

# VINCENZO MORINELLI | CV

## UNIVERSITÀ DEGLI STUDI DI MILANO

selezione pubblica per n.1 posto di Ricercatore a tempo determinato ai sensi dell'art.24, comma 3, lettera b) della Legge 240/2010 per il settore concorsuale 01/A3 - Analisi Matematica, Probabilità e Statistica Matematica, settore scientifico-disciplinare MAT/05 - Analisi Matematica presso il Dipartimento di Matematica "Federigo Enriques", (avviso bando pubblicato sulla G.U. n. 68 del 01/09/2020) Codice concorso 4453

- » **Born:** Torre del Greco, Naples - Italy, January 9, 1989.
- » **Office:** Mathematics Department, "Tor Vergata" University of Rome, via della Ricerca Scientifica, 1 - I-00133 Rome, Italy.
- » **E-mail:** [v.morinelli@gmail.com](mailto:v.morinelli@gmail.com), [morinell@mat.uniroma2.it](mailto:morinell@mat.uniroma2.it)
- » **Webpage:** <https://sites.google.com/view/vincenzo-morinelli>



## »»» Employment history

- |                 |   |   |
|-----------------|---|---|
| Mar '20-Feb '21 | <b>Postdoctoral Researcher</b>  | "Tor Vergata" Univ. of Rome                   |
|                 | » postdoc for the Roberto Longo ERC advanced grant "Quantum Algebraic Structures and Models".   |   |
| Mar '19-Feb '20 | <b>Postdoctoral Researcher</b>  | INdAM (Istituto Nazionale di Alta Matematica) |
|                 | » collaboration postdoc fellowship provided by <b>INdAM, the National Institute for High Mathematics</b> . My research project "Operator algebraic aspects of Quantum Field Theory is 2 <sup>nd</sup> ranked on the call. Host Institution: "Tor Vergata" Univ. of Rome |   |
| Mar 16-Feb '19  | <b>Postdoctoral Researcher</b>  | "Tor Vergata" Univ. of Rome                   |
|                 | » postdoc for the Roberto Longo ERC advanced grant "Quantum Algebraic Structures and Models"; from 01/03/2018 supported by the program MIUR FARE R16X5RB55W.  |   |

## »»» Education

- |                |   |                             |
|----------------|---|-----------------------------|
| Dec 15th, 2015 | <b>Ph.D. in Mathematics</b>   | "Tor Vergata" Univ. of Rome |
|                | » <b>Thesis:</b> "On the Bisognano-Wichmann Property, Nuclearity and Particle Localization", Advisor: Prof. Roberto Longo.  |                             |
| Jul 18th, 2012 | <b>Master's degree in Mathematics</b>   | "Roma Tre" Univ. of Rome    |
|                | » Final Mark: 110/110 cum Laude   |                             |
|                | » <b>Thesis:</b> "The Semilinear Klein-Gordon Equation in two and three space dimensions", Advisor: Prof. Giovanni Mancini. |                             |
| Jul 15th, 2010 | <b>Bachelor's degree in Mathematics</b>   | "Roma Tre" Univ. of Rome    |
|                | » Final Mark: 110/110 cum Laude   |                             |

## »»» Fields of interests

My **research interests** concern *Functional Analysis*, *Operator Algebras* and its applications to *Relativistic Quantum* systems with infinitely many degrees of freedom. My research centrally involves further topics as *Operator Theory*, (*compact and locally compact*) *Group Representation Theory*, Lie algebra/group theory, *Wavelet Theory*, Subfactor theory. Moreover part of my research is deeply related with *Entropy in Quantum Information*. *Partial differential equations*, in particular elliptic and hyperbolic equations, are also part of my background (referring to undergraduate studies, cf. master thesis).

I am also interested in **science communication** (see additional information section).

## Scientific Contributions:

My research concerns the relation between geometric and algebraic properties in the operator algebraic approach to QFT. The Haag-Kastler axioms describe (continuum) infinite degrees of freedom systems respecting basic quantum and relativistic assumptions. In brief, models are defined axiomatically by algebras of bounded operators (observables) on an infinite dimensional Hilbert space, associated to regions of the spacetime (Minkowski,  $S^1$ -chirality) undergoing a covariant action of the symmetry group (Poincaré, Möbius, Diffeomorphisms...). They further commute when they are spacelike separated (locality).

### My scientific contributions:

- Solution of a long standing problem on infinite spin representations localization property (Paper 1)  
*We study the (non-)dilation covariance of infinite spin Poincaré representations to conclude the absence of local algebras*  
with R. Longo (Univ. Tor Vergata) and K.-H. Rehren (Univ. Göttingen)
- An algebraic sufficient condition for the Bisognano-Wichmann property (Paper 2,4)  
*I introduce new algebraic condition on the Poincaré covariant representation that ensures an identification of algebraic and geometric objects/symmetries.*
- Split Property for conformal field theories (Paper 3)  
*Existence of product state (statistical independence) for local positive-spacelike separated von Neumann algebras under conformal symmetry assumption*  
with Y. Tanimoto (Univ. Tor Vergata) and M. Weiner (BME).
- Dilation covariance imply Möbius covariance in 1+1 spacetime dimension (Paper 5)  
*Algebraic structure of von Neumann algebra (Tomita operators) allows a larger symmetry group: from Poincaré + Dilation to conformal (Möbius) symmetries*  
with Y. Tanimoto (Univ. Tor Vergata)
- Split Property for free massless finite helicity fields (Paper 6)  
*Existence of conformal subtheories ensure the existence of product states (statistical independence) for positive-spacelike separated local von Neumann algebras*  
with R. Longo (Univ. Tor Vergata), F. Preta (NYU), K.-H. Rehren (Univ. Göttingen)
- Bisognano-Wichmann property in massless interacting theory (Publication 7)  
*Identification of geometric and algebraic objects in general QFT (possibly interacting); breakthrough technique based on Publication 4.*  
with W. Dybalski (TU München)
- New algebraic constructions in QFT Publication 8)  
*New constructions and relations between Poincaré representations and free QFT obtained by deforming Lie generators*  
with K.-H. Rehren (Univ. Göttingen)
- Scaling limit and operator-algebraic renormalization procedure (preprint 1, a review on the paper in preparation 1.)  
*We provide a rigorous operator algebraic procedure for the lattice scaling limit to the continuum which applies to the free field. A central role in the lattice approximation is covered by wavelets and scaling functions* with G. Morsella, A. Stottmeister, Y. Tanimoto

## Ongoing projects topics:

- Algebraic sufficient condition for the Bisognano-Wichmann property, Modular covariance in Quantum Field Theory.
- Nuclearity and compactness conditions on superselection sectors, namely for the representation theory of chiral theories.
- Modular covariance on Lie group and for general interacting theories  
in part with K.-H. Neeb (Univ. Erlangen-Nürnberg) and W. Dybalski (TU München)
- Scaling limit on lattice Quantum field theory  
with A. Stottmeister (Univ. Münster) (Univ. Münster), Gerardo Morsella and Yoh Tanimoto (Univ. Tor Vergata)
- Entropy and Tomita modular theory in QFT  
in part with R. Longo (Univ. Tor Vergata) and G. Lechner (Univ. Cardiff)



## Publications:

### Published:

1. R. Longo, V. Morinelli, K.-H. Rehren, *Where Infinite Spin Particles Are Localizable*, Commun. in Math. Phys., Volume 345, Issue 2, pp 587–614 (2016).  
<https://doi.org/10.1007/s00220-015-2475-9>
2. V. Morinelli, *An algebraic condition for the Bisognano-Wichmann Property*, Proceedings of the 14th Marcel Grossmann Meeting - MG14, Rome pp. 3849–3854 (2017)  
[https://doi.org/10.1142/9789813226609\\_0509](https://doi.org/10.1142/9789813226609_0509)
3. V. Morinelli, Y. Tanimoto, M. Weiner, *Conformal covariance and the split property* Commun. Math. Phys. Volume 357, Issue 1, pp 379–406 (2018).  
<https://doi.org/10.1007/s00220-017-2961-3>
4. V. Morinelli, *The Bisognano-Wichmann property on nets of standard subspaces, some sufficient conditions*, Ann. Henri Poincaré, Volume 19, Issue 3, 937–958 (2018).  
<https://doi.org/10.1007/s00023-017-0636-4>
5. V. Morinelli, Y. Tanimoto, *Scale and Möbius covariance in two-dimensional Haag-Kastler net*, Commun. in Math. Phys. Vol 371, Issue 2, pp 619–650 (2019)  
<https://doi.org/10.1007/s00220-019-03410-x>
6. R. Longo, V. Morinelli, F. Preta, K.-H. Rehren, *Split property for free finite helicity fields*, Ann. Henri Poincaré, Volume 20, Issue 8, pp 2555–2258 (2019).  
<https://doi.org/10.1007/s00023-019-00820-4>
7. W. Dybalski, V. Morinelli, *Bisognano-Wichmann property for asymptotically complete massless QFT*, Commun. in Math. Phys. (2020) - In press  
<https://doi.org/10.1007/s00220-020-03755-8>
8. V. Morinelli, K.-H. Rehren, *Spacelike deformations: Higher-helicity fields from scalar fields*, Lett. in Math. Phys., 110, 2019–2038 (2020)  
<https://doi.org/10.1007/s11005-020-01294-w>

### Preprint:

1. A. Stottmeister, V. Morinelli, G. Morsella, Y. Tanimoto, *Operator-algebraic renormalization and wavelets*<sup>1</sup>  
<https://arxiv.org/abs/arXiv:2002.01442> (2020) (submitted to a scientific journal)

### In preparation:

1. V. Morinelli, G. Morsella, A. Stottmeister, Y. Tanimoto, *Scaling limit and operator-algebraic renormalization* (expected 2020)
2. V. Morinelli, and K.-H. Neeb, *Covariant homogeneous nets of standard subspaces* (expected 2020)

## Involvement in funding research projects:

- June 15th, 2016 - December 15th, 2017: participating in the research project: Ricerca Scientifica di Ateneo, Consolidate the Foundations - *Operator Algebraic Structures in Noncommutative Geometry*.
- December 1st, 2019 - June 1st, 2021: participating in the research project: Ricerca Scientifica di Ateneo, Beyond Borders - *Interaction of Operator Algebras with Quantum Physics and Noncommutative Structure*

## Student supervision

- Benedikt Wegener, (INdAM Cofund, Univ. Roma Tor Vergata, Advisor: Prof Roberto Longo), **Ph. D. Student**, Ongoing
- Francesco Preta, (Univ. Roma Tor Vergata, Advisor: Prof. Roberto Longo), **M. sc.** 2015- Joint paper on Annales Henri Poincaré. Now he is Ph.D. student at New York University (NYU), Courant Institute of Mathematical Sciences.
- Francesco Bonesi (Univ. Roma Tor Vergata, Advisor: Prof. Roberto Longo), **M.Sc.** 2014 (unofficially), Stefania Romani (Univ. Roma Tor Vergata, Advisor: Prof. Gerardo Morsella), **M.Sc.** 2013 (unofficially)



<sup>1</sup>the contribution of the authors have to be considered equal. Alexander Stottmeister is the corresponding author.

## Services

- **Referee** for Communication in Mathematical Physics, Annales Henri Poincaré, Nuclear Physics B.
- **Reviewer** for Mathematical Reviews of AMS.

## Organization of international conferences

- 43rd LQP workshop "Foundations and Constructive aspects of QFT" Galileo Galilei Institute Firenze (Italy) February 20-22, 2019.  
**Webpage:** <https://sites.google.com/view/43-lqp>

## Some special events I took part:

1. May 2-8, 2014, spring school: "NCGOA Spring Institute 2014, Subfactors, CFT and VoA", Department of Mathematics, **Vanderbilt University, Nashville, Tennessee, USA**.
2. March, 22-28, 2015, workshop: "Subfactors and Conformal Field Theory", **Oberwolfach**, Germany.
3. July 12-18, 2015 "**14th Marcel Grossmann Meeting**" Rome, Italy.  
**Invited talk:** "Where Infinite Spin Particles Are Localizable" ("QF3 - Operator Algebras and Quantum Field Theory" session)
4. February 8-14, 2017, "Operator Algebras: Subfactors and their Applications" programme, Isaac Newton Institute, **Cambridge**, UK.  
**Invited talk:** "Conformal covariance and the split property".  
<http://www.newton.ac.uk/seminar/20170209140015002>
5. June, 17-22, 2019, Participation to the program at **the Simons Center for Geometry and Physics Program: Operator Algebras and Quantum Physics**, State University of **New York, Stony Brook (USA)**.  
**Invited talk:** Scale and Möbius covariance in two-dimensional Haag-Kastler net.  
[http://scgp.stonybrook.edu/video\\_portal/video.php?id=4176](http://scgp.stonybrook.edu/video_portal/video.php?id=4176)
6. July 10, 2020, **Colloquium** "Mathematical Physics Regensburg-Munich", LMU and TU Munich.  
**Invited talk:** "Covariant homogeneous nets of standard subspaces".

## Next events I will join to

- August 17th-21st, 2020, International Workshop on Operator Theory and its Applications, Lancaster (UK).  
**Invited talk** at special session on "Quantum groups and algebraic quantum field theory" Postponed for COVID pandemic to 2021

## Some events I took part:

### Past events:

1. December 17-19, 2012, workshop: "NGAP - Noncommutative geometry and application to physics" Milan, Italy.
2. January 29-February 2, 2013, workshop: "Trails in quantum mechanics and surroundings" Frascati, Italy.
3. June 17-28, 2013, summer school: "Rigidité et actions de groupes" at Institut Mathématiques de Jussieu, at Paris Diderot University, Paris, France.
4. July 8-12, 2013 workshop: "Mathematics and Quantum Physics" Accademia dei Lincei, Rome, Italy.
5. September 1-8, 2013, workshop: "Noncommutative Geometry and Applications" organized by Stoilow Institute of Mathematics of the Romanian Academy, Poiana Brasov, Romania.
6. November 14-16, 2013, workshop: 33rd Workshop "Foundations and Constructive Aspects of QFT", Göttingen, Germany,
7. June 16-21, 2014, workshop: "Noncommutative Geometry and Applications"; Villa Mondragone, Frascati, Italy.
8. February 11-13, 2015, workshop: "New trends in algebraic quantum field theory", LNF-INFN, Frascati, Italy
9. April 20-24, 2015, conference: "Advances in Noncommutative Geometry", Paris, France;  
**Invited talk:** "The Bisognano-Wichmann Theorem and Particle Localization"
10. May 29-30, 2015, workshop: "36th, Local Quantum Physics", Leipzig, Germany.  
**Title of the talk:** "On Localization of Infinite Spin Particles"



11. May 17-25, 2016, "*NCGOA Spring Institute 2016*", Bonn, Germany.
12. June 23, 2016, "*Ph.D. Colloquium*", Uni. Tor Vergata, Rome, Italy.  
**Invited talk:** "Particle Localization and Infinite Spin"
13. December 20, 2016, "*Department's day*", Uni. Tor Vergata, Rome, Italy.  
**Invited talk:** "Conformal covariance and the split property".
14. June 6-September 30, 2016, "*Intensive trimester Mathematics and Physics at the Crossroads*" LNF, Frascati and INdAM, Rome, Italy.
15. February 26- March 3, 2017, workshop: "*Noncommutative Geometry and Applications*", ICTP - Trieste, Italy.  
**Invited talk:** "Conformal covariance and the split property".
16. June 23-24, 2017, *LQP 40 Foundations and Constructive Aspects of Quantum Field Theory*, Max-Planck institute for Mathematics in the Sciences, Leipzig (Germany).
17. September 19-22, 2017, "Advances in Mathematics and Theoretical Physics" accademia dei Lincei, Rome.
18. December 8-10, 2017, workshop "Quantum Physics meets Mathematics", Hamburg, Germany.
19. February 2-3, 2018, workshop: "*41st, Local Quantum Physics*", Leipzig, Germany.  
**Title of the talk:** "A sufficient condition for the Bisognano-Wichmann property"
20. February 15-16, 2018, workshop "*Quantum Information and Operator Algebras*", INdAM, Rome (Italy)
21. June 4-8, 2018, conference "Algebraic Quantum Field Theory: where Operator Algebra meets Microlocal Analysis", INdAM meeting, Cortona (Italy).  
**Title of the Talk:** "A sufficient condition for the Bisognano-Wichmann property".
22. February 20-22, 2019, 43rd LQP workshop "Foundations and Constructive aspects of QFT" Galileo Galilei Institute Firenze (Italy). **I am part of the organizing committee.**
23. April 16-18, 2019, "Algebraic and geometric aspects in Quantum Field Theory", Universität Freiburg, (Germany),  
**Invited talk:** Bisognano-Wichmann property for asymptotically complete massless theories.
24. December 4-7, 2019, "Operator Algebras in Quantum Field Theory and Quantum Probability", Department of Mathematics, University of Rome Tor Vergata  
**Invited talk:** Bisognano-Wichmann property for asymptotically complete massless theories.
25. June 17-19, 2020, "First Virtual LQP Workshop - 45th LQP", Cardiff Univ. School of Mathematics  
**Title of the talk:** Covariant homogeneous nets of standard subspaces

## Scientific visits

1. May 30-June 6, 2015 visiting Prof. K.-H. Rehren at Institut für Theoretische Physik, Göttingen, Germany.
2. January 23-28, 2017, Visiting Prof. Mihaly Weiner at Department of Mathematical Analysis, Budapest University of Technology and Economics (BME)
3. August 21-25, 2017, visiting Dr. Wojciech Dybalski, Technische Universität München, München (Germany)  
**Invited Seminar talk:** "An algebraic condition for the Bisognano-Wichmann property"
4. December 3-8, 2017 visiting Prof. K.-H. Rehren at Institut für Theoretische Physik, Göttingen, Germany.  
**Invited Seminar talk:** "An algebraic condition for the Bisognano-Wichmann property".
5. March 11-16, 2018, visiting Dr. Wojciech Dybalski, Technische Universität München, München (Germany)  
**Invited Seminar talk:** "Comments on the Split property for conformal theories in 3+1 dimensional spacetime"
6. November 5-10, 2018, visiting Dr. Wojciech Dybalski, Technische Universität München, München (Germany)  
**Invited Seminar talk:** "Scale and Möbius covariance in two-dimensional Haag-Kastler net"
7. January 27 - February 2, 2019, visiting Prof. Gandalf Lechner, Univ. Cardiff, School of Mathematics (United Kingdom)  
**Invited Seminar talk:** "Scale and Möbius covariance in two-dimensional Haag-Kastler net"
8. April 8-12, 2019, Visiting Prof. Claudio Dappiaggi, Univ. Pavia. (Italy).  
**Invited Seminar talk:** Split property for free massless finite helicity fields.





9. May 5-10, 2019, visiting Dr. Daniela Cadamuro, Institute of Theoretical Physics, Leipzig (Germany).  
**Invited Seminar talk:** Split property for free massless finite helicity fields.
10. July 21-26, 2019, visiting K.-H. Neeb, Department Mathematik, FAU Erlangen-Nürnberg, (Germany).  
**Invited Seminar talk:** On the Bisognano-Wichmann property for one-particle nets.
11. February 23- March 6, 2020, visiting K.-H. Neeb, Department Mathematik, FAU Erlangen-Nürnberg, (Germany).  
**Invited Seminar Talk:** Spacelike deformations: Higher-spin fields from scalar fields

### »» Teaching:

- Teaching assistance at University of Rome "Tor Vergata":
  - **a.y. 2019/2020** Course: "Matematica Generale" at Economy and Finance department, Tor Vergata University (Prof. Stefano Viaggiu).
  - **a.y. 2018/2019** Course: "Matematica Generale" at Economy and Finance department, Tor Vergata University (Prof. Stefano Viaggiu).
  - **a.y. 2017/2018** Course: "Matematica Generale" at Economy and Finance department, Tor Vergata University (Prof. Stefano Viaggiu).
  - **a.y. 2016/2017** Course: "Matematica Generale" at Economy and Finance department, Tor Vergata University (Prof. Stefano Viaggiu).
  - **a.y. 2015/2016** Course: "Matematica Generale" at Economy department, Tor Vergata University (Prof. Stefano Viaggiu).
  - **a.y. 2012/2013** Teaching assistance for the Bachelor/Master degree courses in Mathematics (Prof. Livio Triolo).
- Teaching assistance at University of Rome "Roma Tre":
  - **from a.y. 2010/11 to a.y. 2011/12** Course of Mathematical Analysis: "AM210 - Analisi Matematica 3" at Mathematics Department (Prof. Giovanni Mancini).
  - **a.y. 2011/12** Course of Mathematical Analysis: "AM120 - Analisi Matematica 2" at Mathematics Department (Prof. Luigi Chierchia).
  - **a.y. 2009/10** Course of Mathematical Analysis: "AM2 - Analisi Matematica 2" at Mathematics Department (Prof. Giovanni Mancini).
  - **a.y. 2009/10** Course of Mathematical Analysis: "AM3 - Analisi Matematica 3" at Mathematics Department (Prof. Pierpaolo Esposito).

### »» For Recommendation Information

- **Prof. Roberto Longo**, Univ. of Rome Tor Vergata, [longo@mat.uniroma2.it](mailto:longo@mat.uniroma2.it)
- **Prof. Karl-Henning Rehren**, Univ. of Göttingen, [rehren@theorie.physik.uni-goettingen.de](mailto:rehren@theorie.physik.uni-goettingen.de)
- **Prof. Karl-Hermann Neeb**, Univ. Erlangen-Nürnberg, [neeb@mi.uni-erlangen.de](mailto:neeb@mi.uni-erlangen.de)

### »» Additional information:

- Member of INdAM-GNAMPA from 2012
- **Science communication:** 2016-2017, attending the "Scuola Sperimentale di Comunicazione della Scienza" ("Sperimental school of Science Communication"), Rome, Italy: school with lectures given by experts in communicating science for INFN, ASI, CNR, Radio Tre, and chief editors of Zanichelli  
<http://maddmaths.simai.eu/news-2/scuola-sperimentale-di-comunicazione-della-scienza-201617/>  
I collaborate with the blog on Mathematics and its applications: *Math is in the air - Blog divulgativo sulla matematica applicata*: <http://www.mathisintheair.org/wp/author/vincenzo/>  
*The article on false positive had more than 1500 reads.*
- Programming Languages/Mathematics Software: C, Mathematica.
- Languages: Italian (native language), English (second language), French (Intermediate), German (beginner)

- September, 2007, Grant by Roma Tre University for first year students of Bachelor's courses of Mathematics.
- May, 2011, 14<sup>th</sup> placement to the mathematical national contest organized by INdAM

## »» Me at the Politecnico of Milan

The researcher position at the University of Politecnico of Milan would be one of the greatest environment to further develop my research and expand my scientific interests by interacting with the Mathematical Analysis group. I am particularly interested in a scientific collaboration with *Prof. Fabio Cipriani* and his collaborators on Spectral Triples, Dirichlet forms and Noncommutative analysis on Fractals. Indeed, there are many relations with my research on lattice approximation and on Scaling Limit of Theories on Lattices and potential theory on fractals (see Ongoing project section).

My Partial Differential Equation background (cf. my master thesis ) allows me to interact with a larger community and possibly motivate new collaborations.

**Le dichiarazioni rese nel presente curriculum sono da ritenersi rilasciate ai sensi degli artt. 46 e 47 del D.P.R. 445/2000.**

Rome, 14/09/2020



Vincenzo Morinelli