Dominik Lentrodt

Postdoctoral researcher

| Nationality | German |
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| Work address | Physikalisches Institut |
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| Website | https://dlentrodt.github.io/ |
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| | Educational history & Employment |
| 2021- | Postdoctoral researcher, Georg H. Endress Postdoctoral Fellow, Physikalis- |
| | ches Institut, Albert-Ludwigs-Universität Freiburg, Germany & University of Basel, |
| | Switzerland |
| 2017-2021 | PhD (Dr. rer. nat.), Max-Planck-Institut für Kernphysik, Heidelberg, Germany |
| | Title of thesis: Ab initio approaches to x-ray cavity QED |
| | Advisor: api. Prof. Dr. Jorg Evers Secondary advisors: Prof. Dr. Christoph H. Keitel, Prof. Dr. Thomas Pfeifer |
| | Date of disputation: 13. Oktober 2021 |
| | Grade: summa cum laude |
| 2016–2017 | 4+4 Program of the Heidelberg Graduate School for Fundamental Physics, |
| | Max-Planck-Institut für Kernphysik and University of Heidelberg, Heidelberg, |
| 2012 2016 | MSc & BA Hone Dhysics Conville and Caius College University of Cambridge |
| 2012-2010 | Cambridge, UK |
| 2009–2012 | German Abitur. Maria-Theresia Gymnasium. Munich. Germany |
| 2010-2011 | Frühstudium Informatik Technical University of Munich Munich Germany |
| 2010 2011 | |
| | Relevant awards |
| 2024 | Finalist of the DPG SAMOP Dissertation Prize 2024 |
| 2023 | Otto Hahn Medal |
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Scholarships, funding and scientific proposals

2024 **Principle investigator of Proposal I-20240061 at PETRA III (Hamburg)**, Proposal title: "Probing fundamental interference phenomena with Mössbauer nuclei"

Proposal approved. Experiment scheduled for October 2024.

- 2021 **Georg H. Endress Postdoctoral Fellowship**, *Georg H. Endress Postdoc Cluster*, *Freiburg University & Basel University* Competitive fellowship funding three years of independent research as part of a postdoc cluster in collaboration with groups at Freiburg & Basel University.
- 2018 XXV International Summer School Nicolás Cabrera scholarship, Instituto Nicolás Cabrera at the Universidad Autónoma de Madrid Value approx. 400€.
- 2018 **RACIRI Summer School scholarship**, *Röntgen-Angström-Cluster (RAC)*, *Ioffe-Röntgen-Institute (IRI) & German electron synchrotron (DESY)* Value approx. 1500€.
- 2016 IMPRS-QD PhD Fellowship, International Max Planck Research School for Quantum dynamics, Heidelberg, Germany
- 2016 Summer research project, University of Cambridge, Cambridge, UK
- 2013–2016 **Gonville and Caius College Scholar**, *University of Cambridge*, Cambridge, UK Yearly prize for continued academic excellence.
 - 2015 Gonville and Caius College Bell-Wade Bursary, University of Cambridge, Cambridge, UK

Financial support for students succesfully performing in academia and sports.

Teaching experience

- 2023 Invited Lecture Course on "Cavity QED", IMPRS Summer School on ''Lightmatter interactions: from atoms and molecules to solids"
 3 hours. Invited by: Dr. Panagiotis Giannakeas, Prof. Dr. Petr Slavíček.
- 2023 **Theoretische Physik IV Statistische Physik, Head Tutor**, *University of Freiburg* Design of exercise sheets. Prepared excercise collection with solutions. Four replacement lectures.
- 2022 Selected topics in modern physics, Head tutor and tutor to class of 15, University of Freiburg

Design of exercise sheets and tutoring. Prepared exercise collection with solutions. ${\sim}12$ hours of lessons + preparation, exercise design & correction and feedback meetings.

- 2021 Selected topics in modern physics, Tutor to class of 10, University of Freiburg Novel course format for education students with emphasis on relevant topics for physics taught in highschools. Helped co-design exercises and course structure. \sim 12 hours of lessons + preparation, exercise design & correction and feedback meetings.
- 2017 **Theoretical quantum optics, Head tutor and tutor to class of 8**, *University of Heidelberg*

Theoretical quantum optics including advanced topics

 \sim 12 hours of lessons + preparation, exercise correction and co-conducting oral examinations.

2017 Experimental physics I (PEPI), Tutor to class of 22, University of Heidelberg Mechanics and Thermodynamics

 ${\sim}12$ hours of lessons + preparation, exercise correction and grading exams.

2017-2019 Various replacement teaching, University of Heidelberg Replacement lectures and tutorials for apl. Prof. Dr. Jörg Evers. ~4 hours of lecturing theoretical quantum optics. ~6 hours of tutoring experimental and theoretical physics courses.

Students

- 2022–2023 **Johannes Wahl**, *Bachelor Student at the University of Freiburg* Role: Scientific advisor (Official supervisors: Prof. Dr. Andreas Buchleitner, Prof. Dr. Christian Schindelhauer)
- 2022–2023 Felix Riesterer, Master Student at the University of Freiburg Role: Scientific advisor (Official supervisor: Prof. Dr. Andreas Buchleitner)
 - 2022– Lucas Weitzel Dutra Souto, *PhD Student at the University of Freiburg* Role: Scientific advisor (Official supervisor: Prof. Dr. Andreas Buchleitner)
- 2020–2021 **Oliver Diekmann**, Master Student at the Max Planck Institute for Nuclear Physics, Heidelberg

Role: Co-supervision (Main supervisor: apl. Prof. Dr. Jörg Evers)

Languages

- German Mother tongue
- English Fluent; 4 years of undergraduate studies at an English university

Programming

Python, MATLAB, C++, Java

Scientific proposals and large-scale facility experiments

2024- **Principle investigator of Proposal I-20240061 at PETRA III (Hamburg)**, Proposal title: "Probing fundamental interference phenomena with Mössbauer nuclei"

Proposal approved. Experiment scheduled for October 2024.

- 2022-2023 **Co-proposer and Co-investigator of Proposal No. 3334 at the European XFEL** (Hamburg), Proposal title: "Multiphoton Collective Lambshift in Nuclear Resonant Scattering" Experiment conducted May 2023.
- 2019–2022 **Co-proposer and Co-investigator of Proposal No. 2628 at the European XFEL** (Hamburg), Proposal title: "Multiphoton Collective Lambshift in Nuclear Resonant Scattering" Experiment conducted May 2022

Experiment conducted May 2022.

2018–2019 **Co-proposer and Co-investigator of Proposal I-20180786 at PETRA III** (Hamburg), Proposal title: "Optimizing resonant photon flux enhancement with yoctosecond phase stability in mechanically controlled nuclear resonance scattering" Experiment conducted May 2019.

2016–2022 Co-investigator of 7 experiments at PETRA III (Hamburg) and ESRF (Grenoble)

Resulting in two refereed publications (publication 1 & 4) and articles in preparation.

Peer reviewing

Regular Physical Review Letters, Physical Review Research, Nanophotonics, Communications journals Physics, New Journal of Physics, Scientific Reports

Review Physics Reports

journals

Leadership roles and outreach

2018–2021 Student Representative of the International Max-Planck Research School for Quantum Dynamics in Physics, Chemistry and Biology (IMPRS-QD) Representing interests of the student body (~40 students) at board meetings and in the candidate selection process. Organized lab tours for new students, a seminar series to practice PhD defense presentations and various social events.

2018–2019 **Organising Committee of the 12th HGSFP Winterschool** A committee of five students elected to organise the yearly winterschool funded by the Heidelberg Graduate School for Fundemental Physics (HGSFP). Financial volume of ~27000€.

- 2017–2019 **Outreach at the Max Planck Institute for Nuclear Physics** Jointly organised the "Girls day" and two other outreach projects at the Max Planck Institute for Nuclear Physics, which involved teaching students and children about the physics of light in interactive experiments.
- 2014–2015 Cambridge University Kickboxing Society Committee: Treasurer Responsible for a financial volume of ~1000 GBP.

Publications

Published in refereed journals

- K. P. Heeg, A. Kaldun, C. Strohm, P. Reiser, C. Ott, R. Subramanian, <u>D. Lentrodt</u>, J. Haber, H.-C. Wille, S. Goerttler, R. Rüffer, C. H. Keitel, R. Röhlsberger, T. Pfeifer and J. Evers, "Spectral narrowing of x-ray pulses for precision spectroscopy with nuclear resonances", *Science* **357**, 375-378 (2017)
- 2. <u>D. Lentrodt</u> and J. Evers, "Ab Initio Few-Mode Theory for Quantum Potential Scattering Problems", *Phys. Rev. X* **10**, 011008 (2020)
- <u>D. Lentrodt</u>, K. P. Heeg, C. H. Keitel and J. Evers, "Ab initio quantum models for thin-film X-ray cavity QED with Mössbauer nuclei", *Phys. Rev. Research* 2, 023396 (2020)
- K. P. Heeg, A. Kaldun, C. Strohm, P. Reiser, C. Ott, R. Subramanian, <u>D. Lentrodt</u>, J. Haber, H.-C. Wille, S. Goerttler, R. Rüffer, C. H. Keitel, R. Röhlsberger, T. Pfeifer and J. Evers, "Coherent x-ray-optical control of nuclear excitons with zeptosecond phase-stability", *Nature* **590**, 401–404 (2021)

- 5. O. Diekmann, <u>D. Lentrodt</u> and J. Evers, "Inverse design approach to x-ray quantum optics with Mössbauer nuclei in thin-film cavities", *Phys. Rev. A* **105**, 013715 (2022)
- O. Diekmann, <u>D. Lentrodt</u> and J. Evers, "Inverse design in nuclear quantum optics: From artificial x-ray multi-level schemes to spectral observables", *Phys. Rev. A* 106, 053701 (2022)
- <u>D. Lentrodt</u>, O. Diekmann, C. H. Keitel, S. Rotter, and J. Evers, "Certifying multi-mode light-matter interaction in lossy resonators", *Phys. Rev. Lett.* 130, 263602 (2023)

Theses

t1 <u>D. Lentrodt</u>, "Ab initio approaches to x-ray cavity QED – From multi-mode theory to nonlinear dynamics of Mössbauer nuclei", *PhD Thesis*, Heidelberg University (2021)

Preprints/Submitted

- p1 M. Gerharz, <u>D. Lentrodt</u> et al., "Fast resonant adaptive x-ray optics via mechanicallyinduced refractive-index control", *submitted*
- p2 <u>D. Lentrodt</u>, C. H. Keitel and J. Evers et al., "Towards nonlinear optics with Mössbauer nuclei using x-ray cavities", *submitted*, arXiv:2405.12773 [quant-ph]
- p3 <u>D. Lentrodt</u>, C. H. Keitel and J. Evers et al., "Excitation of narrow x-ray transitions in thin-film cavities by focused pulses", *submitted*, arXiv:2405.12780 [quant-ph]

In Preparation

- p4 L. Weitzel Dutra Souto, F. Riesterer, F. Lindel, E. Brunner, H.-P. Breuer, A. Buchleitner, <u>D. Lentrodt</u>, "Global pseudomodes for cavity QED with extended systems", *in preparation*
- p5 A. Colla, I. Picatoste, H.-P. Breuer, <u>D. Lentrodt</u>, "Exceptional points in non-Markovian quantum dynamics", *in preparation*

Presentations

Invited Conference Talks

- Mar. 2024 DPG SAMOP Spring Meeting SYAD Symposium, Freiburg, Germany, Quantum Optical Few-mode Models for Lossy Resonators Invited by: Prof. Dr. Gereon Niedner-Schatteburg
- Jan. 2024 **54th Winter Colloquium on the Physics of Quantum Electronics (PQE)**, Snowbird, Utah, USA, *Towards nonlinear effects with Mössbauer nuclei and x-ray cavities Invited by:* Prof. Dr. Ralf Röhlsberger

- June 2023 FRIAS Conference Quantum Info meets Attosecond Science, Freiburg, Germany, *Towards quantum optics with x-rays & Mössbauer nuclei Invited by:* Dr. Christoph Dittel
- Feb. 2023 43rd Extreme Atomic Systems (EAS) conference, Rietzlern, Kleinwalsertal, Austria, Nonlinear excitation of Mössbauer nuclei in thin-film cavities Invited by: Prof. Dr. Thomas Pfeifer
- Sep. 2022 FRIAS Junior Researcher Conference Quantum Control of Complex Systems, Freiburg, Germany, Multi-mode quantum optics in lossy resonators Invited by: Dr. Edoardo Carion, Andreas Woitzik, Frieder Lindel
- Apr. 2022 **14th Annual Meeting Photonic Devices (AMPD2022)**, Berlin, Germany, *Multi-mode quantum optics in lossy resonators Invited by:* Prof. Dr. Sven Burger, Dr. Felix Binkowski

Sep. 2021 ICAME 2021 - International Conference on the Applications of the Mössbauer Effect, Brasov, Romania, Progress in the Theory of X-ray Quantum Optics with Mössbauer Nuclei Invited by: Prof. Dr. Victor Kuncser

- Jan. 2020 **41st Extreme Atomic Systems (EAS) conference**, Rietzlern, Kleinwalsertal, Austria, *Ab initio few-mode theory Invited by:* Prof. Dr. Thomas Pfeifer
- Sep. 2019 **QSEC 2019**, Heidelberg, Germany, *Ab initio few-mode theory for quantum potential scattering problems Invited by:* Conference committee
- July 2019 LPHYS'19 28th annual International Laser Physics Workshop, Gyeongju, South Korea Coherent X-Ray-Optical Control of Nuclear Dynamics with Zeptosecond Phase-Stability Invited by: Prof. Dr. Olga Kocharovskaya
- Feb. 2019 **40th Extreme Atomic Systems (EAS) conference**, Rietzlern, Kleinwalsertal, Austria, *X-ray Quantum Optics with Mössbauer Nuclei*

Invited by: Prof. Dr. Thomas Pfeifer

Invited Seminar Talks/Colloquia

- July 2024 **QuCoLiMa Colloquium**, Colloquium at the University of Erlangen within the Collaborative Research Center "QuCoLiMa", Erlangen, Germany *Towards nonlinear optics at x-ray energies with Mössbauer nuclei*
- Apr. 2024 **Rauschenbeutel Group Seminar**, Seminar talk at the Humboldt University of Berlin, Berlin, Germany *From single to multi-photon physics in x-ray quantum optics with Mössbauer nuclei*

- Nov. 2023 **Quantum Dynamics Seminar**, Seminar talk at the Max Planck Institute for the Physics of Complex Systems, Dresden, Germany *Quantum optical few-mode models for lossy resonators*
- Nov. 2023 Pálffy Group Seminar, Seminar talk at the University of Würzburg, Germany X-ray cavity QED with Mössbauer nuclei
- Oct. 2023 Lesanovsky Group Seminar, Seminar talk at the University of Tübingen, Germany Towards quantum optics with x-rays & Mössbauer nuclei
- May 2023 **Georg H. Endress Seminar**, Seminar talk at the University of Basel, Switzerland *Quantum optical few-mode models for lossy resonators*
- Jan. 2022 **Kaffeepalaver**, Seminar talk at Max Planck Institute for Nuclear Physics, Heidelberg, Germany *X-ray cavity QED with Mössbauer nuclei*
- Nov. 2021 Haverkort Group Seminar, University of Heidelberg, Germany X-ray cavity QED with Mössbauer nuclei Hosts: Prof. Dr. Maurits W. Haverkort
- Okt. 2019 Seminarium Fizyki Materii Skondensowanej, University of Warsaw, Warsaw, Poland *Ab initio few-mode theories for quantum potential scattering problems Hosts:* Dr. habil. Magdalena Stobińska, Dr. Thomas Sturges
- May 2019 **MPSD Theory Seminar**, Max-Planck-Institut für Struktur und Dynamik der Materie, Center for Free-Electron Laser Science, Hamburg, Germany *Ab initio few-mode theories for quantum potential scattering problems Hosts:* Prof. Dr. Angel Rubio, Dr. Michael Ruggenthaler
- Feb. 2019 Quantum Optics and Statistics Colloquium, Albert-Ludwigs-Universität Freiburg, Freiburg, Germany,
 Ab initio few-mode theories for quantum potential scattering problems
 Hosts: Prof. Dr. Andreas Buchleitner, Dr. Stefan Buhmann
- Nov. 2018 **ITP Seminar**, Institute for Theoretical Physics, Vienna University of Technology, Vienna, Austria *Effective few-mode theories for ab initio cavity QED Hosts:* Prof. Dr. Stefan Rotter, Dr. Himadri Shekhar Dhar

Contributed Talks/Other Talks

- Apr. 2024 **16th Annual Meeting Photonic Devices (AMPD2024)**, Berlin, Germany, *Pseudomodes models for cavity QED Invited by:* Prof. Dr. Sven Burger, Dr. Felix Binkowski
- Mar. 2023 DPG Spring Meeting for Atomic, Molecular, Quantum Optical and Plasma Physics, Hanover, Germany Certifying multi-mode light-matter interactions in lossy resonators
- July 2022 **CCPQ Windsor 2022**, Cumberland Lodge, Windsor, UK *Quantum optical few-mode models for lossy resonators*
- July 2019 LPHYS'19 28th annual International Laser Physics Workshop, Gyeongju, South Korea Ab Initio Few-Mode Theories for Quantum Potential Scattering Problems

- Mar. 2019 **DPG Spring Meeting for Atomic, Molecular, Quantum Optical and Plasma Physics**, Rostock, Germany *Ab initio few-mode Hamiltonians for cavity QED*
- Nov. 2018 **CQD Colloquium IMPRS-QD Pretalk**, Center for Quantum Dynamics, Heidelberg University, Heidelberg, Germany Effective few-mode theories for resonant quantum scattering problems
- May 2018 **Evaluation of the International Max Planck Research School for Quantum Dynamics in Physics, Chemistry and Biology - Student Talk**, MPI für Kernphysik, Heidelberg, Germany *X-ray quantum optics with Mössbauer nuclei*
- Mar. 2018 DPG Spring Meeting for Atomic, Molecular, Quantum Optical and Plasma Physics, Erlangen, Germany Linking ab initio theory and phenomenological models in cavity QED
- Jan. 2018 **Seminar Theoretical Quantum Dynamics**, MPI für Kernphysik, Heidelberg, Germany Effective few-mode theories for quantum scattering problems in X-ray cavity QED

Posters

- Sep. 2019 **QSEC 2019**, Heidelberg, Germany Ab initio few-mode theory for quantum potential scattering problems
- Mar. 2019 DPG Spring Meeting for Atomic, Molecular, Quantum Optical and Plasma Physics, Rostock, Germany Beyond input-output models in X-ray cavity QED with overlapping modes
- Sep. 2018 XXV International Summer School Nicolás Cabrera, Miraflores de la Sierra, Madrid, Spain X-ray cavity QED in the overlapping modes regime
- Aug. 2018 **RACIRI Summer School**, Sellin, Rügen, Germany X-ray cavity QED with Mössbauer nuclei in the overlapping modes regime
- May 2018 SFB 1225 ISOQUANT Workshop, Heidelberg, Germany Effective few-mode theories for quantum potential scattering in X-ray cavity QED
- Mar. 2018 **DPG Spring Meeting for Atomic, Molecular, Quantum Optical and Plasma Physics**, Erlangen, Germany *X-ray cavity QED beyond the input-output formalism*
- Jan. 2018 **11th Winterschool of the Heidelberg Graduate School for Fundamental Physics**, Obergurgl, Austria *Effective few-mode theories for quantum scattering problems in X-ray cavity QED*
- Dez. 2017 Center for Quantum Dynamics Colloquium, Ruprecht-Karls University, Heidelberg, Germany Cavity QED beyond the input-output formalism
- Mar. 2017 **DPG Spring Meeting for Atomic, Molecular, Quantum Optical and Plasma Physics**, Mainz, Germany *Collective sensing at x-ray energies*

Feb. 2017 SFB 1225 ISOQUANT Kick-Off Workshop, Obergurgl, Austria Many-body dynamics of large ensembles of nuclei