

Fei Cao

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Born: January 13, 1995 in Hubei (China)
Nationality: Chinese

Current position

Visiting Assistant Professor, University of Massachusetts Amherst, 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

2022-2025 Visiting Assistant Professor at the University of Massachusetts Amherst
2017-2022 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*, to appear on SIAM Journal on Mathematical Analysis (2025).
- 2025 F. Cao, S. Reed, *The iterative persuasion-polarization opinion dynamics and its mean-field analysis*, to appear on SIAM Journal on Applied Mathematics (2025).
- 2025 F. Cao, J. Yang, *Quantitative convergence guarantees for the mean-field dispersion process*, to appear on Discrete and Continuous Dynamical Systems (2025).

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)

WORKING IN PROGRESS (INCOMPLETE LIST)

- 2025 J. Brust, M. Badal, F. Cao, S. Motsch, *Natural projected flow: PDE solvers using neural networks* (tentative title).

Teaching experience

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

Miscellaneous

- 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)

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, Syracuse, 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, Syracuse, 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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Associate Professor Sebastien Motsch

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