# Mattia Sensi

Postdoctoral researcher at Politecnico di Torino

Politecnico di Torino
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## Research Interests

Mathematical modelling, mathematical biology, mathematical epidemiology, dynamical systems, 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**, Politecnico di Torino. March 2023 – present
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**, TUDelft. March – November 2021
Postdoctoral researcher in the group NAS, led by Prof. Piet Van Mieghem.

## Publications

19. **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, Volume 185, August 2024, 115104
18. **P. Kaklamanos, A. Pugliese, M. S. and S. Sottile**. *A geometric analysis of the SIRS model with secondary infections*. SIAM Journal on Applied Mathematics, Vol. 84, Iss. 2 (April 2024)
17. **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*. Phys. Rev. E 109, 034308
16. **M. Adimy, A. Chekroun, L. Pujo-Menjouet and M. S.**. *A multigroup approach to delayed prion production*. Discrete and Continuous Dynamical Systems-B 29.7 (2024): 2972-2998
15. **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, Volume 455, December 2023, 133887
14. **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, Volume 75, February 2024, 103986
13. **N. Cangiotti, M. Capolli, M. S. and S. Sottile**. *A survey on Lyapunov functions for epidemic compartmental models*. Bollettino dell'Unione Matematica Italiana 17.2 (2024): 241-257
12. **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 (2023)
11. **N. Cangiotti, M. Capolli and M. S.**. *A generalization of unaimed fire Lanchester's model in multi-battle warfare*. Operational Research volume 23, Article number: 38 (2023)
10. **M. A. Achterberg and M. S.**. *A minimal model for adaptive SIS epidemics*. Nonlinear Dynamics 111.13 (2023): 12657-12670
9. **S. Ottaviano, M. S. and S. Sottile**. *Global stability of multi-group SAIRS epidemic models*. Mathematical Methods in the Applied Sciences, 46.13 (2023): 14045-14071
8. **S. Ottaviano, M. S. and S. Sottile**. *Global stability of SAIRS epidemic models*. Nonlinear Analysis: Real World Applications, Volume 65, June 2022, 103501
7. **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 18.2 (2024): 206-219
6. **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, vol 1015, p. 607-618, Springer (2022)
5. **N. Cangiotti and M. S.**. *A geometric characterization of VES and Kadiyala-type production functions*. Filomat, Volume 35, No 5, 1661-1670 (2021)
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., Series A, Vol. 83, Iss. 2, 2021
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 83, 72 (2021)
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 83, 37 (2021)
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, Volume 58, April 2021, 103220

## Preprints

3. **A. Chizhov, L. Pujo-Menjouet, T. Schwalger and M. S.**. *A refractory density approach to a multi-scale SEIRS epidemic model*. Preprint on arXiv
2. **L. Eigentler and M. S.**. *Delayed loss of stability of periodic travelling waves: insights from the analysis of essential spectra*. Preprint on arXiv
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

## Teaching experience

**At Università degli Studi di Trento:**

- 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

**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**, 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
- 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 Dynamics
- Physica D: Nonlinear Phenomena
- 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

**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
External 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).