

# Sébastien Motsch

## Associate Professor

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### Research interests

- Mathematical biology (modeling self-organized dynamics)
- Data-model comparisons (machine learning)
- Multiscale modeling (derivation of macroscopic limits)
- Numerical methods for PDEs

### Employment

- 2019–present **Associate Professor**, Arizona State University  
2013–2019 **Assistant Professor**, Arizona State University  
2012–2013 **Postdoctoral Fellow**, University of Texas/University of Maryland (CSCAMM),  
KI-Net program, supervised by **Irene Gamba** and **Eitan Tadmor**  
2009–2012 **Postdoctoral Fellow**, University of Maryland (CSCAMM), FRG program:  
*Kinetic equations and complex systems*, supervised by **Eitan Tadmor**

### Education

- 2006–2009 **Ph.D.**, University Paul Sabatier (UPS), Toulouse (France)  
Title: *Mathematical modeling of animal displacements and derivation of macroscopic models*. Advisers: **Pierre Degond** (Mathematics Institute of Toulouse), **Guy Théraulaz** (Center for Research on Animal Cognition).
- 2005–2006 **Master 2 applied mathematics**, UPS, Toulouse, *summa cum laude*  
2004–2005 **Agrégation of mathematics**, UPS, Toulouse  
2003–2004 **Master 1 fundamental mathematics**, UPS, Toulouse, *summa cum laude*  
2002–2003 **License fundamental mathematics**, UPS, Toulouse, *summa cum laude*  
2000–2002 **Deug MIAS**, UPS, Toulouse

### Mentoring students

- 2023 - present **Vince Campo**, *doctoral candidate*, Stable diffusion  
2022 - present **En-Ya Kuo**, *doctoral candidate*, Fraud detection  
2022 - present **Mario Badal**, *doctoral candidate*, PDE and machine learning  
2020 - present **Atta Ullah**, *doctoral candidate*, Density estimation  
2022 - present **Justin Le**, *Master student*, Segmentation and generative models

- Former PhD students

**Fei Cao** (2018-2022), **Dylan Weber** (2017-2021), **Sarah Jamous** (2015-2019)

- Former Master students

**Mario Badal** (2020-2022), **Michael Rozowski** (2017-2019), **Ryan Theisen** (2017-2018), **Daniel Weser** (2016-2017), **Shane Lubold** (2015-2016), **GuanLin Li** (2015-2016)

- Undergraduate students

**REU MCTP**, Summer 2015-2017, **REU (AM)<sup>2</sup>**, Summer 2019, 2022

## Grants

- 2015–2019 NSF Applied Mathematics (#1515592), *Characterizing spatio-temporal patterns of swarms*, PI, Dieter Armbruster co-PI (ASU).
- 2021–2026 NIH (# 1R01NS122234-01A1), *The role of collagen and its signaling mechanisms in glioma progression and invasion*, co-PI (subaward), Pedro Lowenstein PI (Univ. Michigan).
- 2022–2025 NSF Applied Mathematics, *Opinion Formation and Graph Dynamics: From Modeling to Empirical Applications*, PI, Dylan Weber co-PI (Artis international).

## Publications

- [33] F. Cao, S. Motsch, *Uncovering a Two-Phase Dynamics from a Dollar Exchange Model with Bank and Debt*, SIAM J. Applied Math (2023)
- [32] K. Wood, A. Comba, S. Motsch, T. Grigera, P. Lowenstein, *Scale-free correlations and potential criticality in weakly ordered populations of brain cancer cells*, Science Advances (2023)
- [31] F. Cao, S. Motsch, *Derivation of wealth distributions from biased exchange of money*, Kinetic and Related Models (KRM) (2023)
- [30] F. Cao, P-E. Jabin, S. Motsch, *Entropy dissipation and propagation of chaos for the uniform reshuffling model*, M3AS (2022)
- [29] A. Comba, S.M. Faisal, P.J. Dunn, et al., *Spatiotemporal analysis of glioma heterogeneity reveals COL1A1 as an actionable target to disrupt tumor progression*, Nature Communications (2022)
- [28] A. Comba, S. Faisal, ..., S. Motsch, M. Castro, P. Lowenstein, *Uncovering spatiotemporal heterogeneity of high-grade gliomas: from disease biology to therapeutic implications*, Frontiers in oncology (2021)
- [27] F. Cao, S. Motsch, A. Reamy, R. Theisen, *Asymptotic flocking for the three-zone model*, Mathematical Biosciences and Engineering (2020)
- [26] G. Li, S. Motsch, D. Weber, *Bounded confidence dynamics and graph control: Enforcing consensus*, Networks & Heterogeneous Media (2020)
- [25] S. Jamous, A. Comba, P. Lowenstein, S. Motsch, *Self-organization in brain tumors: How cell morphology and cell density influence glioma pattern formation*, PLoS Comp. Bio. (2020)

- [24] L.A. Poissonnier, S. Motsch, J. Gautrais, J. Buhl, A. Dussutour, *Still flowing, ant traffic under crowded conditions*, eLife (2019)
- [23] S. Motsch, Q. Griette, *Kinetic equations and self-organized band formations*, Springer, Active Particles, Volume 2 (2019)
- [22] D. Weber, R. Theisen, S. Motsch, *Deterministic versus stochastic consensus dynamics on graphs*, J. Stat. Phys. (2019)
- [21] S. Motsch, M. Moussaid, E. Guillot, M. Moreau, J. Pettré, G. Théraulaz, C. Appert-Rolland, P. Degond, *Modeling crowd dynamics through coarse-grained data analysis*, Math. Bio. Engineering (2018)
- [20] S. Motsch, D. Peurichard, *From short-range repulsion to Hele-Shaw problem in a model of tumor growth*, J. Math. Biol. (2017)
- [19] P. Degond, M. Ferreira, S. Motsch, *Damped Arrow-Hurwicz algorithm for sphere packing*, J. Comput. Phys. (2017)
- [18] D. Armbruster, S. Motsch, A. Thatcher, *Swarming in Bounded Domains*, Physica D. (2017)
- [17] G. Dimarco, S. Motsch, *Self-alignment driven by jump processes: Macroscopic limit and numerical investigation*, M3AS (2016)
- [16] I. Gamba, J. Haack, , S. Motsch, *Spectral method for a kinetic swarming model*, Journal of Computational Physics (2015)
- [15] G. Baker, V. Yadav, S. Motsch,..., P. Lowenstein et al., *Mechanisms of Glioma Formation: Iterative Perivascular Glioma Growth and Invasion Leads to Tumor Progression, VEGF-Independent Vascularization, and Resistance to Antiangiogenic Therapy*, Neoplasia (2014)
- [14] P-E. Jabin, S. Motsch, *Clustering and asymptotic behavior in opinion formation*, Journal of Differential Equations (2014)
- [13] S. Motsch, E. Tadmor, *Heterophilous dynamics enhances consensus*, SIAM Review (2014)
- [12] P. Degond, J-G. Liu, S. Motsch, V. Panferov, *Hydrodynamic models of self-organized dynamics: derivation and existence theory*, Methods and Applications of Analysis (2013)
- [11] E. Boissard, P. Degond, S. Motsch, *Trail formation based on directed pheromone deposition*, Journal of Mathematical Biology (2013)
- [10] S. Motsch, L. Navoret, *Numerical simulations of a non-conservative hyperbolic system with geometric constraints describing swarming behavior*, SIAM Multiscale Modeling and Simulation (2011) .
- [9] S. Motsch, E. Tadmor, *A new model for self-organized dynamics and its flocking behavior*, Journal of Statistical Physics (2011)
- [8] C. Appert-Rolland, P. Degond, S. Motsch, *Two-way multi-lane traffic model for pedestrians in corridors*, Networks and Heterogeneous Media (2011)
- [7] P. Degond, S. Motsch, *A macroscopic model for a system of swarming agents using curvature control*, Journal of Statistical Physics (2011)

- [6] P. Cattiaux, D. Chafai, S. Motsch, *Asymptotic analysis and diffusion limit of the Persistent Turning Walker Model*, Asymptotic Analysis (2010)
- [5] J. Gautrais, C. Jost, M. Soria, A. Campo, S. Motsch, R. Fournier, S. Blanco, G. Theraulaz, *Analyzing fish movement as a persistent turning walker*, Journal of Mathematical Biology (2009)
- [4] M. Herty, A. Klar, S. Motsch, F. Olawsky, *A smooth model for fiber lay-down processes and its diffusion approximations*, Kinetic and Related Models (KRM) (2009)
- [3] G. Bal, J. Garnier, S. Motsch, V. Perrier, *Random integrals and correctors in homogenization*, Asymptotic Analysis (2008)
- [2] P. Degond, S. Motsch, *Continuum limit of self-driven particles with orientation interaction*, Mathematical Models and Method in Applied Sciences (M3AS) (2008)
- [1] P. Degond, S. Motsch, *Large-scale dynamics of the Persistent Turning Walker model of fish behavior*, Journal of Statistical Physics (2008)

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## Recent invited talks

- Jun. 2023 **Round meanfield II: crowd-opinion-cells and more**, Rome
- May. 2023 **Mathematical Oncology Conference**, Phoenix
- Nov. 2022 **Kinetic Equations: Recent Developments and Novel Applications**, BIRS-CIRM (Mexico)
- Dec. 2021 **Social Dynamics beyond Vehicle Autonomy**, IPAM
- Oct. 2019 **Forward and Inverse Problems in Kinetic Theory**, Wisconsin-Madison
- Aug. 2019 **Mathematical Modeling in Population Dynamics**, Univ. Bordeaux
- Jan. 2019 **Stochastic dynamics for complex networks and systems**, Univ. Mannheim (Germany)
- Jul. 2018 **Asymptotic approach to spatial and dynamical organizations**, Paris
- Nov. 2017 **Workshop Kinetic Theory and Fluid Mechanics**, Toulouse, France
- Oct. 2017 **Current trends in kinetic theory**, College Park, Maryland
- Aug. 2017 **Pedestrian Dynamics: Modeling, Validation and Calibration**, ICERM, Providence
- Jun. 2017 **Data-Driven Modeling of Collective Behavior**, SAMSI, North Carolina
- Mar. 2017 **Dynamics and Geometry from High Dimensional Data**, Carnegie Mellon, Pennsylvania

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## Conference organizer

- Dec. 2020 Co-organizer of the conference **Social Dynamics beyond Vehicle Autonomy**, IPAM, California.
- Feb. 2018 Organizer of the conference **Young Researchers Workshop: Kinetic models in biology and social sciences**, Tempe, Arizona.
- Apr. 2015 Co-organizer of the conference **Collective dynamics and model verification**, Tempe, Arizona.

- Jul. 2014 Organizer of the mini-symposium **Kinetic models for multi-agent systems modeling socio-economic behavior** at the **AIMS conference on Dynamical systems**, Madrid, Spain.
- Oct. 2013 Organizer of the conference **Young researchers workshop: Kinetic and macroscopic models for complex systems**, College Park, Maryland.
- Nov. 2011 Organizer of the mini-symposium **Recent developments in self-organized dynamics** at the **SIAM conference on Analysis on PDEs**, San-Diego, California.

## Teaching experience

- 2013–present **Instructor**, *Machine learning, Numerical analysis, Statistics, PDE, ODE, Linear algebra, Calculus*, Arizona State University
- 2009–2013 **Instructor**, *Advanced calculus, Differential equations*, University of Maryland
- 2006–2009 **Instructor**, *Calculus I-III and Introduction to numerical analysis (with Maple/Matlab)*, University of Paul Sabatier (Toulouse)
- 2005–2006 **Teaching Assistant**, *Calculus I*, University of Mirail (Toulouse)
- 2003–2004 **Instructor**, *high-school level*, Center CNFPT (Toulouse)

## Skills

- Language** English, French (native), Spanish (basic)
- Programming** Julia, Python (Pytorch), C/C++, Fortran, R
- Computer** Linux (Ubuntu), Inkscape, Emacs/Vim, Singularity/Aptainer
- Web** Javascript, HTML/CSS, Wordpress