

Friederike Metz

Curriculum Vitae

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Education

- 2017 - Present **Okinawa Institute of Science and Technology, Japan, Ph.D. student.**
Working on (quantum) machine learning applications for the study and control of quantum systems; supervised by Prof. Dr. Thomas Busch.
- 2015 - 2016 **University of Waterloo, Canada, M.Sc. (Theoretical Physics).**
Perimeter Scholars International program at Perimeter Institute for Theoretical Physics.
Research Essay: Towards an Effective Theory of Monopole - Fermion Scattering; supervised by Prof. Dr. Cliff Burgess.
- 2011 - 2015 **RWTH Aachen University, Germany, B.Sc. (Physics).**
GPA¹: 1.2.
Bachelor's Thesis: Space-Time Circuit-to-Hamiltonian Construction Applied to a MERA Circuit; supervised by Prof. Dr. Barbara Terhal.
- 2013 - 2014 **University of California, Davis, USA.**
Year abroad in cooperation with RWTH Aachen University, GPA²: 3.92.
- 2009 - 2011 **Theodor-Heuss-Gymnasium, Dinslaken, Germany, high school.**
GPA¹: 1.3.
- 2008 - 2009 **Ogaki-Shogyo High School, Japan, high school.**
Exchange student through AFS Intercultural Programs Germany.

Internships and Work Experience

- May 2022 - **Quantum Researcher Summer Intern, IBM, Yorktown Heights, USA.**
Aug 2022 Developed code for quantum software algorithms and tools as part of the prototypes team.
Member of the quantum intern advisory board.
- Jan 2022 - **Guest Scientist, Max Planck Institute for the Physics of Complex Systems, Dresden,**
May 2022 Germany.
Pursued research on quantum many-body control and reinforcement learning.
- May 2017 - **High school teacher intern, Theodor-Heuss-Gymnasium, Dinslaken, Germany.**
Jul 2017 Taught physics and mathematics to high school students.
- Sept 2012 - **Student research assistant in the AMS project, Physics Institute IB at RWTH**
Aug 2013 Aachen University, Germany.
Developed and maintained monitoring software for AMS-02.
- Jul 2011 - **Internship, Nuclear Physics Institute at Jülich Research Centre, Germany.**
Sept 2011 Contributed to the development of dipole magnets for the HESR synchrotron.

Achievements

- 2022 **IBM Be(e) Innovative Challenge Top 5 Teams.**
Designed an MVP involving a technology solution that tackles sustainability issues in supply chains in a team of 5.
- 2021 **Winner of the Qiskit Hackathon Europe: Research Study Groups.**
Developed a quantum machine learning algorithm for quantum data in a team of 4. I implemented the training framework in Qiskit.
- 2016 **2015/2016 Perimeter Scholars International Honourary Scholarship Award.**
Recognizing my academic performance as a PSI master's student at Perimeter Institute.

¹On a 1.0(A) - 5.0(F) grade scale.

²On a 4.0(A) - 0.0(F) grade scale.

- 2015 - 2016 **Perimeter Scholars International Award**, received from Perimeter Institute and the University of Waterloo.
Full financial support for the duration of the PSI program.
- 2013 - 2015 **Dean's List**, received from RWTH Aachen University.
Ranked in the upper 5% of the physics class for the academic years of 2013/14 and 2014/15.
- 2014 **Award for outstanding leadership performance**, received from University of California, Davis.
Recognizing my work as an ambassador for foreign students at the University of California, Davis.
- 2014 **Award for academic excellence**, received from University of California, Davis.
- 2013 **First prize of the Undergraduate Research Project Competition**, held by the Department of Physics at RWTH Aachen University.
- 2012 - 2013 **Scholarship from the Education Fund of RWTH Aachen University**, supported by a donation from Hans Hermann Voss-Stiftung.
For excellent academic performance and in expectation of outstanding achievement at university.
- 2011 **German Physical Society (DPG) Book Award**.
In recognition of outstanding performance in the subject of physics.

Outreach and Teaching

- Mar 2021 **Teacher of OIST Mini Course: Julia**, Okinawa Institute of Science and Technology, Japan.
Taught introductory lecture on the Julia programming language.
- 2017 - 2019 **Teaching programming to kids**, Okinawa, Japan.
Taught children MIT's programming language Scratch through interactive lectures and tutorials at local science events in Okinawa.
- 2018 - 2019 **Tutor for OIST Science Challenge**, Okinawa Institute of Science and Technology, Japan.
Tutored undergraduate students on research related topics and presentation skills during week-long workshops.
- 2018 **Organizer of TEDxOIST2018**, Okinawa Institute of Science and Technology, Japan.
Co-organized a TEDx event for an audience size of 500. My tasks included: license application, budget planning, speaker recruitment & training, coordination of volunteers, etc.
- May 2017 - **High school teacher internship**, Theodor-Heuss-Gymnasium, Dinslaken, Germany.
Jul 2017 Prepared and conducted physics and mathematics classes at a local high school.

Publications and Preprints

- 2022 F. Metz, M. Bukov, *Self-Correcting Quantum Many-Body Control using Reinforcement Learning with Tensor Networks*, [arXiv:2201.11790](https://arxiv.org/abs/2201.11790) (2022).
- 2021 K. Kottmann*, F. Metz*, J. Fraxanet, N. Baldelli, *Variational Quantum Anomaly Detection: Unsupervised mapping of phase diagrams on a physical quantum computer*, *Phys. Rev. Research* **3**, 043184 (2021).
- 2021 K. Gietka, F. Metz, T. Keller, and J. Li, *Adiabatic critical quantum metrology cannot reach the Heisenberg limit even when shortcuts to adiabaticity are applied*, *Quantum* **5**, 489 (2021).
- 2021 F. Metz, J. Polo, N. Weber, and T. Busch, *Deep learning based quantum vortex detection in atomic Bose-Einstein condensates*, *Mach. Learn.: Sci. Technol.* **2**, 035019 (2021).
- 2020 A. Gratsea, F. Metz, and T. Busch, *Universal and optimal coin sequences for high entanglement generation in 1D discrete time quantum walks*, *J. Phys. A Math. Theor.* **53**, 44 (2020).
- 2018 R. Sachdeva*, F. Metz*, M. Singh, T. Mishra, and T. Busch, *Two-leg-ladder Bose-Hubbard models with staggered fluxes*, *Phys. Rev. A* **98**, 063612 (2018).

[*] indicates co-first authorship

Talks and Invited Seminars

- May 2022 **ICFO, Barcelona, Spain.**
Self-Correcting Quantum Many-Body Control using Reinforcement Learning with Tensor Networks.
- Apr 2022 **Flatiron Institute, New York, USA, (virtual).**
Self-Correcting Quantum Many-Body Control using Reinforcement Learning with Tensor Networks.
- Mar 2022 **AML D EPFL 2022, Lausanne, Switzerland, (conference).**
Self-Correcting Quantum Many-Body Control using Reinforcement Learning with Tensor Networks.
- Mar 2022 **Forschungszentrum Jülich, Germany, (virtual).**
Self-Correcting Quantum Many-Body Control using Reinforcement Learning with Tensor Networks.
- Dec 2018 **Institute of Laser Physics, Hamburg, Germany.**
Staggered fluxes for the Bose-Hubbard model in two-leg ladder configuration.
- Oct 2018 **Shanghai University, China.**
Staggered fluxes for the Bose-Hubbard model in two-leg ladder configuration.

Experience in Supervision

- May 2020 - **Natalya Weber.**
Aug 2020 Rotation student.
- May 2019 - **Aikaterini Gratsea.**
Oct 2019 Intern student.

Attended Conferences and Schools

- Apr 2022 **Simulating Quantum Many-Body Systems on Noisy Intermediate-Scale Quantum Computers, MPI-PKS, Dresden, Germany.**
International Focus Workshop.
- Mar 2022 **AML D EPFL 2022, Lausanne, Switzerland.**
Applied Machine Learning Days.
- Aug 2021 **Machine Learning in Quantum Physics and Chemistry, Warsaw, Poland.**
- Jan 2021 **The Hitchhiker's Guide to Condensed Matter and Statistical Physics: Machine Learning for Condensed Matter, ICTP Virtual School.**
- Sept 2020 **Mesoscopic cold atom systems in and out of equilibrium, Virtual Workshop.**
- Jul 2020 **Ellis QPhML 2020 Virtual Meeting.**
Quantum and Physics based machine learning.
- Nov 2019 **TENSOR19, San Sebastian, Spain.**
Tensor Network based approaches to Quantum Many-Body Systems.
- Sept 2019 **CQD, Okinawa, Japan.**
Okinawa School in Physics: Coherent Quantum Dynamics.
- Jul 2019 **Machine Learning for Quantum Design, Waterloo, Canada.**
- May 2019 **Synthetic Topological Matter, Dresden, Germany.**
- Mar 2019 **FPUA2019, Okinawa, Japan.**
International Workshop on Fundamental Physics Using Atoms.
- Sept 2018 **CQD, Okinawa, Japan.**
Okinawa School in Physics: Coherent Quantum Dynamics.
- Jul 2018 **ICAP2018, Barcelona, Spain.**
International Conference on Atomic Physics and Summer School.
- Sept 2017 **CQD, Okinawa, Japan.**
Okinawa School in Physics: Coherent Quantum Dynamics.

Skills

Research expertise

- Quantum physics Quantum simulation, quantum many-body systems, quantum control, quantum computation, quantum metrology, quantum phases of matter
- Machine learning Reinforcement learning, object detection, tensor network-based machine learning
- Numerical tools Tensor networks (DMRG, TEBD), optimization methods

Technical skills

- Programming Python, Julia
- Libraries Qiskit, JAX, TeNPy, QuSpin, PyTorch, Flux (Julia)
- Other Git, HPC, Mathematica, L^AT_EX, Unit testing

Languages

- German native
- English fluent
- Japanese intermediate JLPT (Japanese Language Proficiency Test) Level 3

Additional relevant skills

- Research Referee for MLST journal; IOP trusted reviewer certificate.
- Communication Trained student peer supporter, certified by Ganjuu Wellbeing Service at OIST, Okinawa.

References

- Prof. Thomas Busch**, Ph.D. supervisor.
Okinawa Institute of Science and Technology, Japan.
- Dr. Marin Bukov**, collaborator.
Max Planck Institute for the Physics of Complex Systems, Germany.