Romeo Brunetti

CONTACT INFORMATION

Dipartimento di Matematica
Università di Trento
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ACADEMIC APPOINTMENTS

Associate Professor (tenure) of Mathematical Analysis September 2010 to present
Dipartimento di Matematica, Università di Trento
- Affiliations:
  - Mathematical Physics Group
  - INFN, Istituto Nazionale di Fisica Nucleare, sez. Trento

Kähler Research Fellow 2 months 2013
ZMP, Zenter für Mathematische Physik, Hamburg, Germany,

Senior Research Fellow March 2007 to May 2007
ESI, Erwin Schrödinger Institut, Vienna, Austria,

Research Fellow under "Rientro dei Cervelli" procedure Sept. 2006 to Aug. 2010
Dipartimento di Matematica, Università di Trento
- Affiliations:
  - Mathematical Physics Group
  - INFN, Istituto Nazionale di Fisica Nucleare, sez. Trento

Max-Planck Research Fellow July to August 2006
Max-Planck-Inst. f. Mathematik in der Naturwissenschaften, Leipzig, Germany,

DFG Research Fellow July 2002 to February 2003, June 2003 to February 2004, July 2004 to July 2006
II Inst. f. Theor. Physik, Universität Hamburg, Hamburg, Germany

Professor of Mathematical Analysis (Contract) March to June 2002, March to June 2003, March to June 2004
Dipartimento di Matematica, Università della Basilicata, Potenza, Italia

Research Fellow (Assegno di Ricerca) January 2000 to February 2002
Dipartimento di Fisica, Università di Napoli "Federico II," Napoli, Italia

Marie Curie Research Fellow March 1996 to March 1997
II Inst. f. Theor. Physik, Universität Hamburg, Hamburg, Germany

Post Doc January 1995 to January 1996
Dipartimento di Fisica, Università di Napoli "Federico II," Napoli, Italia

Foundation "A. Della Riccia" Research Fellow September 1993 to February 1994
Department of Physics, Syracuse University, Syracuse, NY, USA

Foundation "A. Della Riccia" Research Fellow January 1989 to June 1989
Department de Physique, ENS, École Normale Supérieure, Paris, France

SCIENTIFIC ACHIEVEMENTS

◇ **Reconstruction of space-time symmetries from intrinsic data** (Tomita-Takesaki modular theory of standard von Neumann algebras, conformal field theories in dimensions $d \geq 1$: in collaboration with Guido and Longo, [17,18]).

◇ **First construction of Wick polynomials on Lorentzian space-times, microlocal spectrum condition** (Microlocal analysis for systems with infinite degrees of freedom: in collaboration with Köhler and Fredenhagen, [16]).

◇ **Complete classification of renormalization for perturbative quantum field theories on external backgrounds** (Microlocal Analysis on globally hyperbolic space-times: in collaboration with Fredenhagen, [15]).

◇ **Foundations of locally covariant quantum field theory** (Functorial description of physical theories, C^*-algebras: in collaboration with Fredenhagen and Verch, [11]).

◇ **Intrinsic Wigner formalism and Borchers commutation rules** (Modular theory of standard real subspaces, spectral condition and localizations: in collaboration with Guido and Longo, [13]).

◇ **First general construction of time operators in quantum mechanics (absolutely continuous Hamiltonians), and their intrinsic Heisenberg uncertainties** (Positive operator-valued measures, weights on C^*-algebras, completely positive maps: in collaboration with Fredenhagen, [5,12,14]).

◇ **Superselection sectors for locally covariant quantum field theory, and new sectors of topological nature** (Analysis of theories with infinite degrees of freedom described by C^*-algebras on globally hyperbolic spacetimes, geometric invariants: in collaboration with Ruzzi, [7,9]).

◇ **Construction of relativistic interacting classical field theories** (Infinite dimensional geometry, quasi-linear hyperbolic equations on globally hyperbolic spacetimes, Nash-Moser Theorem: in collaboration with Fredenhagen and Ribeiro, [24,26,27]).

◇ **Perturbative Quantum Gravity as a locally covariant quantum field theory** (Batalin-Vilkoviski formalism with infinite dimensional geometry, construction of states for interacting theory, background independence: in collaboration with Fredenhagen and Rejzner, [3]).

◇ **Cosmology and Quantum Gravity** (Derivation of Standard Cosmological Perturbation Theory from first principles of Quantum Gravity, in collaboration with Fredenhagen, Hack, Pinamonti and Rejzner, [2]).

BOOKS

[1] Advances in Algebraic Quantum Field Theory. R. Brunetti, C. Dappiaggi, K. Fredenhagen, J. Yngvason Ed.. Springer Verlag, Berlin, October 2015.

REFEREED JOURNAL PUBLICATIONS

[2] R. Brunetti, K. Fredenhagen, T-P Hack, N. Pinamonti, and K. Rejzner, Cosmological Perturbation Theory and Quantum Gravity, accepted on JHEP (2016).

[3] R. Brunetti, K. Fredenhagen, and K. Rejzner, Quantum Gravity as a Locally Covariant Quantum Field Theory. Communications in Mathematical Physics. Online First (2016), doi:10.1007/s00220-016-2676-x

[4] R. Brunetti, K. Fredenhagen, P. Imani and K. Rejzner, The Locality Axiom in Quantum Field Theory and Tensor Products of C^*-algebras. Reviews in Mathematical Physics, 26(6):1450010 (2014) doi:10.1142/S0129055X1450010X

[5] R. Brunetti, K. Fredenhagen and M. Hoge, Time in quantum physics: from an external parameter to an intrinsic observable. Foundations of Physics, 40(9-10):1368-1378, (2010). doi:10.1007/s10701-009-9400-z

[6] R. Brunetti, M. Dütsch and K. Fredenhagen, Algebraic quantum field theory and the renormalization groups, Advances in Theoretical and Mathematical Physics, 13(5):1541-1599, (2009).

[7] R. Brunetti and G. Ruzzi, Quantum charges and spacetime topology: The emergence of new superselection sectors, Commun. Math. Phys. 287, 523-563 (2009).

[8] R. Brunetti, L. Franceschini and V. Moretti, Topological sectors for massive bosons on two dimensional Einstein cylinder. I: Spatial Approach, Ann. Inst. H. Poincaré, (2009).

[9] R. Brunetti and G. Ruzzi, Superselection sectors and general covariance. I, Commun. Math. Phys, 270, 69-108 (2007).

[10] R. Brunetti, K. Fredenhagen and S. Hollands, A remark on alpha vacua for quantum field theory on de Sitter space, JHEP 05 (2005) 063-067.

[11] R. Brunetti, K. Fredenhagen and R. Verch, The generally covariant locality principle – a new paradigm in local quantum field theory, Commun. Math. Phys., 237, (2003) 221-241.

[12] R. Brunetti and K. Fredenhagen, Remarks on time-energy uncertainty relations, Rev. Math. Phys., 14, (2002) 897-903.

[13] R. Brunetti, D. Guido and R. Longo, Modular localization and Wigner particles, Rev. Math. Phys., 14, (2002) 759-785.

[14] R. Brunetti and K. Fredenhagen, Time of occurrence observable in quantum mechanics, Phys. Rev. A66 (2002) 044101-044105.

[15] R. Brunetti and K. Fredenhagen, Microlocal analysis and interacting quantum field theories; Renormalization on physical backgrounds, Commun. Math. Phys. 208, (2000) 623-661. (**Featured Review on Mathematical Reviews**, MR1736329 (2001 g:81176))

[16] R. Brunetti, K. Fredenhagen and M. Köhler, The microlocal spectrum condition and the Wick polynomials of free fields on curved spacetimes, Commun. Math. Phys. 180, (1996) 633-652.

[17] R. Brunetti, D. Guido and R. Longo, Group cohomology, modular theory and space-time symmetries, Reviews in Math. Phys. 7, (1995) 54-71.

[18] R. Brunetti, D. Guido and R. Longo, Modular structure and duality for conformally invariant theories, Commun. Math. Phys., 156, (1993) 201-219.

[19] R. Brunetti, G. Parisi and F. Ritort, Asymmetric Little spin glass model, Phys. Rev. B, 46 (1992) 5339-5355.

[20] R. Brunetti, G. Parisi and F. Ritort, Study of the asymmetric Little model, Physica A, 185 (1992) 247-253.

[21] R. Brunetti, G. Parisi and F. Ritort, On the replica symmetry for random weighted matchings, J. Phys. A: Math. Gen. 24, (1991) 5077-5083.

[22] R. Brunetti, W. Krauth, M. Mézard and G. Parisi, Extensive numerical simulation of weighted matchings: total length and distribution of links in the optimal solution, Europhysics Letters, 14 (4), (1991) 295-301.

[23] R. Brunetti and G. Parisi, Cavity fields approach in spin glasses; one step beyond, Europhysics Letters, 11 (3), (1990) 281-286.

SUBMITTED JOURNAL PUBLICATIONS

[24] R. Brunetti, K. Fredenhagen and P.L. Ribeiro, Algebraic Structure of Classical Field Theory I: Kinematics and Linearized Dynamics for Real Scalar Fields. Submitted to Communications in Mathematical Physics (2015). arXiv:1209.2148

[25] C. Bergbauer, R. Brunetti and D. Kreimer, Renormalization and resolution of singularities. Submitted to Communications in Mathematical Physics (2010). arXiv:0908.0633

PAPERS IN PREPARATION

[26] R. Brunetti, K. Fredenhagen and P. L. Ribeiro, Algebraic Structure of Classical Field Theory II: The Main Dynamical Theorem and its Applications. (manuscript 2013)

[27] R. Brunetti, K. Fredenhagen and P. L. Ribeiro, Algebraic Structure of Classical Field Theory III: The Principle of Space-Time Descent. (manuscript 2013)

[28] R. Brunetti, K. Fredenhagen, T-P. Hack, N. Pinamonti and K. Rejzner, Quantum Effects in Standard Cosmology, (2016)

[29] R. Brunetti. K. Fredenhagen, Quantum Field Theory of interacting Bose-Einstein condensate in a trap, (2016)

WORKS IN PROGRESS

[30] R. Brunetti and P. L. Ribeiro, Towards Fedosov construction in Perturbative Algebraic Quantum Field Theory. (manuscript 2014)

CHAPTERS IN BOOKS

[31] R. Brunetti and K. Fredenhagen, Quantum Field Theories on Curved Backgrounds, chapter 5 in: Lectures Notes in Physics, vol.786, Springer 2009.

[32] R. Brunetti and V. Moretti, Quantum field theories on curved spacetimes, Encyclopedia of Mathematical Physics, Springer-Verlag (2007).

[33] R. Brunetti, M. Porrmann and G. Ruzzi, General covariance in algebraic quantum field theory, in "Lecture Notes of Seminario Interdisciplinare di Matematica", vol.5 (2006), ed. E. Barletta.

[34] R. Brunetti and K. Fredenhagen, Algebraic approach to quantum field theory. Encyclopedia of Mathematical Physics, Elsevier Publishing (2004).

REFEREED CONFERENCE PUBLICATIONS

[35] R. Brunetti and K. Fredenhagen, Towards a background independent formulation of perturbative quantum gravity, in: Quantum Gravity –Mathematical Models and Experimental Bounds, B. Fauser, J. Tolksdorf, E. Zeidler Eds., Birkhäuser Basel, 2006, 151-159.

[36] R. Brunetti, Locally covariant quantum field theories, in: Rigorous Quantum Field Theory, A Festschrift for Jacques Bros, Progress in Mathematics vol. 251, A. Boutet de Monvel, D. Buchholz, D. Iagolnitzer, U. Moschella Eds., Birkhäuser Basel, 2006, 39-47.

[37] R. Brunetti and K. Fredenhagen, Interacting quantum fields on curved background, XII International Congress in Mathematical Physics, Brisbane, Australia 1997, International Press 1999.

[38] R. Brunetti and K. Fredenhagen, Interacting quantum fields in curved space: Renormalization of ϕ^4, "Operator Algebras and Quantum Field Theory," ed. S. Doplicher, R. Longo, J.E. Roberts, L. Szido, International Press 1997.

CONFERENCE TALKS

[39] R. Brunetti and P. L. Ribeiro, A Semiclassical Interacting *-Product in Perturbative Algebraic Quantum Field Theory. Presentation at the Conference "Mathematical Aspects of Quantum Field Theory and Quantum Statistical Mechanics" (Hamburg, July 30th – August 1st, 2012). Available at http://www.qq12.org/talks/Monday/8.Ribeiro.pdf.

CONFERENCE POSTERS

[40] R. Brunetti, K. Fredenhagen and P. L. Ribeiro, The Principle of Space-Time Descent. XVII International Congress on Mathematical Physics (Aalborg, August 6 – 11, 2012). Available at http://docs.math.aau.dk/timeline/e-posters/S09/Ribeiro.pdf. Prize for the best poster of the Congress.

OTHER PUBLICATIONS

[41] R. Brunetti, Perturbative quantum field theories: Still surprises?, ESI-News, December 2007.

[42] R. Brunetti, Simmetrie e Dualità in Teoria Algebrica dei Campi. Ph.D. thesis (1994) (in Italian)

[43] R. Brunetti, Fluttuazioni e stabilità nei vetri di spin. Diploma thesis (1988) (in Italian)

UNPUBLISHED MANUSCRIPTS

[44] R. Brunetti, K. Fredenhagen and K. Szlachany, On the construction of the universal algebra for (even) CAR algebras on the circle. (1994).

[45] R. Brunetti and K. Fredenhagen, Natural domains for Wick Polynomials of a Free Massive Scalar Field. (2000).

[46] R. Brunetti, On revival times via time of occurrence observables. (2004).

[47] R. Brunetti and K. Fredenhagen, Regularized alpha vacua and inflation. (2007).

[48] R. Brunetti and V. Moretti, On Modular dynamics. (2010)

GRANTS, FELLOWSHIPS, HONORS, PRIZES

- ◇ *Habilitation for professorship in Italy for Mathematical Physics* 2013.
- ◇ *ZMP Kähler Fellowship* 2013
  (ZMP, Hamburg University)
- ◇ *Prize for Best-Poster at International Congress in Mathematical Physics*, Prague (CZ) 2009.
- ◇ *Habilitation for professorship in France by the CNU (Conseil National des Université)* 2007.
- ◇ *Erwin Schrödinger Institute Senior Fellowship* 3/2007 – 4/2007.
- ◇ *Max Planck Institute fellowship* 2006
  (MPI, Leipzig, Germany)
- ◇ *Winner of the competitive procedure "Rientro dei cervelli" (Revert of Brain Drain) of the Italian Ministry of University and Research (MIUR)* 2006.
- ◇ *Deutsche Forschungsgemainschaft, DFG, fellowship* 2002 – 2006.
  (Hamburg Universität, Hamburg, Germany)
- ◇ *Featured Review in Mathematical Reviews* MR1736329 (2001 g:81176).
- ◇ *Marie Curie research fellowship* 1996 – 1997.
  (Hamburg Universität, Hamburg, Germany)
- ◇ *Foundation "Angelo Della Riccia" research fellowship* 1993.
  (Syracuse University, Syracuse, N.Y., U.S.A.)
- ◇ *Foundation "Angelo Della Riccia" research fellowship* 1989.
  (École Normale Superieure, Paris, France)

ACADEMIC SERVICE

Doctorate's Board
Università di Trento, Dipartimento di Matematica, 2007 – to present.

National Evaluation of Research
Referee, 2008.

STUDENT ADVISING

Master

- **Lorenzo Franceschini**
  Master level student, Dipartimento di Fisica, Università di Trento.
  Superselection sectors of topological origin. 2008-2009.
- **Chiara Entradi**
  Master level student, Dipartimento di Fisica, Università di Milano.
  Renormalization on Riemannian spaces. 2012-2013. (Since 2013 PhD student in Goettingen with Prof. Dr. D. Bahns)

Post-doc

- **Igor Khavkine**
  Post-doc, Dipartimento di Matematica, Università di Trento.
  Quantum Gravity. 2013-2015. (Now in Roma, Univ. Roma II, Prof. R. Longo)

PROFESSIONAL SERVICE

Editorial Boards

- *Abstract and Applied Analysis*, Hindawi Publishing Corporation. (IF 1.102, ISI 2012)
- *Mathematical Analysis*, The Scientific World Journal, Hindawi Publishing Corporation. (IF 1.730, ISI 2012)

Referee Service (Main Journals)

- *Communications in Mathematical Physics*
- *Reviews in Mathematical Physics*
- *Annales de l'Inst. H. Poincaré*
- *Journal of Mathematical Physics*
- *Journal of Non Commutative Geometry*

Conference Service

- Mini-Workshop at Mathematical Institute of Oberwolfach, Oberwolfach, Germany, October 2000, "Quantum Field Theory and Microlocal Analysis," in collaboration with K. Fredenhagen and E. Schrohe.
- Research Program at E.S.I. on "Mathematical and Physical Aspects of Perturbative Approaches to Quantum Field Theory," Wien, Austria, March-April 2007, in collaboration with K. Fredenhagen, D. Kreimer, and J. Yngvason.
- Workshop at E.S.I. "New Developments for Perturbative Quantum Field Theories," Wien, Austria 26.3.2007-30.3.2007, in collaboration with K. Fredenhagen, D. Kreimer, and J. Yngvason.
- Mini-workshop Mathematical Institute of Oberwolfach, Oberwolfach, Germany, October 2013, "New Crossroads between Mathematics and Field Theory," 21 July - 27 July 2013 in collaboration with C. Bär, C. Dappiaggi, and K. Fredenhagen.
- Workshop at E.S.I. "Algebraic Quantum Field Theory: Its status and its future," Wien, Austria 26.5.2014-30.5.2014, in collaboration with C. Dappiaggi, K. Fredenhagen, and J. Yngvason.

TEACHING ACTIVITY

- "Algebraic aspect of local quantum theories," Dip. Scienze Fisiche, Univ. di Napoli "Federico II," 1991
- "Mathematical Methods in Physics," Dip. Scienze Fisiche, Univ. di Napoli "Federico II," 1999-2000
- "Mathematical Methods in Physics," Dip. Scienze Fisiche, Univ. di Napoli "Federico II," 2000-2001
- "Mathematical Methods in Physics," Dip. Scienze Fisiche, Univ. di Napoli "Federico II," 2001-2002
- "Mathematical Analysis II" for mathematicians, Dip. di Matematica, Univ. della Basilicata, 2001-2002
- "Mathematical Analysis IV" for mathematicians, Dip. di Matematica, Univ. della Basilicata, 2001-2002
- "Introduction to microlocal analysis and applications to quantum field theory," Dept. of Mathematics, Hamburg Univ., 2001
- "Mathematical Analysis II " for mathematicians, Dip. di Matematica, Univ. della Basilicata, 2002-2003
- "Mathematical Analysis IV" for mathematicians, Dip. di Matematica, Univ. della Basilicata, 2002-2003
- "Mathematical Analysis II" for mathematicians, Dip. di Matematica, Univ. della Basilicata, 2003-2004
- "Mathematical Analysis IV" for mathematicians, Dip. di Matematica, Univ. della Basilicata, 2003-2004
- "Microlocal Analysis," Dip. di Matematica, Univ. di Trento, 2007-2008
- "Mathematical Aspects in Quantum Mechanics," Dip. di Matematica, Univ. di Trento, 2008-2009
- "Analysis II," Faculty of Engineering, Univ. di Trento, 2008-2009
- "Analysis II," Faculty of Engineering, Univ. di Trento, 2009-2010
- "Analysis II," Faculty of Engineering, Univ. di Trento, 2010-2011
- "Analysis I," Faculty of Engineering, Univ. di Trento, 2010-2011
- "Analysis I," Faculty of Engineering, Univ. di Trento, 2011-2012
- "Mathematics and Statistics," Faculty of Engineering, Univ. di Trento, 2011-2012
- "Analysis I," Faculty of Engineering, Univ. di Trento, 2012-2013
- "Geometry and Linear Algebra," Faculty of Engineering, Univ. di Trento, 2012-2013
- "Analysis 2," Dept. of Information and Communications Technologies, Univ. di Trento, 2013-2014
- "Analysis II," Dept. of Physics Univ. di Trento, 2013-2014
- "Analysis II," Dept. of Physics, Univ. di Trento, 2014-2015
- "Analysis III," Dept. of Physics, Univ. di Trento, 2015-2016
- PAF (Percorso di Approfondimento in Fisica) (honor classes: Hutchinson's Theorem and self-similar fractals as IFS), Dept. of Physics, Univ. di Trento, 2014-2015
- "Analysis II," Dept. of Physics, Univ. di Trento, 2015-2016
- PAF (Percorso di Approfondimento in Fisica) (honor classes: Hutchinson's Theorem and self-similar fractals as IFS), Dept. of Physics, Univ. di Trento, 2015-2016
- "Analysis III," Dept. of Physics, Univ. di Trento, 2016-2017
- "Topics in the Mathematical Physics of Quantum Theory," Dept. of Mathematics/Physics, Master, Univ. di Trento, 2016-2017
- "Analysis II," Dept. of Physics, Univ. di Trento, 2016-2017
- "Dynamical evolutions in quantum lattice theories," Dept. of Mathematics, Ph.D., Univ. di Trento, 2016-2017