Diletta Burini

Research Interests

My initial research focused on the natural continuation of the activity developed in my PhD program, i.e., wave dynamics and inverse problems of interest in mathematical physics. Subsequently, turned to the modeling, qualitative analysis, and simulations of living, i.e. complex, systems by developing and applying theoretical tools from the kinetic theory of active particles. Specifically, on vehicular traffic, collective learning and social dynamics. Special attention has been given to the derivation of models at the macroscopic scale from the underlying description at the microscopic scale provided by the tools of kinetic theory. This line of research, somehow inspired by the sixth Hilbert problem, focused on the derivation of biological tissues from the microscopic dynamics.
An intense activity has been addressed to the multi scale modeling of the epidemics of SARS-CoV-2.

International Collaborations

2020–2024 *Scientific collaborations have been devoted both to research activity and to on-line lectures for PhD students and young researchers. In detail:*
Nicola Bellomo *presently distinguished professor at the University of Granada, Spain;*
Lorenzo Pareschi*, Università di Ferrara;*
Giuseppe Toscani*, Università di Pavia;*
Raluca Eftimie*, Université de Franche-Comté, France;*
Livio Gibelli*, University of Edinburg;*
Damian Knopoff*, University Deusto in Bilbao, Spain;*
Giovanni Dosi*, Scuola Superiore Sant'Anna, Pisa;*
Maria Enrica Virgillito*, Scuola Superiore Sant'Anna, Pisa;*
Pietro Terna*, Fondazione Collegio Carlo Alberto, Torino, Italy;*
Valeria Secchini*, Charles University of Praga, Czechoslovakia;*
Nadia Chouhad *and* ***Nisrine Outada****, University of Caddy Ayad Morocco*

2017–2019 *I was co-supervisor, with Prof. Nicola Bellomo, of two PhD students: Nadia Chouhad (Cadi Ayyad University, Marrakech) and Nisrine Outada (Lab. J.L.Lions, Paris and Cadi Ayyad University, Marrakech. PhD in Co-Tutelae). The activity with Nadia Chouhad (presently.."****Ecole Supérieure de Technologie, Essaouira, Morocco****") focused on the derivation of equations at the macroscopic scale from the underlying description at the microscopic scale by a development of the Hilbert method towards the study of multicellular systems in the parabolic limit. This collaboration continued with the study of multiscale nonlinear diffusion problems in biology. While the activity with Nisrine Outada focused on the modeling of social dynamics*

2015–2016 *I collaborated with Prof. Nicola Bellomo and Research Fellow Livio Gibelli (presently Senior Lecturer at the University of Edinburgh) on the activity of the European project eVAQUATE of the European Union Seventh Framework Program (FP7/20072013) under Grant Agreement No. 313161, supported also by a PRIN Project coordinated at national level by Prof. Mario Pulvirenti. The activity focused on the modeling of collective learning dynamics in view of application to the collective dynamics of large living systems, specifically human crowds*

2012–2013 *During my participation in the research group headed by Prof. Mark Ablowitz, at the Department of Applied Mathematics of the University of Colorado, I studied a problem of propagation of nonlinear waves in a system of stratified fluids. This work was reported in my PhD thesis "Nonlinear models in fluid dynamics" (2013). The analytical work started in Boulder was then completed with numerical simulations once I returned to Perugia*

Current Position

September 2024–Present **RTDB MATH-04/A, Fisica Matematica**
Dipartimento di Matematica e Informatica, Università degli Studi di Perugia

Education

January 15th, 2013 **Ph.D. in *Mathematics and Computer Science for Information and Knowledge treatment*** *XXV PhD cycle*, Università degli Studi di Perugia

July 17th, 2009 **Master Degree in *Mathematics*** *Università degli Studi di Perugia*

February 22nd, 2007 **Bachelor Degree in *Mathematics*** *Università degli Studi di Perugia*

Ph.D. Thesis

Title *Nonlinear Models in Fluid Dynamics*

Supervisor Prof. Silvana De Lillo

National Academic Qualification

November 9th, 2020 **Abilitazione a Professore di II Fascia**
S.C. 01/A4 - Fisica Matematica

Open access lectures on the dynamics of complex systems, University of Granada, Spain

2022 *N. Bellomo, D. Burini, D.A. Knopoff, and P. Terna*, "From a Mathematics of Living Systems To Modeling Virus Pandemics", University of Granada, Spain and Collegio Carlo Alberto, Torino
https://www.youtube.com/@modeling_life

2021 *N. Bellomo, D. Burini, D. Knopoff, N. Outada, G. Dosi, P. Terna and M.E. Virgillito*, "What is life? Seven Lectures on Collective Dynamics in Science and Society", University of Granada, Spain
https://www.modelingnature.org/training

Academic Didactic Activity

A.Y. 2022-23 **Co-Teaching:** *Mathematics course*, degree in Economy, Università degli Studi di Perugia

A.Y. 2021-22 *Open Access Lectures for Young Researchers*

A.Y. 2016-18 **Teaching:** *Institutions of Mathematics course*, degree in Primary Education Sciences, Università degli Studi di Perugia

A.Y. 2015-16 **Co-Teaching:** *Geometry course*, degree in Engineering, Politecnico di Torino

A.Y. 2012-13 **Tutoring:** *Mathematical Analysis course*, degree in Engineering, Università degli Studi di Perugia

A.Y. 2011-12 **Tutoring:** *Mathematical Analysis course*, degree in Veterinary Medicine, Università degli Studi di Perugia

A.Y. 2010-11 **Tutoring:** *Mathematical Analysis course*, degree in Computer Science, Università degli Studi di Perugia

A.Y. 2009-10 **Tutoring:** *Mathematical Physics and Rational Mechanics courses*, degree in Mathematics, Università degli Studi di Perugia

A.Y. 2008-09 **Tutoring:** *Mathematical Analysis course*, degree in Geology, Università degli Studi di Perugia

A.Y. 2007-08 **Tutoring:** *Mathematical Analysis course*, degree in Geology, Università degli Studi di Perugia

Research Fellowships

November 2015 - October 2016 **Post-Doc grant** *Qualitative analysis and computational modeling of biological dynamics with mutation and Darwinian selection, with applications to the immune competition*, DISMA, Politecnico di Torino, Projects: PRIN 2012 Mathematical problems in kinetic theory and applications
The Scientific: Prof. Nicola Bellomo

November 2014 - October 2015 **Post-Doc grant** *Physico-Mathematical models of polymer chains*, Department of Mathematics, Università degli Studi di Perugia, Projects: PRIN+INSTM(FIRB)
The Scientific: Prof. Silvana De Lillo

April 2013 - April 2014 **Post-Doc grant** *Study of polymer chains in fluids: propagation of solitary waves*, Department of Mathematics, Università degli Studi di Perugia, Project: PRIN 2010-2011
The Scientific: Prof. Silvana De Lillo

April 2012 - June 2012 **Research grant** *Nonlinear Weaves*, Department of Applied Mathematics, University of Colorado (Boulder, USA)
The Scientific: Prof. Mark J. Ablowitz

December 2011 - December 2012 **Research grant** *Physical mathematical models for elastic string description analytical biopolymers and synthetic polymers*, Department of Mathematics, Università degli Studi di Perugia, Project: PRIN 2008
The Scientific: Prof. Silvana De Lillo

October 2010 - August 2011 **Research grant** *Physical-Mathematical models of biological and synthetic polymers*, Department of Mathematics, Università degli Studi di Perugia
The Scientific: Prof. Silvana De Lillo

Schools, Conferences and Workshops

October 6th - 7st, 2017 **Problems in discrete dynamics: from biochemical systems to rare events, networks, clustering and related topics II,** *as a speaker*
Arcidosso, Italy

September 25th - 26st, 2017 **BIOPHYS17,** *Theoretical Physics Tools and Complex Network Physics applied to Biology and Social Systems*, as an invited speaker
Pisa, Italy

October 20th - 21st, 2016 **Kinetic Theory and its neighbours** *GSSI*
L'Aquila, Italy

September 13th - 16th, 2016 — **SIMAI 2016,** *Società Italiana di Matematica Applicata e Industriale*, Milano, Italy

June 1st - 3rd, 2016 — **Biomat 2016,** *Cell Dynamics and Polymerization*, Granada, Spain

January 26th - 30th, 2016 — **NAMB 2016,** *Nonlocal Aspect in Mathematical Biology*, Bedlewo, Poland

November 5th - 6th, 2015 — **Complex System Methods in Biology**, Torino, Italy

May 24th - 31st, 2015 — **NEEDS 2015,** *Nonlinear Evolution Equations and Dynamical Systems*, as a speaker, Santa Margherita di Pula, Italy

July 7th - 10th, 2014 — **SIMAI 2014,** *Società Italiana di Matematica Applicata e Industriale*, Taormina, Italy

June 22nd - 29th, 2013 — **PMNP 2013,** *Physics and Mathematics of Nonlinear Phenomena*, as a speaker, Gallipoli, Italy

Sept. 19th - Oct. 1st, 2011 — **XXXVI Summer School on Mathematical Physics**, Ravello, Italy

June 12th - 18th, 2011 — **WASCOM 2011,** *Waves and Stability in Continuous Media*, as a speaker, Brindisi, Italy

September 9th - 11th, 2010 — **BIOPHYS10**, Arcidosso, Italy

Stages

May, June, 2016 — **Universidad de Granada,** *Departamento de Matemática Aplicada*, Granada (ES)

April - June, 2012 — **University of Colorado,** *Department of Applied Mathematics*, Boulder (CO)

20 Selected Publications

[1] *N. Bellomo, D. Burini and J. Liao*, New Trends in Kinetic Theory Towards the Complexity of Living Systems, arXiv:2506.08752, **2025**.

[2] *G. Bertaglia, A. Bondesan, D. Burini, R. Eftimie, L. Pareschi and G. Toscani*, New Trends on the Systems Approach to Modeling SARS-CoV-2 Pandemics in a Globally Connected Planet, *Mathematical Models and Methods in Applied Sciences*, 34(11), 1995–2054, **2024**.

[3] *D. Burini and D.A. Knopoff*, Epidemics and society—A multiscale vision from the small world to the globally interconnected world, *Mathematical Models and Methods in Applied Sciences*, 34(8), 1567-1596, **2024**.

[4] *N. Bellomo, D. Burini, V. Secchini and P. Terna*, Active Particles Methods: New perspectives in the interaction between mathematics and economics, *Cambridge University Press. Series: Cambridge Elements in Complexity and Agent-based Economics*, Cambridge University Press, **2024**.

[5] *D. Burini and N. Chouhad*, Cross diffusion models in complex frameworks from microscopic to macroscopic, *Mathematical Models and Methods in Applied Sciences*, 33(9), 1909–1928, **2023**.

[6] *D. Burini, N. Chouhad and N. Bellomo*, Waiting for a Mathematical Theory of Living Systems from a Critical Review to Research Perspectives, *Symmetry*, 15(2), 351, **2023**.

[7] *D. Burini and N. Chouhad*, Virus models in complex frameworks: Towards modeling space patterns of SARS-CoV-2 epidemics, *Mathematical Models and Methods in Applied Sciences*, 32(10), 2017–2036, **2022**.

[8] *N. Bellomo, D. Burini and N. Outada*, Pandemics of mutating virus and society: a multi-scale active particles approach, *Philosophical Transactions of the Royal Society A*, 380(2224), 20210161, **2022**.

[9] *N. Bellomo, D. Burini and N. Outada*, Multiscale Models of Covid-19 with Mutations and Variants, *Networks Heterogeneous Media*, 17(3), 293–310, **2022**. **Highly cited paper by Clarivate WEB of Science**.

[10] *N. Bellomo, D. Burini, G. Dosi, L. Gibelli, D. Knopoff, N. Outada, P. Terna and M.E. Virgillito*, What is life? A perspective of the mathematical kinetic theory of active particles, *Mathematical Models and Methods in Applied Sciences*, 31(9), 1821–1866, **2021**. **Highly cited paper by Clarivate WEB of Science**.

[11] *D. Burini and N. Chouhad*, A multiscale view of nonlinear diffusion in biology: From cells to tissues, *Mathematical Models and Methods in Applied Sciences*, 29(4), 791–823, **2019**.

[12] *D. Burini and S. De Lillo*, On the Complex Interaction between Collective Learning and Social Dynamics, *Symmetry*, 11(8), 967–980, **2019**.

[13] *D. Burini, E. De Angelis and M.Lachowicz*, A continuous–time Markov chain modeling cancer–immune system interactions, *Communications in Applied and Industrial Mathematics*, 9(2), 106–118, **2018**.

[14] *D. Burini, S. De Lillo and G. Fioriti*, Nonlinear diffusion in arterial tissues: a free boundary problem, *Acta Mechanica*, 229, 4215–4228 **2018**.

[15] *D. Burini, S. De Lillo and G. Fioriti*, Influence of drivers ability in a discrete vehicular traffic model, *International Journal of Modern Physics C*, 28(3), 1750030, **2017**.

[16] *D. Burini and N. Chouhad*, Hilbert method toward a multiscale analysis from kinetic to macroscopic models for active particles, *Mathematical Models and Methods in Applied Sciences*, 27(7), 1327–1353, **2017**.

[17] *D. Burini, L. Gibelli and N. Outada*, Chapter: A Kinetic Theory Approach to the Modelling of Complex Living Systems, *Active Particles, Volume 1, Bellomo et al.(eds.). Modeling and Simulation in Science, Engineering and Technology*, 229–258, **2017**.

[18] *D. Burini, S. De Lillo and L. Gibelli*, Collective Learning Modeling Based on the Kinetic Theory of Active Particles, *Physics of Life Reviews*, 16, 123–139, **2016**.

[19] *D. Burini, S. De Lillo and G. Fioriti*, On the well posedness of the initial value problem in a kinetic traffic flow model, *Journal of Computational and Theoretical Transport*, 45(7), 528–539, **2016**.