Hannes Bernien, Ph.D.

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CURRENT POSITION

Feb. 2019- **Assistant Professor,** Pritzker School of Molecular Engineering, University of Chicago

RESEARCH EXPERIENCE

2015-19 **Postdoctoral Fellow in Physics,** Harvard University
Faculty Advisor: Mikhail Lukin, Professor of Physics
Project: Quantum information processing and simulation with individually trapped atoms and atoms coupled to nanophotonic devices

2014-15 **Postdoctoral Fellow in Physics,** QuTech, Delft, The Netherlands
Faculty Advisor: Ronald Hanson, Professor of Physics
Project: Loophole-free Bell test with electronic spins separated by 1.3km

EDUCATION

2014 **Ph.D. in Physics**, Technical University Delft, The Netherlands
Thesis: Quantum information processing with spins in diamond
Advisor: Ronald Hanson, Professor of Physics

2009 **Seoul National University**, South Korea
Research Internship: Terahertz nanophotonics

2009 **Diplom (German Masters equivalent) in Physics**, University of Hannover, Germany
Thesis: Spin Noise Spectroscopy on GaAs
Advisor: Prof. Michael Oestreich

2006-7 **Peking University,** China
Studies in Physics and Chinese

AWARDS & SCHOLARSHIPS

Awards

Sloan Research Fellowship (2021)
IOP international Quantum Technology Young Scientist Award (2020)
Kavli Publication Prize, Delft (2016)
Kavli PhD Thesis Prize, Delft (2015)
The Paul Ehrenfest Best Paper award (2015)
FOM Film challenge 2012, winning film about my research (>85,000 views on YouTube) (2013)
1st place: Young Speakers contest of the Dutch Physical Society NNV (2013)
Elsevier Diamond and Carbon Materials Young Scholar Prize (2012)
Best PhD Candidate Award, Universiteitsfonds Delft (2012)
Poster Prize, Casimir Springschool (2010)

Fellowships & Scholarships

Rubicon postdoctoral fellowship, Dutch research organization, NWO (2015-17)
DAAD-KOSEF scholarship: "Korean Summer Institute Program" (2009)

PUBLICATIONS

- 24 articles in peer-reviewed journals, h-index = 22, > 7800 total citations (Google Scholar).
- Publications by journal: 6xNature, 4xScience, 1xNature Physics, 1xNature Photonics (invited review), 1xPNAS, 5xPRL, 1xNano Letters, 1xPRB, 1xOptics Express, 2xNJP, 1xOptics Letters
- Co-filed two patents.

Selected publications in peer-reviewed journals:

1. **H. Bernien**, S. Schwartz, A. Keesling, H. Levine, A. Omran, H. Pichler, S. Choi, A.S. Zibrov, M. Endres, M. Greiner, V. Vuletic, M.D. Lukin. Probing many-body dynamics on a 51-atom quantum simulator. *Nature* **551**, 579-584 (2017).
   This work was highlighted in *Nature News and Views*.

2. **H. Bernien**, B. Hensen, W. Pfaff, G. Koolstra, M.S. Blok, L. Robledo, T.H. Taminiau, M. Markham, D.J. Twitchen, L. Childress, R. Hanson. Heralded entanglement between solid-state qubits separated by three meters. *Nature* **497**, 86-90 (2013).
   This work was highlighted in *Nature News*.

3. B. Hensen, **H. Bernien**, A.E. Dréau, A. Reiserer, N. Kalb, M.S. Blok, J. Ruitenberg, R.F.L. Vermeulen, R.N. Schouten, C. Abellán, W. Amaya, V. Pruneri, M. W. Mitchell, M. Markham, D.J. Twitchen, D. Elkouss, S. Wehner, T.H. Taminiau, R. Hanson. Loophole-free Bell inequality violation using electron spins separated by 1.3 kilometres. *Nature* **526**, 682-686 (2015).
   This work was selected as a *Physics World* breakthrough of 2015. It was highlighted in *Nature News*, *Science News*, and featured in international news such as: *The New York Times* (front page), *Economist*, *Time*, *Zeit*, *LeMonde*.

4. S.G. Menon, K. Singh, J. Borreegaard, and **H.Bernien**. Nanophotonic quantum network node with neutral atoms and an integrated telecom interface. *New Journal of Physics* **22**, 073033 (2020)

5. L. Robledo*, L. Childress*, **H. Bernien***, B. Hensen, P.F.A. Alkemade, R. Hanson. High-fidelity projective read-out of a solid-state spin quantum register. Nature **477**, 547-578 (2011) (*contributed equally).
   This work was highlighted in: Quantum computing: Snapshots of diamond spins, J. Morton and S. Benjamin, *Nature Physics* **7**, 929–930 (2011). News and Views section.

Publications in peer-reviewed journals continued chronologically:

6. P. Samutpraphoot, T. Dordevic, P. Ocola, **H. Bernien**, C. Senko, V. Vuletic, and M.D. Lukin. Strong Coupling of Two Individually Controlled Atoms via a Nanophotonic Cavity. *Physical Review Letters* **124**, 063602 (2020)

7. G. Torlai*, B. Timar*, E.P.L. van Nieuwenburg, H. Levine, A. Omran, A. Keesling, **H. Bernien**, M. Greiner, V. Vuletić, M.D. Lukin, R.G. Melko, M. Endres. Integrating neural networks with a quantum simulator for state reconstruction. *Physical Review Letters* **123**, 230504 (2019) (*contributed equally)

8. H. Levine, A. Keesling, G. Semeghini, A. Omran, T.T. Wang, S. Ebadi, **H. Bernien**, M. Greiner, V. Vuletić, H. Pichler, M. D. Lukin. Parallel Implementation of High-Fidelity Multiqubit Gates with Neutral Atoms. *Physical Review Letters* **123**, 170503 (2019).

9. A. Omran*, H. Levine*, A. Keesling, G. Semeghini, T.T. Wang, S. Ebadi, **H. Bernien**, A.S. Zibrov, H. Pichler, S. Choi, J. Cui, M. Rossignolo, P. Rembold, S. Montangero, T. Calarco, M. Endres, M. Greiner, V. Vuletić, and M.D. Lukin. Generation and manipulation of Schrödinger cat states in Rydberg atom arrays. *Science* 365, 570-574 (2019) (*contributed equally)

10. D. Kim, A. Keesling, A. Omran, H. Levine, **H. Bernien**, M. Greiner, M.D. Lukin, D.R. Englund. Large-scale uniform optical focus array generation with a phase spatial light modulator. *Optics Letters* **44**, 3178-3181 (2019).

11. A. Keesling, A. Omran, H. Levine, **H. Bernien**, H. Pichler, S. Choi, R. Samajdar, S. Schwartz, P. Silvi,

S. Sachdev, P. Zoller, M. Endres, M. Greiner, V. Vuletić, M.D. Lukin. Quantum Kibble–Zurek mechanism and critical dynamics on a programmable Rydberg simulator. *Nature* **568**, 207–211 (2019).

12. H. Levine, A. Keesling, A. Omran, **H. Bernien**, S. Schwartz, A.S. Zibrov, M. Endres, M. Greiner, V. Vuletic, M.D. Lukin. High-Fidelity Control and Entanglement of Rydberg-Atom Qubits. *Physical Review Letters* **121**, 123603 (2018).

13. M. Endres*, **H. Bernien***, A. Keesling*, H. Levine*, E.R. Anschuetz, A. Krajenbrink, C. Senko, V. Vuletic, M. Greiner, M.D. Lukin. Atom-by-atom assembly of defect-free one-dimensional cold atom arrays. *Science* **354**, 1024-1027 (2016) (*contributed equally).
    This work was featured in *MIT News*.

14. W. B. Gao, A. Imamoglu, **H. Bernien**, R. Hanson. Coherent manipulation, measurement and entanglement of individual solid-state spins using optical fields. *Nature Photonics* **9**, 363–373 (2015).

15. W. Pfaff, B. Hensen, **H. Bernien**, S. van Dam, M.S. Blok, T.H. Taminiau, M.J. Tiggelman, M. Markham, R.N. Schouten, D.J. Twitchen, R. Hanson. Unconditional quantum teleportation between distant solid-state qubits. *Science* **345**, 532-535 (2014).
    This work was highlighted in: A gem of a quantum teleporter, M. Atature and J. Morton, *Science* **345**, 510-511. Perspective section. It was featured in international news such as: *The New York Times*, *The Telegraph*, *BBC*.

16. R.E. George, L. Robledo, O.J.E. Maroney, M.S. Blok, **H. Bernien**, M. Markham, D.J. Twitchen, J.J.L. Morton, G.A.D. Briggs, R. Hanson. Opening up three quantum boxes causes classically undetectable wavefunction collapse. *Proceedings of the National Academy of Sciences* **110**, 3777-3781 (2013)

17. W. Pfaff, T.H. Taminiau, L. Robledo, **H. Bernien**, M.L. Markham, D. J. Twitchen, R. Hanson. Demonstration of entanglement-by-measurement of solid state qubits. *Nature Physics* **9**, 29-33 (2013)

18. T. van der Sar, Z.H. Wang, M.S. Blok, **H. Bernien**, T.H. Taminiau, D.M. Toyli, D.A. Lidar, D.D. Awschalom, R. Hanson, V.V. Dobrovitski. Decoherence-protected quantum gates for a hybrid solid-state spin register. *Nature* **484**, 82-86 (2012).

19. **H. Bernien**, L. Childress, L. Robledo, M. Markham, D.J. Twitchen, R. Hanson. Two-photon quantum interference from separate nitrogen vacancy centers in diamond. *Physical Review Letters* **108**, 043604 (2012).
    This work was featured in a *Physics* Synopsis.

20. L. Robledo, **H. Bernien**, T. van der Sar, R. Hanson. Spin dynamics in the optical cycle of single nitrogen-vacancy centres in diamond. *New Journal of Physics* **13**, 025013 (2011).

21. Y.G. Jeong, **H. Bernien**, J.S. Kyoung, H.R. Park, H.S. Kim, J.W. Choi, B.J. Kim, H.T. Kim, K.J. Ahn, D.S. Kim. Electrical switching of THz radiation on VO2 thin film fabricated with antennas. *Optics Express* **19**, 21211 (2011).

22. L. Robledo, **H. Bernien**, I. van Weperen, R. Hanson. Control and coherence of the optical transition of single defect centers in diamond. *Physical Review Letters* **105**, 177403 (2010).

23. M. Seo, J.S. Kyoung, H.R. Park, S. Koo, H.S. Kim, **H. Bernien**, B.J. Kim, J.H. Choe, Y.H. Ahn, H.T. Kim N. Park, Q.H. Park, K.J. Ahn, D.S. Kim. Active THz nanoantennas based on VO2 phase transition. *Nano Letters* **10**, 2064 (2010).

24. M. Roemer, **H. Bernien**, G. Mueller, D. Schuh, J. Huebner, M. Oestreich. Electron-spin relaxation in bulk GaAs for doping densities close to the metal-to-insulator transition. *Physical Review B* **81**, 075216 (2010).

Patents

1. Neutral atom quantum information processor, (2017, pending)
2. Device for achieving multi-photon interference from NV centers, US9335606B2 (2011)

ADVISING EXPERIENCE

University of Chicago:

- Kevin Singh: Postdoctoral Researcher, Winner of IC Postdoc Fellowship (2020)
- Jordan Kemp: Graduate Student, Winner of NSF graduate student fellowship (2020)
- Shankar Menon: Graduate Student
- Samantha Lapp: Graduate Student
- Noah Glachman: Graduate Student
- Wenjun Zhang: Graduate Student
- Yuzhou Chai: Graduate Student
- Jeremy Estes: Research Assistant
- Undergraduate Students: Haley Nguyen, Andrew Pocklington, Kin Fung Ngan, Sam Li, Rohan Kumar, Roberto Cohen

Harvard University: Supervision of 5 Ph.D. students.

TU Delft: Supervision of 1 bachelor, 1 master, and 2 Ph.D. students.

PROFESSIONAL SERVICE

Referee

Review of Modern Physics, Science, Nature Physics, Nature Photonics, Nature Communication, PRL, PRA, Optics Express, JOSA

Conference Organization

- Subcommittee organizer for CLEO 2020 and 2021 conference, "Quantum and atomic devices and instrumentation"
- Quantum Sensing Workshop of the Chicago Quantum Exchange (2019)
- Session Chair APS March meeting 2019 and 2021
- Frontiers of interacting systems of Rydberg atoms, 3-day international workshop at the ITAMP, Harvard University (2017).

Service at the University of Chicago

- PME Graduate Student Admission and Recruitment Committee (2020 - present)
- PME Faculty Award Committee (2020 - present)
- Lecturer at the PME Mentor Training Lunch Series (2019, 2020)
- Lecturer at the Model Classes for the Family Visiting Weekend (2019, 2020)
- PhD Thesis Defense Committee (5) (2019 - present)

FUNDING

Current support:

Funding Organization: NSF
Project Title: QLCI-CI: Hybrid Quantum Architectures and Networks
Grant Amount: $25,000,000
Duration: 5 years
Start/End Dates: 9/2020 - 8/2025
Description: This is a multi-institutional research proposal led by the University of Illinois Urbana-Champaign with 30 research groups involved. As a co-PI, Bernien leads the University of Chicago effort in investigating distributed hybrid quantum systems.

Funding Organization: Office of Naval Research
Project Title: A2D2 Quantum Arrays - A two atomic species, two-dimensional quantum array

Grant Amount: $ 585,074
Duration: 3 years
Start/End Dates: 4/2020 - 3/2023
Description: In this project, Bernien develops a quantum nondemolition readout by using a two-atomic species scheme. The second species will also be used to create large entangled states.

Pending support:
Funding Organization: Air Force Office of Scientific Research
Project Title: Towards Robust Scalable Quantum Random Access Memories
Grant Amount: $ 7,500,000
Duration: 5 years
Start/End Dates: 5/2021 - 4/2026
Description: As a part of a 7 PI collaboration, Bernien will investigate the implementation of a Quantum Random Access memory using Rydberg atoms.

Past support:
Funding Organization: Army Research Office
Project Title: Quantum Network Nodes Based on Atomic Qubits with a Nanophotonic Telecom Interface.
Grant Amount: $ 60,000
Duration: 9 months
Start/End Dates: 5/2020 - 2/2021
Description: In this project, Bernien proposes to develop a quantum network node that consists of individual atoms coupled to nanophotonic crystal cavities.

PRESENTATIONS

Since 2010: more than 55 oral presentations at international conferences and seminars (>40 invited).

Invited Conference and Workshop Talks
Atom-Nanophotonic Quantum Network Node, Quantum Networking Meeting, ANL, Chicago, USA (2020)
Rydberg atom arrays for, Quantum Simulation and Information Processing, Conference on Emerging Quantum Information Technologies, Hong Kong (2019)
Rydberg atom arrays - The dark horse of quantum science and technology, Spinoza Workshop, Delft (2019)
Quantum simulation and computing with atomic arrays, QIS Workshop, ANL, Chicago, USA (2019)
Quantum many-body dynamics on a Rydberg quantum simulator, Workshop on non-equilibrium physics Mazara, Italy (2019)
Exploring quantum many-body dynamics and quantum information processing with reconfigurable arrays of atoms, PQE Conference, Snowbird, USA (2019)
Scalable quantum technologies with arrays of trapped atoms, MCAW, Urbana Champaign, USA (2018)
Many-body dynamics on a 51-atom quantum simulator, APS March Meeting, Los Angeles, USA (2018)
Probing many-body dynamics on a 51-atom quantum simulator, BEC2017, Sant Feliu, Spain (2017)
Quantum Dynamics of Strongly Interacting Atom Arrays, QSE workshop, Hannover, Germany (2017)
Cold Matter Assembled Atom-by-Atom, SCFQIS workshop, Seoul, South Korea (2016)
Quantum networks based on diamond spins, SPIE Photonics West, San Francisco, USA (2015)
Quantum Networks with Spins in Diamond, Condensed Matter in Paris, France (2014)
From remote entanglement to distant quantum teleportation, Workshop, Konstanz, Germany (2014)
Quantum Networks with Spins in Diamond, QDiamond2013, HuangShan, China (2013)
Preparation, single-shot readout and long-distance coupling of solid-state quantum registers, APS March Meeting, Boston, USA (2012)

Invited Seminars and Colloquia

Building quantum processors and quantum networks atom-by-atom, IQUIST, UIUC, USA (2020)
Engineering large quantum systems atom-by-atom, Colloquium University of Chicago, USA (2020)
Rydberg atom arrays for Quantum Simulation and Information Processing, Colloquium Marquette University, Milwaukee, USA (2020)
Quantum LEGOs: Engineering large quantum systems atom-by-atom, Miami University, Ohio, USA (2019)
Quantum LEGOs: Engineering large quantum systems atom-by-atom, ANL, Chicago, USA (2019)
Exploring quantum many-body dynamics and quantum information processing with reconfigurable arrays of atoms, University of Wisconsin Madison, USA (2018)
Exploring quantum many-body dynamics and quantum information processing with reconfigurable arrays of atoms, University of Colorado Boulder, USA (2018)
Exploring many-body dynamics on a 51-atom quantum simulator, CUA, Harvard, USA (2017)
Exploring many-body dynamics on a 51-atom quantum simulator, ICFO, Barcelona, Spain (2017)
Quantum LEGOs: Building large quantum systems atom-by-atom, UNSW, Sydney, Australia (2017)
Quantum LEGOs: Building large quantum systems atom-by-atom, Tübingen, Germany (2017)
Exploring Many-Body Dynamics in Strongly Interacting Atom Arrays, Hannover, Germany (2017)
Quantum Science with Arrays of Atoms, TU Delft, The Netherlands (2017)
Quantum Many-Body Dynamics of Strongly Interacting Atom Arrays, IST, Austria (2017)
Quantum Many-Body Dynamics of Arrays of Atoms, HQOC, Harvard, USA (2017)
Loophole-free violation of Bell's inequality, IQI, Caltech, USA (2016)
Loophole-free violation of Bell's inequality, iQuISE, MIT, USA (2016)
Loophole-free violation of Bell's inequality, BBN, Cambridge, USA (2015)
Quantum Networks with Spins in Diamond, Pines Lab, Berkeley, USA (2015)
From quantum teleportation to a loophole-free Bell test, HCOQ, Harvard, USA (2015)
Entanglement between diamonds separated by 3 meters, McGill, Montreal, Canada (2013)
Heralded entanglement between two distant diamonds, Cambridge University, UK (2013)
Quantum Networks with Spins in Diamond, Seminar at HP-labs, Palo Alto, USA (2013)
Quantum Networks with Spins in Diamond, Stanford University, Palo Alto, USA (2013)
Heralded entanglement between qubits separated by 3 meters, UCL, London, UK (2012)
Interference of two distant NV centers, University of Hannover, Germany (2011)

Contributed Conference Talks
Defect-free atom arrays on demand, Damop, Providence, USA (2016)
Towards Atom Arrays on Demand, CUA workshop, MIT/Harvard, USA (2016)
From remote teleportation to a 'loophole-free' Bell test, QCMC, Hefei, China (2014)
Quantum Networks with Spins in Diamond, APS March Meeting,Denver, USA (2014)
Quantum Networks with Spins in Diamond, Workshop, Leeds, England (2014)
Heralded entanglement between qubits separated by 3 meters, QIPC, Florence, Italy (2013)
Heralded entanglement between solid-state qubits, DAMOP, Quebec City, Canada (2013)
Quantum Networks with Spins in Diamond, Kavli-MPQ workshop, Delft Netherlands (2013)
Heralded entanglement between two distant diamonds, MRS , San Fransisco, USA (2013)
Heralded entanglement between qubits separated by 3 meters, DPG, Hannover, Germany (2013)
Heralded entanglement between solid-state qubits, IOP conference, London, UK (2012)
Quantum Networks with Spins in Diamond, QCMC-conference, Vienna, Austria (2012)
Readout and long-distance coupling of quantum registers, FOM, Veldhoven, Netherlands (2012)
Projective read-out of a solid state quantum register, Lunteren, Netherlands (2011)
Initialization and Readout of a Multi-Spin Quantum Register, Wesss, Lecce, Italy (2011)
Single-shot readout of the electron spin, Diamant Kick-Off meeting, Ulm, Germany (2011)