
Dr. Philip Willke

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Research Experience

05/2020 - current: Young Investigator, Karlsruhe Institute of Technology

Young Investigator in the YIG Prep Pro program of the KIT. Setting up a new lab and a new group with a focus on quantum coherent control of single atoms and molecules.

05/2018 – 04/2020: 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)

Performing electron spin resonance in a scanning tunneling microscopy (ESR-STM) on single atoms and nanostructures. Start of operation of a low temperature scanning tunneling microscope system (Unisoku USM1300, <0.5 Kelvin, UHV and vector magnetic field)

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

Investigating electronic and magnetic properties of single atoms using ESR-STM including Hyperfine coupling in individual atoms (Iron, Titanium and Copper), Magnetic resonance imaging on the atomic scale by employing a scanning field gradient method and Decoherence mechanisms

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

Investigating electron transport on the nanometer scale in graphene by employing scanning tunneling potentiometry and Kelvin probe force microscopy. Theoretical modeling using Matlab and Comsol. Doping of graphene by substitutional doping (nitrogen and boron), characterized by using scanning tunneling microscopy and spectroscopy as well as transport experiments. Starting operation of a low-temperature high magnetic field STM system (6 K, 7 T) for magnetic field scanning tunneling potentiometry and magnetotransport experiments.

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

Establishing a single-atom quantum sensor using magnetic dipole-dipole interaction. Reading and writing of the magnetic state of single Holmium atoms to demonstrate atomic-scale stable 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 and Awards

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)
- Finalist for the 2020 Gerhard-Ertl Young Investigator Award, Deutsche Physikalische Gesellschaft (DPG) meeting, 15-20 March 2020, Dresden (Germany).

Scholarships

- 05/2018 - 05/2019: Feodor-Lynen scholarship of the Alexander-von-Humboldt foundation
 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

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 und Accounts Payable Department

Languages

- German (Mother tongue)
- English (Fluent in speaking, reading and writing)
- Korean (basic skills)
- Chinese (basic skills)
- French (basic skills)

Publications

Since 2013, I published 20 publications in peer-reviewed journals [13 different journals. 1x *Nature*, 2x *Science*, 3x *Nature X*, 2x *Phys. Rev. Lett.*, 2x *Science Adv.*, 3x *Nature Commun*]. **Citations:** 298 (237 without self-citations). **h-index:** 8 (Source: [Web of Knowledge](#)). **Papers as first author:** 10/20 = 50%. **Papers without thesis supervisor:** 12/20 = 60%. **Papers as corresponding author:** 2.

Highlights (peer-reviewed, * marks publications relevant for the proposed project at KIT):

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* 15, 1005-1010 (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* 13, 1120–1125 (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](#)

Full List (peer-reviewed):

11. 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.*, *accepted* (2020) [Link](#)
12. * 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](#)
13. [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](#)

14. * 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](#)
15. * 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](#)
16. 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](#)
17. [P. Willke](#), M. A. Schneider, M. Wenderoth
Electronic transport properties of 1D-defects in graphene and other 2D-systems. *Annalen der Physik* (2017) [Link](#)
18. [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](#)
19. [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](#)
20. 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](#)

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](#)

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), *Physical Review Research* (2019) and *Physical Review B* (2020)

Conference contributions

Invited Talks

1. *Magnetic Sensing Using Single Atom Electron Spin Resonance*, International Conference on Nanoscience and Technology (ICN+T) 2020, Vancouver, Canada, July 2020
2. *Magnetic Sensing Using Single Atom Electron Spin Resonance*, 2nd Sino-Swiss Science and Technology Cooperation (SSSTC2019) Workshop on Endohedral Fullerenes, Hefei, China, November 2019
3. *Magnetic Sensing Using Single Atom Electron Spin Resonance*
8th international conference on scanning probe spectroscopy (SPS'19), Hamburg, Germany, June 2019
4. *The Quantum Science of Atoms on Surfaces*
14th international conference on atomically controlled surfaces, interfaces and nanostructures (ACSIN-14), Sendai, Japan, October 2018
5. *Hyperfine interaction of individual atoms on a surface*
The 69th Shinchon Solid Physics Workshop in Seoul, South Korea, July 2018

Seminar Talks

6. *Towards Quantum Science with Single Atoms on Surfaces*
Physikalisches Institut, Karlsruhe Institute of Technology, June 2019
7. *Magnetic sensing of atoms on a surface using ESR-STM*
Max-Planck-Institute for Solid State Research, April 2019.
8. *Magnetic sensing of atoms on a surface using ESR-STM*
Institute for Functional Matter and Quantum Technologies, University of Stuttgart, April 2019
9. *Quantum Science with Single Atoms on Surfaces*
Institute for Nanotechnology, Karlsruhe Institute of Technology, February 2019
10. *Quantum Science with Single Atoms on Surfaces*
Institute for Science and Technology Austria, Vienna, February 2019
11. *Magnetic sensing of atoms on surfaces using ESR-STM*
Munich Quantum Center, Technical University of Munich, February 2019
12. *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
13. *Atomic-scale transport in graphene: the role of localized defects and substitutional doping*
Ewha Womans University, Department of Physics, August 2016
14. *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)