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Quantum computation with Majorana zero modes in superconducting circuits

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Curriculum Vitæ

I was born on 4th June 1986 in Rome, where I attended primary and middle school. I received my secondary education during the years 2000 – 2005 at the Liceo Virgilio in Rome, specializing in classical studies.

After finishing high school I enrolled in the Physics Department at the University of Rome “La Sapienza”. There, I received my Bachelor degree under the supervision of Prof. Massimo Testa in December 2008, and my Master degree under the supervision of Prof. Antonio Polosa in April 2011, with a thesis entitled “The problem of confinement for two-dimensional massless Dirac fermions”. During the final year of my studies, my research interests shifted from high energy to condensed matter physics.

After my graduation I moved to Leiden University, where I began my Ph.D. under the supervision of Prof. Carlo Beenakker. Since September 2013, I am also a guest student at the Kavli Institute for Nanoscience at the Technical University of Delft, where I work with my co-supervisor Dr. Anton Akhmerov. This thesis contains part of the research performed in these four years, during which I greatly benefited from a lively and diverse research environment.

During my Ph.D. studies I taught exercise classes in quantum mechanics. I participated in several schools, workshop and conferences, and I presented my work in Italy, Austria, Germany and the United States of America.

After completing my Ph.D. studies, I will join the Physics Department of Yale University as a Postdoctoral Associate.

List of Publications

1. *Realization of microwave quantum circuits using hybrid superconducting semi-conducting nanowire Josephson elements*, G. de Lange, B. van Heck, A. Bruno, D.J. van Woerkom, A. Geresdi, S.R. Plissard, E.P.A.M. Bakkers, A.R. Akhmerov, and L. DiCarlo, arXiv:1503.08483 (2015) [Chapter 7].
2. *Single fermion manipulation via superconducting phase differences in multiterminal Josephson junctions*, B. van Heck, S. Mi, and A.R. Akhmerov, Phys. Rev. B **90**, 155450 (2014), Editors' Suggestion.
3. *Minimal circuit for a flux-controlled Majorana qubit in a quantum spin-Hall insulator*, B. van Heck, T. Hyart, and C.W.J. Beenakker, arXiv:1407.2851, submitted to Physica Scripta as contribution for the proceedings of the Nobel Symposium on topological insulators [Chapter 6].
4. *Thermal conductance as a probe of the non-local order parameter for a topological superconductor with gauge fluctuations*, B. van Heck, E. Cobanera, J. Ulrich, and F. Hassler, Phys. Rev. B **89**, 165416 (2014) [Chapter 11].
5. *Statistical Topological Insulators*, I.C. Fulga, B. van Heck, J.M. Edge, and A.R. Akhmerov, Phys. Rev. B **89**, 155424 (2014), Editors' Suggestion.
6. *Effects of disorder on Coulomb-assisted braiding of Majorana zero modes*, I.C. Fulga, B. van Heck, M. Burrello, and T. Hyart, Phys. Rev. B **88**, 155435 (2013) [Chapter 5].
7. *Flux-controlled quantum computation with Majorana fermions*, T. Hyart, B. van Heck, I.C. Fulga, M. Burrello, A.R. Akhmerov, and C.W.J. Beenakker, Phys. Rev. B **88**, 035121 (2013) [Chapter 4].
8. *Topological phases in two-dimensional arrays of parafermionic zero modes*, M. Burrello, B. van Heck, and E. Cobanera, Phys. Rev. B **87**, 195422 (2013) [Chapter 10].
9. *Braiding of non-Abelian anyons using pairwise interactions*, M. Burrello, B. van Heck, and A.R. Akhmerov, Phys. Rev. A **87**, 022343 (2013); **87**, 049905(E) (2013) [Chapter 9].

10. *Topological blockade and measurement of topological charge*, B. van Heck, M. Burrello, A. Yacoby, and A.R. Akhmerov, Phys. Rev. Lett. **110**, 086803 (2013) [Chapter 8].
11. *Coulomb-assisted braiding of Majorana fermions in a Josephson junction array*, B. van Heck, A.R. Akhmerov, F. Hassler, M. Burrello, and C.W.J. Beenakker, New J. Phys. **14**, 035019 (2012) [Chapter 3].
12. *Coulomb stability of the 4π -periodic Josephson effect of Majorana fermions*, B. van Heck, F. Hassler, A.R. Akhmerov, and C.W.J. Beenakker, Phys. Rev. B **84**, 180502 (2011), Rapid Communication [Chapter 2].