

Fei Cao

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Current position

Visiting Researcher in Applied Mathematics, Amherst College, Amherst, MA, USA.

Research interests

- Interacting particle systems with applications to econophysics and sociophysics
- Probability theory and related fields (such as gradient-based optimization algorithms)
- Derivation of macroscopic models from microscopic interactions
- Applications of ordinary, partial, and stochastic differential equations

Employment

2025-2026 Visiting Researcher at Amherst College
2022-2025 Visiting Assistant Professor at the University of Massachusetts Amherst
2017-2022 Graduate Teaching Assistant at Arizona State University

Education

2017-2022 PH.D in Applied Mathematics, Arizona State University.
2013-2017 BACHELOR in Applied Mathematics, Southwestern University of Finance and Economics.

Publications

2020 F. Cao, S. Motsch, A. Reamy, R. Theisen, *Asymptotic flocking for the three-zone model*, Mathematical Biosciences and Engineering, AIMS Press, 17 (6) (2020) 7692–7707.
2021 F. Cao, *K-averaging agent-based model: propagation of chaos and convergence to equilibrium*, Journal of Statistical Physics, Springer, 184 (2) (2021) 1–19.
2022 F. Cao, *Explicit decay rate for the Gini index in the repeated averaging model*, Mathematical Methods in the Applied Sciences, 46 (4) (2023) 3583–3596.
2023 F. Cao, P-E. Jabin, S. Motsch, *Entropy dissipation and propagation of chaos for the uniform reshuffling model*, Mathematical Models and Methods in Applied Sciences, 33 (4) (2023) 829–875.
2023 F. Cao, S. Motsch, *Derivation of wealth distributions from biased exchange of money*, Kinetic &

Related Models, 16 (5) (2023) 764–794.

- 2023 F. Cao, S. Motsch, *Uncovering a two-phase dynamics from a dollar exchange model with bank and debt*, SIAM Journal on Applied Mathematics, 83 (5) (2023) 1872–1891.
- 2024 F. Cao, N. Marshall, *From the binomial reshuffling model to Poisson distribution of money*, Networks and Heterogeneous Media, 19 (1) (2024) 24–43.
- 2024 F. Cao, P-E. Jabin, *From interacting agents to Boltzmann-Gibbs distribution of money*, Nonlinearity, 37 (12) (2024) 125020.
- 2025 F. Cao, R. Cortez, *Uniform propagation of chaos for a dollar exchange econophysics model*, European Journal of Applied Mathematics, 36 (1) (2025) 27–39.
- 2025 F. Cao, R. Cortez, *Fractal opinions among interacting agents*, SIAM Journal on Applied Dynamical Systems, 24 (2) (2025) 1529–1552.
- 2025 F. Cao, S. Reed, *A biased dollar exchange model involving bank and debt with discontinuous equilibrium*, Mathematical Modelling of Natural Phenomena, 20 (2025) 5.
- 2025 F. Cao, S. Motsch, *Sticky dispersion on the complete graph: a kinetic approach*, SIAM Journal on Mathematical Analysis, 57 (4) (2025) 3953–3980.
- 2025 F. Cao, S. Reed, *The iterative persuasion-polarization opinion dynamics and its mean-field analysis*, SIAM Journal on Applied Mathematics, 85 (4) (2025) 1596–1620.
- 2026 F. Cao, J. Yang, *Quantitative convergence guarantees for the mean-field dispersion process*, Discrete and Continuous Dynamical Systems, 47 (2026) 487–518.

SUBMITTED PAPERS

- 2025 F. Cao, X. Gong, *On the equivalence between Fourier-based and Wasserstein distances for probability measures on \mathbb{N}* (2025)
- 2025 F. Cao, *From Gini index as a Lyapunov functional to convergence in Wasserstein distance* (2025)
- 2025 F. Cao, *Mean-field analysis of a random asset exchange model with probabilistic cheaters* (2025)
- 2025 F. Cao, K. Johnston, T. Laurent, J. Li, S. Motsch, *Generative diffusion models from a PDE perspective* (2025)
- 2025 F. Cao, N. Loy, *The Bennati–Dragulescu–Yakovenko model in the continuous setting: PDE derivation and long-time behavior* (2025)
- 2026 F. Cao, R. Cortez, *The fractal geometry of opinion formation*

WORKING IN PROGRESS (INCOMPLETE LIST)

- 2025 J. Brust, M. Badal, F. Cao, S. Motsch, *Natural projected flow: PDE solvers using neural networks* (tentative title).
- 2025 F. Cao, X. Gong, A. Keimer, *Analysis for the large-time behavior of the “Bando-Follow-the-Leader” car-following model* (tentative title).
- 2026 F. Cao, R. Cortez, *From opinion fragmentation to generalized Bernoulli convolution* (tentative title).
- 2026 F. Cao, X. Gong, *A bias-amplifying opinion dynamics and its mean-field analysis* (tentative title).
- 2026 F. Cao, S. Motsch, A. Mellet, M. Rozowski, A. Ullah, *Continuous Lloyd’s algorithm and its PDE counterpart* (tentative title).

Teaching experience

2018	Teaching Assistant , <i>Applied Probability and Stochastic Processes</i> , Arizona State University
2019	Recitation Instructor , <i>Precalculus</i> (Math 171), Arizona State University
2020	Teaching Assistant , <i>Introduction into Deep Neural Networks</i> , Arizona State University
2021	Teaching Assistant , <i>Ordinary Differential Equations</i> , Arizona State University
2022	Instructor , <i>Calculus II</i> , University of Massachusetts Amherst
2023	Instructor , <i>Ordinary Differential Equations</i> , University of Massachusetts Amherst
2024	Instructor , <i>Calculus I</i> , University of Massachusetts Amherst
2025	Instructor , <i>Ordinary Differential Equations</i> , University of Massachusetts Amherst

Miscellaneous

2025	2025 AMS-Simons Travel Grant awarded by the American Mathematical Society during Summer 2025.
2025	Visiting Scholar in the Department of Mathematics at The Pennsylvania State University (02/13/2025 - 02/24/2025), hosted by Professor Pierre-Emmanuel Jabin.
2024	FY25 MSP Research Support Fund A intramural grant (\$1,000) allocated by University of Massachusetts Amherst during 2024 - 2025 to support research-related expenses.
2023	FY24 MSP Research Support Fund A intramural grant (\$1,000) allocated by University of Massachusetts Amherst during 2023 - 2024 to support research-related expenses.
2023	Visiting Scholar in the School of Mathematical and Statistical Sciences at Arizona State University (11/06/2023 - 11/10/2023), hosted by Associate Professor Sebastien Motsch.
2022	Visiting Scholar in the Department of Mathematics at The Pennsylvania State University (02/02/2022 - 02/18/2022), hosted by Professor Pierre-Emmanuel Jabin.
2023	REU mentor during summer 2023, the undergraduate mentee Minh Le is guided to work on gradient descent and related optimization algorithms.
2022	Graduate Student Research Award awarded by School of Mathematical and Statistical Sciences at Arizona State University.

Skills

- **Programming:** \LaTeX , Julia, Matlab, Python
- **Language:** English (fluent), Chinese (native language), Japanese (basic), Germany (basic)

Referee Service for

- Mathematical Modelling of Natural Phenomena
- Methods and Applications of Analysis
- Networks and Heterogeneous Media
- SIAM Journal on Applied Mathematics

Invited Talks

SIAM Conference on Applications of Dynamical Systems (DS25) *Summer 2025*

Invited talk at a mini-symposium as part of the SIAM Dynamical Systems conference held from May 11 to May 15, 2025 in Denver, Colorado, USA.

Financial Mathematics Seminar at Worcester Polytechnic Institute *Spring 2025*

Invited talk at on March 31, 2025 at Worcester Polytechnic Institute, Worcester, Massachusetts, USA.

Dynamical Systems Seminar at Boston University *Spring 2025*

Invited talk on March 24, 2025 at Boston University, Boston, Massachusetts, USA.

Tufts Ergodic and Dynamical Systems Seminar *Fall 2023*

Invited talk on November 28, 2023 at Tufts University, Boston, Massachusetts, USA.

Conferences and Summer Schools

2025 Seminar on Stochastic Processes *Spring 2025*

Three days conference on stochastic processes at Indiana University Bloomington, Bloomington, USA.

ICERM Topical Workshop “Patterns, Dynamics, and Data in Complex Systems” *Winter 2025*

Four days workshop on patterns, dynamics, and data in complex systems at the Institute for Computational and Experimental Research in Mathematics, Rhode Island, USA.

New England Dynamics Seminar 2024 *Fall 2024*

A joint one-day seminar on dynamical systems and PDEs at the University of Massachusetts Amherst, Amherst, USA.

ICERM Topical Workshop “Robust Optimization and Simulation of Complex Stochastic Systems” *Fall 2024*

Three days workshop on optimization and simulation of stochastic systems at the Institute for Computational and Experimental Research in Mathematics, Rhode Island, USA.

Graduate Student Probability Conference 2024 *Fall 2024*

Two days conference on probability theory at University of Wisconsin–Madison, Madison, USA.

13th Cornell Probability Summer School *Summer 2024*

Two weeks workshop on probability theory and related fields at Cornell University, Ithaca, USA.

Recent Progress in Stochastic Analysis and its Applications *Summer 2024*

One week workshop on stochastic analysis at Loyola University Chicago, Chicago, USA.

Mathematical Problems in Industry (MPI) Workshop *Summer 2024*

One week workshop on problems of interest to science and industry at the University of Vermont, Burlington, USA.

The 52nd John H. Barrett Memorial Lectures *Summer 2024*

Three days workshop on stochastic analysis and its application at the University of Tennessee, Knoxville, USA.

ICERM Topical Workshop “Interacting Particle Systems: Analysis, Control, Learning and Computation” *Spring 2024*

One week workshop on interacting particle systems at the Institute for Computational and Experimental Research in Mathematics, Rhode Island, USA.

49th Annual New York State Regional Graduate Mathematics Conference *Spring 2024*

One day conference on mathematics focusing on graduate research at Syracuse University, Syra-

cuse, USA.

2024 Seminar on Stochastic Processes

Spring 2024

Three days conference on stochastic processes at Rice University, Houston, USA.

Probability and Algebra: New Expressions in Mathematics

Summer 2023

One week workshop in analysis and probability at Texas A&M University, Texas, USA.

21st International Conference on Random Structures & Algorithms

Summer 2023

One week conference on random structures and algorithms at Carnegie Mellon University, Pennsylvania, USA.

Current Developments in Mathematics 2023

Spring 2023

Two days conference on mathematics at Harvard University, Boston, USA.

2023 Seminar on Stochastic Processes

Spring 2023

Three days conference on stochastic processes at University of Arizona, Tucson, USA.

2022 Fall Eastern Sectional Meeting

Fall 2022

Two days AMS sectional meeting at University of Massachusetts Amherst, Amherst, USA.

2022 PIMS-IFDS-NSF Summer School on Optimal Transport

Summer 2022

Two weeks summer school on optimal transport at Seattle, Washington, USA.

2022 MRC Conference: Data Science at the Crossroads of Analysis, Geometry, and Topology

Summer 2022

One week workshop on mathematics, statistics, and related fields at Beaver Hollow Conference Center, Java Center, NY, USA.

2022 Seminar on Stochastic Processes

Spring 2022

Three days conference on stochastic processes at Lehigh University, Pennsylvania, USA.

2021 Frontier Probability Days

Fall 2021

Three days conference on probability theory and related fields at University of Nevada, Las Vegas, USA.

2021 Blackwell Tapia Conference

Fall 2021

Three days conference focusing on diversity in mathematics at UCLA, California, USA.

2021 CRM-PIMS Summer School in Probability (Online)

Summer 2021

Four weeks graduate summer school at the Mathematical Sciences Research Institute (MSRI), Canada.

2021 Summer Program in Partial Differential Equations (Online)

Summer 2021

Two weeks of concentrated study of topics in analysis at graduate level, USA.

2021 AMS Short Course on Mathematical and Computational Methods for Complex Social Systems (Online)

Spring 2021

Three days short course at the American Mathematical Society (AMS), USA.

2020 Introduction to water waves graduate summer school (Online)

Summer 2020

Two weeks graduate summer school at the Mathematical Sciences Research Institute (MSRI), Berkeley, USA.

2020 Summer School: Ergodic Theory via Continued Fractions (Online)

Summer 2020

One week graduate summer school at the University of North Carolina Greensboro, North Carolina, USA.

2020 Hot Topics: Optimal transport and applications to machine learning and statistics (Online)

Summer 2020

One week workshop at the Mathematical Sciences Research Institute (MSRI), Berkeley, USA.

45-th Annual New York State Regional Graduate Mathematics Conference (Online)

Spring 2020

One day conference on mathematics focusing on graduate research at Syracuse University, Syra-

cuse, USA.

2020 Seminar on Stochastic Processes

Spring 2020

Three days seminar on stochastic processes at the Michigan State University, Michigan, USA.

2019 AARMS Summer School on Dynamical Systems, Differential Equations, and Special Functions

Summer 2019

Four weeks summer school on dynamical systems, differential equations, and special functions at Charlottetown, Prince Edward Island, Canada.

2019 RMMC Summer School on Inverse Problems in Imaging

Summer 2019

One week summer school on inverse problems at Laramie, Wyoming, USA.

2019 Interacting Particle Systems, Statistical Mechanics and Related Topics

Spring 2019

Three days conference on interacting particle systems at UCLA, California, USA.

2018 Advances in Asymptotic Probability

Winter 2018

One week conference on theory of Asymptotic Probability at Stanford, California, USA.

2018 Institute for Advanced Study

Summer 2018

IAS/PCMI 2018: Harmonic Analysis, Park City, Utah, USA.

2018 Boston City Limits

Summer 2018

Two weeks summer School on Mathematical General Relativity and the Geometric Analysis of Waves of Fluids at MIT, Boston, USA.

Short Course on Free Boundary Problems

Summer 2017

Free boundary problems in mathematical finance, Cheng Du, China.

References

Professor Pierre-Emmanuel Jabin

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