

## Curriculum vitae

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### EDUCATION:

- October 1972, Graduated in Mathematics at the University of Pavia - Italy

### CURRENT POSITION:

- Professor Emeritus of Mathematical Physics, Department of Mathematics, University of Pavia, Italy

### PREVIOUS POSITIONS:

- 1972-1980, Assistant Professor of Mathematical Physics, Faculty of Sciences, University of Pavia, Italy
- 1981-1986, Associated Professor of Rational Mechanics, Faculty of Sciences, University of Pavia, Italy
- 1987-1992, Full Professor of Mathematical Physics, Faculty of Sciences, University of Ferrara, Italy
- 1992-2020, Full Professor of Mathematical Physics, Department of Mathematics, University of Pavia, Italy

## HONORS AND ACADEMIC DUTIES

- Correspondent Member of the Accademia Nazionale dei Lincei in Rome (Italy).
- Member of the European Academy of Sciences (EURASC).
- Correspondent Member of the Istituto Lombardo di Scienze e Lettere in Milan (Italy).
- Awarded with a Rothschild Visiting Professorship at the Isaac Newton Institute for Mathematical Sciences at the University of Cambridge (August 2010).
- Awarded with the Gili-Agostinelli Prize 2022 for Applied Mathematics by the Turin Academy of Sciences.
- Member of the Academic Senate of the University of Pavia for the period 2008-2012.
- Member of the Scientific Council of the National Group of Mathematical Physics (GNFM) of Institute of High Mathematics (INDAM) of Italy for the periods 2005–2008, 2009–2012.
- Coordinator of the national project “Kinetic and hydrodynamic equations of complex collisional systems” (2007-2009) founded by the Italian Minister for Research.
- Leader of the North-Italy group of the TMR-Project Asymptotics Methods in Kinetic Theory (1997–2001) (<http://www.math.tu-berlin.de/tmr/>).
- Member of the Scientific Advisory Board of the EU-funded network “HYperbolic and Kinetic Equations: Asymptotics, Numerics, Analysis” (HYKE) , Contract Number HPRN-CT-2002-00282 (<http://www.hyke.org/>).

## EDITORIAL BOARDS:

- Journal of the European Mathematical Society (2015-2019), ISSN: 1435-9855;
- Kinetic and Related Models, ISSN: 1937-5077;
- Rendiconti Lincei Matematica e Applicazioni, ISSN: 1120-6330;
- Annali dell’Università di Ferrara, Sezione VII, ISSN: 0430-3202;
- Ricerche di Matematica, ISSN: 0035-5038.

## SHORT CURRICULUM VITAE:

Author of more than 250 papers, written both individually, and in collaboration with national and international experts, of two monographs on the mathematical aspects of the Boltzmann equation and of the Enskog equation in the kinetic theory of rarefied gases.

In the last twenty-five years he has collaborated, among others, with the French mathematicians Pierre-Louis Lions, winner of a Fields medal in 1998, and Cedric Villani, winner of a Fields medal in 2010, and has entertained an ongoing and intense research activity with the Austrian mathematician Peter Markowich, winner in 2001 of the Wittgenstein Prize, one of the most prestigious scientific awards in Austria.

In August 2010, he was appointed with a Rothschild Visiting Professorship at the Isaac Newton Institute for Mathematical Sciences at the University of Cambridge. As of 2010, he is a member of the Accademia Nazionale dei Lincei, the most most prestigious Italian academy, which dates back to Galileo. In the year 2022 he was awarded the Gili-Agostinelli Prize for Applied Mathematics by the Turin Academy of Sciences. During the five-year period 1997-2001 he coordinated one of the two Italian teams of the European project TMR “Asymptotic Methods in Kinetic Theory”. For the period 2003-2008 he has been member of the Scientific Council of the National Group of Mathematical Physics Physics of INDAM (National Institute of High Mathematics).

The main scientific results concern the behavior in large time of the Boltzmann equation, the kinetic theory of dissipative systems with application to granular gases, and the asymptotic behavior of nonlinear diffusion equations with entropy methods. Most of the mentioned contributions are strongly dependent on sharp differential inequalities, which can be applied to different fields. One of the fields of application is classical information theory, where a strengthened form of the entropy power inequality has been obtained. One of the results on the rate of convergence to equilibrium for the Boltzmann equation, co-written with Cedric Villani, was cited in the motivation for Villani’s Fields medal.

In the last twenty years he has worked intensively in the mathematical modeling of kinetic models for multi-agent socio-economic systems, and in the mathematical description of human behavior. On the mathematical aspects of socio-economic systems he has published, co-authored with L. Pareschi, the book “Interacting Multiagent Systems, Kinetic equations and Monte Carlo Methods”.

The results have been presented in several national and international Conferences, and in various lectures at Italian and foreign institutions.

## INVITED LECTURES (Selected)

- June 10-15, 2001 *International Conference on Nonlinear Evolutionary PDEs*, City of Yellow Mountain, China.
- September 17-21, 2001 *EuroConference on Asymptotic Methods and Applications in Kinetic and Quantum-Kinetic Theory*, Granada, Spain.
- February 10-13, 2003, *First EMS -SMAI -SMF Joint Conference on Applied Mathematics and Applications of Mathematics*, Nice, France.
- September 30 - October 3, 2003 *International Silk Road Conference on Quantum Theory, Partial Differential Equations of Mathematical Physics and their Applications*, Tashkent, Uzbekistan
- September 19–23, 2004 *The Sixth International Workshop on Mathematical Aspects of Fluid and Plasma Dynamics*, Kyoto, Japan
- June 26–30 2006 *Nonlinear PDEs: Homogenization and Kinetic Equations* Vienna, Austria.
- April 20-23, 2009 *Workshop on Modern Topics in Nonlinear Kinetic Equations* Cambridge, UK.
- July 20-24, 2009 *Kinetics and statistical methods for complex particle systems*, Lisbon, Portugal.
- September 6-10, 2010 *Fluid-Kinetic Modelling in Biology, Physics and Engineering* Cambridge, UK
- January 12–13, 2012 *Workshop on Functional Inequalities and PDE's in the Life Sciences*, Paris, France
- December 11–13, 2013 *Mathematical Modelling of Complex Systems*, Paris, France.
- May 19–23, 2014, *Collective Behavior: Macroscopic versus Kinetic Descriptions*, London, UK
- June 30–July 4, 2014 *First Joint International Meeting RSME-SCM-SEMA-SIMAI-UMI* Bilbao, Spain
- May 27–29, 2015 *BIOMAT-2015: Emergence and self-organization in Social and Biological Systems*, Granada, Spain
- May 22–29, 2017 *Advanced School and Workshop on Nonlocal PDEs and Applications to Geometry, Physics and Probability*, Trieste, Italy
- May 20–24, 2019 *Trails in kinetic theory: foundational aspects and numerical methods* Bonn, Germany
- June 13–19, 2019 *Biomat 2019, Patterns in Life and Social Sciences* Granada, Spain

## VISITING AND RESEARCH POSITIONS (Selected)

- April 2000, Visiting Professor at the École Normale Supérieure of Paris, France (one month).
- January 2004, Department of Mathematics of the Autònoma of Barcellona (two weeks)
- May 2006, Wolfgang Pauli Institute of Vienna, Austria (two weeks).
- May 2007, Visiting Professor at the Mathematics Department of the University of Toulouse, France (one month).
- March 2010, Visiting Professor at the Université Paris Pauphine, Paris, France (one month)
- September 2010, Rotschild Visiting Professor at the Isaac Newton Institute, Cambridge, UK (one month)
- March 2014, King Abdullah University of Science and Technology, Jeddah, Saudi Arabia (Two weeks)
- July 2015, Capital Normal University, Beijing, China (One week)

## SELECTED LIST OF 12 PUBLICATIONS

- P.L.Lions, G.Toscani, Diffusive limits for finite velocity Boltzmann kinetic models, *Revista Mat. Iberoamer.* **13** 473–513 (1997)
- G. Toscani, C. Villani, Sharp entropy dissipation bounds and explicit rate of trend to equilibrium for the spatially homogeneous Boltzmann equation, *Commun. Math. Phys.* **203** 667–706 (1999)
- J. A. Carrillo, G. Toscani, Asymptotic L1-decay of the porous medium equation to self-similarity, *Indiana Univ. Math. J.* **46** 113–142 (2000)
- A. Arnold, P. Markowich, G. Toscani, A. Unterreiter, On convex Sobolev inequalities and the rate of convergence to equilibrium for Fokker-Planck type equations, *Commun. Partial Diff. Equa.* **26** 43-100 (2001)
- J.A. Carrillo, G. Toscani, Long-Time asymptotics for strong solutions of the thin film equation, *Commun. Math. Phys.* **225** 551–571 (2002)
- Hailiang Li, G. Toscani, Long-time asymptotics of kinetic models of granular flows, *Arch. Ration. Mech. Anal.* **172** (3) 407–428 (2004)
- S. Cordier, L. Pareschi, G. Toscani, On a kinetic model for a simple market economy, *J. Statist. Phys.* **120** 253–277 (2005)
- U. Gianazza, G. Savaré, G. Toscani, The Wasserstein gradient flow of the Fisher information and the quantum drift-diffusion equation, *Arch. Rat. Mech. Anal.* **194** (1) 133–220 (2009)
- G. Toscani, A strengthened entropy power inequality for log-concave densities, *IEEE Transactions on Information Theory* **61** (12) 6550–6559 (2015)
- G. Furioli, A. Pulvirenti, E. Terraneo, G. Toscani, Fokker–Planck equations in the modelling of socio-economic phenomena, *Math. Models Methods Appl. Sci.* **27** (1) 115–158 (2017)
- S. Gualandi, G. Toscani, Human behavior and lognormal distribution. A kinetic description. *Math. Models Methods Appl. Sci.* **29**, (4) 717–753 (2019)
- G. Dimarco, B. Perthame, G. Toscani, M. Zanella, Kinetic models for epidemic dynamics with social heterogeneity. *Journal of Mathematical Biology*, **83** (4) (2021)

## ACHIEVEMENTS

The main scientific achievements of G. Toscani are concerned with classical kinetic theory of rarefied gases, with the asymptotic behavior of nonlinear diffusion equations by entropy methods, and with the mathematical modeling of socio-economic systems.

In classical kinetic theory, his main result is concerned with the large-time behavior of the solution of the spatially homogeneous Boltzmann equation. Jointly with Cedric Villani, he obtained strong results about exponential convergence in relative entropy of the solution to equilibrium<sup>1</sup>. These results about the spatially homogeneous Boltzmann equation, who solved in an elegant way the so-called Cercignani's conjecture, were quoted in the motivation of the Fields medal of Villani in 2010. Also, he first studied the large-time behavior of the classical Fokker–Planck equation, by establishing a deep link between this equation and the logarithmic Sobolev inequality<sup>2</sup>, a result that was subsequently generalized with A. Arnold, P. Markowich and A. Unterreiter<sup>3</sup>.

These ideas were subsequently used to study convergence towards self-similarity for the solution to nonlinear diffusion equations. Pioneering papers in this direction have been written with José Antonio Carrillo, first for the class of second-order diffusion equations modeling porous media<sup>4</sup>, and subsequently for higher-order diffusion equations modeling thin films<sup>5</sup>.

Most of the aforementioned contributions are heavily related to sharp differential inequalities, that appear in different fields. One of the fields in which G. Toscani was able to apply his results is the classical information theory. Here, jointly with G. Savaré, he was able to generalize the concavity property of the famous entropy power inequality by Shannon to the case of Rényi entropies, by emphasizing a new connection between these entropies and nonlinear diffusion equations<sup>6</sup>. On the same field he was able to obtain a strengthened form of the entropy power inequality by Shannon<sup>7</sup>.

A leading part of the recent scientific activity of G. Toscani is related to the mathematical modeling on socio-economic systems, where he recently wrote, jointly with L. Pareschi, a successful book<sup>8</sup>. Starting from the study of the distribution of wealth in a western society<sup>9</sup>, he was able to apply methods of classical kinetic theory to the study of both social and economic phenomena of multi-agent systems, including opinion formation<sup>10</sup>, and, more recently, various aspects of human behavior<sup>11</sup>.

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<sup>1</sup>G. Toscani, C. Villani, Sharp entropy dissipation bounds and explicit rate of trend to equilibrium for the spatially homogeneous Boltzmann equation, *Commun. Math. Phys.* **203** 667–706 (1999)

<sup>2</sup>G. Toscani, Entropy production and the rate of convergence to equilibrium for the Fokker-Planck equation, *Quarterly of Appl. Math.*, Vol. LVII (1999), 521–541

<sup>3</sup>A. Arnold, P. Markowich, G. Toscani, A. Unterreiter, On convex Sobolev inequalities and the rate of convergence to equilibrium for Fokker-Planck type equations, *Commun. Partial Diff. Equa.* **26** 43–100 (2001)

<sup>4</sup>J. A. Carrillo, G. Toscani, Asymptotic L1-decay of the porous medium equation to self-similarity, *Indiana Univ. Math. J.* **46** 113–142 (2000)

<sup>5</sup>J.A. Carrillo, G. Toscani, Long-Time asymptotics for strong solutions of the thin film equation, *Commun. Math. Phys.* **225** 551–571 (2002)

<sup>6</sup>G. Savaré, G. Toscani, The concavity of Rényi entropy power, *IEEE Transactions on Information Theory*, **60** (5) 2687–2693 (2014)

<sup>7</sup>G. Toscani, A strengthened entropy power inequality for log-concave densities, *IEEE Transactions on Information Theory* **61** (12) 6550–6559 (2015)

<sup>8</sup>L. Pareschi, G. Toscani, *Interacting Multiagent Systems: Kinetic Equations and Monte Carlo Methods*, Oxford University Press, Oxford (2014), pg. XII + 376

<sup>9</sup>S. Cordier, L. Pareschi, G. Toscani, On a kinetic model for a simple market economy, *J. Statist. Phys.* **120** 253–277 (2005)

<sup>10</sup>G. Toscani, Kinetic models of opinion formation, *Commun. Math. Sci.* **4** (3) (2006) 481–496

<sup>11</sup>S. Gualandi, G. Toscani, Human behavior and lognormal distribution. A kinetic description. *Math. Models Methods Appl. Sci.* **29**, (4) 717–753 (2019)