Diletta Burini

Research Interests

My research is devoted to the development of a multiscale mathematical theory of complex living systems. The core idea is that biological and social systems must be understood as hierarchically organized structures, where dynamics at different scales — microscopic, mesoscopic, and macroscopic — are intrinsically coupled and cannot be treated independently.

I investigate kinetic frameworks in which interacting functional subsystems are linked across scales through structured activity variables and nonlinear interaction rules, providing a rigorous description of scale transitions and cross-scale feedback mechanisms.

Ongoing International Collaborations

Nicola Bellomo presently distinguished professor at the University of Granada, Spain;
Damian Knopoff, University Deusto in Bilbao, Spain;
Pietro Terna, Fondazione Collegio Carlo Alberto, Torino, Italy;
Jie Liao, School of Mathematics Shanghai University in Finance and Economy, Shanghai, China;

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 at **École 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

Active Courses

2024–present	**Teaching:** *Meccanica Razionale I*, Bachelor's degree in Mathematics, Università degli Studi di Perugia
2024–present	**Teaching:** *Fisica Matematica I*, Bachelor's degree in Mathematics, Università degli Studi di Perugia
2025–present	**Teaching:** *Modelli Matematici per le Applicazioni*, Master's degree in Mathematics, Università degli Studi di Perugia

Previous Courses

2021–2022	*Open Access Lectures for Young Researchers*
2016–2018	**Teaching:** *Institutions of Mathematics course*, degree program in Primary Education Sciences, Università degli Studi di Perugia
2015–2016	**Co-Teaching:** *Geometry course*, degree program in Engineering, Politecnico di Torino
2007–2013	**Tutoring activities at Università degli Studi di Perugia:** *Mathematical Analysis (degree programs in Engineering, Geology, Computer Science, Veterinary Medicine), Mathematical Physics and Rational Mechanics (degree program in Mathematics)*

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
Scientific Supervisor: 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)
Scientific Supervisor: 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
Scientific Supervisor: Prof. Silvana De Lillo

April 2012 - June 2012 — **Research grant** *Nonlinear Waves*, Department of Applied Mathematics, University of Colorado (Boulder, USA)
Scientific Supervisor: 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
Scientific Supervisor: 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
Scientific Supervisor: Prof. Silvana De Lillo

Schools, Conferences and Workshops

2026 — **From Micro To Macro in Mathematical Biology** *Recent advances in the modeling and analysis of biological systems*
Politecnico di Torino, Italy

2017 — **Problems in discrete dynamics: from biochemical systems to rare events, networks, clustering and related topics II** *as a speaker*
Arcidosso, Italy

2017 — **BIOPHYS17** *Theoretical Physics Tools and Complex Network Physics applied to Biology and Social Systems*, as an invited speaker
Pisa, Italy

2016 — **Kinetic Theory and its neighbours** *GSSI*
L'Aquila, Italy

2016 — **SIMAI 2016** *Società Italiana di Matematica Applicata e Industriale*
Milano, Italy

2016 — **Biomat 2016** *Cell Dynamics and Polymerization*
Granada, Spain

2016 — **NAMB 2016** *Nonlocal Aspect in Mathematical Biology*
Bedlewo, Poland

2015 — **Complex System Methods in Biology**
Torino, Italy

2015	**NEEDS 2015** *Nonlinear Evolution Equations and Dynamical Systems*, as a speaker
	Santa Margherita di Pula, Italy
2014	**SIMAI 2014** *Società Italiana di Matematica Applicata e Industriale*
	Taormina, Italy
2013	**PMNP 2013** *Physics and Mathematics of Nonlinear Phenomena*, as a speaker
	Gallipoli, Italy
2011	**XXXVI Summer School on Mathematical Physics**
	Ravello, Italy
2011	**WASCOM 2011** *Waves and Stability in Continuous Media*, as a speaker
	Brindisi, Italy
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)

Recent Contributions

[1] *N. Bellomo, D. Burini and J. Liao*, New Trends in Kinetic Theory Toward the Complexity of Living Systems, *Mathematical Models and Methods in Applied Sciences*, 36(2), 341–397, **2026**.

[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 and 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**. Nonlinear diffusion in arterial tissues: a free boundary problem, *Acta Mechanica*, 229, 4215–4228, **2018**. Influence of drivers ability in a discrete vehicular traffic model, *International Journal of Modern Physics C*, 28(3), 1750030, **2017**.

[14] *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**.

[15] *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**.

[16] *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**. 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**.

Interdisciplinary open access lectures on the dynamics of complex systems

2022   *N. Bellomo, D. Burini, D. Knopoff, N. Outada, G. Dosi, P. Terna and M.E. Virgillito*, "From a Mathematics of Living Systems To Modeling Virus Pandemics", Collegio Carlo Alberto, Torino
`https://www.modelingnature.org/training` and `https://www.carloalberto.org/cca-events/collegioaperto/six-lectures-in-the-time-of-covid-19`

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`