

LORENZO MACCONE'S CURRICULUM VITÆ

WITH A STATEMENT OF RESEARCH INTEREST AND A LIST OF PUBLICATIONS

Lorenzo Maccone, born in Ivrea (TO) –Italy– on April 21, 1972 (Italian citizen).

CONTACT INFORMATION

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ACADEMIA (reverse chronological order)

PRESENT¹

Associate professor from October 2010 at the Dipartimento di Fisica of the University of Pavia, Italy. He has received two **scientific habilitations to full professor**: December 2013 (reconfirmed in December 2019), scientific habilitation for Theoretical Structure of Matter (02/B2); January 2014 (reconfirmed in January 2020), scientific habilitation for Theoretical Physics of Fundamental Interactions (02/A2).

His main current **research lines** refer to **theoretical quantum mechanics and its applications**, primarily: Quantum Information, Quantum Optics, Quantum Computation, and Foundations of Quantum Mechanics.

His current **research group** consists of two postdocs under his direct supervision (Wojciech Górecki and Simanraj Sadana), two PhD students he is co-tutoring (Simone Roncallo, Angela Rosy Morgillo), one long-term visiting scientist (Roberto Di Candia) and two further future visiting guests for the period October-December 2023 (Lu Xi and Rozhin Yousefjani). In the past he has tutored numerous PhD students, and Post-docs financed through his **funded research projects** (full list below).

He **currently teaches** the courses of “Classical Electrodynamics and special relativity” (i.e. fisica generale 2), an undergraduate course for Mathematicians; “Quantum Optics” (i.e. ottica quantistica), an undergraduate and master course for physicists. In the past he has held the module of “Foundations of quantum mechanics” in the course “Foundations of Physics” (i.e. fondamenti della fisica) and the “Open quantum systems” graduate course for physics PhD students.

¹Present and past according to a reference system connected to the surface of Earth.

He is currently the **international exchange coordinator** for the Physics department of the university of Pavia (Erasmus program and other international programs).

PAST¹

June 2010-September 2010: **Official Faculty Guest at the Los Alamos National Laboratories** in the group of W.H. Zurek, working on Foundations of Quantum Mechanics and Quantum Metrology.

June 2009-May 2010: **Visiting Scientist at the Massachusetts Institute of Technology (MIT)** in the xQIT, “Center for Extreme Quantum Information theory” (funded by the W. M. Keck foundation).

February 2009-May 2009: **Research associate at ISI** (Institute for Scientific Interchange Foundation) in Torino, Italy.

December 2004- December 2008: **Contract Professor** at the University of Pavia (contract of 4 years).

March 2004-December 2004: **Postdoctoral Associate (UNIPV)** in the Quantum Information theory group of the University of Pavia.

November 2000-February 2004: **Postdoctoral Associate (MIT)** in the Research Laboratory of Electronics of the Massachusetts Institute of Technology (MIT) in the groups of Prof. J. H. Shapiro and Prof. S. Lloyd. This position was renewed three times: in November 2001, November 2002, and November 2003.

January 2000-November 2000: **Postdoctoral fellowship (UNIPV)** at the University of Pavia.

CURRICULUM STUDIORUM

September 1996-December 13, 1999: **Ph.D. in theoretical Physics** in Pavia.

September 1992-June 7, 1996: **Master in Physics** obtained with full marks (110 on 110) *cum laude* and an average mark of 29.77 on 30 for the eighteen required exams.

High School: Liceo Classico (Liceo “C. Botta”, Ivrea), where literary and humanistic subjects are emphasized. Final score: 60 on 60 (full marks).

SCIENTIFIC RESEARCH RESULTS

Numerous publications on peer-reviewed international scientific journals— Nature, Science, Nature Photonics, Nature Physics, Physical Review Letters, and IEEE Transactions on Information Theory among others (see full list of publications below).

Bibliometry: In September 2023 he had an h-index $h = 47$ with a total of 17149 citations (source: Google scholar), or $h = 40$ with a total of 10656 citations (source: Web of Science), or $h = 40$ with a total of 11571 citations (source: Scopus).

Presentation of his research in numerous conferences and workshops, and in about **108 invited talks and keynote seminars** (full list below). Co-organizer of multiple conferences and workshops (full list below).

Active in the **science outreach** and communication to the general public of Physics, Quantum Mechanics in particular. Seminars for all age groups, from elementary schools to evening talks (partial list below).

Referee for the journals (among others) Science, Nature, Science, Nature Physics, Nature Photonics, Nature Communications, Proceedings of the National Academy of Sciences (PNAS), IEEE Photonics Technology Letters, Scientific reports, Foundations of Physics, Phys. Rev. Lett., Phys. Rev. A, Phys. Rev. X, npj Quantum Information, Quantum, Annalen der Physik, Quantum Information and Computation, Physics Letters, New Journal of Physics, Journal of Physics A: Mathematical and General, Journal of Physics B: Atomic, Molecular & Optical Physics, European Physical Journal D, European Physical Journal Plus, Journal of the Optical Society of America B, Journal of Mathematical Physics, Complexity, Theoretical Computer Science, Physics essays, International Journal of Quantum Information, Quantum Information Processing, Symmetry, Inverse Problems, Proceedings of the Royal Society A, Synthese, Entropy, Information Sciences, Quantum Measurements and Quantum Metrology, Journal of Physics Communications, Quantum Chemistry, The Journal of Chemical Physics, American Journal of Physics, Advances in Space Research, International Journal of Modelling and Simulation, Foundations of Science.

Referee for multiple national and international grant proposals, including European projects, German, Swiss, Polish, etc., national projects. Referee or committee member for multiple PhD thesis of national and international students (French, Canadian, Australian, Finnish, Austrian).

Recognition for “Outstanding Referee” from the American Physical Society in 2012.

SKILLS

Foreign languages: Fluent English, basic French.

Computer abilities: excellent skills in information technologies; started programming in 1981; programming languages: C, Fortran, Assembler 8086, and Basic; Latex typesetting language; Operating systems: Linux (since 1995), MS-DOS, and Windows (from 2.0 to Win10); system administrator for Linux and mixed Linux-Windows computer clusters, web servers, mail servers, FTP servers, samba servers, and a domain name server; applications: Mathematica, emacs, Open Office, Microsoft Office, etc.

Scholarships: three scholarships from the private institution INPDAI for study achievements.

MISCELLANEA:

Sports: mountain sports (alpine ski, trekking, free climbing, *piolet traction*, mountain biking), sailing (provisional rating and experience on a 38-foot vessel), long distance bicycle trips, swimming.

Hobbies: computers and electronics (I love building microcontroller based devices, with Arduino, ESP32 and others, I am a radio amateur, license I-Z2ZYY), reading, traveling (I typically spend the summer riding my bicycle: I’ve crossed the Atacama desert three times, pedaled the famed Pamir highway, Crossed Iceland, pedaled over 1000km above the Arctic circle in Norway, etc.). He is currently an active Green Cross volunteer (Croce Verde Pavese).

Civil service: EMT-trained ambulance technician with “Croce Verde Fornovese” in Fornovo, PR (he has also volunteered on the Italian Red Cross ambulances, at the Red Cross in Pavia). He has thus fulfilled the mandatory military requirements for his country.

The day I was born people were landing on the moon. Explore, discover, invent: reading the book of nature is my dream. I am a theoretical physicist, mainly interested in the study of fundamental aspects and of practical applications of quantum mechanics. My research activity has been chiefly devoted to quantum optics, quantum theory of measurement, quantum information theory, quantum communication, quantum computation, quantum metrology, and foundations of quantum mechanics. A schematic list of the research topics I pursued, or I am currently pursuing, follows. The references refer to the publications in the subsequent list. My research has been performed also in collaboration with numerous coauthors from all the world. I am coordinating a research group, I have obtained numerous grants for scientific research activities. I have co-organized multiple conferences and hosted at my institution many scientists from all over the world.

- **Quantum parameter estimation:** quantum positioning [17], quantum metrology [51, 41, 75, 82, 80, 86, 90, 96, 114, 105, 102, 104,113], interferometric tunability of the absorption [53], quantum imaging [66,quantum illumination [64,60].
- **Quantum foundations:** interpretation of entanglement [92,95,100], quantum time [94,112, 89,103,101,117], information-disturbance tradeoffs [52,56], quantum thermodynamics [68], quantum descriptions of closed timelike curves [72], quantum reference frames [83], uncertainty relations [91,107,109], axiomatic formulation of quantum mechanics [115].
- **Quantum computation:** quantum Random Access Memory [59,63], quantum solution to the Ulam problem [50], quantum optical computation [9], blind quantum computation [87].
- **Quantum cryptography:** secure database interrogation: the QPQ cryptographic primitive [61,67,69,87], quantum cryptographic ranging [22], quantum cryptographic protocol for the communication of reference frames [57], cryptographic metrology [108].
- **Quantum state reconstruction:** weak-value tomography [88], theoretical analysis and proposal of tomographic procedures for optical systems [3,5] and systems with $SU(1,1)$ and $SU(2)$ symmetries [16,25], contribution to generalized tomography [14,15], application of quantum tomography to classical imaging [46].
- **Experimental proposals:** Liouvillian superoperator measurement [3,4], optical Schrödinger cat [5], optical Fock state synthesis-measurement [12,13].
- **Entanglement, uses:** quantum clock synchronization with dispersion cancellation [18], dynamical evolution of composite systems [27,28], conversion between speakable and unspeakable information [83].
- **Entanglement, new sources:** difference-beam state [20,24].
- **Quantum-channel capacities:** minimum output entropy conjecture [70], entanglement assisted capacity of bosonic channels [29,31], classical capacity of bosonic and Gaussian channels [32,85], waveguide capacity [35], ultimate limits to channel capacity [39], decoding schemes for achieving the classical capacity [77,79].

- **Numerical simulations:** Monte-Carlo simulations of laser master and Fokker Plank equations [1], Monte-Carlo simulations of numerous tomographic schemes.
- **Clock synchronization:** conveyor belt clock synchronization protocol [40], limits to synchronization in the presence of decoherence [21].

In addition to the above research, I am also active in communicating Quantum Physics to the general public [54,62,73,84,98].

PATENTS

- “Method for ensuring privacy while querying a database by using quantum superposition and multiple responses”. US Patent 8126830 B2. Filed on June 24, 2008, serial number 12/145,050. Internationally (PCT) filed on July 2, 2008, serial number PCT/US08/68995. [Provisional patent filed on July 3, 2007, serial number 60/947,720.]
- “Bucket Brigade Address Decoding Architecture for Classical and Quantum Random Access Memories”. US Patent 7764568. Internationally (PCT) filed on July 2, 2008, serial number PCT/US08/68993. [Provisional patent filed on July 3, 2007, serial number 60/947,719.]

PUBLICATIONS

1. G. M. D’Ariano, C. Macchiavello, L. Maccone, “*Noise, errors and information in quantum amplification*”, Int. J. Mod. Phys. B **11**, 3385 (1997).
2. G. M. D’Ariano and L. Maccone, “*Quantum Tomography of Optical Devices*”, in *5th International Conference on Squeezed States and Uncertainty Relations*, ed. by J. Janszky, Y. S. Kim, and V. I. Man’ko, p. 529 (1997).
3. G. M. D’Ariano, L. Maccone, “*Measuring Quantum Optical Hamiltonians*”, Phys. Rev. Lett. **80**, 5465 (1998).
4. G. M. D’Ariano and L. Maccone, “*Quantum characterization of optical devices*”, Fortschr. Phys. **46**, 6 (1998).
5. G. M. D’Ariano, C. Macchiavello, and L. Maccone, “*Quantum tomography of mesoscopic superpositions of radiation states*”, Phys. Rev. A **59**, 1816 (1999).
6. G. M. D’Ariano, P. Kumar, C. Macchiavello, L. Maccone, and N. Sterpi, “*A Test of the State Reduction Rule*”, Phys. Rev. Lett. **83**, 2490 (1999).
7. G. M. D’Ariano, A. Garuccio, L. Maccone, and M. F. Sacchi, “*Tomographic test of Bell’s inequality*”, J. Opt. B, **1**, 576 (1999).
8. G. M. D’Ariano, L. Maccone, M. G. A. Paris and M. F. Sacchi, “*Generation and measurement of nonclassical states by quantum Fock filter*”, Acta Phys. Slov. **49**, 659 (1999).

9. G. M. D'Ariano, C. Macchiavello, and L. Maccone, "*Quantum Computation with Polarized Photons*", Fortschr. Phys. **48**, 573 (2000).
10. G. M. D'Ariano, L. Maccone, M. F. Sacchi and A. Garuccio, "*Homodyning Bell's inequality*", in '4th Int. Conf. on Quantum Communication, Measurement, and Computing', Kluwer/Plenum, pg. 163 (2000).
11. G. M. D'Ariano, L. Maccone, M. G. A. Paris and M. F. Sacchi, "*State preparation by photon filtering*", Fortschr. Phys. **48**, 671 (2000).
12. G. M. D'Ariano, L. Maccone, M. G. A. Paris, and M. F. Sacchi, "*Optical Fock-state synthesizer*", Phys. Rev. A, **61**, 053817 (2000).
13. G. M. D'Ariano, L. Maccone, M. G. A. Paris and M. F. Sacchi, "*State measurement by photon filtering in a ring cavity*", Mod. Phys. Lett. B **14**, 15 (2000).
14. G. M. D'Ariano, L. Maccone and M. G. A. Paris, "*Orthogonality relations in Quantum Tomography*", Phys. Lett. A **276**, 25 (2000).
15. G. M. D'Ariano, L. Maccone, M. G. A. Paris "*Quorum of observables for universal quantum estimation*", Journ. of Phys. A **34**, 93 (2001).
16. G. M. D'Ariano, E. De Vito, and L. Maccone, "*SU(1,1) tomography*", Phys. Rev. A **64**, 033805 (2001).
17. V. Giovannetti, S. Lloyd, and L. Maccone, "*Quantum-enhanced positioning and clock synchronization*", Nature **412**, 417 (2001).
18. V. Giovannetti, S. Lloyd, L. Maccone, and F. N. C. Wong, "*Clock synchronization with dispersion cancellation*", Phys. Rev. Lett. **87**, 117902 (2001).
19. V. Giovannetti, S. Lloyd, and L. Maccone, "*Positioning and clock synchronization through entanglement*", Phys. Rev. A **65**, 022309 (2002).
20. V. Giovannetti, L. Maccone, J. H. Shapiro, and F. N. C. Wong, "*Generating entangled two-photon states with coincident frequencies*", Phys. Rev. Lett. **88**, 183602 (2002).
21. V. Giovannetti, S. Lloyd, L. Maccone, and S. M. Shahriar, "*Limits to clock synchronization induced by completely dephasing communication channels*", Phys. Rev. A **65**, 062319 (2002).
22. V. Giovannetti, S. Lloyd, and L. Maccone, "*Quantum cryptographic ranging*", J. Opt. B: Quantum Semiclass. Opt. **4**, S413 (2002).
23. V. Giovannetti, S. Lloyd, L. Maccone, and F. N. C. Wong, "*Clock synchronization and dispersion*", J. Opt. B: Quantum Semiclass. Opt. **4**, S415, (2002).
24. V. Giovannetti, L. Maccone, J. H. Shapiro, and F. N. C. Wong, "*Extended phase-matching conditions for improved entanglement generation*", Phys. Rev. A **66**, 043813 (2002).

25. G. M. D'Ariano, L. Maccone, M. Painsi, "*Spin tomography*", J. Opt. B: Quantum Semiclass. Opt. **5**, 77 (2003).
26. V. Giovannetti, S. Lloyd, and L. Maccone, "*The quantum speed limit*" in 'Fluctuations and Noise in Photonics and Quantum Optics', edited by D. Abbott, J. H. Shapiro, and Y. Yamamoto, proc. of the SPIE, **5111**, 1 (2003).
27. V. Giovannetti, S. Lloyd, and L. Maccone, "*Quantum limits to dynamical evolution*", Phys. Rev. A **67**, 052109 (2003).
28. V. Giovannetti, S. Lloyd, and L. Maccone, "*The role of entanglement in dynamical evolution*", Europhys. Lett. **62**, 615 (2003).
29. V. Giovannetti, S. Lloyd, L. Maccone, and P. Shor, "*Entanglement assisted capacity of the broadband lossy channel*", Phys. Rev. Lett. **91**, 047901 (2003).
30. V. Giovannetti, L. Maccone, J. H. Shapiro, and F. N. C. Wong, "*Maximal entanglement generation via pulsed parametric downconversion*", in *6th International Conference on Quantum Communication Measurement and Computing*, (Rinton Press, Princeton NJ, 2003), pg. 163.
31. V. Giovannetti, S. Lloyd, L. Maccone, and P. Shor, "*Broadband channel capacities*", Phys. Rev. A **68**, 062323 (2003).
32. V. Giovannetti, S. Guha, S. Lloyd, L. Maccone, J. H. Shapiro, and H. P. Yuen, "*Classical Capacity of the lossy bosonic channel: the exact solution*", Phys. Rev. Lett. **92**, 027902 (2004).
33. V. Giovannetti, S. Lloyd, and L. Maccone, "*Quantum positioning system*", in *Coherence and Quantum Optics VIII* pg. 303, Proceedings of the 8th Rochester Conference, ed. N. P. Bigelow, J. H. Eberly, C. R. Stroud, and I. A. Walmsley (Kluwer Academic, New York, 2003).
34. V. Giovannetti, S. Lloyd, and L. Maccone, "*The speed limit of quantum unitary evolution*", "Special Issue on Fluctuations & Noise in Photonics & Quantum Optics" of J. Opt. B: Quantum Semiclass. Opt. **6**, S807 (2004) (Hermann Haus memorial special issue).
35. V. Giovannetti, S. Lloyd, L. Maccone, and J. H. Shapiro, "*Information rate of a waveguide*", Phys. Rev. A **69**, 052310 (2004).
36. V. Giovannetti, S. Guha, S. Lloyd, L. Maccone, and J. H. Shapiro, "*Minimum output entropy of bosonic channels: a conjecture*", Phys. Rev. A **70**, 032315 (2004).
37. V. Giovannetti, S. Lloyd, L. Maccone, J. H. Shapiro, and B. J. Yen, "*Minimal Rényi and Wehrl entropies at the output of bosonic channels*", Phys. Rev. A **70**, 022328 (2004).
38. V. Giovannetti, S. Lloyd, and L. Maccone, "*Capacity of nonlinear bosonic systems*", Phys. Rev. A **70**, 012307 (2004).

39. S. Lloyd, V. Giovannetti, and L. Maccone, “*Physical limits to communication*”, Phys. Rev. Lett. **93**, 100501 (2004).
40. V. Giovannetti, S. Lloyd, L. Maccone, J. H. Shapiro, and F. Wong, “*Conveyor belt clock synchronization*”, Phys. Rev. A **70**, 043808 (2004).
41. V. Giovannetti, S. Lloyd, and L. Maccone, “*Quantum-enhanced measurements: beating the standard quantum limit*”, Science **306**, 1330 (2004).
42. V. Giovannetti, S. Guha, S. Lloyd, L. Maccone, J. H. Shapiro, and B. J. Yen, “*Minimum output entropy of a gaussian bosonic channel*” proceedings of FQI04, International Journal of Quantum Information **3**, No. 1, 153-158 (2005).
43. G. M. D’Ariano, P. Lo Presti, and L. Maccone, “*Quantum Calibration of measurement instrumentation*”, Phys. Rev. Lett. **93**, 250407 (2004).
44. V. Giovannetti, S. Guha, S. Lloyd, L. Maccone, J. H. Shapiro, B. J. Yen, and H. P. Yuen, “*Classical Capacity of Free-Space Optical Communication*”, in *Quantum Information, Statistics, Probability, dedicated to A. S. Holevo on the occasion of his 60th birthday*, edited by O. Hirota (Rinton Press, 2004), pg. 90. Published also as Quantum Information and Computation, **4**, 489 (2005).
45. V. Giovannetti, S. Guha, S. Lloyd, L. Maccone, J. H. Shapiro, B. J. Yen, and H. P. Yuen, “*Information capacity of bosonic channels*”, in Proceedings of the International Symposium on Information Theory (*ISIT 2004*), IEEE Conference Proceedings pg. 325 (2004).
46. G. M. D’Ariano, L. Maccone, “*Quantum Tomography for Imaging*”, Electronic Notes in Discrete Mathematics, **20**, 133 (2005), Proceedings of the Workshop on Discrete Tomography and its Applications 13-15 June 2005 Ed. G. T. Herman; A. Kuba.
47. G. M. D’Ariano, L. Maccone, and M. F. Sacchi, “*Homodyne tomography and the reconstruction of quantum states of light*”, in “Quantum Information with Continuous Variables of Atoms and Light”, Ed. N. Cerf, G. Leuchs, and E. Polzik (World Scientific Press, London, 2007).
48. J. H. Shapiro, V. Giovannetti, S. Guha, S. Lloyd, L. Maccone, and B. J. Yen, “*Capacity of Bosonic Communications*”, S. M. Barnett, E. Anderson, J. Jeffers, P. Öhberg, and O. Hirota, eds., *Proceedings of the Seventh International Conference on Quantum Communication, Measurement and Computing* (American Institute of Physics, New York, 2004), pg. 15.
49. V. Giovannetti, S. Guha, S. Lloyd, L. Maccone, J. H. Shapiro, and B. J. Yen, “*Minimum bosonic channel output entropies*”, S. M. Barnett, E. Anderson, J. Jeffers, P. Öhberg, and O. Hirota, eds., *Proceedings of the Seventh International Conference on Quantum Communication, Measurement and Computing* (American Institute of Physics, New York, 2004), pg. 21.

50. S. Mancini, L. Maccone, “*Using Quantum Mechanics to Cope with Liars*”, Int. J. Quantum Inf. **3**, 729 (2005).
51. V. Giovannetti, S. Lloyd, L. Maccone, “*Quantum metrology*”, Phys. Rev. Lett. **96**, 010401 (2006). [This paper was highlighted in Nature’s “News and Views”: S. L. Braunstein, Nature **440**, 617 (2006), which is dedicated to our paper.]
52. L. Maccone, “*Information-disturbance tradeoff in quantum measurements*”, Phys. Rev. A **73**, 042307 (2006).
53. V. Giovannetti, S. Lloyd, and L. Maccone, “*Interferometric tunability of the absorption*”, Opt. Express **14**, 8622 (2006).
54. S. Mancini, L. Maccone, “*Una strategia per Geppetto*”, italian didactic version of [50], Sapere October 2006, pg. 78 (2006).
55. M. Razavi, V. Giovannetti, L. Maccone, and J. H. Shapiro, “*Hot-cavity loading: A Heisenberg-Langevin analysis*”, in *Quantum Electronics and Laser Science Conference, Technical Digest:QFA7*, Long Beach, CA, (2006).
56. L. Maccone, “*Entropic information-disturbance tradeoff*”, Europhys. Lett. **77**, 40002 (2007).
57. G. Chiribella, L. Maccone, P. Perinotti, “*Secret communication of a reference frame*”, Phys. Rev. Lett. **98**, 120501 (2007).
58. L. Maccone, “*A quantification of disturbance*”, in *Foundations of Probability and Physics-4*, Eds. G. Adenier, C. A. Fuchs, A. Yu. Khrenikov (AIP Conference Proceedings, Melville NY, 2007).
59. V. Giovannetti, S. Lloyd, L. Maccone, “*Quantum random access memory*”, Phys. Rev. Lett. **100**, 160501 (2008). New Scientist news service reviewed this article (even before it was published) in Stephen Battersby, NewScientist.com news service, <http://technology.newscientist.com/article/dn12516-blueprints-drawn-up-for-quantum-computer-ram.html> This preprint also made slashdot.org on August 23 (2007).
60. S. Tan, B. I. Erkmen, V. Giovannetti, S. Guha, S. Lloyd, L. Maccone, and J. H. Shapiro, “*Quantum Illumination: Enhanced Background-Limited Target Detection by Means of Entanglement*”, in *International Conference on Quantum Information*, paper QTuB6, (Optical Society of America, 2008).
61. V. Giovannetti, S. Lloyd, L. Maccone, “*Quantum private queries*”, Phys. Rev. Lett. **100**, 230502 (2008). An article on Scientific American (October 2009) was devoted to the results presented here. This paper was reviewed by physorg.com scientific news service on June 27, 2008: <http://www.physorg.com/news133765318.html>
62. L. Maccone and L. Salasnich, “*Fisica moderna: Meccanica Quantistica, Caos e Sistemi Complessi*”, (i.e. “*Modern Physics: Quantum Mechanics, Chaos and Complex Systems*”) Italian textbook, Carocci Ed., ISBN 978-88-430-4725-3 (2008).

63. V. Giovannetti, S. Lloyd, L. Maccone, “*Architectures for a quantum random access memory*”, Phys. Rev. A **78**, 052310 (2008).
64. S.-H. Tan, B.I. Erkmen, V. Giovannetti, S. Guha, S. Lloyd, L. Maccone, S. Pirandola, J. H. Shapiro, “*Quantum Illumination with Gaussian States*”, Phys. Rev. Lett. **101**, 253601 (2008). The article “Quantum afterlife” in the February 2009 issue of Scientific American was devoted to quantum illumination.
65. L. Maccone, G. De Cillis, “*Robust strategies for lossy quantum interferometry*”, Phys. Rev. A **79**, 023812 (2009).
66. V. Giovannetti, S. Lloyd, L. Maccone, J. H. Shapiro, “*Sub-Rayleigh-diffraction-bound quantum imaging*”, Phys. Rev. A **79**, 013827 (2009).
67. F. De Martini, V. Giovannetti, S. Lloyd, L. Maccone, E. Nagali, L. Sansoni, F. Sciarrino, “*Experimental implementation of the Quantum Private Queries*”, Phys. Rev. A (Rapid Communication) **80**, 010302(R) (2009).
68. L. Maccone, “*A quantum solution to the arrow-of-time dilemma*”, Phys. Rev. Lett. **103**, 080401 (2009).
69. V. Giovannetti, S. Lloyd, L. Maccone, “*Quantum Private Queries: security analysis*”, IEEE Trans. Inf. Theory **56**, 3465 (2010).
70. V. Giovannetti, A. S. Holevo, S. Lloyd, L. Maccone, “*Generalized minimal output entropy conjecture for Gaussian channels: definitions and some exact results*”, J. Phys. A: Math. Theor. **43**, 415305 (2010).
71. F. Guerrieri, L. Maccone, F. N. C. Wong, J. H. Shapiro, S. Tisa, and F. Zappa, “*Sub-Rayleigh Imaging via N-Photon Detection*”, Phys. Rev. Lett. **105**, 163602 (2010).
72. S.Lloyd, L.Maccone, R.Garcia-Patron, V.Giovannetti, Y.Shikano, S.Pirandola, L.A. Rozema, A.Darabi, Y.Soudagar, L.K.Shalm, A.M.Steinberg, “*Closed timelike curves via postselection: theory and experimental test of consistency*”, Phys. Rev. Lett. **106**, 040403 (2011).
73. L. Maccone, “*Il Gatto di Schrödinger*” (a didactic explanation of the Schrödinger’s cat paradox, analyzed from a modern perspective), Atti dell’Accademia degli Agiati, anno 260, ser. VIII, Vol. 10B, pg.19 (2011); also published as L. Maccone, “*Il Gatto di Schrödinger*”, Scienze e Ricerche **2**, 110 (2014).
74. L.Maccone, “*The Thermodynamic Arrow-of-time and Quantum Mechanics*”, Electronic Notes in Theoretical Computer Science **270**, 75-79 (2011) [Proceedings of the Joint 5th International Workshop on Quantum Physics and Logic and 4th Workshop on Developments in Computational Models (QPL/DCM 2008)].
75. V.Giovannetti, S.Lloyd, L.Maccone, “*Advances in Quantum Metrology*”, Nature Phot. **5**, 222 (2011).
76. L.Maccone, V.Giovannetti, “*Beauty and the noisy beast*”, Nature Phys. **7**, 376 (2011).

77. V.Giovannetti, S.Lloyd, L.Maccone, “*Sequential projective measurements for channel decoding*”, Phys. Rev. Lett. **106**, 250501 (2011).
78. S. Lloyd, L. Maccone, R. Garcia-Patron, V. Giovannetti, Y. Shikano, “*The quantum mechanics of time travel through post-selected teleportation*”, Phys. Rev. D **84**, 025007 (2011).
79. V.Giovannetti, S.Lloyd, L.Maccone, “*Achieving the Holevo bound via sequential measurements*”, Phys. Rev. A **85**, 012302 (2012).
80. V.Giovannetti, L.Maccone, “*Sub-Heisenberg estimation strategies are ineffective*”, Phys. Rev. Lett. **108**, 210404 (2012).
81. N. Spagnolo, C. Vitelli, V.G. Lucivero, V. Giovannetti, L. Maccone, F. Sciarrino, “*Phase estimation via quantum interferometry for noisy detectors*”, Phys. Rev. Lett. **108**, 233602 (2012).
82. V.Giovannetti, S. Lloyd, L.Maccone, “*Quantum measurement bounds beyond the uncertainty relations*”, Phys. Rev. Lett. **108**, 260405 (2012).
83. G. Chiribella, V. Giovannetti, L. Maccone, P. Perinotti, “*Teleportation transfers only speakable quantum information*”, Phys. Rev. A **86**, 010304(R) (2012).
84. L.Maccone, “*Simplest proof of Bell’s inequality*”, Am. J. Phys. **81**, 854 (2013).
85. V.Giovannetti, S.Lloyd, L.Maccone, J.H. Shapiro, “*Electromagnetic channel capacity for practical purposes*”, Nature Phot. **7**, 834 (2013).
86. L.Maccone, “*Intuitive reason for the usefulness of entanglement in quantum metrology*”, Phys. Rev. A **88**, 042109 (2013).
87. V. Giovannetti, L. Maccone, T. Morimae, T.G. Rudolph, “*Efficient universal blind computation*”, Phys. Rev. Lett. **111**, 230501 (2013).
88. L. Maccone, C.C. Rusconi, “*State estimation: A comparison between direct state measurement and tomography*”, Phys. Rev. A **89**, 022122 (2014). This paper was selected as “Editors’ Suggestion” for Phys. Rev. A.
89. E. Moreva, G. Brida, M. Gramegna, V. Giovannetti, L. Maccone, M. Genovese, “*Time from quantum entanglement: an experimental illustration*”, Phys. Rev. A **89**, 052122 (2014).
90. R. Demkowicz-Dobrzański, L. Maccone, “*Using entanglement against noise in quantum metrology*”, Phys. Rev. Lett. **113**, 250801 (2014).
91. L. Maccone, A. Pati, “*Stronger uncertainty relations*”, Phys. Rev. Lett. **113**, 260401 (2014). This paper was reviewed in Nature India, at <http://www.natureasia.com/en/nindia/article/10.1038/nindia.2015.6>

92. L. Maccone, D. Bruß, C. Macchiavello, *Complementarity and correlations*, Phys. Rev. Lett. **114**, 130401 (2015).
93. E. Moreva, G. Brida, M. Gramegna, V. Giovannetti, L. Maccone and M. Genovese, “The time as an emergent property quantum mechanics, a synthetic description of a first experimental approach”, invited papers at DICE 2014, Journ. of Phys. Conf. series **626**, 012019 (2015).
94. V. Giovannetti, S. Lloyd, L. Maccone, “*Quantum time*”, Phys. Rev. D **92**, 045033 (2015).
95. Z. Huang, L. Maccone, A. Karim, C. Macchiavello, R. Chapman, A. Peruzzo, “*High-dimensional entanglement certification*”, Sci. Rep. **6**, 27637 (2016).
96. Z. Huang, C. Macchiavello, L. Maccone, “*Entanglement-assisted quantum metrology*”, Phys. Rev. A **94**, 012101 (2016).
97. M. Menotti, L. Maccone, J. E. Sipe, and M. Liscidini “*Generation of energy-entangled W states via parametric fluorescence in integrated devices*”, Phys. Rev. A **94**, 013845 (2016).
98. L. Maccone, “*Computer quantistici: status e prospettive*”, presented at the Istituto Lombardo Accademia di Scienze e Lettere, on November 24, 2016. Accepted for publication on the “Rendiconti dell’Istituto”.
99. A. Riccardi, C. Macchiavello, L. Maccone, “*Tight entropic uncertainty relations for systems with dimension three to five*”, Phys. Rev. A **95**, 032109 (2017).
100. D. Sauerwein, C. Macchiavello, L. Maccone, B. Kraus, “*Multipartite correlations in mutually unbiased bases*”, Phys. Rev. A **95**, 042315 (2017).
101. J. Leon, L. Maccone, “*The Pauli Objection*”, Found. Phys. **47**(12), 1597 (2017).
102. M. Hassani, C. Macchiavello, L. Maccone, “*Digital quantum metrology*”, Phys. Rev. Lett. **119**, 200502 (2017).
103. E. Moreva, G. Brida, M. Gramegna, L. Maccone, M. Genovese, “*Quantum time: experimental multi-time correlations*”, Phys. Rev. D, **96**, 102005 (2017).
104. M. Sbroscia, I. Gianani, L. Mancino, E. Roccia, Z. Huang, L. Maccone, C. Macchiavello, M. Barbieri, “*Experimental ancilla-assisted phase-estimation in a noisy channel*”, Phys. Rev. A **97**, 032305 (2018).
105. Z. Huang, C. Macchiavello, L. Maccone, “*Noise-dependent optimal strategies for quantum metrology*”, Phys. Rev. A **97**, 032333 (2018).
106. A. Riccardi, C. Macchiavello, L. Maccone “*Multipartite steering inequalities based on entropic uncertainty relations*”, Phys. Rev. A **97**, 052307 (2018).
107. H. de Guise, L. Maccone, B. C. Sanders, N. Shukla “*State-independent uncertainty relations*”, Phys. Rev. A **98**, 042121 (2018).

108. Z. Huang, C. Macchiavello, L. Maccone, “*Cryptographic quantum metrology*”, Phys. Rev. A **99**, 022314 (2019).
109. P. Giorda, L. Maccone, A. Ricciardi, “*State-independent uncertainty relations from eigenvalue minimization*”, Phys. Rev. A **99**, 052121 (2019).
110. L. Maccone, “*A fundamental problem in quantizing general relativity*”, Found. Phys. **49**(12), 1394 (2019).
111. Z. Huang, C. Macchiavello, L. Maccone, P. Kok, “*Ancilla-assisted schemes are beneficial for Gaussian state phase estimation*”, Phys. Rev. A, **101**, 012124 (2020).
112. L. Maccone, K. Sacha, “*Quantum measurements of time*”, Phys. Rev. Lett. **124**, 110402 (2020).
113. L. Maccone, C. Ren, “*Quantum Radar*”, Phys. Rev. Lett. **124**, 200503 (2020).
114. L. Maccone, A. Ricciardi, “*Squeezing Metrology: a unified framework*”, Quantum **4**, 292 (2020).
115. G. Carcassi, L. Maccone, C.A. Aidala, “*The four postulates of quantum mechanics are three*”, Phys. Rev. Lett. **126**, 110402 (2021).
116. A. Carmi, E. Cohen, L. Maccone, H. Nikolic, “*Knowledge of Quantum Hidden Variables Enables Backwards-In-Time Signaling*”, Appl. Sci. **11**, 4477 (2021).
117. M. Fadel, L. Maccone, *The time-energy uncertainty relation for quantum events*, Phys. Rev. A **104**, L050204 (2021).
118. S. Sadana, L. Maccone, U. Sinha, *Testing quantum foundations with quantum computers*, Phys. Rev. Research **4**, L022001 (2022).
119. N. Mosco, L. Maccone, High-Dimensional Methods for Quantum Homodyne Tomography, Physics Letters A **449**, 128339 (2022).
120. Stefano Mangini, Chiara Macchiavello, Lorenzo Maccone, Qubit noise deconvolution, European Journal of Physics, Quantum Technology **9**, 29 (2022).
121. W. Gorecki, A. Ricciardi, L. Maccone, Quantum metrology of noisy spreading channels, Phys. Rev. Lett. **129**, 240503 (2022).
122. L. Maccone, Una storia di amicizia?, Asimmetrie **33**, 18 (2022), DOI: 10.23801/asimmetrie.2022.33.3.
123. V. Giovannetti, S. Lloyd, L. Maccone, Geometric Event-Based Quantum Mechanics, New J. Phys. **25**, 023027 (2023).
124. S. Roncallo, L. Maccone, C. Macchiavello, Multiqubit noise deconvolution and characterization Phys. Rev. A **107**, 022419 (2023).
125. S. Roncallo, K. Sacha, L. Maccone, When does a particle arrive? Quantum **7**, 968 (2023).

126. Giovanni Chesi, Roberto Rubboli, Alberto Riccardi, Lorenzo Maccone, Chiara Macchiavello, Protocol for global multiphase estimation, *Phys. Rev. A* **108**, 012613 (2023).
127. Simanraj Sadana, Lorenzo Maccone, Urbasi Sinha, Noise-analysis for the Sorkin and Peres tests performed on a quantum computer, *Quantum Information Processing* **22**, 317 (2023).
128. Simone Roncallo, Lorenzo Maccone, Chiara Macchiavello, Pauli transfer matrix direct reconstruction: channel characterization without full process tomography, *Quantum Sci. Technol.* **9**, 015010 (2023).
129. Simone Roncallo, Lorenzo Maccone, Chiara Macchiavello, Quantum JPEG, *AVS Quantum Sci.* **5**, 043803 (2023).
130. Lorenzo Maccone, Schrödinger Cats and Quantum Complementarity, *Found. Phys.* **54**, 17 (2024).
131. Alberto Riccardi, Giovanni Chesi, Chiara Macchiavello, Lorenzo Maccone, Tight Bounds from Multiple-Observable Entropic Uncertainty Relations, *Ann Phys.* 2400020 (2024).
132. Xi Lu, Wojciech Górecki, Chiara Macchiavello, Lorenzo Maccone, Number of bits returned by a quantum estimation, *Phys. Rev. A* **110**, 032405 (2024).

SEMINARS, CONFERENCES AND WORKSHOPS

International scientific conferences with presentation of research in oral or poster form:

- 2024: Algorithmiq mini-workshop Amici (Helsinki, 6-9/12) (**invited oral presentation**); MIT visit to S. Lloyd's group (Cambridge MA, USA, 16-23/11) (**invited oral presentation**); Time Machine Factory (Torino, 23-25/9) (**invited oral presentation**); DICE24 (Castiglioncello, 16-20/9) (**oral presentation**); Time in Quantum Theory TiQT24 (Smolenice, Slovakia, 10-13/9); 32nd Annual International Laser Physics Workshop (3-9/7, Sao Carlos, Brasil) (**invited oral presentation**); Quantum Information 2024 (23-28/6, Seefeld, Austria) (**invited oral presentation**); Quiche final project meeting (Paderborn, Germany, 3-4/6); XV ICTQT-KCIK Symposium on Quantum Information (Sopot, Poland, 16-18/5) (**invited oral presentation**); Virtual Seminar at Isfahan University of Technology (online 13/5) (**invited virtual presentation**); Colloquium Jülich research center (Jülich, Germany, 26/4) (**invited oral presentation**); Colloquium Warsaw university (Warsaw, 11/4) (**invited oral presentation**); Doubts and Beliefs in Quantum Information, (Dusseldorf 4-5/4) (**invited oral presentation**); PAFT24 (Vietri, 24-27/3) (**oral presentation**); PsiKet (Online for Sharif University, 8/3) (**invited online oral presentation**); Scuola Normale Superiore (Pisa, 5/3) (**invited oral presentation**); Padova University department seminar (Padova, 24/1) (**invited oral presentation**); Quiche consortium meeting (London, 11-12/1); NQSTI consortium meeting (Roma 15-16/1).

- 2023: SQMS Meeting (Batavia, USA, 5-8/11); Italian Quantum Information Science IQIS23 (Trieste 18-22/9); Quantum 2023 (Torino 10-15/9) (**invited oral presentation**); CE-QIP 23 (Smolenice, Slovakia 6-8/9) (**oral presentation**); Erice SQMS Workshop: Quantum Technologies for fundamental Physics (Erice, 1-6/9) (**co-organizer and oral presentation**); Central European Workshop on Quantum Optics CEWQO23 (Milano 4-7/7) (**invited oral presentation**); Matter and Light for Quantum Computing ML4Q (Eitorf, Germany, 4-5/7) (**invited keynote colloquium**); Benasque workshop on Quantum Information (Benasque, Spain, 19-24/6); Chengdu-Chongqing Quantum Workshop CCQW23 (Chengdu, China, 13-16/6) (**Invited oral presentation**); Quantum Technologies (Computing, Sensing & Simulation) (Torino, 7-9/6) (**Invited keynote talk**); New Directions in the Foundations of Physics (Viterbo, 26-28/5); Quantum Information and Quantum Technology (QIQT23) (online, 23/5) (**online invited presentation**); Qsail2023 (Isola d'Elba, Italy, 14-20/5) (**co-organizer**); Mini-course at the University of Mandalay in the Erasmus Plus "staff mobility for teaching" program (Mandalay, Myanmar, 25/2-5/3) (**international school**); SPIE Photonics West (San Francisco, USA, 28/1-2/2) (**invited oral presentation**).
- 2022: SQMS internal meeting (Padova, 15-16/12) (**oral presentation**); L'Aquila, colloquium at the university (11/11) (**invited oral presentation**); The Many-Worlds Interpretation of Quantum Mechanics (Tel Aviv, 19-24/10) (**oral presentation**); Time in Quantum Theory 2022 (Vienna 19/9) (**online oral presentation** due to health reasons); IQIS 2022 (Palermo, 12-16/9) (**oral presentation**); Amaldi Research Center Summer School (Paestum, 9/9) (**invited lecture**); Quantum Hiking workshop (Rifugio Miserin, Rifugio Sella, Parco Gran Paradiso, 5-9/7) (**co-organizer**); Quantum Time Machines 2022 (University of San Diego, San Diego USA, 19-22/7) (**Invited panelist**); GGI SQMS Summer School on quantum simulation of field theories (GGI Firenze, 25-29/7) (**co-organizer**); Laws of Nature Conference (Munich, 8-12/8) (**talk**); New Directions in the Foundations of Physics (Viterbo, 27-29/5).
- 2021: Zanardi-Lidar group meeting (16/4 online); Quantizing Time online conference (Perimeter Institute, Waterloo, 14-18/6) (**Invited web-seminar**); Quantum Information and Quantum Technology 2021 (QIQT-21) (IISER Kolkata, India, 22/6) (**Invited web-seminar**); Time in Quantum Theory: from mathematical foundations to operational characterization (ETH Zurich, 30/8-3/8) (**invited talk**); Quantum Optics X (Toru'n, Poland, 5-11/9) (**oral presentation**); Italian Quantum Information Science conference IQIS21 (Naples, Italy, 11-15/10) (**invited talk**).
- 2020: Q-Turn 2020 (23-27/11, online conference) (**oral presentation**); Mathematisches Oberseminar, D. Dürr group (Munich via zoom, 5/6) (**Invited web-seminar**); SQMS NQI center proposal scientific discussions meeting (Fermilab, Batavia IL, 27-28/3); University of Vienna (Vienna, 20/1) (**Invited PhD colloquium**); Quantum Frontiers and Fundamentals 2020 (Bangalore, 13-19/1) (**Invited talk and invited department seminar**).
- 2019: Università dell'Insubria (Como, 11/11) (**Invited PhD colloquium**); Time Machine Factory TMF2019 (Torino, 22-25/9) (**Invited oral presentation**); Causality in the physical world (Anacapri, 17-20/9) (**Invited oral presentation**); Italian Quantum Informa-

tion Science IQIS19 (Milano, 10-12/9); FQXi 2019 International Conference “Mind Matters” (Il Ciocco, Toscana, 21-25/7) (**5-minute presentation**); Quantum Hiking workshop (Rifugio Locatelli e Rifugio Comici, Tre cime di Lavaredo, 15-19/7) (**co-organizer**); Benasque worksop on quantum information (Benasque, Spain, 26 June-3 July); ICSSUR 19 International Conference on Squeezed states and uncertainty relations (Madrid, Spain, 17-21/6) (**Invited oral presentation**); Quantum 2019 (Torino, 27-31/5) (**Invited oral presentation**); New Directions in the Foundations of Physics (Viterbo, 24-26/5); AT-TRACT kickoff meeting (Ginevra, 20-21/5); International Conference on Quantum Optics and Quantum Information ICQOQ19 (Minsk, 13-17/5) (**Invited oral presentation**); Current Problems in Theoretical Physics PAFT19 (Vietri sul Mare, 13-17/4) (**Invited oral presentation**); New Trends in Complex Quantum Systems Dynamics QCS19 (Venezia, 9-12/4) (**Oral presentation**); OSA Quantum Information and Measurement (QIM) V: Quantum Technologies (Roma, 4-6/4) (**Oral presentation**); Photonics West, SPIE (San Francisco, 2-7/2) (**Invited oral presentation**); Time and fundamentals of quantum mechanics (Tel Aviv, Israel, 28-31/1) (**Invited oral presentation**).

- 2018: Quantum Cagliari 2018 (Cagliari, Italy 8-10/10) (**Invited oral presentation**); Italian Quantum Information Science IQIS18 (Catania, Italy, 17-20/9) (**Invited oral presentation**); SPIE Remote Sensing and Defense+Security (Berlin, Germany 10-12/9) (**Invited oral presentation**); International Iran Conference on Quantum Information IICQI18 (Tehran, Iran 8-10/9) (**Invited oral presentation**); Quantum Technology International Conference Qtech2018 (Paris, France 5-7/9) (**Oral presentation**); IQSA Conference on quantum structures 2018 (Kazan, Russia, 16-22/7) (**Oral presentation**); 7th International Conference on New Frontiers in Physics ICNFP2018 (Kolymbari, Grece 8-13/7) (**Invited oral presentation**); Is quantum theory exact? (Frascati, 2-5/7) (**Invited oral presentation**); New Directions in Fundamental Physics (Viterbo, 8-11/6); Three days in quantum mechanics (Genova, 6-7/6) (**invited oral presentation**); Brukner group at IQOQI (Vienna, 9-11/5) (**invited oral presentation**); Quantum Frontiers and Fundamentals QFF18 (Bangalore, India, 30/4-4/5) (**invited oral presentation**); Bristol Quantum Information Technologies workshop BQIT18 (Bristol, UK, 18-20/4) (**invited oral presentation**); Baku state university, Erasmus Plus “staff mobility for teaching” program (Baku, Azerbaijan, 2-8 April) (**international school and seminar**); Quantum Communication, Measurement and Computing 2012 (QCMC12) (Baton Rouge, LA, USA, 11-16/3); International conference on Quantum Optics 2018 (Obergurgl, Austria, 26/2-2/3); Department of Physics, Informatics and Mathematics, University of Modena & Reggio Emilia (Modena, 23/2) (**invited seminar and public outreach seminar**).
- 2017: International Conference on Quantum Foundations ICQF17 (Patna, India, 4-18/12) (**invited oral presentation**); Workshop Quantum Foundations: New frontiers in testing quantum mechanics from underground to space (Frascati, 29/11-1/12) (**invited oral presentation**); MEDiT Health Innovation (Vicenza, 17-18 November) (**invited oral presentation**); Applied Quantum group Milan meeting, AQM17 (Varazze, 25-27 September) (**invited oral presentation**); IQIS17 (Firenze, 12-15 September) (**oral presentation**); 6th International Conference on New Frontiers in Physics ICNFP (Kolymbari, Crete, Greece, 19-26 August) (**invited oral presentation**); Benasque worksop on quantum information (Benasque, Spain, 9-15 July); Micro-workshop to discuss fu-

- ture projects, Ulm university (Ulm, Germany, 22-23 June) (**oral presentation**); Grup d'Informaci/'o Quántica, Universitat Autónoma Barcelona (Barcelona, Spain, 29 May) (**invited oral presentation**); Quantum 2017 (Torino, May 7-12) (**invited oral presentation**); QuProCS II (Palma de Mallorca, April 6-7) (**invited oral presentation**).
- 2016: Quantum measurement: a dialog of big and small (Warwick, UK, 28 September) (**invited oral presentation**); IQIS 2016 9th Italian Quantum Information Science Conference (Roma, Italy, 20-23 September) (**invited oral presentation**); Taming quantum noise TQN16 (Mazara del Vallo, Italy, September 5-9—) (**invited oral presentation**); FQXi 2016 'If A Tree Falls: the Physics of What Happens and Who is Listening' (Banff, Canada, August 17-22) (**5-minute presentation**); 3rd Seefeld workshop on Quantum Information (Seefeld, Austria, June 26 - July 1) (**invited oral presentation**); 619th WE-Heraeus-Seminar: Quantum Speed Limits (Bad Honnef, Germany, June 8-10) (**invited oral presentation**); 4th International Conference on the Nature and Ontology of Spacetime (Varna, Bulgaria, May 30-June 2) (**oral presentation**); Testing Quantum Gravity (TQC) (Torino, May 26-27) (**invited oral presentation**); Symposium on quantum information and foundations of physics KCIK (Sopot, Poland, 19-21 May) (**invited oral presentation**); Mini-course at the University of Jordan in the Erasmus Plus “staff mobility for teaching” program (Amman, Jordan, 15-21 April) (**international school**); Recent advances in quantum metrology, RAQM16 (Warsaw, Poland, March 2-4) (**invited oral presentation**); Winter school in Signagi, Erasmus Plus “staff mobility for teaching” program (Signagi, Georgia, 2-9 February) (**international school**).
- 2015: Quantum Information Processing and Applications (QIPA-2015) (Allahabad, India, 3-11 December) (**invited oral presentation**); International Conference on Quantum Foundations ICQF15 (Patna, India, 1-4 December) (**invited keynote presentation**); MEDIT Health innovation (Vicenza, 28-29 October) ((**invited oral presentation via teleconference**), shared with Prof. D'Ariano and Dr. Stopazzolo M.D.); Time Machine Factory 2015 TM2015 (Torino, 25-28 October) (**invited oral presentation plus invited public outreach talk**); Quantum UnConference QUC15 (Menesjärvi, Finlandia, 15-18 October) (**invitation to the meeting**); Workshop on Time in Physics (ETH Zurich, September 7-11) (**invited oral presentation**); 1 month research visit to MIT, thanks to the “Progetto Pavia-Boston” of the University of Pavia (Cambridge MA, USA, August 10-September 4); Second Bucharest School on Quantum Technologies, SpaceTech (Bucharest, Romania, June 30- July 3) (**invited lecture series**); Q+ hangout seminar (internet-distributed seminar based on Google Hangouts organized by D. Burgarth and M. Leifer, June 9) (**invited oral presentation**); 589 WE-Heraeus-Seminar: Continuous Variable Entanglement in Atomic Systems: Fundamentals and Applications (Bad Honnef, Germany, May 11-15) (**invited oral presentation**); Quantum Physics Of Nature, QUPON 2015 (Vienna, May 18-22).
- 2014: Workshop on Quantum Metrology, Interaction, and Causal Structure, (Tsinghua University, Beijing, China, December 1-5) (**invited oral presentation**); one-day workshop on Quantum Technology – Quantum Expo 14/15 (Milano, Oct. 3) (**invited oral presentation**); 7th Italian Quantum Information Science Conference (IQIS-2014) (Salerno, Sep. 15-19) (**invited oral presentation**); Sharif University (Tehran, Iran, September

- 2) (**Invited oral presentation**); International Iran Conference on Quantum Information, IICQI14 (Esfahan, Iran, September 5-11) (**invited keynote speaker**); Advances in Foundations of Quantum Mechanics and Quantum Information with atoms and photons (Torino, May 26-30) (**invited oral presentation**); Institut für Theoretische Physik, Universität Innsbruck, (Innsbruck, August 4) (**invited oral presentation**).
- 2013: 6th Italian Quantum Information Science Conference (IQIS-2013) (Como, September 24-29) (**invited oral presentation and public outreach talk**); Quantum information seminar in Hiroshima (Hiroshima University, August 10-14) (**invited oral presentation**); International workshop on New Science and Technologies using Entangled Photons (NSTEP) (Osaka, Japan, 8-9 August) (**invited oral presentation**); *Quantum Information Benasque workshop* (Benasque, Spain, June 29-August 6); Twin Workshop on Complex Quantum Systems (Ackergill Tower, Wick, Scotland 27-30 May) (**invited oral presentation**); Seminar at the Quantum Information Group of the Universitat Autònoma de Barcelona (UAB), (Bellaterra, Spain, May 21) (**invited oral presentation**); Multiweek invitation for the “Control of Complex Quantum Systems” program at the Kavli Institute for Theoretical Physics (Santa Barbara, CA, USA, Jan 26-Feb 22) (**invited oral presentation**).
- 2012: First NASA Quantum Future Technologies Conference (Mountain View, CA, USA, Jan 17-21) (**invited oral presentation**); Quantum 2012, *Advances in Foundations of Quantum Mechanics and Quantum Information with atoms and photons* at INRIM (Torino, May 21-25) (**invited oral presentation**); *Central European Workshop on Quantum Optics 2012 (CEWQO12)* (Sinaia, Romania, July 2-6) (**oral presentation**); Quantum Communication, Measurement and Computing 2012 (QCMC12) (Vienna, Austria, July 30-August 3); 3rd COQUIT Workshop (ISI, Torino, Sep. 11-12) (**invited oral presentation**); Sources and signatures of quantum enhancements in technology at the Royal Society at Chicheley Hall (Chicheley, Sep. 13-14) (**invited oral presentation**); Sixth International Workshop DICE2012 (Castiglione, Italy, Sep. 17-21) (**oral presentation**); 5th Italian Quantum Information Science Conference (IQIS-2012) (Padova, Sep. 26-28) (**invited oral presentation**); TM2012 (Torino, Oct. 14-20) (**invited oral presentation and public outreach seminar**).
- 2011: Seminar at INRIM (Torino, May 12) (**invited oral presentation**); *Difficult Problems in Quantum Information Theory (2011 xQIT conference)* (Cambridge MA, May 3-4) (**invited oral presentation**); Entanglement, Quantum information and the Quantum-to-classical transition (Accademia dei Lincei, Roma, May 5-7); PhD cycle of lectures on quantum information and computation (Padova, Italy, April-May) (**invited oral presentation**); International Conference on Quantum Optics and Quantum Computing IC-QOQC11 (Noida, India, March 22-26) (**invited oral presentation**); First International Workshop on High Dimensional Entanglement (Como, June 20-24) (**oral presentation**).
- 2010: Quantum Coherence and Decoherence workshop (Benasque, Spain, September 6-17) (**oral presentation**); CQuIC Seminar at UNM (Albuquerque, September 2) (**invited oral presentation**); PIQuDos seminar at the Perimeter Institute for Theoretical Physics (Waterloo, Canada, April 28) (**invited oral presentation**); BBN Technologies Cor-

- poration (Cambridge, MA, April 20) (**invited oral presentation**); Chalmers University of Technology, Linnaeus Colloquium (Göteborg, Sweden, March 4) (**invited oral presentation**); Nagoya Winter Workshop on Quantum Information, Measurement, and Foundations (Nagoya, Japan, February 18-24) (**invited oral presentation**); Los Alamos National Laboratory, quantum lunch seminar series (Los Alamos, NM, February 3) (**invited oral presentation**); Los Alamos National Laboratory, quantum lunch seminar series (Los Alamos, NM, January 27) (**invited oral presentation**).
- 2009: Amherst College Physics Colloquium (Amherst, MA, December 3) (**invited oral presentation**); Aspuru-Guzik Group meeting seminar, Harvard university (Cambridge, MA, October 14) (**invited oral presentation**); Seminar at IFISC (Palma de Mallorca, Spain, October 1) (**invited oral presentation**); *Intern. Conf. on Quantum Information Processing and Communication (QIPC09)* (Roma, September 21-25); *Quantum Information Benasque workshop* (Benasque, Spain, June 7-17); *Central European Workshop on Quantum Optics 2009 (CEWQO09)* (Turku, Finland, May 23-26) (**oral presentation**); Seminar at ETH in the group of Stefan Wolf, Zürich (Zürich, Switzerland, May 19) (**invited oral presentation**); *Quantum Information and Many body Quantum Systems, QUROPE09 International school* (Cortona, Italy, May 3-8) (**oral presentation**); Seminar at INRIM (Torino, April 2) (**invited oral presentation**); Seminar at Scuola Normale Superiore (Pisa, April 16) (**invited oral presentation**).
- 2008: three weeks invitation at the Massachusetts Institute of Technology for a research project (Cambridge MA, January 6-February 1); *IV workshop ad memoriam of Carlo Novero Advances in Foundations of QM and QI with atoms and photons* (Torino, May 19-23) (**oral presentation**); *Quantum Information and Control In Queensland QICIQ and Asia Pacific Conference on Quantum Information Science, APCQIS* (Cairns, Australia, June 30 - July 5) (**oral presentation**); *Joint 5th QPL and 4th DCM Workshops: Quantum Physics and Logic*, satellite workshop of ICALP2008 (Reykjavik, Iceland, July 12-13) (**oral presentation**); *Quantum Communication Measurement and Computing (QCMC) 2008* (Calgary, August, 19-24); *Italian Quantum Information Science Conference 2008 (IQIS08)* (Camerino, October, 24-29) (**oral presentation**); *Difficult Problems in Quantum Information Theory (2008 xQIT conference)* (Cambridge MA, November 19-20) (**invited oral presentation**); *Theorie Kolloquium at the ITP* (Innsbruck, December 3) (**invited oral presentation**).
- 2007: three weeks invitation at the Massachusetts Institute of Technology for a research project (Cambridge MA, January 7-February 2); *Quantum Information and Many-Body Quantum Systems* (Pisa, March 26-31) (**oral presentation**); *first Quantumbionet Workshop* (Pavia University, May 25) (**invited oral presentation**); *Vienna Symposium on the Foundations of Modern Physics* (Vienna, Austria, June 7-10); *Quantum Information Benasque workshop* (Benasque, Spain, June 11-20); *Photons, Atoms and Qubits 2007 - PAQ07* (Royal Society, London, United Kingdom, September 2-5); *International Iran Conference on Quantum Information - IICQI* (Kish, Iran, September 7-10) (**invited oral presentation**); *Noise Information & Complexity @ Quantum Scale* (Centro Ettore Majorana, Erice, Italy, November 4-10) (**oral presentation**).

- 2006: *Advances in Foundations of Quantum Mechanics and Quantum Information with atoms and photons*, (Torino, May 2-5) (**oral presentation**); *XI International Conference on Quantum Optics ICQO'2006*, (Minsk, Belarus, May 26-31) (**invited oral presentation**); *Foundations of Probability and Physics-4* (Växjö, Sweden, June 4-9) (**oral presentation**); *QUPREST 2006, Focus meeting: quantum process estimation*, (Budmerice, Slovakia, September 27–October 1) (**invited oral presentation**); *QCM&C 2006* (Tsukuba, Japan, November 28– December 3); Quantum information seminar in Hiroshima (Hiroshima University, December 8) (**invited oral presentation**).
- 2005: *Frisno8, 8th French-Israeli symposium on nonlinear optics* (Ein Bokek, Israel, February 20-25) (**oral presentation**); *Quantum Information Benasque workshop* (Benasque, Spain, June 12-25); *Seminari di Quantum Information* (Milano, October 28) (**invited oral presentation**).
- 2004: *International DFG Workshop on Quantum Entanglement - from Error Correction to Secure Key Distribution* (Hirschegg, Austria, March 30 - April 2) (**invited oral presentation**); *Foundations of Quantum Information* (Camerino, April 16-19); 2nd Workshop ad memoriam of Carlo Novero “Advances in Foundations of Quantum Mechanics and Quantum Information with atoms and photons” (Torino, April 26); *X International Conference on Quantum Optics* (Minsk, Belarus, May 30-June 3) (**invited oral presentation**); *5th European QIPC Workshop* (Roma, September 20-22); *Mini workshop on Quantum Open Systems* (Pavia, Italy, October 25-26). Cambridge, Pisa.
- 2003: *Advances in Quantum Information Processing: from theory to experiment* (Erice, Italy, March 15-22); *8th International Conference on Squeezed States and Uncertainty Relations* (Puebla, Mexico, June 9-13); *Third annual MIT/NU MURI workshop* (Cambridge MA, USA, July 10-11); *QIT-EQIS ERATO conference on quantum information science* (Kyoto, Japan, September 2-6) (**oral presentation**); *3rd Annual MIT-Cambridge Quantum Information Workshop* (Cambridge MA, USA, October 2-3).
- 2002: *Quantum Information Quantum Entanglement – Euroconference* (San Feliu de Guixols, Spain, March 23-28); *Second annual MIT/NU MURI workshop* (Northwestern University, Evanston IL, USA, 11 April); *IX international conference on quantum optics 2002* (Raubichi, Belarus, May 14-17) (**invited oral presentation**); *II Cambridge-MIT Quantum Information Workshop* (Cambridge, UK, June 13-14) (**oral presentation**); *Progress in Electromagnetics Research Symposium: Quantum computation session* (Cambridge MA, USA, July 5); *QCM&C 2002* (Cambridge MA, USA, July 22-26); *MIT/NU MURI review workshop* (Cambridge MA, USA, October 23); *NASA-DoD workshop on quantum Imaging and Metrology* (Pasadena CA, USA November 14-15) (**invited oral presentation**).
- 2001: *7th International Conference on Squeezed States and Uncertainty Relations ICSSUR2001* (Boston MA USA, June 4-8); *CQO8: 8th Rochester Conference on Coherence & Quantum Optics* and *ICQI2001: International Conference on Quantum Information* (Rochester NY USA, June 10-16) (**oral presentation**); *Mysteries, Puzzles and Paradoxes in Quantum Mechanics* (Gargnano Italy, August 27-September 1); *Quantum Optics – EuroConference* (San Feliu de Guixols, Spain, October 06-11).

- 2000: *Seventh central-european workshop on quantum optics* (Balatonfured Hungary, April 28 - May 1); *QCM&C Y2K* (Capri Italy, 3-8 July); *Mysteries, puzzles and paradoxes in Quantum Mechanics* (Gargnano Italy, September 17-23); *Quantum Optics XI – EuroConference* (Palma Spain, October 14-19).
- 1999: *III Adriatico research conference on quantum interferometry* (Trieste Italy, March 1-5); *Fundamental Problems in Quantum Theory Workshop* (Baltimore MD USA, August 9-13).
- 1997: *II Working Party on Quantum Optics and Quantum Computation* (at the Scuola Normale di Pisa, Pisa, June 26-28); *LXXXIII congresso nazionale Società Italiana di Fisica, Congresso del Centenario* (Villa Olmo Como Italy, October 27-31).

PUBLIC OUTREACH, (VERY) PARTIAL LIST:

- 2024: Notte Europea dei ricercatori: outreach seminar on quantum reality (Pavia, 26/9).
- 2023: Pavia university: outreach seminars for elementary school kids (6/5); Belluno, associazione “Amici del Lollino” outreach seminar (31/3); Leonardo Scuola Media, outreach seminars 6) (28/3); Pi day (14/3, Pavia); Caravaggio, Bergamo, outreach seminar (23/2).
- 2022: Outreach seminars at local schools “un’ora con il ricercatore” (two seminars at San Genesio, four seminars in Pavia); Outreach online seminar for Discovery Activators, Pavia (15/11). Outreach seminar in Cairoli high school (7/2). Pi day seminar for high schools in Foscolo high school (12/3). Researchers @School - digital edition, ciclo di lezioni di fisica moderna rivolto alle allieve e agli allievi dell’ultimo anno delle Scuole secondarie di II grado, richiesto dal Servizio Informazione e Divulgazione Scientifica dei Laboratori Nazionali di Frascati INFN (25/3).
- 2021: Online talk for the Pi day: International Day of Mathematics (14/3). Various seminars for primary and secondary schools. Schrodinger cat for children presentation at the university (9/10); ”un’ora con il ricercatore” activity: 4 seminar in high schools and elementary schools (some in presence others via zoom): november/december; Attivita’ di aggiornamento insegnanti (organizer Vittoria Cinquini): Seminar ”La realta’ quantistica in relazione con la freccia del tempo”.
- 2020: Online talk (due to Covid-19) for INSPYRE, INternational School on modern PhYsics and REsearch, organized by INFN Frascati National Laboratory is addressed to High School students (online, 31/3) published at youtube.com/watch?v=nxuvMLp7Hck; Seminario divulgativo per stage a fisica (4/9); Seminari di Fisica Moderna (dipartimento di Fisica di Pavia, 9/11); Science College (Autonomous) Hinjilicut, Ganjam, Odisha International Webinar on “Recent Trends in Quantum Mechanics” (3/10); Notte dei ricercatori (online talk 27/11); Seminario AIF (Associazione Insegnanti di Fisica) 30/11.
- 2019: Rotary club Pavia (Pavia, 4/12); Seralmente (conference cycle) (Grugliasco, 18/10), 550 participants; Cinema Massimo public outreach during TMF19 (Torino, 23/9); DOMOSOFIA 2019 (Domodossola, 22/9); Officina di didattica e divulgazione della fisica

OFIS 2019 (Como, 20/9); Unitre Pavia (Pavia, 4/1); Liceo Leonardo da Vinci (Milan, 27/3); Liceo Cairoli (Pavia, 23/1); Liceo Aselli (Cremona, 26/2); Liceo Cairoli (Pavia, 27/2); Istituto Omodeo (Mortara, 1/3).

2018: Liceo Scientifico Copernico (Pavia, 30/11); Liceo Scientifico Abbiategrasso (Abbiategrasso 8/11); Aula del '400 (Pavia, 17/5); Voghera, Liceo Scientifico (Voghera, 9 April); Liceo Copernico Pavia.

2017: Cose Cosmiche, dialoghi sul tempo (Palazzo Archinto, Milano, 9/11); “Il cielo di Roma 2017” (Parco Appia antica, Roma, 2 June); “Non e’ la classica fisica” IV Convegno Marveggio (Sondrio, April 22) (300 people); Collegio Borromeo (Pavia, March 30).

2016: Istituto Lombardo, Accademia di scienze e lettere (Milano, 24 November); Pint of Science (Pavia, May 24).

2015: Ciclo di conferenze “Seralmente” (Grugliasco, 12 November); Notte Europea dei ricercatori (Pavia, September 21).

2014: Public outreach seminar (> 300 attendees) at the “Festival della Scienza di Genova”, (Palazzo Ducale, Sala del Maggior Consiglio, Genova, Oct. 27).

DIDACTICS

University Courses held:

- Classical electrodynamics and special relativity (“Fisica Generale 2”, 9 CFU), bachelor’s course in the math department.
- Quantum Optics (“Ottica quantistica”, 6 CFU), master course in the physics department.
- Open quantum systems, graduate course for the PhD program in Physics.
- Foundations of quantum mechanics, modulus of the Foundations of Physics bachelor’s course in the physics department.

Member of the teaching board for the Pavia PhD.

Thesis advisor:

- PhD: G. D. C. “Non classical states in interferometry” (2008).
- PhD: A. R. (informal) “Uncertainty relations, quantum correlations and applications”, (2019).
- PhD: S. R. “From imaging to timekeeping. Position, phase and time in quantum technologies”, (2025).
- Masters: C. C. R. “Quantum state estimation: direct state measurement vs tomography” (2013).
- Masters: A. A. “Quantum Private Queries in the Presence of Noise” (2015).

- Masters: (co-relatore) S. B. “Improving Machine Learning and Deep Learning techniques using Quantum Computers” (2022).
- Masters: (co-relatore) S. M. “Qudit noise deconvolution” (2022).
- Masters: E. T. “Quantum JPEG: analysis and developments” (2023).
- Masters: D. T. “Entropy Production of a Quantum Ticking Clock” (2024).
- Bachelor: F. P. “Envariance and the emergence of probabilities in quantum mechanics” (2012).
- Bachelor: C. I. “Differential forms electrodynamics in reciprocal space” (2023).

PROJECTS

Participation in many research projects. The list of projects financed as a PI (Principal Investigator) follows:

- 2023: PI for the AQuTE (Advanced Quantum Time Experiment) project of the PRIN 2022 call. Realization of an experiment on the foundations of quantum mechanics (quantum time-of-arrival tests). The experimental effort will be carried out by the INRIM (Istituto Nazionale di Ricerca Metrologica) in Torino. Funding of 210k Euros.
- 2020: Superconducting Quantum Materials and Systems Center (SQMS) at Fermilab for the development of a super-conducting quantum computer. PI for the Pavia node through INFN. Budget to Pavia: two post-doctoral positions+funds for computers.
- 2019: ATTRACT Call (EU): 100,000 Euros for developing quantum medical tomography.
- 2018: Finanziamento delle attività base di ricerca (FABR). Funding of 3,000 Euros.
- 2017: Bando per fondo di ricerca Ateneo “Blue Sky Research” for a two-year foundational ‘curiosity driven’ proposal. Funding of 60,000 Euros.
- 2015: FQXi’s Physics of What Happens program grant, from the Foundational Questions Institute (a private foundation from the US). Funding of 44,965 \$ for the project “Quantum Spacetime from Events” (<http://fqxi.org/grants/large/awardees/list>); funding for a month-long exchange program at MIT (internal funding competition from the University of Pavia).
- 2014: Fondazione Banca del Monte di Lombardia. Project “A quantum digital universe”: financing of 22.268 Euros for buying hardware (for a theoretical research project!).