



Mauro Carfora
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Università degli Studi di Pavia
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Pavia

CURRICULUM VITAE

Research Interests

- Geometrical Analysis in mathematical general relativity and relativistic cosmology. Combinatorial methods in theoretical and mathematical physics. Applications in quantum gravity and moduli space theory. Ricci flow and rigorous renormalization group flow on Riemannian manifolds and their applications to theoretical and mathematical Physics.

Author of a large number of research papers in relativity, cosmology, differential geometry, and quantum gravity, often in collaboration with internationally renowned colleagues (G.F.R. Ellis, R. Kolb, J. Isenberg, R. Williams, M. McCallum, J. Ambjorn, C. Guenther, T. Buchert ...), and co-author with Annalisa Marzuoli of 4 Springer monographs:

- M. Carfora, A. Marzuoli *Einstein Constraints and Ricci Flow*
A Geometrical Averaging of Cosmological Initial Data Sets
Mathematical Physics Studies, Springer Nature (2023), xii+173 pp
- M. Carfora, A. Marzuoli *Quantum Triangulations, Non-linear sigma models and Ricci Flow*
Lecture Notes in Physics 942 (2017), Springer Heidelberg, xx+392 pp
- M. Carfora, A. Marzuoli *Quantum Triangulations: Moduli Spaces, Strings, and Quantum Computing*
Lecture Notes in Physics 845 (2012), Springer Heidelberg, xvii+282 pp
- M. Carfora, A. Marzuoli and J. Ambjorn *The Geometry of Dynamical Triangulations*
Lecture Notes in Physics m50 (1992) Springer Heidelberg, viii+197 pp
- M. Carfora(illustrator), G. F. R. Ellis, R. Williams *Flat and Curved Spacetimes*
Clarendon Press, Oxford (1988), x+ 351 pp (e circa 300 illustrazioni (M.C.))

Chronology of Education

- Ph.D. Physics, May 1981, The University of Texas at Dallas (Supervisor W. Rindler)
- M.A. Physics, (Cum Laude), February 1977 University of Rome "La Sapienza", Rome (Supervisor C. Cattaneo)

Chronology of Employment

- The University of Pavia, Full Professor of Mathematical Physics, 2001 – Present
- The University of Pavia, Associate Professor of Theoretical Physics, 1997-2001
- International School for Advanced Studies (ISAS-SISSA), Associate Professor of Mathematical Physics, 1992-1997
- The University of Pavia, Researcher (Theoretical Physics), 1985-1992
University of Rome "La Sapienza", Researcher (Theoretical Physics), 1981-1985

Visiting Positions

- He has held visiting positions in many universities and research institutions abroad, among these: the University of California, Berkeley (Physics Dept); BIRS at the Banff Centre, Canada; KITP(Kavli Institute) at the University of California, Santa Barbara; the University of Texas at Dallas, Ludwig-Maximilians-Universität München, N. Copernicus Astronomical Centre Warsaw, Banach Institute Warsaw; University of Oregon, Eugene; N. Bohr Institute, Copenhagen.

Honors and Awards

- Winner of *The International prize Tullio Levi-Civita for the Mathematical and Mechanical Sciences* (shared with Tudor Ratiu) (2016).
- Winner of the *Bruno Finzi Prize for Mathematical Physics* of the Istituto Lombardo di Scienze (1997)
- *2nd Prize of The Gravity Research Foundation* (with C. Rovelli and A. Bareira, 1996)
- *Profile of Success* (together with Rebecca Bishop and Joseph P. Estrera) as a testimonial of the Graduate School in Physics of the University of Texas at Dallas (2011).

Research Projects

- Core-Team Member of the external Collaborators of the European *project ERC-2016-ADG advanced grant "arthUS": advances in the research on theories of the dark Universe*. (Principal Investigator: Thomas Buchert)
http://cordis.europa.eu/project/rcn/210041_en.html.
Responsible for the WorkPackages:
WP-A3 (*Scale-dependent partitioning of spatial sections*);
WP-A5 (*Construction of template metrics and reinterpretation of observational data*);
WP-C3 (*Averaging tensorial variables, gravitational entropies, and global topology*).

PRIN Projects

Local coordinator (Pavia) of the research projects of National Interest (PRIN):

- "*Geometry of Integrable systems I*" (2000-2001 e 2002-2003).
- "*Geometry of Integrable systems II*" (2004-2005)
- "*Moduli spaces, integrable structures, and PDE of evolutive type*" (2006-2007)
- "*Geometrical methods in non-linear wave equations and applications*" (2008-2010).
- "*Geometrical and analytical theories of finite and infinite-dimensional Hamiltonian systems*" (PRIN 2010-11)

Local coordinator (Pavia) of the INFN research projects

- "*Differential geometrical methods in field and string theory*", (1985-2013)
- Local coordinator (Pavia) of the European HCM project *Constrained Dynamical Systems* (1993-96);

National and International Service

- Member elected of the *Scientific Committee of the National Group of Mathematical Physics* (GNFM) of the National Institute of Advanced Mathematics (INDAM), 2001-2013 and 2017-2021.
- Member of the Scientific Committee of the *Centro Di Cultura Scientifica Alessandro Volta* (associated with the Universities of Pavia, Como, Milano Statale, Milano Bicocca) 2012.
- Chief Editor (with Carlo Mantegazza) of the Journal "*GEOMETRIC FLOWS*" published by DeGruyter, 2013-2021.

- Member of the Advisory Board of the journal "MEMOCS" (2012-...) published by the International Research Center for the Mathematics and Mechanics of Complex Systems (Università Dell'Aquila, Italy).
- Member of the Editorial Board of the Springer journal *Ricerche di Matematica: A journal of pure and applied mathematics*, 2016-present.
- Member of the Scientific Committee of the annual Italian meetings on *Actual Problems in Theoretical Physics* (Vietri, Salerno).
- Member of the Steering Committee of the *Italian Society for Relativity and Gravitational Physics* (SIGRAV) (1990-96, 2004-2008).
- Founding Member of the *Italian Society for Relativity and Gravitational Physics (1990)*
- Member of the Scientific Committee of *Collegio Nuovo – Sandra e Enea Mattei Foundation* (one of the university colleges associated with the University School for Advanced Studies IUSS in Pavia) (2017-...)
- Member of the Academic Progression Committee for various universities and research institutions (USA, Australia, Germany, France) and the attribution of international prizes.
- External reviewer for National Science Foundation projects (USA).
- External reviewer for National Academy of Science projects (Poland)

Departmental Committees

- Dean of Graduate Studies in Physics of the University of Pavia, 2007-2014.
- Vice-Director of the Department of Nuclear and Theoretical Physics of the University of Pavia, 2001-2012.
- Coordinator of the theoretical group (Pavia section) of the Italian National Institute for Nuclear Physics 1987-1993.

University Committees

- Counselor of the School of Graduate Studies in Science and Technology (Scuola di Alta Formazione Dottorale) (SAFD) of the University of Pavia 2014-2021.

Organization of Conferences and Workshops

- Organizer of the Classical and Quantum Gravity workshop framed in the Conference "*Current Problems in Theoretical Physics*" (XXIII ed.) Vietri Sul Mare 7-11 April 2017.
- Organizer (with Giorgio Patrizio, Tommaso Ruggeri, Justin Corvino, Pengzi Miao) of the Summer School "*Mathematical General Relativity in Cortona*" (29 July-9 August 2013) sponsored by INdAM (Istituto Nazionale di Alta Matematica), MSRI (Mathematical Science Research Institute), SMI (Scuola Matematica Interuniversitaria), CMI (Clay Mathematics Institute),
- Organizer (together with Zinedine Djadli (Institut Fourier, Universite Grenoble), Gerhard Huisken (Albert-Einstein-Institut), Lei Ni (University of California, San Diego), Eric Woolgar (University of Alberta)) of the International Workshop: *Geometric flows in mathematics and physics*
- "Geometric flows in mathematics and physics" BIRS (Banff International Research Station- 5 days (workshop 11w5010) Banff Centre (Canada), (17/04/2011 - 22/04/2011).
- Member of the Advisory Board of the *XXXV International Conference of Theoretical Physics "Matter to the Deepest,"* Ustron, Poland, 12-18 Settembre 2011
- Organizer (together with Zinedine Djadli, Andrea Malchiodi, and Carlo Mantegazza) of the International Workshop: "*Geometric Flows in Mathematics and Theoretical Physics*"
- Centro Ennio De Giorgi – Scuola Normale Superiore di Pisa, 22-25 June 2009
- Member of the Scientific Committee of "*The Jubilee 40th Symposium on Mathematical Physics: "Geometry and Quanta"*", June 25-28, 2008, Torun, Poland

- President (together with Bruno Bertotti) of the Scientific Committee of the International Conference "*Spacetime in Action: one hundred years of Relativity*" (Pavia March 29- April 2, 2005), framed within the UNESCO World Year of Physics 2005 Programme.
- Member of the Scientific Committee of the meeting "*Problemi attuali di Fisica Teorica*" (Vietri, 2001, 2004, 2005, 2006, 2007, 2008, 2010, 2012, 2014, 2015); Chair of the Quantum Gravity workshop.
- Chairperson of the *Classical and Quantum Gravity workshop of the Italian Meeting on General Relativity and Gravitational Physics* (2004, 2006).

Reviewer for Physical Review Letters, Physical Review D, Communication in Mathematical Physics, Classical and Quantum Gravity, Journal of Geometry and Physics, Journal of Differential Geometry, Physics Letters (A and B), Journal of Physics A, Journal of Mathematical Analysis and Applications, and many other journals.

Invited Colloquia and Conference Talks (a selection)

- 6 lectures on *An introduction to Relativistic Cosmology* XLIX GNFM (Gruppo Nazionale di Fisica Matematica dell'INDAM) Summer School on Mathematical Physics, Ravello, September 2-14, 2024
- *Imaging Functionals and the Dark Energy Riddle: A Case Study of Applied Mathematics in Cosmology*, Invited Conference at *One-day Workshop on Applied Mathematics 2024*, Bari, May 30, 2024
- *Ricci curvature and Quantum Geometry*, invited talk at *Integrable Systems in Geometry and Mathematical Physics*, Conference in Memory of Boris Dubrovin, June 28- July 2, 2021
- *Inhomogeneities in Cosmology and the geometry of spacetime averaging: the light cone case*, Invited plenary Conference at the *Kosmologische Modelbildung* DPG-Fruhjahrstagung 2019, Munchen, 17-22 March 2019
- *Ricci curvature and Quantum Geometry*, invited talk at Current Problems in Theoretical Physics XXV Edition, Vietri sul mare, April 13-17, 2019
- *Ricci curvature unfolding*, invited talk at the XXIII SIGRAV Conference, Cagliari 9-15 Settembre 2018
- "*The many faces of Ricci curvature*," Invited talk at the conference "Geometry of Integrable Systems," Sissa, Trieste 7-9 June 2017.
- "*The many faces of Ricci curvature: Relativity, geometric flows, renormalization group*" The **Tullio Levi-Civita Lecture 2016** (on the occasion of the presentation of the Levi-Civita Prize 2016), Aula del Consiglio, Dipartimento di Matematica Guido Castelnuovo, La Sapienza Università di Roma, 6 October 2016
- "*The Back-Reaction Debate*," Invited talk at the XXII SIGRAV Conference "A Century of General Relativity," Cefalù 12-18 September 2016.
- "*General Relativity and Einstein Equations*" 6 lectures for the first part of the course "*Introduction to Mathematical General Relativity*" (Justin Corvino held the 2nd part) of the XL SUMMER SCHOOL ON MATHEMATICAL PHYSICS (RAVELLO - SEPTEMBER 14 - 26, 2015).
- "*Topology, Entropy, and the Emergence of Geometrical Structures in Molecular Self-Assembly*" Invited Talk at "Quantum Days in Bilbao: Mathematical Methods in Atomic and Molecular Physics," Bilbao, Basque Center for Applied Mathematics, (Bilbao, July 13-14 2015).
- "*Heat kernel embedding, dilatonic sigma models and Ricci flow extensions*" Invited Talk at the BIRS Workshop "Geometric Flows: Recent Developments and Applications" (15w5148) (Banff, April 12-17, 2015)
- "*Heat Kernel Embedding, Non-Linear Sigma Models and Ricci Flow Extensions*" Invited Talk at "Integrability and Nonlinearity in Field Theory" (Vietri, 28-31 March 2015).

- "*Einstein Constraints and Ricci Flow*," a series of two lectures at the Indam-MSRI "Summer School on Mathematical Relativity in Cortona." (July 29- August 9, 2013).
- "*Entropy: From geometrical enumeration to quantum field theory*" Invited talk at 92e rencontre entre physiciens théoriciens et mathématiciens : Entropie en mathématiques et en physique. 26-28 Septembre 2013, (IRMA), Strasbourg, France.
- "*Polyhedral surfaces and Open/Closed string duality*" plenary talk at the XX SIGRAV Conference on Gravitational Physics and General Relativity Napoli, Osservatorio Astronomico di Capodimonte, Ottobre 22-26, 2012.
- "*Changes of scale, Discretizations & Quantum Geometry*," Invited Talk at CECAM-ETH Zurigo, 27-29 Giugno 2011
- "*(Quantum) Glimpses of Spacetime Geometry*" Invited talk at 87e rencontre entre physiciens théoriciens et mathématiciens : Géométrie de Lorentz en mathématiques et en physique 16-18 juin 2011, (IRMA), Strasbourg, France.
- "*Ricci Flow: A Theoretical Physics Perspective*" and "*Ricci Flow Conjugation and Initial Data Sets for Einstein Equations*" Invited talks at the Numerical Ricci Flow in Computer Science, Geometry, and Physics, Pacific Institute for Mathematical Sciences, Vancouver 14-16 Luglio 2011.
- "*Ricci Flow and Quantum Field Theory Landscaping*" Invited talk at XXI Fall Workshop on Geometry and Physics, Madrid 31 Agosto-3 Settembre, 2011.
- "*QFT landscaping and the Ricci Flow*" Invited talk at the: "The moon of Einstein-The scientific legacy of Ruggiero de Ritis," Istituto Italiano di Studi Filosofici, Napoli 1-3 Ottobre 2010.
- "*Back and Forth with the Ricci flow*" Invited talk at the XIX SIGRAV Conference, Scuola Normale Superiore, 27 Settembre-1 Ottobre 2010
- "*Ricci Flow and Einstein equations*" Invited talk at the: "Aspects géométriques at probabilistes de la théorie de la relativité", 10-12 juin 2010, (IRMA), Strasbourg, France
- "*Einstein Equations, Lorentzian Geometry, and Ricci Flow Conjugation*" Invited talk at the Workshop "Geometric Evolutions and Minimal Surfaces in Lorentzian Manifolds", Centro DeGiorgi, SNS Pisa, 7 September - 10 September 2010
- "*Ricci flow in Mathematical and Theoretical Physics*," A two-week course during the trimester: "Geometric Flows and Geometric Operators" organized by the Scuola Normale Superiore (SNS), in collaboration with INdAM, May 2, 2009 - July 30, 2009, Centro DeGiorgi, SNS Pisa, Organized by L. Ambrosio, G.Besson, J.-P. Bourguignon, Sun-Yung (Alice) Chang, Z. Djadli, G. Huisken, A. Malchiodi, C. Mantegazza. Lecturers: (M. Carfora, K. Ecker, M. Gursky, A.Malchiodi, J. Viaclovsky, L. Ni)
- "*Quantum fluctuations and Riemannian Geometry: The case of the Ricci flow*" Invited lecture at ADVANCES IN NUMBER THEORY AND GEOMETRY, 150 years of Riemann Hypothesis, April 19-24, 2009, RISM (Riemann International School of Mathematics), Viterbo (Italy). Organizers: G. Benedek, L. De Michele, C. D. Pagani, B. Ruf, T. Pera; M. Bertolini, M. Rasetti, S. Salamon, G. Tomassini, U. Zannier. Speakers: (MiniCourses by E. Bombieri, J. Cheeger, J. P. Demailly, P. Sarnak; Lectures by W. Ballmann, M. Bertolini, M. Carfora, A. Granville, E. Kowalski, R. Narasimhan, A. Perelli, M. Rasetti, H. Rosenberg, N. Snaith, G. Thorbergsson, C. Voisin)
- "*Averaging and back-reaction in relativistic cosmology I & II*," A series of two lectures at SIGRAV School in Cosmology and INFN Formation School "Coarse-Grained Cosmology," 26-29 January 2009. The Galileo Galilei Institute for Theoretical Physics (GGI), Arcetri, Florence. Organized by S. Capozziello, MF. De Laurentis, L. Fatibene, L. Lusanna, S. Matarrese Lecturers: E.J. Copeland, G.F.R. Ellis, E. W. Kolb, M. Carfora, P.K.S. Dunsby
- "*Green functions for the Ricci flow and their applications*" Invited talk at: "Workshop on Field Theory and Geometric Flows," November 24 - 28, 2008, Ludwig-Maximilians-Universität München (LMU), Arnold-Sommerfeld-Center, Munich. Organized by: I. Bakas,

- D. Lüst. Speakers: (G. Tian, D. Friedan, N. Manton, M. Petropoulos, G. Huisken, H-D. Cao, I. Brunner, C. Bachas, E. Kuwert, S. Shatashvili, E. Wolgar, L. Ni, J. Isenberg, M. Gaberdiel, C. Warnick, T. Olyinyk, D.H. Phong, K. Skenderis, M. Carfora)
- "*Physical and Mathematical applications of the Conjugate Ricci Flow*", Invited talk at: 8ème rencontre entre physiciens théoriciens et mathématiciens : *Le flot de Ricci en mathématique et en physique*", 11-13 septembre 2008, Institut de Recherche Mathématique Avancée (IRMA), Strasbourg, France. Organized by Sylvain Maillot et Athanase Papadopoulos. Speakers: (M. Carfora, P. Topping, E. Woolgar, J. Keller, G. Besson, I. Bakas, D. Friedan, F. Luo, W. Graf, B. Wilking)
 - "*Quantum Fluctuations and Geometry: From Graphs Counting to Ricci Flow*" Invited talk at The jubilee 40th Symposium on Mathematical Physics, "Geometry and Quanta," (member of the Classical and Quantum Gravity Programme Committee), June 25-28, 2008, Torun, Poland. Organized by : Andrzej Jamiolkowski, Dariusz Chruściński, Jacek Jurkowski, Miłosz Michalski, Jacek Jezierski, Jerzy Kijowski, Jerzy Lewandowski, Edward Malec, Piotr Kielanowski. Speakers: (N. O'Murchadha, E.T. Newman, M. Carfora, J. Pullin, Ch. Fleischhack)
 - "*Quantum fluctuations and Geometry*" Invited talk at: the conference More Geometrico 3, "*De l'univers au monde quantique : structure géométriques et topologiques*", 5-10 May, 2008, Fondation des Treilles - 83690 TOURTOUR , France. Organized by: L. Boi, J-P. Luminet
 - "*Conjugate linearized Ricci Flow, heat content and deformation of G.R. initial data sets.*" Invited talk at Conference on "Geometric Flows in Mathematics and Physics," 13–18 April 2008, Banff International Research Station (BIRS), Banff, Canada. Organized by: G. Huisken, T. Oliynyk, E. Woolgar. Speakers: (H-D. Cao, L. Ni, M. Simon, G. Holzegel, C. Warnick, I. Bakas, M. Carfora, D. Friedan, D. Morrison, J. Gegenberg, V. Suneeta, X. Dai, P. Miao, J-F. Li, R. Bartnik, J. Lamm, J. Streets, N. Sesum, S. Anco, M. Athanassenas, J. Metzger, F. Schulze).
 - "*Physical Applications of Ricci flow*" Geometric Analysis Lecture Series, Mathematical Physics Seminar at The University of Arizona, December 5, 2007, Department of Mathematics, The University of Arizona, Tucson
 - "*The conjugate linearized Ricci flow*" Geometric Analysis Lecture Series, Analysis and Its Applications Seminar at The University of Arizona, December 4, 2007, Department of Mathematics, The University of Arizona, Tucson
 - "*Fokker-Planck equation and Ricci flow*" Geometric Analysis Lecture Series seminar at The University of Arizona, December 3, 2007, Department of Mathematics, The University of Arizona, Tucson
 - "*The conjugate Linearized Ricci Flow and its (nice) properties*" invited talk at: "Workshop on Renormalization Group Flow and Ricci flow," October 22-25, 2007, E. Schroedinger International Institute for Mathematical Physics (ESI), Wien, Austria. Organized by: G. Gentile, H. Grosse, G. Huisken, V. Mastropietro, Speakers: (R. McCann, G. Huisken, C. Kopper, M. Carfora, A. Grigoryan, V. Schomerus, B. Wilking)
 - "*Changes of scale, quantum gravity and quantum geometry*" invited talk at: "II ème Rencontre "More geometrico" Changement d'échelle - changement de niveau," May 2-4, 2007, Université René Descartes - Paris 5, Paris. Organized by: Pierre-Paul Vidal (Université Paris 5), Luciano Boi (EHESS-CAMS), Giuseppe Longo (ENS-CNRS) Speakers: (P-P. Vidal, P. Viviani, C. Sinigaglia, J. Droulez, K. Cullen, P. Mamassian, Y. Bouligand, L. Nottale, J-F. Sadoc, A. Soto, M. Ladjimi, U. Bruzzo, C. Bartocci, M. Carfora, J-P. Luminet, T. Paul)
 - "*Ricci flow, entropies and the averaging of cosmological spacetimes*" invited talk at: "Workshop on Geometric and Renormalization Group Flows," November 22-24, 2006, Max Planck Institute for Gravitational Physics (Albert Einstein Institute) Potsdam, Germany.

Organized by: G. Huisken and T. Oliynyk. Speakers: (A. Tseytlin, A. Zamolodchikov, M. Carfora, K. Smoczyk, E. Kuwert, K. Ecker, I. Bakas, E. Woolgar, B. Wilking);

- "*Applications of the Hamilton-Perelman flow in theoretical physics*" invited talk at: "Geometric Evolutions and Applications," 18-19 December 2006, Pisa, Centro di Ricerca Matematica E. DeGiorgi, Scuola Norm. Sup.
- "*Ricci flow, Perelman's entropy and FLRW templates in Relativistic Cosmology*" invited talk at: "Heat Equation and Curvature Flows," September 24-25, 2004, Università di Roma "La Sapienza." Organized by: M. Bordoni, S. Marchiafava, A. Savo. Speakers: (M. Carfora, K. Ecker, R.S. Hamilton, C. Sinestrari, T. Coulhon, A. Grigoryan, G. Huisken).

Outreach (a small selection)

- "*Scaling and Entropy for the RG-2 flow*" in collaboration with Christine Guenther, presented (by C. Guenther) at the AMS Special Session on Geometric Analysis and Geometric Flows, II(1135-58-2651), during the Joint Mathematics Meetings of the American Math. Soc., (San Diego, 10-13 January 2018).

- *Raiscuola: Caccia ai numeri primi* Documentary-Interview (together with E. Bombieri, J. Cheeger, P. Sarnak, et al.) broadcasted by RaiScuola, December 2017

<http://www.raiscuola.raai.it/articoli-programma-puntate/memex-doc-caccia-ai-numeri-primi/39642/default.aspx>

- Invited conferences at *La Forza della Poesia* (Frascati Roma, XI^a edizione (2021) e XIII^a edizione (2023)), alla *Fondazione Vivarium Novum* (Frascati, Villa Falconieri 2018, 2019)
- Member of the scientific board of *Fondazione ScienzaNuova* (Università Bocconi, Libera Università di Bolzano, Accademia Italo-Tedesca di Merano) (2017-2022)
- Author (upon a request from Istituto Poligrafico della Zecca dello Stato) of the Italian stamp for the celebration of the World Year of Physics 2005

https://it.wikipedia.org/wiki/File:Anno_mondiale_fisica_francobollo.jpg

- "*Spazio, Tempo e Materia: dal Principio di Relatività alla Fisica di Interstellar*," A series of lectures for the general public on Einstein's relativity theory on the occasion of the centenary of General Relativity. Pavia, January-July 2016.