Mattia Sensi

Caritro postdoctoral fellow at Università degli Studi di Trento

Università degli Studi di Trento
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Research Interests

Mathematical modelling, mathematical biology, mathematical epidemiology, dynamical systems, billiards, multiple time scales dynamics, Geometric Singular Perturbation Theory (GSPT), qualitative theory of ordinary differential equations, partial differential equations, integro-differential equations, delay differential equations.

Education

Ph.D. in Mathematics, *cum laude*, Università degli Studi di Trento. November 2017 – January 2021
Thesis: "A Geometric Singular Perturbation approach to epidemic compartmental models"
Supervisor: Prof. Andrea Pugliese

M.Sc. in Mathematics, Universiteit van Amsterdam. September 2015 – June 2017
Thesis: "Homoclinic vegetation stripes in a Klausmeier-Gray-Scott model"
Supervisor: Prof. Dr. Arjen Doelman

B.Sc. in Mathematics, Università degli Studi di Padova. September 2011 – September 2014
Thesis: "Portfolio optimization for quadratic utility function with partial information"
Supervisor: Prof. Wolfgang J. Runggaldier

Research experience

Postdoctoral researcher in Mathematics, Università degli Studi di Trento. March 2025 – present
Caritro postdoctoral fellow in the group of Prof. Andrea Pugliese, researching the project "*Modelli matematici di malattie infettive più ospiti e popolazioni eterogenee: applicazioni all'influenza aviaria*" (Mathematical models of infectious disease spreading in multi-host and heterogeneous populations: applications avian flu).

Postdoctoral researcher in Mathematics, Politecnico di Torino. March 2023 – February 2025
Postdoctoral researcher in the group of Prof. Andrea Tosin, as part of PRIN 2020 project "*Integrated Mathematical Approaches to Socio-Epidemiological Dynamics*" (No. 2020JLWP23, CUP: E15F21005420006).

Postdoctoral researcher in Mathematics, Inria at Université Côte d'Azur. December 2021 – February 2023
Postdoctoral researcher in the group MathNeuro, led by Prof. Mathieu Desroches.

Postdoctoral researcher in Mathematics, TU Delft. March – November 2021
Postdoctoral researcher in the group NAS, led by Prof. Piet Van Mieghem.

Publications

26. **J. Borsotti and M. S.**. *A geometric analysis of the Bazykin-Berezovskaya predator-prey model with Allee effect in an economic framework*. Accepted, to appear in Nonlinear Analysis: Real World Applications. Preprint on arXiv
25. **E. Bernardi, T. Lorenzi, M. S. and A. Tosin**. *Heterogeneously structured compartmental models of epidemiological systems: from individual-level processes to population-scale dynamics*. Studies in Applied Mathematics 155, no. 2 (2025): 155, e70091
24. **A. Chizhov, L. Pujo-Menjouet, T. Schwalger and M. S.**. *A refractory density approach to a multi-scale SEIRS epidemic model*. Infectious Disease Modelling, 2025, 10(3), pp. 787–801
23. **M. A. Achterberg, M. S. and S. Sottile**. *A minimal model for multigroup adaptive SIS epidemics*. Chaos, 2025, 35(3), 033127
22. **L. Eigentler and M. S.**. *Delayed loss of stability of periodic travelling waves: insights from the analysis of essential spectra*. Journal of Theoretical Biology, 2024, 595, 111945
21. **I. M. Bulai, M. S. and S. Sottile**. *A geometric analysis of the SIRS compartmental model with fast information and misinformation spreading*. Chaos, Solitons and Fractals, 2024, 185, 115104
20. **P. Kaklamanos, A. Pugliese, M. S. and S. Sottile**. *A geometric analysis of the SIRS model with secondary infections*. SIAM Journal on Applied Mathematics, 2024, 84(2), pp. 661–686
19. **R. Persoons, M. S., B. Prasse and P. Van Mieghem**. *Transition from time-variant to static networks: Timescale separation in N-intertwined mean-field approximation of susceptible-infectious-susceptible epidemics*. Physical Review E, 2024, 109(3), 034308
18. **M. Adimy, A. Chekroun, L. Pujo-Menjouet and M. S.**. *A multigroup approach to delayed prion production*. Discrete and Continuous Dynamical Systems - Series B, 2024, 29(7), pp. 2972–2998
17. **M. S., M. Desroches and S. Rodrigues**. *Slow-fast dynamics in a neurotransmitter release model: delayed response to a time-dependent input signal*. Physica D: Nonlinear Phenomena, 2023, 455, 133887
16. **R. Della Marca, A. d'Onofrio, M. S. and S. Sottile**. *A geometric analysis of the impact of large but finite switching rates on vaccination evolutionary games*. Nonlinear Analysis: Real World Applications, 2024, 75, 103986
15. **N. Cangiotti, M. Capolli, M. S. and S. Sottile**. *A survey on Lyapunov functions for epidemic compartmental models*. Bollettino dell'Unione Matematica Italiana, 2024, 17(2), pp. 241–257
14. **P. Kaklamanos, C. Kuehn, N. Popovic and M. S.**. *Entry-exit functions in fast-slow systems with intersecting eigenvalues*. Journal of Dynamics and Differential Equations, 2025, 37(1), pp. 559–576, 103220
13. **N. Cangiotti, M. Capolli and M. S.**. *A generalization of unaimed fire Lanchester's model in multi-battle warfare*. Operational Research, 2023, 23(2), 38
12. **M. A. Achterberg and M. S.**. *A minimal model for adaptive SIS epidemics*. Nonlinear Dynamics, 2023, 111(13), pp. 12657–12670
11. **S. Ottaviano, M. S. and S. Sottile**. *Global stability of multi-group SAIRS epidemic models*. Mathematical Methods in the Applied Sciences, 2023, 46(13), pp. 14045–14071

10. **N. Cangiotti and M. S.**. *Exact solutions for a Solow-Swan model with non-constant returns to scale*. IJPAM, 2023, 54(4), pp. 1278–1285
9. **S. Ottaviano, M. S. and S. Sottile**. *Global stability of SAIRS epidemic models*. Nonlinear Analysis: Real World Applications, 2022, 65, 103501
8. **S. Sottile, O. Kahramanogullari and M. S.**. *How network properties and epidemic parameters influence stochastic SIR dynamics on scale-free random networks*. Journal of Simulation, 2024, 18(2), pp. 206–219
7. **B. Chang, L. Yang, M. S., M. A. Achterberg, F. Wang, M. Rinaldi and P. Van Mieghem**. *Markov Modulated Process to model human mobility*. Complex Networks & Their Applications X. Studies in Computational Intelligence, 2022, 1015, pp. 607–618
6. **N. Cangiotti and M. S.**. *Benford's Law: a Number-Theoretical Perspective*. PJM, 2022, 11(3), pp. 379–385
5. **N. Cangiotti and M. S.**. *A geometric characterization of VES and Kadiyala-type production functions*. Filomat, 2021, 35(5), pp. 1661–1670
4. **N. Cangiotti and M. S.**. *Notes on a conformal characterization of 2-dimensional Lorentzian manifolds with constant Ricci scalar curvature*. U.P.B. Sci. Bull., 2021, 83(2), pp. 129–136
3. **T. Lorenzi, A. Pugliese, M. S. and A. Zardini**. *Evolutionary dynamics in an SI epidemic model with phenotype-structured susceptible compartment*. Journal of Mathematical Biology, 2021, 83(6-7), 72
2. **H. Jardón-Kojakhmetov, C. Kuehn, A. Pugliese and M. S.**. *A geometric analysis of the SIRS epidemiological model on a homogeneous network*. Journal of Mathematical Biology, 2021, 83(4), 37
1. **H. Jardón-Kojakhmetov, C. Kuehn, A. Pugliese and M. S.**. *A geometric analysis of the SIR, SIRS and SIRWS epidemiological models*. Nonlinear Analysis: Real World Applications, 2021, 58, 103220

Preprints

3. **A. Andò, N. Cangiotti and M. S.**. *Exploring Exponential Runge-Kutta Methods: A Survey*. Preprint on arXiv
2. **C. Oelen, B. Rink and M. S.**. *Non-Birkhoff periodic orbits in symmetric billiards*. Preprint on arXiv, GitHub repository BilliardOrbitFinder
1. **M. Aguiar, B. Kooi, A. Pugliese, M. S. and N. Stollenwerk**. *Time scale separation in the vector borne disease model SIRUV via center manifold analysis*. Preprint on medRxiv

Grants & Awards

- Progetti Giovani GNFM 2025 with the project "*Analisi geometrica della diffusione spaziale di epidemie su più scale temporali*" (Geometric analysis of the spatial diffusion of epidemics on multiple time scales), coordinated by Rossella Della Marca, from August 2025 to July 2026. Participant, 2000 €
- Caritro postdoctoral fellowship 2024 with the project "*Modelli matematici di malattie infettive più ospiti e popolazioni eterogenee: applicazioni all'influenza aviaria*" (Mathematical models of infectious disease spreading in multi-host and heterogeneous populations: applications to avian flu), from March 2025 to February 2027. Principal investigator, 85000 €

ASN (Italian National Scientific Qualification)

- ASN 2023/2025, Abilitazione Scientifica Nazionale alle funzioni di professore universitario di Seconda Fascia nel Settore Concorsuale 01/A3: Analisi Matematica, Probabilità e Statistica Matematica (Scientific Area 01/A3: Mathematical Analysis, Probability and Mathematical Statistics; qualification to become Associate Professor). From 28/02/2025 to 28/02/2037
- ASN 2023/2025, Abilitazione Scientifica Nazionale alle funzioni di professore universitario di Seconda Fascia nel Settore Concorsuale 01/A4: Fisica Matematica (Scientific Area 01/A4: Mathematical Physics; qualification to become Associate Professor). From 07/03/2025 to 07/03/2037

Teaching experience

At Università degli Studi di Trento:

- Teacher for the course *Analisi matematica 1*, for first year students of Bachelor's Degree in Industrial Engineering, September 2025 – February 2026
- Teacher for Ph.D. course "Advances in Mathematical Applications to Biology and Medicine: Stability analysis of dynamical systems in mathematical biology", for first year Ph.D. students in Mathematics, June 2024
- Assistant teacher for Prof. Alberto Valli's course *Analisi 1*, for first year students of Bachelor's Degree in Civil, Environmental and Mechanical Engineering, September 2018 – February 2019; September 2020 – February 2021; September – December 2022
- Tutor for Prof. Andrea Pugliese's course *Probabilità e Statistica 2*, for second year students of Bachelor's Degree in Biotechnologies, February – May 2018

At Politecnico di Torino:

- Assistant teacher for Prof. Luisa Mazzi's course *Analisi 1*, for first year students of Bachelor's Degree in Aerospace Engineering, October 2023 – February 2024; September 2024 – February 2025

At Inria – Université Côte d'Azur:

- Teacher of Mathematics for *Linear Algebra Bootcamp*, for first year students of Master's Degree in Computational Neuroscience, September – October 2022

At Università Popolare Trentina (CFP-UPT):

- Teacher of Mathematics, October 2019 – June 2020

At Universiteit van Amsterdam:

- Assistant teacher for Prof. Dr. Rob Stevenson's course *Numerieke Analyse*, for third year students of Bachelor's Degree in Mathematics, February – June 2017
- Assistant teacher for Dr. Han Peters' course *Wiskunde 3*, for third year students of Bachelor's Degree in Physics, November – December 2015

Other:

- Private tutor for Camplus, Torino, May – June 2023
- Private tutor for WisMon / Bèta onderwijsinstituut, Amsterdam and Utrecht, April 2016 – June 2017
- Freelance private teacher of Mathematics and Physics, for high-school and university students, 2008 – present

Mentoring

Master thesis:

- Brian Chang, February – June 2021. Modeling the Spread of Epidemics
- Liufei Yang, February – June 2021. Developing a Markov-Modulated Process Model for Mobility Processes

Visiting periods

Visiting postdoc:

- Lyon, France, 4 – 8 June 2023. At Inria Lyon, working with Laurent Pujo-Menjouet and Mostafa Adimy
- Trento, Italy, 5 – 8 December 2022; 27 – 31 March 2023. At University of Trento, working with Andrea Pugliese and Sara Sottile
- Amsterdam and Groningen, the Netherlands, 21 – 25 November 2022. At Vrije Universiteit Amsterdam and Rijksuniversiteit Groningen, working with Bob Rink and Hildeberto Jardón-Kojakhmetov

Visiting Ph.D. student:

- München, Germany, 15 April – 15 June 2019. At Technische Universität München (TUM), working with Christian Kuehn and Hildeberto Jardón-Kojakhmetov

Communications

Invited speaker, Biomath 2025, Sofia, Bulgaria. 15 – 20 June 2025
Title: *"A general kinetic model for the spread of infectious diseases in continuously structured compartments"*

Invited speaker, BIMSA Computational Math Seminar, Beijing. 22 May 2025
Title: *"Geometric Singular Perturbation Theory in epidemic modelling: motivation and examples"*

Invited speaker, CDLab, Udine. 1 April 2025
Title: *"A general kinetic model for the spread of infectious diseases in continuously structured compartments"*

Invited speaker, EPIMAT seminar, Trento. 11 March 2025
Title: *"A general kinetic model for the spread of infectious diseases in continuously structured compartments"*

Invited speaker, Numerical Aspects of Hyperbolic Balance Laws and Related Problems, Ferrara. 17 – 19 December 2024
Title: *"A general kinetic model for the spread of infectious diseases in continuously structured compartments"*

Scientific committee, Complex Networks 2024, Istanbul, Turkey. 10 – 12 December 2024
Member of the scientific committee which evaluates abstract and article submissions.

Invited speaker, MACBES team, Inria d'Université Côte d'Azur. 18 November 2024
Title: *"Various approaches to the mathematical modelling of epidemics"*

Minisymposium organizer, ECMTB 2024, Toledo. 22 – 26 July 2024
Minisymposium: "Travelling wave phenomena in biology"

Invited speaker, GIMC SIMAI YOUNG 2024, Napoli. 10 – 12 July 2024
Title: *"A general kinetic model for the spread of infectious diseases in continuously structured compartments"*
Part of the minisymposium "MS01 – Mathematical Models for Socio-Epidemiological Dynamics"

Invited speaker, Laboratoire de Mathématiques Appliquées du Havre. 2 May 2024
Title: *"Various approaches to the mathematical modelling of epidemics"*

Invited speaker, Integrated Mathematical approaches to Socio-Epidemiological Dynamics, Trento. 29 – 31 January 2024
Title: *"A general kinetic model for the spread of infectious diseases in continuously structured compartments"*

Scientific committee, Complex Networks 2023, Menton Riviera, France. 28 – 30 November 2023
Member of the scientific committee which evaluates abstract and article submissions.

Poster presentation, Special Semester on Mathematical Methods in Medicine, Linz, Austria. 30 October – 3 November 2023
Title: *"A general kinetic model for the spread of infectious diseases in continuously structured compartments"*.
Part of workshop 1 "Epidemics modeling"

Invited speaker, SIMAI 2023, Matera. 28 August – 1 September 2023
Title: *"A general kinetic model for the spread of infectious diseases in continuously structured compartments"*.
Part of the minisymposium "MS03: Recent Advances on the mathematical and numerical modeling of epidemics"

Invited speaker, Inria Lyon. 7 June 2023
Title: *"Various approaches to the mathematical modelling of epidemics"*

Scientific committee, FRCCS 2023, Le Havre. 31 May – 02 June 2023
Member of the scientific committee which evaluates abstract and article submissions.

Contributed speaker, Workshop MSE, Napoli. 18 – 19 May 2023
Title: *"A geometric analysis of the SIRS model with secondary infections"*

Invited speaker, University of Trento. 7 December 2022
Mathematics Seminar, title: *"Delayed loss of stability in multiple time scale models of natural phenomena"*

Invited speaker, Rijksuniversiteit Groningen. 23 November 2022
Floris Takens Seminar, title: *"Entry-exit functions in fast-slow systems with intersecting eigenvalues"*

Invited speaker, Vrije Universiteit Amsterdam. 21 November 2022
Extra Dynamics Seminar, title: *"A Geometric Singular Perturbation approach to epidemic compartmental models"*

Invited speaker, University of Edinburgh. 14 October 2022
Applied and Computational Mathematics, title: *"Delayed loss of stability in multiple time scale models of natural phenomena"*

Minisymposium organizer and contributed speaker, ECMTB 2022, Heidelberg. 19 – 23 September 2022
Title: *"A generalization of the full SNARE-SM model"*.
Minisymposium: "Recent advances in mathematical modelling in neuroscience"

Contributed speaker, ENOC 2022, Lyon. 17 – 22 July 2022
Title: *"Delayed loss of stability in multiple time scale models of natural phenomena"*.
Part of the minisymposium "MS-05 Slow-Fast Systems and Phenomena"

Contributed speaker, 100 UMI - 800 UniPD, Padova. 23 – 27 May 2022
Title: *"A Geometric Singular Perturbation approach to epidemic compartmental models"*

Seminar organizer, Inria – Université Côte d'Azur. April – September 2022
MathNeuro seminars, cycle of seminars on mathematical models in neuroscience

Invited speaker, University of Edinburgh. 11 March 2022
Edinburgh Dynamical Systems Study Group, title: *"Entry-exit functions: beyond eigenvalue separation"*

Invited speaker, University of Edinburgh. 18 June 2021
Edinburgh Dynamical Systems Study Group, title: *"A Geometric Singular Perturbation approach to epidemic compartmental models"*

Organizer, scientific committee and contributed speaker, DSABNS 2020, Trento. 4 – 7 February 2020
Title: *"A GSPT approach to epidemics on homogeneous graphs"*

Invited speaker, University of Trento. 12 September 2019
Doc in Progress, title: *"An introduction to Geometric Singular Perturbation Theory"*

Contributed speaker, Edinburgh Slow-Fast-Ival, Edinburgh. 4 – 5 July 2019
Title: *"A GSPT approach to perturbed SIR and SIRWS models"*

Contributed speaker, DSABNS 2019, Naples. 3 – 6 February 2019
Title: *"A GSPT approach to perturbed SIR and SIRWS models"*

Invited speaker, Technische Universität München (TUM). 21 January 2019
Oberseminar Dynamics, title: *"A GSPT approach to perturbed SIR and SIRWS models"*

Reviewing

Journals:

- Advances in Difference Equations
- Applied Mathematical Modelling
- Bollettino dell'Unione Matematica Italiana
- Contemporary Mathematics
- Epidemiologia
- International Journal of Biomathematics
- Journal of Biological Systems
- Journal of Complex Networks
- Journal of Mathematical Biology
- Mathematical Biosciences and Engineering
- Mathematical Methods in the Applied Sciences
- Mathematics
- Mathematics and Computers in Simulation
- Nonlinear Analysis: Hybrid Systems
- Nonlinear Analysis: Real World Applications
- Nonlinear Dynamics
- Physica D: Nonlinear Phenomena
- Qualitative Theory of Dynamical Systems
- Results in Applied Mathematics
- SIAM Journal on Applied Dynamical Systems (SIADS)

Attended conferences, schools and workshops

Selected participant, Modeling, analysis, and control of multi-agent systems across scales, Pisa. 22 – 26 January 2024
Selected participant, NeuroMod Meeting 2022, Antibes. 30 June – 1 July 2022
Selected participant, MoDiS – Modelling Diffusive Systems: Theory & Biological Applications, Edinburgh. 6 – 9 September 2021
Selected participant, online Hausdorff School: Diffusive Systems, Bonn. 12 – 15 April 2021
Selected participant, Mathematical Biology on the Mediterranean Conference, Samos. 1 – 8 September 2019
Selected participant, Multiscale Phenomena in Geometry and Dynamics, München. 22 – 26 July 2019
Selected participant, Mathematics for BioMedicine, Rome. 8 – 11 October 2018
Selected participant, The Helsinki Summer School on Mathematical Ecology and Evolution 2018, Turku. 19 – 26 August 2018

Membership and collaborations

GNFM – INdAM 2025 – present
Member of the group *Gruppo Nazionale di Fisica Matematica*, of the *Istituto Nazionale di Alta Matematica*

EMS - TAG - MLS 2024 – present
Member of the *EMS Topical Activity Group Mathematical Modelling in Life Sciences* (EMS - TAG - MLS) of the *European Mathematical Society*

ESMTB 2024 – present
Member of the *European Society for Mathematical and Theoretical Biology* (ESMTB)

Collaborazioni Matematiche con il Sud Globale - UMI 2024 – present
Member of the group *Collaborazioni Matematiche con il Sud Globale* (Mathematical Collaborations with the Global South) of the *Unione Matematica Italiana*

MSE - UMI 2023 – present
Member of the group *Modellistica Socio-Epidemiologica* (Social-Epidemiological Modelling) of the *Unione Matematica Italiana*

CSSF 2023 – present
Member of the *Complex Systems Society France*

Mathematical Epidemiology group, University of Trento 2021 – present
Collaborator of the *Mathematical Epidemiology group*, University of Trento

GNAMPA – INdAM 2017 – 2021
Member of the group *Gruppo Nazionale per l'Analisi Matematica, la Probabilità e le loro Applicazioni*, of the *Istituto Nazionale di Alta Matematica*

Software

LaTeX, Matlab, Wolfram Mathematica, Python, Microsoft Office tools.

Languages

Italian (mother tongue), English (C1), French (basic).