
Dr. Philip Willke

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Date of birth: 03.10.1987

Nationality: German

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Research Experience

10/2020 - current: **Independent Junior Research Group Leader in the Emmy-Noether Program of the German Science Foundation, Karlsruhe Institute of Technology, Physikalisches Institut, Karlsruhe, Germany**

Starting my own lab on *Quantum Coherent Control of Atomic and Molecular Spins on Surfaces*

06/2020 – 10/2020: **Young Investigator Group Preparation Program of the Karlsruhe Institute of Technology, Physikalisches Institut, Karlsruhe, Germany**

Preparation to set up my own lab, acquiring equipment

05/2018 - 05/2020: **Postdoctoral Researcher and Feodor-Lynen Fellow (05/2018-05/2019), IBS Center for Quantum Nanoscience and Ewha Womans University, Seoul, South Korea (Advisor: Prof. Andreas Heinrich, Prof. Taeyoung Choi)**

Setting up a new lab for electron spin resonance scanning tunneling microscopy at the newly founded Center for Quantum Nanoscience

02/2017-04/2018: **Postdoctoral Researcher at the IBM Almaden Research Center (CA, USA, Advisor: Christopher Lutz, Prof. Andreas Heinrich)**

Pioneering the field of electron spin resonance scanning tunneling microscopy

12/2013-01/2017: **PhD at Georg-August Universität Göttingen (Summa cum Laude), Scanning Tunneling Microscopy group (Advisor: PD Dr. Martin Wenderoth)**

Thesis title: Atomic-scale transport in graphene: the role of localized defects and substitutional doping

11/2015 – 5/2016: **Research Visit, IBM Almaden Research Center, San Jose, CA, USA (Advisor: Dr. Andreas Heinrich)**

Establishing a single-atom quantum sensor and single atom magnets

Education

02/2012 - 11/2013: **Master of Science in Physics at Georg-August Universität Göttingen**, Focus on Solid State and Material Physics, Final Grade: 1.0 (Best possible)

09/2011 - 01/2012: **General Visiting Student at Peking University**, PR China, Studying Chinese and Physics

10/2008 - 09/2011: **Bachelor of Science in Physics at Georg-August Universität Göttingen**, Final Grade: 1.3 with distinction

Scholarships, Funding and Awards

Funding

09/2020: Research Program on Quantum Technologies of the Baden-Württemberg Foundation. Subproject *AMoDiQuS* in Cooperation with Prof. Sebastian Loth (U Stuttgart) and Prof. Wolfgang Wernsdorfer (KIT), 434.112 EUR

07/2020: Emmy-Noether Program of the German Science Foundation. ~2 Mio. EUR (6 years)

07/2020: ERC Starting Grant: ~2.2 Mio EUR (5 years, turned down in favor of the Emmy-Noether Program)

05/2020: Young Investigator Preparation Program of the KIT, 127.500 EUR + own salary for 4 months
05/2018: Feodor-Lynen scholarship of the Alexander-von-Humboldt foundation, estimated 30.000 kEUR (2/3 of one year net salary)

Awards

- Science Award of Lower Saxony 2012, student category (Niedersächsischer Wissenschaftspreis 2012)
- Young Talent Award Rotary-Club, section Goslar-Nordharz (09/2014)
- 2nd place idea competition University of Göttingen. Topic: Diversity (12/2012)
- 2nd place German science slam championship, Darmstadt (12/2016)
- The *golden Albert* award, winner of the science slam hosted at the spring meeting of the German physical society, Berlin (03/2015)

Scholarships

11/2015 - 05/2016: DAAD-scholarship for PhD-students
09/2011 - 01/2012: Fellow of the Chinese Scholarship Council
04/2011 - 11/2013: Fellow of the German National Academic Foundation (Studienstiftung des deutschen Volkes)
10/2010 - 11/2013: Fellow of the Konrad-Adenauer-Foundation

Publications

Since 2013, I published 21 publications in peer-reviewed journals [14 different journals. 1x *Nature*, 2x *Science*, 3x *Nature X*, 2x *Phys. Rev. Lett.*, 2x *Science Adv.*, 3x *Nature Commun*]. **Citations:** 406 **h-index:** 10 (Source: [Web of Knowledge](#)). **Papers as first author:** 11/21 = 52%. **Papers without thesis supervisor:** 12/21 = 57%. **Papers as corresponding author:** 2.

Selected Key Publications (Full List at the end):

1. P. Willke, Y. Bae, K. Yang, J. L. Lado, A. Ferrón, T. Choi, A. Ardavan, J. Fernández-Rossier, A. J. Heinrich, and C. P. Lutz
Hyperfine interaction of individual atoms on a surface, *Science* 362, 336–339 (2018) [Link](#)
2. P. Willke, K. Yang, Y. Bae, A. J. Heinrich and C. P. Lutz
Magnetic resonance imaging of single atoms on a surface, *Nature Physics* (2019) [Link](#)
3. K. Yang, P. Willke, Y. Bae, A. Ferrón, J. L. Lado, A. Ardavan, J. Fernández-Rossier, A. J. Heinrich, C. P. Lutz
Electrically controlled nuclear polarization of individual atoms, *Nature Nanotechnology* (2018) [Link](#)
4. P. Willke, W. Paul, F. D. Natterer, K. Yang, Y. Bae, T. Choi, J. Fernández-Rossier, A. J. Heinrich, C. P. Lutz
Probing quantum coherence in single atom electron spin resonance, *Science Advances* 4(2), eaaq1543 (2018) [Link](#)
5. P. Willke*, A. Singha*, X. Zhang*, T. Esat, C. P. Lutz, A. J. Heinrich, T. Choi, *equal contribution ,
Tuning Single-Atom Electron Spin Resonance in a Vector Magnetic Field, *Nano Lett.* 19(11), 8201-8206 (2019) [Link](#)
6. K. Yang, W. Paul, S.-H. Phark, P. Willke, Y. Bae, T. Choi, T. Esat A. Ardavan, A. J. Heinrich, C. P. Lutz, Coherent spin manipulation of individual atoms on a surface, *Science* 366, 509-512 (2019) [Link](#)
7. P. Willke, T. Kotzott, T. Pruschke, M. Wenderoth
Magnetotransport on the nanoscale. *Nature Communications* 8, 15283 (2017) [Link](#)
8. F. D. Natterer, K. Yang, W. Paul, P. Willke, T. Choi, T. Greber, A. J. Heinrich and C. F. Lutz
Reading and writing single atom magnets, *Nature* 543, 226-228 (2017) [Link](#)
9. T. Choi, W. Paul, S. Rolf-Pissarczyk, A. J. Macdonald, F. D. Natterer, K. Yang, P. Willke, C.P. Lutz, and A. J. Heinrich
Atomic-scale magnetic dipolar sensor using electron spin resonance on surfaces. *Nature Nanotechnology* 12, 420-424 (2017) [Link](#)
10. P. Willke, J. A. Amani, A. Sinterhauf, S. Thakur, T. Kotzott, T. Druga, S. Weikert, K. Maiti, H. Hofsäss, M. Wenderoth

Doping of graphene by low-energy ion beam implantation: structural, electronic and transport properties, *Nano Letters* 15 (8), 5110–5115 (2015) [Link](#)

Impact and Visibility:

- 1 paper featured in [The New York Times](#) [Nat. Phys. (2019)]
- 1 paper selected as „[Editor’s suggestion](#)“ [Phys. Rev. Lett. 122, 227203 (2019)]
- 2 papers featured on Korean national television [Nat. Phys. (2019) on [JTBC News](#), Science 362, 336–339 (2018) on [Yonhap News](#)]
- 4 paper with very high press coverage [Nature 543, 226-228 (2017): [Almetric](#) 1193, Nat. Phys. (2019): [Almetric](#) 288, Nature Nano 12, 420-424 (2017): [Almetric](#) 72, Science 362, 336–339 (2018): [Almetric](#) 71]
- 1 paper featured as a [Nature Research Highlight](#) [Science Adv. eaaq1543 (2018)].
- 1 paper featured by the Youtube-channel “[Seeker](#)” (~4 mio followers, ~518.000 views)

Researcher identifiers: ORCID: <http://orcid.org/0000-0002-7215-8419>, ResearchID: [Q-3441-2018](#)

Teaching Experience

Thesis Supervisor

- (2014-2016, University of Goettingen): Supervision of several Bachelor students (3), Master students (3) and one visiting postdoc in the group of Dr. Martin Wenderoth. *Topics:* STM/AFM of graphene, transport measurements of doped graphene, STM on high-temperature superconductors.
- (2018-2019, Center for Quantum Nanoscience): Supervision of one master student and 3 student interns in the group of Prof. Taeyoung Choi. *Topics:* STM on single Fe atoms and single molecules, software programming, building electronic devices.

Teaching Assistant

- (2019, Center for Quantum Nanoscience): Lecturer for Ewha international summer school on Quantum Computing (5 lectures)
- (2009-2016, University of Goettingen): Teaching assistant for several lectures at the Faculty of Physics (Quantum Mechanics, Atomic Physics, Electrodynamics, Physics for Medical Students, Basic Programming, Physics for Agricultural Science Students)

Lab Course

- (2013-2015, University of Goettingen): Design and Supervision of the advanced lab course of *Low Energy Electron Diffraction (LEED) of Epitaxial Graphene* within the Master of Science Physics.

Voluntary Work

2009-2013 **Student representative of the Faculty of Physics and member of several committees**
Student member for two selection committees for theoretical particle physics and experimental solid state physics, Vice-president of the student representatives, Organization of the lecture series *Bier und Brezeln*, Organization of the pupil information days

02/2010 – 02/2012: Student representative of the Faculty Board

Further International Experience

08/2010 – 09/2010: **DAAD Taiwan Summer Institute Program**, Internship at the Department of Electrophysics at the National Chiao Tung University in Hsinchu, Taiwan

05/2008 – 09/2008: **CROWN Packaging UK PLC** in Wantage, England, Internship in Treasury Department and Accounts Payable Department

Languages

- German (Mother tongue)
- English (Fluent in speaking, reading and writing)

- Korean (basic skills)
- Chinese (basic skills)
- French (basic skills)

Science Communication and Outreach

- Host for the Youtube channel of the [Center for Quantum Nanoscience](#) explaining topics related to Quantum Science and Nanotechnology (>10.000 views in total).
- Participation in more than 20 Science Slams during my PhD explaining research topics such as *superconductivity* and *graphene* (Public events in which scientists present their research in a comprehensive and entertaining way to a general audience; audiences between 100 – 1000 people).
- Writing several press releases and blog posts about my research at the Center for Quantum Nanoscience and the University of Göttingen; including coordination with media and press.

Journal Review

- I have been reviewing 3 scientific papers for the journals *Nature Communications* (2018), *Nanoletters* (2019) and *Physical Review Research* (2019)

Conference contributions

Invited Talks

1. *Magnetic Sensing Using Single Atom Electron Spin Resonance*, 2nd Sino-Swiss Science and Technology Cooperation (SSSTC2019) Workshop on Endohedral Fullerenes, Hefei, China, November 2019
2. *Magnetic Sensing Using Single Atom Electron Spin Resonance*
8th international conference on scanning probe spectroscopy (SPS'19), Hamburg, Germany, June 2019
3. *The Quantum Science of Atoms on Surfaces*
14th international conference on atomically controlled surfaces, interfaces and nanostructures (ACSIN-14), Sendai, Japan, October 2018
4. *Hyperfine interaction of individual atoms on a surface*
The 69th Shinchon Solid Physics Workshop in Seoul, South Korea, July 2018

Seminar Talks

5. *Towards Quantum Science with Single Atoms on Surfaces*
Physikalisches Institut, Karlsruhe Institute of Technology, June 2019
6. *Magnetic sensing of atoms on a surface using ESR-STM*
Max-Planck-Institute for Solid State Research, April 2019.
7. *Magnetic sensing of atoms on a surface using ESR-STM*
Institute for Functional Matter and Quantum Technologies, University of Stuttgart, April 2019
8. *Quantum Science with Single Atoms on Surfaces*
Institute for Nanotechnology, Karlsruhe Institute of Technology, February 2019
9. *Quantum Science with Single Atoms on Surfaces*
Institute for Science and Technology Austria, Vienna, February 2019
10. *Magnetic sensing of atoms on surfaces using ESR-STM*
Munich Quantum Center, Technical University of Munich, February 2019
11. *Advances in single atom electron spin resonance: hyperfine interaction and magnetic resonance imaging*
Peking University, Tsinghua University and Chinese Academy of Sciences in China, Beijing, July 2018
12. *Atomic-scale transport in graphene: the role of localized defects and substitutional doping*
Ewha Womans University, Department of Physics, August 2016
13. *Scanning Tunneling Potentiometry of Epitaxial Graphene*
Stanford University, Zhi-Xun Shen Group in Palo Alto, California, April 2016

Conference Oral Contribution

1. *Hyperfine interaction of individual atoms on a surface*
Spring Meeting of the German Physical Society, April 2019
2. *Hyperfine interaction of individual atoms on a surface*
Workshop on advanced scanning probe microscopy 2018, South Korea, Busan, August 2018
3. *Detection and Manipulation of the Hyperfine Interaction of Individual Atoms using Scanning Tunneling Microscopy*
American Physical Society March meeting in Los Angeles, March 2018
4. *Controlling Quantum Coherence in Single Atom Electron Spin Resonance*
The 8th International Symposium on Surface Science in Tsukuba, Japan, October 2017
5. *Controlling Quantum Coherence in Single Atom Electron Spin Resonance*
Advanced Scanning Probe Microscopy 2017 in Gyeonggi-do, Korea, August 2017
6. *Magnetotransport in Graphene on the Nano Scale*
Annual Meeting of the priority program 'Graphene' of the German Science Foundation, September 2016
7. *Magnetotransport in Graphene on the Nano Scale measured by Scanning Tunneling Potentiometry*
American Physical Society March meeting in Baltimore, March 2016
8. *New Perspectives in Scanning Tunneling Potentiometry*
Scanning Probe Spectroscopy 2015 in Posnan/Poland, June 2015
9. *Electronic and Transport Properties of Epitaxial Graphene on the Atomic Scale*
Spring Meeting of the German Physical Society, March 2014
10. *Electronic and Transport Properties of Epitaxial Graphene on the Atomic Scale*
Annual Meeting of the priority program 'Graphene' of the German Science Foundation, April 2014

Conference Poster Contribution

11. *Probing Quantum Coherence in Single Atom Electron Spin Resonance*
654. WE-Heraeus-Seminar on topical insights into the nanoscience in Germany, Bad Honneff, November 2017
12. *Magnetotransport in Graphene on the Nano Scale*
Graphene Week in Warsaw/Poland, June 2016
13. *Doping of Graphene by Low-Energy Ion Beam Implantation: Structural, Electronic, and Transport Properties*
Graphene Week in Warsaw/Poland, June 2016
14. *Scanning Tunneling Potentiometry: Magnetotransport in Graphene on the Atomic Scale*
Annual Meeting of the priority program 'Graphene' of the German Science Foundation in Berlin, May 2015
15. *Scanning Tunneling Microscopy of epitaxial Graphene with single ion-implanted Boron, Nitrogen and Carbon*
Spring Meeting of the German Physical Society in Berlin, March 2015
16. *Electronic and Transport Properties of Epitaxial Graphene on the Atomic Scale*
Graphene Week in Göteborg/Sweden, May 2014
17. *An STM-study on the Electronic Properties of SiC-Graphene using Thermovoltage Effects*
Spring Meeting of the German Physical Society, March 2014
18. *Electronic and Transport Properties of Epitaxial Graphene on the Atomic Scale*
544. WEH-Seminar on Interactions with the Nanoworld: Local Probes with High Time, Energy and Force Resolution in Bad Honneff, Germany, November 2013
19. *Quantum-Well-States with non-vanishing momentum component in Cu/Co/Cu(100)-Systems*
Spring Meeting of the German Physical Society in Regensburg, March 2013
20. *Local electronic and transport properties of epitaxial graphene studied by scanning tunneling potentiometry*
FAU Physics Academy on Cutting Edge Research on Graphene in Erlangen, March 2013

Conference and Workshop Organization

I have organized 2 scientific workshops (3 days each) as the main organizer for fellows of the Konrad-Adenauer Foundation

1. *Annual Natural Science Meeting – Research topics of the 21st century (2015)*, Workshop for fellows of the Konrad-Adenauer-Foundation (head of organizing committee and program)
2. *The Göttingen Nobel Prize Wonder (2012)* – Workshop for fellows of the Konrad-Adenauer-Foundation (head of organizing committee and initiator)

Miscellaneous

1. Selected participant of the 66th Lindau Noble Laureate meeting on Physics (2016)

Press Releases and Articles

- Article for *Physik in unserer Zeit*: [Wie man ein Magnetfeld an ein einzelnes Atom anlegt](#)
- QNS press release: [World's Smallest MRI Performed on Single Atoms](#)
(Also featured in *The New York Times*: [Scientists Took an M.R.I. Scan of an Atom](#))
- QNS press release: [Breakthrough in Accessing the Tiny Magnet within the Core of a Single Atom.](#)
- QNS press release: [Major Discovery In Controlling Quantum States of Single Atoms.](#)
- Press release University of Goettingen: [Wie der Strom im Magnetfeld fließt.](#) (German)
- Press release University of Goettingen: [Die kleinsten Widerstände der Welt.](#) (German)
- Article for the Lindau Nobel Laureate Meetings blog: [Doppelt forscht besser – Wie man zwei Nobelpreise miteinander verbindet.](#) (German)

List of Publications (continued)

11. X. Zhang, P. Willke*, A. Singha, C. Wolf, T. Esat, M. Choi, A.J. Heinrich, T. Choi, *equal contribution, **The Journal of Physical Chemistry Letters** 11 (14), 5618-5624 (2020) [Link](#)
12. A. Sinterhauf, G. A. Traeger, D. M. Pakdehi, P. Schädlich, P. Willke, F. Speck, T. Seyller, C. Tegenkamp, K. Pierz, H. W. Schumacher, M. Wenderoth
Substrate induced nanoscale resistance variation in epitaxial graphene, *Nat. Commun.* 11, 555 (2019) [Link](#)
13. K. Yang, Y. Bae, W. Paul, F. D. Natterer, P. Willke, J. L. Lado, A. Ferrón, T. Choi, J. Fernández-Rossier, A. J. Heinrich, and C. P. Lutz
Engineering the eigenstates of coupled spin-1/2 atoms on a surface. *Phys. Rev. Lett.* 119, 227206 (2017) [Link](#)
14. P. Willke*, T. Druga*, R. G. Ulbrich, M. A. Schneider, M. Wenderoth, *equal contribution
Spatial extent of a Landauer residual-resistivity dipole in graphene quantified by scanning tunnelling potentiometry, *Nature Communications* 6, 6399 (2015) [Link](#)
15. K. Yang, W. Paul, F. D. Natterer, J. L. Lado, Y. Bae, P. Willke, T. Choi, A. Ferrón, J. Fernández-Rossier, A. J. Heinrich, and C. P. Lutz
Tuning the Exchange Bias on a Single Atom from 1 mT to 10 T, *Phys. Rev. Lett.* 122, 227203 (2019) [Link](#)
16. Y. Bae, K. Yang, P. Willke, T. Choi, A. J. Heinrich and C. P. Lutz
Enhanced quantum coherence in exchange coupled spins via singlet-triplet transitions, *Science Advances* 4(11), eaau4159 (2018) [Link](#)
17. D. M. Pakdehi, J. Aprojanz, A. Sinterhauf, K. Pierz, M. Kruskopf, P. Willke et al.
Minimum Resistance Anisotropy of Epitaxial Graphene on SiC, *ACS Applied Materials & Interfaces* 10 (6), 6039–6045 (2018) [Link](#)
18. P. Willke, M. A. Schneider, M. Wenderoth
Electronic transport properties of 1D-defects in graphene and other 2D-systems. *Annalen der Physik* (2017) [Link](#)
19. P. Willke, C. Möhle, A. Sinterhauf, H. K. Yu, A. Wodtke, M. Wenderoth
Local transport measurements in Graphene on SiO₂ using Kelvin Probe Force Microscopy, *Carbon* 102, 470-476 (2016) [Link](#)
20. P. Willke, J. A. Amani, S. Thakur, S. Weikert, T. Druga, K. Maiti, H. Hofsäss and M. Wenderoth
Short-range ordering of ion-implanted nitrogen atoms in SiC-graphene, *Applied Physics Letters* 105 (11), 11605 (2014) [Link](#)

21. P. Kloth, M. Wenderoth, P. Willke, H. Prüser, and R. G. Ulbrich
Quantum well states with non-vanishing parallel momentum in Cu/Co/Cu(100), *Physical Review B* 89
(12), 125412 (2013) [Link](#)

09/2020