Marco Benini

Curriculum Vitae

Physics Institute - University of Pavia (on leave)
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Last update: January 20, 2015.

Post-doctoral experience

Feb – Aug 2015 **Visiting researcher**, *Department of Mathematics*, Heriot-Watt University, United Kingdom.
Project: *Abelian duality in algebraic quantum field theory.* Supervisor: Prof. Dr. Richard J. Szabo.

Education

Nov 2011 – Jan 2015 **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.

Feb – Jul 2013 **Visiting researcher**, *II.Institute for Theoretical Physics*, University of Hamburg, Germany.
Project: *Abelian Yang-Mills field theory on globally hyperbolic spacetimes in the framework of general local covariance.* Supervisor: Prof. Dr. Klaus Fredenhagen.

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

Oct 2006 – Oct 2009 **BSc in Physics**, *University of Pavia*, Italy.
Thesis: *Supersymmetries in quantum mechanics.* Supervisor: Barbara Pasquini.

Grants and Prizes

Feb – Aug 2015 **Research grant funded by the Della Riccia Foundation**, *Department of Mathematics*, Heriot-Watt University, United Kingdom.

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

Dec 11, 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 – May 2013 **4-month DAAD scholarship**, *II.Institute for Theoretical Physics*, University of Hamburg, Germany.

Teaching

Mar – Jun 2014 **Foundations of mechanics**, *Mathematics Institute*, University of Pavia, Italy.
6 two-hour seminars for second year students of the undergraduate degree in Mathematics (mostly exercise classes).

PhD thesis

Title	*Locality in Abelian gauge theories over globally hyperbolic spacetimes*
Supervisor	Prof. Dr. Claudio Dappiaggi
Co-supervisor	Dr. Alexander Schenkel

Description The thesis investigates the locality axiom of *general local covariance* for Abelian gauge theories. Two models, *Maxwell k-forms*, a generalization of the vector potential of electromagnetism, and the $U(1)$ *Yang-Mills model*, which describes electromagnetism in a geometric fashion, are analyzed over globally hyperbolic spacetimes. Our attention focuses on the *locality axiom* of general local covariance, which states that an embedding between spacetimes (compatible with the causal structures) should induce an inclusion at the level of observables. Both at the classical and at the quantum level, it turns out that the models we consider violate locality depending on certain global features of the background spacetime. For Maxwell k-forms, we prove that there is no coherent way to recover the locality axiom. For the $U(1)$ Yang-Mills model we adopt two different approaches: in the first case locality can be recovered coherently, but the class of observables we consider fails in detecting those field configurations which correspond to the Aharonov-Bohm effect; in the second case observables are defined in the spirit of Wilson loops, hence also the Aharonov-Bohm configurations are captured, but locality cannot be recovered coherently.

Thesis evaluated positively by the external referees, Prof. Dr. Christian Bär and Dr. Alexander Strohmaier. Final exam on January 12, 2015.

Master thesis

Title *Relative Cauchy evolution for spin 1 fields*

Supervisor Prof. Dr. Claudio Dappiaggi

Description The principle of general local covariance and its implications are discussed for free fields as sections of a vector bundle over a globally hyperbolic spacetime. Three examples are developed in detail: the Klein-Gordon field, the Proca field and the vector potential of the electromagnetic field. This analysis extends to the cases of the Proca field and of the vector potential a well-known result for the Klein-Gordon field, namely the relation between its relative Cauchy evolution and the commutator between the field and its stress tensor.

Repository `arXiv`:1111.6471 [math-ph]

Languages

Italian	**Native**	
English	**Advanced**	*C1 according to the European Language Grid*
German	**Basic**	*A1 according to the European Language Grid*

Scientific interests

Classical and quantum field theory on curved spacetimes, algebraic quantum field theory, gauge theories and their topological features.

Publications

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, to be published by Springer in 2015.

2 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].

3 M. Benini, *Relative Cauchy evolution for the vector potential on globally hyperbolic spacetimes,* Feb 2014, accepted for publication in **MEMOCS**.

4 M. Benini, *Optimal space of linear classical observables for Maxwell k-forms via spacelike and timelike compact de Rham cohomologies,* Jan 2014, `arXiv`:1401.7563 [math-ph].

5 M. Benini, C. Dappiaggi, T.-P. Hack, A. Schenkel, *A C^*-algebra for quantized Abelian 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].

6 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].

7 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].

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

Invited talks

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

May 20, 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.

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

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

Contributed talks

Jul 10, 2014 *Quantization of $U(1)$-connections on globally hyperbolic spacetimes*, "Mathematics Days in Sofia – Algebraic Methods in Quantum Field Theory", Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences, Sofia.

Mar 26, 2013 *No end in sight: The quest for quantizing electromagnetism*, II.Institute for Theoretical Physics, University of Hamburg.

Nov 24, 2012 *Quantum field theories on affine bundles*, "31$^{\text{st}}$ LQP Workshop on Foundations and Constructive Aspects of Quantum Field Theory", Max Plank Institute for Mathematics in the Sciences, Leipzig.

Jun 23, 2012 *Relative Cauchy evolution for the electromagnetic field*, "30$^{\text{th}}$ LQP Workshop on Foundations and Constructive Aspects of Quantum Field Theory", University of Paderborn.

Posters

Jul 30 – Aug 1, 2012 *Relative Cauchy evolution for the vector potential*, "Mathematical Aspects of Quantum Field Theory and Quantum Statistical Mechanics", II.Institute for Theoretical Physics, University of Hamburg.