# Marco Benini

## *Curriculum Vitae*

*Department of Mathemtics, University of Genova*
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## Scientific interests

Mathematical physics, algebraic topology, differential geometry, quantum field theory on Lorentzian manifolds, algebraic quantum field theory, higher structures in gauge theories.

## Academic career

30 Mar 2018 – 30 Mar 2027 **Abilitazione Scientifica Nazionale**, *Seconda fascia*, Settore Concorsuale 01/A2, Geometria e Algebra.

30 Mar 2018 – 30 Mar 2027 **Abilitazione Scientifica Nazionale**, *Seconda fascia*, Settore Concorsuale 01/A4, Fisica Matematica.

1 May 2019– 30 Apr 2022 **Lecturer in Mathematical Physics (RTDa MAT/07)**, *Department of Mathematics*, University of Genova, Italy.

1 Sep 2017 – 30 Apr 2019 **Research assistant in the research group of Prof. Dr. Christoph Schweigert**, *Department of Mathematics*, University of Hamburg, Germany.

1 Sep 2015 – 31 Aug 2017 **Humboldt postdoctoral fellow in the research group of Prof. Dr. Christian Bär**, *Institute of Mathematics*, University of Potsdam, Germany.

1 Feb 2015 – 31 Aug 2015 **Visiting scholar in the research group of Prof. Dr. Richard J. Szabo**, *Department of Mathematics*, Heriot-Watt University, Edinburgh, UK.

1 Feb 2013 – 31 Jul 2013 **Visiting researcher in the research group of Prof. Dr. Klaus Fredenhagen**, *II.Institute for Theoretical Physics*, University of Hamburg, Germany.

## Education

1 Nov 2011 – 31 Oct 2014 **PhD in Mathematical Physics**, *Physics Institute*, University of Pavia, Italy.
Thesis title: *Locality in Abelian gauge field theories over globally hyperbolic spacetimes*. Supervisor: Prof. Dr. Claudio Dappiaggi. Co-supervisor: Dr. Alexander Schenkel. Defended on 12 Jan 2015.

1 Nov 2009 – 31 Oct 2011 **MSc in Physics**, *University of Pavia*, Italy.
Thesis: *Relative Cauchy evolution for spin 1 fields*. Supervisor: Claudio Dappiaggi. Defended on 18 Oct 2011.

1 Nov 2006 – 31 Oct 2009 **BSc in Physics**, *University of Pavia*, Italy.
Thesis: *Supersymmetries in quantum mechanics*. Supervisor: Barbara Pasquini. Defended on 23 Oct 2009.

## Funding and prizes

Jul 2019 – Jul 2020 **INdAM Progetto Giovani 2019 (Italy)**, *Principal investigator*, Co-investigator: P. Rinaldi (University of Pavia).

Sep 2017 – Apr 2019 **Research grant funded by DFG (Germany)**, *Department of Mathematics*, University of Hamburg, Germany.

Jun 2017 – May 2018 **INdAM Progetto Giovani 2017 (Italy)**, *Co-investigator*, Principal investigator: I. Khavkine (Czech Academy of Sciences, Prague).

Sep 2015 – Aug 2017 **Postdoctoral research fellowship funded by the Alexander-von-Humboldt Foundation (Germany)**, *Institute of Mathematics*, University of Postdam, Germany.

Sep 2015 – Aug 2016 **Research grant funded by the Blanceflor Foundation (Sweden)**, *Department of Mathematics*, Heriot-Watt University, Edinburgh, UK. - *Declined*.

Feb 2015 – Aug 2015 **Research grant funded by the Della Riccia Foundation (Italy)**, *Department of Mathematics*, Heriot-Watt University, Edinburgh, UK.

Nov 2011 – Oct 2014 **PhD scholarship in Physics**, *Physics Institute*, University of Pavia, Italy.
Research area: Mathematical Physics.

11 Dec 2013 **Master thesis prize "Professors Silvio Cinquini and Maria Cinquini Cibrario"**, University of Pavia, Italy.
Thesis title: *Relative Cauchy evolution for spin 1 fields.*

Feb 2013 – May 2013 **4-month scholarship funded by DAAD (Germany)**, *II.Institute for Theoretical Physics*, University of Hamburg, Germany.

## Workshop organization

4 – 8 Jun 2018 **"Algebraic quantum field theory: Where operator algebra meets microlocal analysis"**, *Palazzone di Cortona*, Cortona, Arezzo (IT), www.dima.unige.it/aqft/cortona.
Co-organized with C. Dappiaggi, G. Morsella, N. Pinamonti and G. Ruzzi.

8 – 9 Dec 2017 **"Quantum physics meets mathematics"**, *Department of Mathematics*, University of Hamburg (DE), www.lqp2.org/node/1424.
Co-organized with D. Bahns, C. Rejzner, K.-H. Rehren and C. Schweigert.

29 May – 2 Jun 2017 **"Foundational and structural aspects of gauge theories"**, *Mainz Institute for Theoretical Physics*, Germany, indico.mitp.uni-mainz.de/event/76.
Co-organized with C. Dappiaggi and K. Fredenhagen.

18 – 24 Dec 2016 **Oberwolfach mini-workshop 1651a "New interactions between homotopical algebra and quantum field theory"**, *Mathematisches Forschungsinstitut Oberwolfach*, Germany, www.mfo.de/occasion/1651a.
Co-organized with K. Rejzner, A. Schenkel and C. Schweigert.

## Teaching

2019/20 II sem **Analytical Mechanics**, *Department of Mathematics*, University of Genoa, Italy.
Mainly exercise sessions (22 hours).

2019/20 **Mathematical Analysis 2**, *Department of Mathematics*, University of Genoa, Italy.
Mainly exercise sessions (38 hours) for second year B.Sc. students of Physics and Mathematical Statistics and Data Management (SMID).

Oct 2018 **Prep course for mathematical master programs**, *Department of Mathematics*, University of Hamburg, Germany.
Preparatory course for students starting one of the master programs (Pure Mathematics, Mathematical Physics, Business Mathematics) in Mathematics offered by the University of Hamburg.

Oct 2017 **Prep course for mathematical master programs**, *Department of Mathematics*, University of Hamburg, Germany.
Preparatory course for students starting one of the master programs (Pure Mathematics, Mathematical Physics, Business Mathematics) in Mathematics offered by the University of Hamburg.

Oct 2016 – Feb 2017 **Algebraic topology**, *Inst. Mathematics*, University of Potsdam, Germany.
Exercise classes and tutorial sessions.

Mar 2014 – Jun 2014 **Foundations of mechanics**, *Dept. Mathematics*, University of Pavia, Italy.
Exercise classes and tutorial sessions.

## Advising experience

Gorgio Musante **Master student at the University of Pavia**, *graduation expected in Oct 2020*, co-supervised with Prof. Dr. Claudio Dappiaggi.

Angelos Anastopoulos **PhD student at the University of Genoa**, *Nov 2019 – Oct 2022*, project: Higher structures in algebraic quantum field theory.

Albin Grataloup **Internship at University of Hamburg**, *École Normale Supérieure de Lyon*, Oct 2018 – Feb 2019.

Matteo Capoferri

**Master student at the University of Pavia (now PhD student at University College London, United Kingdom)**, *graduated on 21 Jul 2016*, co-supervised with Prof. Dr. Claudio Dappiaggi, thesis title: *Algebra of observables and states for quantum Abelian duality.*

## Publications

### Pre-prints

[P-3] M. Benini, M. Perin, A. Schenkel, *Smooth 1-dimensional algebraic quantum field theories,* Oct 2020, preprint `arXiv`:2010.13808 [math-ph].

[P-2] M. Benini, A. Schenkel, B. Vicedo, *Homotopical analysis of 4d Chern-Simons theory and integrable field theories,* Aug 2020, preprint `arXiv`:2008.018297 [hep-th].

[P-1] M. Benini, M. Perin, A. Schenkel, L. Woike, *Categorification of algebraic quantum field theories,* Mar 2020, `arXiv`:2003.13713 [math-ph].

### Articles on peer-reviewed journals

[A-20] M. Benini, A. Schenkel, L. Woike, *Operads for algebraic quantum field theory,* **Commun. Contemp. Math.** 23:2 (2021) 2050007, DOI: 10.1142/S0219199720500078, `arXiv`:1709.08657 [math-ph].

[A-19] M. Benini, S. Bruinsma, A. Schenkel, *Linear Yang-Mills theory as a homotopy AQFT,* **Commun. Math. Phys.** 378:1 (2020) 185, DOI: 10.1007/s00220-019-03640-z, `arXiv`:1906.00999 [math-ph].

[A-18] M. Benini, M. Perin, A. Schenkel, *Model-independent comparison between factorization algebras and algebraic quantum field theory on Lorentzian manifolds,* **Commun. Math. Phys.** 377:2 (2020) 971, DOI: 10.1007/s00220-019-03561-x,`arXiv`:1903.03396 [math-ph].

[A-17] M. Benini, A. Schenkel, L. Woike, *Involutive categories, colored $*$-operads and quantum field theory,* **Theory Appl. Categ.** 34:2 (2019) 13, `arXiv`:1802.09555 [math.CT].

[A-16] M. Benini, A. Schenkel, L. Woike, *Homotopy theory of algebraic quantum field theories,* **Lett. Math. Phys.** 109:7 (2019) 1487, DOI: 10.1007/s11005-018-01151-x, `arXiv`:1805.08795 [math-ph].

[A-15] C. Becker, M. Benini, A. Schenkel, R. J. Szabo, *Cheeger-Simons differential characters with compact support and Pontryagin duality,* **Commun. Anal. Geom.** 27:7 (2019) 1473, DOI: 10.4310/CAG.2019.v27.n7.a2, `arXiv`:1511.00324 [math-ph].

[A-14] M. Benini, C. Dappiaggi, A. Schenkel, *Algebraic quantum field theory on spacetimes with timelike boundary,* **Ann. Henri Poincaré** 19:8 (2018) 2401, DOI: 10.1007/s00023-018-0687-1, `arXiv`:1712.06686 [math-ph].

[A-13] M. Benini, A. Schenkel, U. Schreiber, *The stack of Yang-Mills fields on Lorentzian manifolds,* **Commun. Math. Phys.** 359:2 (2018) 765, DOI: 10.1007/s00220-018-3120-1, `arXiv`:1704.01378 [math-ph].

[A-12] M. Benini, A. Schenkel, *Quantum field theories on categories fibered in groupoids,* **Commun. Math. Phys.** 356:1 (2017) 19, DOI: 10.1007/s00220-017-2986-7, `arXiv`:1610.06071 [math-ph].

[A-11] M. Benini, M. Capoferri, C. Dappiaggi, *Hadamard states for quantum Abelian duality,* **Ann. Henri Poincaré** 18:10 (2017) 3325, DOI: 10.1007/s00023-017-0593-y, `arXiv`:1611.10282 [math-ph].

[A-10] M. Benini, A. Schenkel, *Poisson algebras for non-linear field theories in the Cahiers topos,* **Ann. Henri Poincaré** 18:4 (2017) 1435, DOI: 10.1007/s00023-016-0533-2, `arXiv`:1602.00708 [math-ph].

[A-9] C. Becker, M. Benini, A. Schenkel, R. J. Szabo, *Abelian duality on globally hyperbolic spacetimes,* **Commun. Math. Phys.** 349:1 (2017) 361, DOI: 10.1007/s00220-016-2669-9, `arXiv`:1511.00316 [math-ph].

[A-8] M. Benini, *Optimal space of linear classical observables for Maxwell $k$-forms via spacelike and timelike compact de Rham cohomologies,* **J. Math. Phys.** 57:5 (2016) 053502, DOI: 10.1063/1.4947563, `arXiv`:1401.7563 [math-ph].

[A-7] M. Benini, A. Schenkel, R. J. Szabo, *Homotopy colimits and global observables in Abelian gauge theory,* **Lett. Math. Phys.** 105:9 (2015) 1193, DOI: 10.1007/s11005-015-0765-y, arXiv:1503.08839 [math-ph].

[A-6] M. Benini, *Relative Cauchy evolution for the vector potential on globally hyperbolic spacetimes*, **Mathematics and Mechanics of Complex Systems** 3:2 (2015) 177, DOI: 10.2140/memocs.2015.3.177.

[A-5] M. Benini, C. Dappiaggi, S. Murro, *Radiative observables for linearized gravity on asymptotically flat spacetimes and their boundary induced states,* **J. Math. Phys.** 55:8 (2014) 082301, DOI: 10.1063/1.4890581, arXiv: 1404.4551 [gr-qc].

[A-4] M. Benini, C. Dappiaggi, T.-P. Hack, A. Schenkel, *A $C^*$-algebra for quantized principal $U(1)$-connections on globally hyperbolic Lorentzian manifolds,* **Commun. Math. Phys.** 332:1 (2014) 477, DOI: 10.1007/s00220-014-2100-3, arXiv:1307.3052 [math-ph].

[A-3] M. Benini, C. Dappiaggi, A. Schenkel, *Quantized Abelian principal connections on Lorentzian manifolds,* **Commun. Math. Phys.** 330:1 (2014) 123, DOI: 10.1007/s00220-014-1917-0, arXiv:1303.2515 [math-ph].

[A-2] M. Benini, C. Dappiaggi, A. Schenkel, *Quantum field theory on affine bundles,* **Ann. Henri Poincaré** 15:1 (2014) 171, DOI: 10.1007/s00023-013-0234-z, arXiv:1210.3457 [math-ph].

[A-1] M. Benini, C. Dappiaggi, T.-P. Hack, *Quantum field theory on curved backgrounds – A primer,* **Int. J. Mod. Phys. A** 17:28 (2013) 1330023, DOI: 10.1142/S0217751X13300238, arXiv:1306.0527 [gr-qc].

### Book contributions

[B-1] M. Benini, C. Dappiaggi, *Models of free quantum field theories on curved backgrounds,* in **Advances in Algebraic Quantum Field Theory**, eds. R. Brunetti, C. Dappiaggi, K. Fredenhagen, J. Yngvason, Springer (2015), DOI: 10.1007/978-3-319-21353-8_3, arXiv:1505.04298 [math-ph].

### Conference proceedings

[C-2] M. Benini, A. Schenkel, *Higher structures in algebraic quantum field theory,* Proceedings of the LMS-EPSRC Durham symposium "Higher structures in M-theory", 12-18 Aug 2018, **Fortschritte der Physik** 67:8-9 (2019) 1910015, DOI: 10.1002/prop.201910015, arXiv:1903.02878 [math-ph].

[C-1] M. Benini, K. Rejzner, A. Schenkel, C. Schweigert, Book of abstracts for the mini-workshop "New interactions between homotopical algebra and quantum field theory", 18-23 Dec 2016, **Oberwolfach Rep.** 13:4 (2016) 3261, DOI: 10.4171/OWR/2016/58.

### Theses

[T-2] M. Benini, *Locality in Abelian gauge theories over globally hyperbolic spacetimes,* PhD thesis, University of Pavia, Nov 2014, ISBN 978-88-95767-78-9, arXiv:1503.00131 [math-ph].

[T-1] M. Benini, *Relative Cauchy evolution for spin 1 fields,* tesi di laurea magistrale, University of Pavia, Oct 2011, arXiv:1111.6471 [math-ph].

## Invited talks

18 Apr 2019 *Higher structures in quantum gauge theories*, "Algebraic and Geometric Aspects in Quantum Field Theory", Mathematical Institute, University of Freiburg (DE).

15 Feb 2019 *Algebraic quantum field theory and gauge theories*, Department of Mathematics, University of Genoa (IT).

14 Jan 2019 *Higher structures in quantum gauge theories*, Institute for Theoretical Physics, University of Leipzig (DE).

15 Nov 2018 *Homotopy field theories*, Department of Mathematics, University of Rome Tor Vergata (IT).

31 Oct 2018 *Homotopy field theories*, DISAT, University of Insubria, Como (IT).

26 Sep 2018 *Homotopy theory of algebraic quantum field theor*ies, School of Mathematical Sciences, The University of Nottingham (UK).

11 Sep 2018 *Operads and homotopy theory in algebraic quantum field theory*, Institute of Mathematics, Czech Academy of Sciences, Praga (CZ).

26 Jun 2018 *Homotopy theory and gauge theories*, Department of Mathematics, University of Hamburg (DE).

16 May 2018 *Homotopical approach to gauge theories*, Department of Mathematics, University of Pisa (IT).

10 Apr 2018 *Operads and homotopy theory in algebraic quantum eld theory*, Max Planck Institut für Mathematik, Bonn (DE).

18 Oct 2017 *Operads for algebraic quantum field theory*, School of Mathematical Sciences, The University of Nottingham (UK).

6 Sep 2017 *The operad of algebraic quantum field theories*, "Modern mathematics of quantum theory", Department of Mathematics, University of York (UK).

5 Jun 2017 *Algebraic quantum field theory meets homotopical algebra*, "Field Theories and Higher Structures in Mathematics and Physics", CMO-BIRS, Oaxaca (MX).

25 Apr 2017 *Algebraic quantum field theory meets homotopy theory and operads*, "Symposium in Mathematical Physics", Institute of Mathematics, University of Zurich (CH).

13 Jan 2017 *Hadamard states for quantum Abelian duality*, "Microlocal analysis: a tool to explore the quantum world", Department of Mathematics, University of Genova (IT).

22 Dec 2016 *Homotopy locally covariant quantum field theory*, "New interactions between homotopical algebra and quantum field theory", Mathematisches Forschungsinstitut Oberwolfach (DE).

26 Oct 2016 *Locally covariant quantum field theory up to homotopy*, School of Mathematical Sciences, The University of Nottingham (UK).

4 Feb 2016 *Maxwell's equations, electric/magnetic charges, duality and differential cohomology*, "GK Colloquium", Faculty of Mathematics, University of Regensburg.

28 Jan 2016 *Homotopical computations for Abelian gauge theory*, "ZMP Colloquium", DESY, Hamburg.

28 Jan 2016 *A homotopical algebra approach to gauge theories*, "Seminar Quantum Physics and Geometry", DESY, Hamburg.

20 Nov 2015 *Differential cohomology with compact support*, "Oberseminar Deformationsquantisierung", Institute for Mathematics, University of Würzburg.

24 Sep 2015 *Global observables for Abelian gauge theories via homotopy colimits*, "DMV2015 - Minisymposium: Algebraic QFT on Lorentzian manifolds", Hamburg.

1 Jul 2014 *Generally covariant gauge field theory*, Department of Mathematics, Heriot-Watt University, Edinburgh.

20 May 2014 *Optimal observables for gauge theories via cohomology with restricted support*, "Algebraic Quantum Field Theory: Its Status and its Future", Erwin Schrödinger International Institute for Mathematical Physics, Vienna.

15 Apr 2014 *Optimal space of observables for gauge field theories*, "Problemi Attuali di Fisica Teorica", Lloyd's Baia Hotel, Vietri sul Mare (SA).

16 May 2012 *Relative Cauchy evolution for the electromagnetic field*, II.Institute for Theoretical Physics, University of Hamburg.

## Languages

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|---|---|---|
| Italian | Native | |
| English | Advanced | *C2 according to the European Language Grid* |
| German | Basic | *A2 according to the European Language Grid* |