Bernard van Heck

bernardvanheck@gmail.com
+31 (0)64-0748467

Date of birth: 4 June 1986
Place of birth: Rome, Italy
Citizenship: Italian, Dutch

Research

since Sep '22 **Researcher (RTD-B)**, Sapienza Università di Roma, Italy

Oct '21 – Sep '22 **Postdoctoral Researcher**, Leiden University, The Netherlands

- Experimental work in the group of Prof. Tjerk Oosterkamp, Microscopy and Quantum Mechanics at mK Temperatures.

Jan '19 – Sep '21 **Senior Researcher**, Microsoft Quantum Lab Delft, The Netherlands.

- Supervising experimental cQED team at QuTech (3 PhD students), since Mar '20.

Jun '17 – Dec '18 **Researcher**, Microsoft Quantum, Station Q, Santa Barbara, U.S.A.

- Visited the Center for Quantum Devices at the Niels Bohr Institute in Copenhagen, Denmark, Sep '18 – Dec '18, to perform experimental research on hybrid semiconductor-superconductor devices.

Oct. '15 – May '17 **Postdoctoral Associate**, Yale University, U.S.A.
Postdoc advisor: Leonid Glazman.

Education

June '11 – Sep '15 **Ph.D.**, Universiteit Leiden, The Netherlands
PhD advisor: Carlo Beenakker
PhD co-advisor: Anton Akhmerov (TU Delft)

Dec. '08 – May '11 **M.Sc.** *cum laude*, Physics, Università di Roma La Sapienza, Italy

Sep. '05 – Dec. '08 **B.Sc.** *cum laude*, Physics, Università di Roma La Sapienza, Italy

Awards and Recognitions

- In 2018, I was selected as an Outsanding Referee by the American Physical Society.
- In 2016, I was granted a Marie Skłodowska-Curie Global Fellowship of the European Commission (declined). My proposal obtained a score of 94.80/100.
- In 2016, I was awarded the Christiaan Huygens prijs for my PhD thesis (see the announcement, in Dutch). The prize is awarded to the best Dutch PhD thesis in physics in a five-year period.
- In 2015, I was one of the seven young scientists selected by the Royal Netherlands Academy of Arts and Sciences to participate in the 65th Lindau Nobel Laureate Meeting, Lindau, Germany, 28 June-3 July 2015.

Synopsis

PhD research (2011-2015). My PhD research was focused on the development of a theory of superconducting circuits in the presence of Majorana zero modes. This focus was complemented by separate works on disordered systems, non-Abelian anyons, and Josephson junctions. Most of my studies were done in the context of the rapidly expanding fields of topological quantum computations and topological aspects of condensed matter physics in general. My PhD Thesis won the Christiaan Huygens prize in 2016 and generated considerable experimental interest.

Postdoctoral research (2015-2017). During my postdoc at Yale University under the supervision of Leonid Glazman, I have focused on the theoretical interpretation of experimental data on proximitized nanowire devices. In 2015 and 2016 I collaborated with the groups of Leo DiCarlo and Leo Kouwenhoven at TU Delft, the Netherlands on two different projects which realized the first prototypes of superconducting circuits involving nanowires and measured the excitation spectrum of a nanowire Josephson junction. I also investigated the transport signatures of the Majorana topological transition in the Coulomb blockade regime, providing a quantitative analysis of some crucial experiments in this field.

Research at Microsoft Quantum (2017-2021). My work continued organically during my tenure with Microsoft Quantum, which started at Station Q in Santa Barbara, U.S.A. and continued in Delft, the Netherlands, after an extended visit at the Center for Quantum Devices in Copenhagen. During this time, I have been heavily involved in the effort to systematize the search for Majoranas by promoting a data-driven approach to transport measurements, and I have been driving research on cQED devices with semiconductor-based Josephson junctions. As part of my research duties, I have been collaborating with the experimental part of Microsoft's quantum computing program daily, contributing to both the conceptual design of experiments and the interpretation of the data as well as, on some occasions, the experimental measurements themselves. In 2020-2021, I supervised a team of two simulation engineers for in-house realistic simulations of hybrid devices, as well as three PhD students performing experiments on hybrid superconducting qubits.

Research at Leiden University. In September 2021 I left the quantum industry in order to return full-time to pure, curiosity-driven research. I have joined the experimental team of Prof. Tjerk Oosterkamp at Leiden University, which uses low-temperature magnetic resonance force microscopy techniques to study quantum measurements and probe the quantum-to-classical boundary.

Publications

All publications are available at my arXiv page. See also Google Scholar for citation metrics.

1. *Magnetic cooling and vibration isolation of a sub-kHz mechanical resonator*, **B. van Heck**, T. Fuchs, J. Plugge, W.A. Bosch, and T.H. Oosterkamp, arXiv:2208.11750.

2. *Microwave spectroscopy of interacting Andreev spins*, J.J. Wesdorp, F.J. Matute-Cañadas, A. Vaartjes, L. Grünhaupt, T. Laeven, S. Roelofs, L.J. Splitthoff, M. Pita-Vidal, A. Bargerbos, D.J. van Woerkom, P. Krogstrup, L.P. Kouwenhoven, C.K. Andersen, A. Levy Yeyati, **B. van Heck**, and G. de Lange, arXiv:2208.11198.

3. *Direct manipulation of a superconducting spin qubit strongly coupled to a transmon qubit*, M. Pita-Vidal, A. Bargerbos, R. Žitko, L.J. Splitthoff, L. Grünhaupt, J.J. Wesdorp, Y. Liu, L.P. Kouwenhoven, R. Aguado, **B. van Heck**, A. Kou, and C.K. Andersen, arXiv:2208.10094.

4. *Spectroscopy of spin-split Andreev levels in a quantum dot with superconducting leads*, A. Bargerbos, M. Pita-Vidal, R. Žitko, L.J. Splitthoff, L. Grünhaupt, J.J. Wesdorp, Y. Liu, L.P. Kouwenhoven, R. Aguado, C.K. Andersen, A. Kou, and **B. van Heck**, arXiv:2208.09314.

5. *Singlet-doublet transitions of a quantum dot Josephson junction detected in a transmon circuit*, A. Bargerbos, M. Pita-Vidal, R. Žitko, J. Ávila, L.J. Splitthoff, L. Grünhaupt, J.J. Wesdorp, C.K. Andersen, Y. Liu, L.P. Kouwenhoven, R. Aguado, A. Kou, and **B. van Heck**, PRX Quantum **3**, 030311 (2022) [14 pages].

6. *Gate-tunable kinetic inductance in proximitized nanowires*, L.J. Splitthoff, A. Bargerbos, L. Grünhaupt, M. Pita-Vidal, J.J. Wesdorp, Y. Liu, A. Kou, C.K. Andersen, and **B. van Heck**, Phys. Rev. Applied **18**, 024074 (2022) [13 pages].

7. *Dynamical polarization of the fermion parity in a nanowire Josephson junction*, J. J. Wesdorp, L. Grünhaupt, A. Vaartjes, M. Pita-Vidal, A. Bargerbos, L. J. Splitthoff, P. Krogstrup, **B. van Heck**, and G. de Lange, arXiv:2112.01936.

8. *Full parity phase diagram of a proximitized nanowire island*, J. Shen, G.W. Winkler, F. Borsoi, S. Heedt, V. Levajac, J.Y. Wang, D. van Driel, D. Bouman, S. Gazibegovic, R.L.M. Op Het Veld, D. Car, J.A. Logan, M. Pendharkar, C.J. Palmstrom, E.P.A.M. Bakkers, L.P. Kouwenhoven, and **B. van Heck**, Phys. Rev. B **104**, 045422 (2021) [7 pages].

9. *Quantum-critical dynamics of a Josephson junction at the topological transition*, V.D. Kurilovich, C.M. Murthy, P.D. Kurilovich, **B. van Heck**, L.I. Glazman, and C. Nayak, Phys. Rev. B **104**, 014509 (2021), Editors' Suggestion [22 pages].

10. *Protocol to identify a topological superconducting phase in a three-terminal device*, D.I. Pikulin, **B. van Heck**, T. Karzig, E.A. Martinez, B. Nijholt, T. Laeven, G.W. Winkler, J.D. Watson, S. Heedt, M. Temurhan, V. Svidenko, R.M. Lutchyn, M. Thomas, G. de Lange, L. Casparis, C. Nayak, arXiv:2103.12217, to be submitted.

11. *Josephson current via an isolated Majorana zero mode*, C.-X. Liu, **B. van Heck**, and M. Wimmer, Phys. Rev. B **103**, 014510 (2021) [9 pages].

12. *Andreev Modes from Phase Winding in a Full-shell Nanowire-based Transmon*, A. Kringhøj, G. W. Winkler, T. W. Larsen, D. Sabonis, O. Erlandsson, P. Krogstrup, **B. van Heck**, K. D. Petersson, and C. M. Marcus, Phys. Rev. Lett. 126, 047701 (2020) [6 pages].

13. *Destructive Little-Parks Effect in a Full-Shell Nanowire-based Transmon*, D. Sabonis, O. Erlandsson, A. Kringhøj, **B, van Heck**, T.W. Larsen, I. Petkovic, P. Krogstrup, K.D. Petersson, and C.M. Marcus, Phys. Rev. Lett. **125**, 156804 (2020) [5 pages].

14. *Suppressed charge dispersion via resonant tunneling in a single-channel transmon*, A. Kringhøj, **B. van Heck**, T.W. Larsen, O. Erlandsson, D. Sabonis, P. Krogstrup, L. Casparis, K.D. Petersson, and C.M. Marcus, Phys. Rev. Lett. **124**, 246803 (2020) [6 pages].

15. *Observation of vanishing charge dispersion of a nearly-open superconducting island*, A. Bargerbos, W. Uilhoorn, C.-K. Yang, P. Krogstrup, L.P. Kouwenhoven, G. de Lange, **B. van Heck**, and A. Kou, Phys. Rev. Lett. **124**, 246802 (2020) [7 pages].

16. *Energy spectrum and current-phase relation of a nanowire Josephson junction close to the topological transition*, C.M. Murthy, V.D. Kurilovich, P.D. Kurilovich, **B. van Heck**, L.I. Glazman and C. Nayak, Phys. Rev. B **101**, 224501 (2020) [26 pages].

17. *Flux-induced topological superconductivity in full-shell nanowires*, S. Vaitiėkenas, G.W. Winkler, **B. van Heck**, T. Karzig, M.-T. Deng, K. Flensberg, L.I. Glazman, C. Nayak, P. Krogstrup, R.M. Lutchyn, C.M. Marcus, Science, **367**, eeav3392 (2020) [9 pages].

18. *Controlled DC monitoring of a superconducting qubit*, A. Kringhøj, T.W. Larsen, **B. van Heck**, D. Sabonis, O. Erlandsson, I. Petkovic, D.I. Pikulin, P. Krogstrup, K.D. Petersson, and C.M. Marcus, Phys. Rev. Lett. **124**, 056801 (2020) [6 pages].

19. *Spectral response of Josephson junctions with low-energy quasiparticles*, A. Keselman, C.M. Murthy, **B. van Heck** and B. Bauer, SciPost Phys. **7**, 050 (2019) [29 pages].

20. *A unified numerical approach to semiconductor-superconductor heterostructures*, G.W. Winkler, A.E. Antipov, **B. van Heck**, A. Soluyanov, L.I. Glazman, M.W. Wimmer, and R.M. Lutchyn, Phys. Rev. B **99**, 245408 (2019) [14 pages].

21. *Parity transitions in the superconducting ground state of hybrid InSb-Al Coulomb islands*, J. Shen, S. Heedt, F. Borsoi, **B. van Heck**, S. Gazibegovic, R. L. M. Op het Veld, D. Car, J. A. Logan, M. Pendharkar, G. Wang, D. Xu, D.Bouman, A. Geresdi, C. J. Palmstrom, E. P. A. M. Bakkers and L. P. Kouwenhoven, Nature Communications **9**, 4801 (2018) [8 pages].

22. *Quantum Criticality in Resonant Andreev Conduction*, M. Pustilnik, **B. van Heck**, R.M. Lutchyn and L.I. Glazman, Phys. Rev. Lett. **119**, 116802 (2017) [5 pages].

23. *Zeeman and spin-orbit effects in the Andreev spectra of nanowire junctions*, **B. van Heck**, J.I. Väyrynen and L.I. Glazman, Phys. Rev. B **96**, 075404 (2017), Editors' Suggestion [21 pages].

24. *Microwave spectroscopy of spinful Andreev bound states in ballistic semiconductor Josephson junctions*, D.J. van Woerkom, A. Proutski, **B. van Heck**, D. Bouman, J.I. Väyrynen, L.I. Glazman, P. Krogstrup, J. Nygård, L.P. Kouwenhoven, and A. Geresdi, Nature Physics **13**, 876-881 (2017) [6 pages].

25. *Conductance of a proximitized nanowire in the Coulomb blockade regime*, **B. van Heck**, R.M. Lutchyn, and L.I. Glazman, Phys. Rev. B **93**, 235431 (2016), Editors' Suggestion [19 pages].

26. *Topologically protected charge transfer along the edge of a chiral p-wave superconductor*, N.V. Gnezdilov, **B. van Heck**, M. Diez, J.A. Hutasoit, and C.W.J. Beenakker, Phys. Rev. B **92**, 121406(R) (2015), Rapid Communication [5 pages].

27. *Realization of microwave quantum circuits using hybrid superconducting-semiconducting 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, Phys. Rev. Lett. **115**, 127002 (2015), Editors' Suggestion and Viewpoint in Physics [5 pages].

28. *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 [9 pages].

29. *Minimal circuit for a flux-controlled Majorana qubit in a quantum spin-Hall insulator*, **B. van Heck**, T. Hyart and C.W.J. Beenakker, Phys. Scr. 014007 (2015) [8 pages]. Contribution for the proceedings of the Nobel Symposium on topological insulators.

30. *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) [5 pages].

31. *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 pages].

32. *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) [7 pages].

33. *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) [17 pages].

34. *Topological phases in two-dimensional arrays of parafermionic zero modes*, M. Burrello, **B. van Heck** and E. Cobanera, Phys. Rev. B **87**, 195422 (2013) [16 pages].

35. *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) [7 pages].

36. *Topological blockade and measurement of topological charge*, **B. van Heck**, M. Burrello, A. Yacoby and A.R. Akhmerov, Phys. Rev. Lett. **110**, 086803 (2013) [5 pages].

37. *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) [14 pages].

38. *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(R) (2011), Rapid Communication [4 pages].

Teaching

- **Course staff** for the massive online open course Topology in condensed matter, initially hosted on edX (2015-2016).
- Delivered a **lecture series** on quantum computation with Majorana zero modes for experimental groups at TU Delft (2015).
- **Teaching assistant** for a course in Quantum Mechanics at the undergraduate level, held by dr. Peter Denteneer at Universiteit Leiden (2015-2016).

Refereeing

I have refereed scientific articles for the following journals: Physical Review Letters, Physical Review A, Physical Review B, Physical Review X, SciPost Physics, New Journal of Physics, Europhysics Letters, Journal of Physics: Condensed Matter, Nano Letters, Physica Scripta. I am an Outstanding Referee of the American Physical Society and a Trusted Reviewer of the IOP.

Presentations

1. *Protecting quantum states in condensed matter*, invited seminar at Sapienza Università di Roma, Italy, 11 July 2022.
2. *Study and control of bound states in superconducting junctions*, invited seminar at Sapienza Università di Roma, Italy, 21 June 2022.
3. *Some recent results in cQED with hybrid nanowires*, invited seminar at ISTA, Vienna, Austria, 17 May 2022.
4. *Transmon-based spectroscopy of an Andreev quantum dot*, invited online talk at the IOP CMD online series "Bound states in hybrid semiconducting-superconducting devices", 28-29 June 2021.
5. *cQED with hybrid superconducting-semiconducting devices*, RWTH Aachen, Germany, 13 February 2020.
6. *cQED with Majorana devices*, workshop "Enabling Quantum Leap: Braiding and Fusing Majoranas", University of Maryland, College Park, USA, 10 July 2019.
7. *Simulating the response of a Majorana transmon device*, APS March Meeting, Boston, USA, 7 March 2019.
8. *Topological superconductivity in proximitized full-shell nanowires*, APS March Meeting, Boston, USA, 7 March 2019.
9. *Topological quantum computing with Majoranas: the search for robust designs*, workshop "Majorana modes and beyond", MagTop IF PAN, Warsaw, Poland, 27 February 2019.
10. *Coulomb blockade in proximitized nanowires*, Leiden University, the Netherlands, 11 October 2017.
11. *Andreev bound states in nanowire Josephson junctions: theory of microwave spectra*, Monday lunch seminar, Yale, USA, 27 March 2017.

12. *Andreev levels in nanowire Josephson junctions: theory of microwave spectra*, APS March Meeting, New Orleans, USA, 17 March 2017.

13. *Microwave measurements of Majorana nanowires*, Station Q, Santa Barbara, USA, 9 January 2017.

14. *Andreev levels in nanowire Josephson junctions: theory of microwave spectra*, Station Q fall meeting, Santa Barbara, USA, 2 December 2016.

15. Invited participant, "Workshop on Majorana Modes in Nanowires: Past and Future, University of Maryland", College Park, USA, October 2016.

16. *Microwave spectroscopy of Andreev bound states in InAs nanowires*, Leiden University, the Netherlands 28 September 2016.

17. *Conductance through a proximitized nanowires in the Coulomb blockade regime*, APS March Meeting, Baltimore, USA, 15 March 2016.

18. Selected particpant of the Royal Netherlands Academy of Arts and Sciences to the 65th Lindau Nobel Laureate Meeting, Lindau, Germany, 28 June-3 July 2015.

19. *Majoranas, superconducting circuits and the experimental design of a topological quantum computer*, "This week's discoveries" seminar, Leiden University, the Netherlands, 2 June 2015.

20. *Breaking Kramers degeneracy of Andreev levels in multi-terminal junctions*, joint Delft-Moscow Workshop "Quantum Matter and Quantum Devices", Delft, the Netherlands, 30 April 2015.

21. *How to braid Majoranas in superconducting circuits*, TopoWerkbespreking, TU Delft, the Netherlands, 12 March 2015 and 9 April 2015.

22. *Superconducting circuits with Majorana modes*, Yale University, USA, 1st December 2014.

23. *Breaking Kramers' degeneracy with Josephson's phase difference*, Leiden-Utrecht joint meeting, Leiden, the Netherlands, 15 September 2014.

24. *Breaking time-reversal symmetry and switching fermion parity with superconducting phase differences*, Kavli-MPQ workshop, Garching, Germany, 13 June 2014.

25. *Quantum computation with Majorana zero modes in superconducting circuits*, "New frontiers for Majorana fermions, from condensed to dark matter", Frascati, Italy, May 2014.

26. *Superconducting circuits for the manipulation of Majorana fermions*,"Frontiers in Quantum Engineered Devices", Obergurgl, Austria, 21 August 2013.

27. *Flux-controlled quantum computation with Majorana fermions*, RWTH Aachen, Germany, 2 May 2013.

28. *Quantum computation with Majorana fermions in topological superconductors*, Università di Roma "La Sapienza", Italy, 18 May 2012.

29. *Braiding Majorana fermions in a Josephson junction array*, SSQIP werkbespreking, TU Delft, the Netherlands, 15 December 2011.

30. *Josephson junction arrays with Majorana fermions*, RWTH Aachen, Germany, 2 November 2011.

31. *Fractional Josephson effect of Majorana fermions in a DC squid*, SSQIP werkbespreking, TU Delft, the Netherlands, 27 October 2011.