

Sébastien Motsch

Associate Professor

Arizona State University
Mathematical & Statistical Sciences
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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

- 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*, Clustering
2018 - present **Nicholaus Cortez**, *doctoral candidate*, Surface motion
2018 - 2022 **Fei Cao**, *PhD*
2017 - 2021 **Dylan Weber**, *PhD*

2015 - 2019 Sarah El Jamous, *PhD*

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, *Mentoring Through Critical Transition Points in the Mathematical Sciences (MCTP)*, Summer 2015-2017

REU, $(AM)^2$, Summer 2019, 2022

Grants

- 2015–2019 NSF Applied Mathematics (#1515592), *Characterizing spatio-temporal patterns of swarms*, PI with 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) with Pedro Lowenstein (PI, Univ. Michigan).
- 2022–2025 NSF Applied Mathematics, *Opinion Formation and Graph Dynamics: From Modeling to Empirical Applications*, PI with Dylan Weber (co-PI, Artis international).

Publications

- [1] Comba, A., Faisal, S.M., Dunn, P.J. et al., *Spatiotemporal analysis of glioma heterogeneity reveals COL1A1 as an actionable target to disrupt tumor progression*, Nature Communications, (2022).
- [2] A. Comba, S. Faisal, M. Varela, T. Hollon, W. Al-Holou, Y. Umemura, F. Nunez, S. Motsch, M. Castro, P. Lowenstein, *Uncovering spatiotemporal heterogeneity of high-grade gliomas: from disease biology to therapeutic implications*, Frontiers in oncology (2021).
- [3] F. Cao, S. Motsch, A. Reamy, R. Theisen, *Asymptotic flocking for the three-zone model*, Mathematical Biosciences and Engineering (2020).
- [4] G. Li, S. Motsch, D. Weber, *Bounded confidence dynamics and graph control: Enforcing consensus*, Networks & Heterogeneous Media (2020).
- [5] 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).
- [6] L.A. Poissonnier, S. Motsch, J. Gautrais, J. Buhl, A. Dussutour, *Still flowing, ant traffic under crowded conditions*, eLife (2019).
- [7] S. Motsch, Q. Griette, *Kinetic equations and self-organized band formations*, Springer, Active Particles, Volume 2 (2019).

- [8] D. Weber, R. Theisen, S. Motsch, *Deterministic versus stochastic consensus dynamics on graphs*, J. Stat. Phys. (2019).
- [9] 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).
- [10] S. Motsch, D. Peurichard, *From short-range repulsion to Hele-Shaw problem in a model of tumor growth*, J. Math. Biol. (2017).
- [11] P. Degond, M. Ferreira, S. Motsch, *Damped Arrow-Hurwicz algorithm for sphere packing*, J. Comput. Phys., 332(1):47-65 (2017).
- [12] D. Armbruster, S. Motsch, A. Thatcher, *Swarming in Bounded Domains*, Physica D., 344(1):58–67 (2017).
- [13] G. Dimarco, S. Motsch, *Self-alignment driven by jump processes: Macroscopic limit and numerical investigation*, Mathematical Models and Method in Applied Sciences, 26(7):1385–1410 (2016).
- [14] I. Gamba, J. Haack, , S. Motsch, *Spectral method for a kinetic swarming model*, Journal of Computational Physics, 297:32-46 (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, 16(7):543-561 (2014).
- [16] P-E. Jabin, S. Motsch, *Clustering and asymptotic behavior in opinion formation*, Journal of Differential Equations, 257(11):4165–4187 (2014).
- [17] S. Motsch, E. Tadmor, *Heterophilious dynamics enhances consensus*, SIAM Review, 56(4):577–621 (2014).
- [18] P. Degond, J-G. Liu, S. Motsch, V. Panferov, *Hydrodynamic models of self-organized dynamics: derivation and existence theory*, Methods and Applications of Analysis, 20(2):89–114 (2013).
- [19] E. Boissard, P. Degond, S. Motsch, *Trail formation based on directed pheromone deposition*, Journal of Mathematical Biology, 66(6):1267–1301 (2013).
- [20] S. Motsch, L. Navoret, *Numerical simulations of a non-conservative hyperbolic system with geometric constraints describing swarming behavior*, Multiscale Modeling and Simulation, 9(3):1253–1275 (2011) .
- [21] S. Motsch, E. Tadmor, *A new model for self-organized dynamics and its flocking behavior*, Journal of Statistical Physics, Springer, 144(5):923–947 (2011).
- [22] C. Appert-Rolland, P. Degond, S. Motsch, *Two-way multi-lane traffic model for pedestrians in corridors*, Networks and Heterogeneous Media, 6(3):351–381 (2011).
- [23] P. Degond, S. Motsch, *A macroscopic model for a system of swarming agents using curvature control*, Journal of Statistical Physics, Springer, 141(4):685–714 (2011).
- [24] P. Cattiaux, D. Chafai, S. Motsch, *Asymptotic analysis and diffusion limit of the Persistent Turning Walker Model*, Asymptotic Analysis, 67(1-2):17–31 (2010).

- [25] 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, 58(3):429–445 (2009).
- [26] M. Herty, A. Klar, S. Motsch, F. Olawsky, *A smooth model for fiber lay-down processes and its diffusion approximations*, Kinetic and Related Models, 2(3):489–502 (2009).
- [27] G. Bal, J. Garnier, S. Motsch, V. Perrier, *Random integrals and correctors in homogenization*, Asymptotic Analysis, 59(1):1–26 (2008).
- [28] P. Degond, S. Motsch, *Continuum limit of self-driven particles with orientation interaction*, Mathematical Models and Method in Applied Sciences, 18(1):1193–1215 (2008).
- [29] P. Degond, S. Motsch, *Large-scale dynamics of the Persistent Turning Walker model of fish behavior*, Journal of Statistical Physics, Springer, 131(6):989–1021 (2008).

Recent invited talks

- Dec. 2020 **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

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.
- Oct. 2014 Co-organizer of the conference **Modeling and Control in Social Dynamics**, Rutgers-Camden, New-Jersey.
- 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.
- Jan. 2013 Co-organizer of the conference **Transport Models for Collective Dynamics in Biological Systems**, Raleigh, North-Carolina.

Teaching experience

- 2013–present **Instructor**, *Machine/Deep learning, Numerical analysis, Statistics, Partial Differential Equations, Ordinary Differential Equations, Linear algebra, Calculus*, Arizona State University
- 2010–2013 **Instructor**, *Advanced calculus, Differential equations*, University of Maryland
- 2009–2010 **Teaching Assistant**, *Calculus II*, 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 language), Spanish (basic)
- Programming** Julia, Python (Pytorch), C/C++, Fortran, Matlab-Octave, R
- Computer** Linux (Ubuntu), Emacs, L^AT_EX, Git, Inkscape, Bash, Singularity
- Web** Javascript, HTML/CSS, Wordpress