learning Talks
Graph-Based Models & Model Selection.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Nov 2020 NJIT Optimization and Machine Learning Talks
Graph-Based Learning.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Feb 2020 Complex Fluids and Soft Matter Group
Continuous-Time Random Walk on a Weighted Dynamic Graph.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Aug 2019 Complex Fluids and Soft Matter Group
A Graph Theory Approach to Study Network-Based Membrane Filter Models.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Aug 2019 Applied Math Group
Graphical Representation of Membrane Filters.
New York Institute of Technology, New York, USA.

Apr 2019 Dana Knox Student Research Showcase
Stochastic Modeling of Membrane Filtration.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Workshops

Jun 2023 Mathematical Problems in Industry
Bulletproofing Bayesian particle flow against stiffness.
New Jersey Institute of Technology, Newark, New Jersey, USA.

Jun 2022 Mathematical Problems in Industry
Finding the Limits of Machine Learning in Optimization.
Worcester Polytechnic Institute, Worcester, Massachusetts, USA.

Nov 2021 Mean-Field Models for Interacting Agents (Meeting attendance)
Distributed Solutions to Complex Societal Problems series
Institute for Mathematical and Statistical Innovation, Chicago, Illinois.

Jul 2021 Analytic and Geometric Approaches to Machine Learning Symposium (Meeting attendance)
University of Bath, United Kingdom.

Jun 2021 CMS 75th Anniversary Summer Meeting (Meeting attendance)

Apr 2021 East Coast Optimization Meeting (Meeting attendance)
George Mason University Fairfax, Virginia, USA

Mar 2021 Tensor Methods and Emerging Applications to the Physical and Data Sciences (Workshop attendance)
Workshop I: Tensor Methods and their Applications in the Physical and Data Sciences
Institute for Pure & Applied Mathematics, UCLA, Los Angeles, California, USA

Jun 2020 Mathematical Problems in Industry
Dynamics on the Ternary Diagram Represetation of Mixtures in a Membrane Filter.
University of Vermont, Burlington, Vermont, USA.

May 2018 Intensive Program on Fluid and Waves (Workshop attendance)
Gran Sasso Science Institute, L'Aquila, Italy.

Jun 2017 Mathematical Problems in Industry
On Characterizing and Simulating Porous Media
New Jersey Institute of Technology, Newark, New Jersey, USA.

Jun 2017 Graduate Student Mathematical Modelling Camp
On Temperature Effects in Reacting Porous Media Applications.
Rensselaer Polytechnic Institute, Troy, New York, USA.

Short-Term Visiting Position

Jun 2019–Jul 2019
Academic Visitor.
Hosts: Prof. Ian M. Griffiths, Dr. Mohit Dalwadi
Mathematical Institute, Oxford University.

Service work

Sep 2023–Present
Applied Math Seminar Organizer
Department of Mathematical Sciences, WPI
Worcester, Massachusetts, USA

Mar 2023 Session Chair
American Physical Society March Meeting 2023
Las Vegas, Nevada, USA

Sep 2022–Present
Reviewer
Journal of Fluid Mechanics

Sep 2020–Aug 2022
Organizer of NJIT Optimization and Machine Learning Talks
Department of Mathematical Sciences,
New Jersey Institute of Technology, Newark, New Jersey, USA.

Sep 2018–Aug 2021
Department Student Representative,
Department of Mathematical Sciences,
New Jersey Institute of Technology, Newark, New Jersey, USA.

Mentorship

Aug 2022–Present
Matthew Illingworth. Ph. D. candidate,
New Jersey Institute of Technology, Newark, New Jersey, USA.

June 2021–Sep 2021
Justin Lee, Siddarth Kunisetty, Heer Patel. High School Students.
Middlesex County Academy for Science, Mathematics & Engineering Technologies, Edison, New Jersey, USA.

June 2021–Sep 2021
Anay Badlani. High School Student.
West Orange High School, West Orange, New Jersey, USA.

Sep 2017–May 2018

Dylan Renaud. Undergraduates.
New Jersey Institute of Technology, Newark, New Jersey, USA.
Now PhD candidate at Harvard University, Applied Physics.

Awards

- Society of Industrial and Applied Mathematics, Travel Award.
  Conference on Mathematical & Computational Issues in the Geosciences, June 2023.
  Bergen, Norway.
- Best Oral Presenter Award.
  Graduate Student Association Research Day, Fall 2021.
  New Jersey Institute of Technology.
- SIAM Student Chapter Certificate of Recognition, awarded Spring 2021.
  Society for Industrial and Applied Mathematics.
- College of Science & Liberal Arts, Outstanding Graduate Student Award, awarded Spring 2021.
  Department of Mathematical Sciences, New Jersey Institute of Technology.
- Provost Doctoral Assistantship, awarded Spring 2017, Fall 2017.
  Department of Mathematical Sciences, New Jersey Institute of Technology.
- Graduate Student Travel Award.
  New Jersey Institute of Technology, Graduate Student Association.

Selected Graduate Courses

NJIT	Real Analysis, Numerical Methods, Asymptotics, Convex Optimization, Probability Theory, Partial Differential Equations Theory, Fluid Dynamics, Stochastic Processes, Calculus of Variations.
NYU	Limit Theorems, Stochastic Calculus, Numerical Methods.
USC	Analysis, Ordinary Differential Equations, Stochastic Calculus and Mathematical Finance.

Teaching

Sep 2023–Dec 2023

Lecturer. Calculus III.
Department of Mathematical Sciences, Worcester Polytechnic Institute.

Jan 2023–Mar 2023

Lecturer. Numerical Methods for Linear and Nonlinear Systems.
Department of Mathematical Sciences, Worcester Polytechnic Institute.

Oct 2022–May 2023

Lecturer. Calculus IV.
Department of Mathematical Sciences, Worcester Polytechnic Institute.

Sep 2021–Dec 2021

Lecturer. Calculus I.
Department of Mathematical Sciences, New Jersey Institute of Technology.

Jan 2020–May 2020

Lecturer. Calculus II.
Department of Mathematical Sciences, New Jersey Institute of Technology.

Aug 2017–May 2018

Capstone Lab Assistant. Methods of Applied Mathematics I and II, Honors.
Department of Mathematical Sciences, New Jersey Institute of Technology.

Aug 2019–Dec 2019

Teaching Assistant. Calculus I, Honors.
Department of Mathematical Sciences, New Jersey Institute of Technology.

Aug 2016–May 2019

Teaching Assistant. Precalculus, Calculus I, Calculus II.
Department of Mathematical Sciences, New Jersey Institute of Technology.

July 2016–Aug 2016

Lecturer. Mathematical Modelling and Applied Statistics.
Duke Talent Identification Program, Wake Forest University.

Aug 2015–May 2015

Teaching Assistant. Calculus I; Probability and Statistics.
Courant Institute of Mathematical Sciences, New York University.

References

Prof. Linda J. Cummings

Ph.D. Advisor,
Department of Mathematical Sciences, New Jersey Institute of Technology,
linda.cummings@njit.edu

Prof. Lou Kondic

Ph.D. Co-Advisor,
Department of Mathematical Sciences, New Jersey Institute of Technology,
kondic@njit.edu

Prof. Burt S. Tilley

Postdoctoral Advisor,
Department of Mathematical Sciences, Worcester Polytechnic Institute,
tilley@wpi.edu

Prof. Anand Oza

Ph.D. Thesis Committee Member,
Department of Mathematical Sciences, New Jersey Institute of Technology,
anand.u.oza@njit.edu

Prof. James Maclaurin

Ph.D. Thesis Committee Member,
Department of Mathematical Sciences, New Jersey Institute of Technology,
james.n.maclaurin@njit.edu

Prof. Ian M. Griffiths

Ph.D. Thesis Committee Member,
Mathematical Institute, Oxford University,
ian.griffiths@maths.ox.ac.uk

Coding skills

- MATLAB, LaTeX, Fortran, Python.

Miscellaneous

- Languages: Mandarin Chinese and Shanghainese (Native), English (Fluent), German (Beginner).
- Royal Conservatory of Music, Technical Certificate for Keyboard, Level 10.
- Play the piano, tenor and baritone saxophone, arrange for acapella groups and wind and brass ensembles, compose recreationally. Aspiring amateur conductor.
- Amateur golfer, handicap 5.
- "By Accidental" podcast – reviews for classical music concerts and competitions; guides listening experience.