Aroosa **Ijaz**

Quantum Physicist · Machine Learning Enthusiast · Inquisitive Scientist

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Education

University of Waterloo, Vector Institute
Toronto, Canada

PhD Physics CGPA: 3.9/4.0 *Sep 2021 - Present*

- **Thesis:** Quantum machine learning: theory, algorithms, and applications.
- **Supervisors:** Prof. Roger Melko, Prof. Juan Felipe Carrasquilla

ETH Zürich
Zürich, Switzerland

PhD Physics - **LEFT TO CHANGE TO THEORETICAL PHYSICS*** *Nov 2016 - Oct 2018*

- **Thesis:** Towards realization of Majorana Fermions in 2D Transition Metal Dichalcogenide heterostructures.
- **Supervisors:** Prof. Klaus Ensslin, Prof. Thomas Ihn

Ulm University
Ulm, Germany

M.Sc. Physics (Quantum Information Specialization) CGPA: 4.0/4.0 *Sep 2014 - Aug 2016*

- **Thesis:** Low temperature spectroscopy of single color centers in diamond: Investigations into Germanium vacancy center in diamond.
- **Supervisors:** Prof. Fedor Jelezko, Prof. Alexander Kubanek

Lahore University of Management Sciences
Lahore, Pakistan

B.Sc. Physics & Computer Science CGPA: 3.27/4.00 *Sep 2009 - Aug 2013*

- **Thesis:** Experimental investigations on confined Excitons in quantum wells and quantum Dots embedded in optical microcavities.
- **Supervisors:** Prof. Ata Ul Haq

Publications

2026 **Double descent in quantum kernel methods**
Marie Kempkes, Aroosa Ijaz, Elies Gil Fuster, ... Vedran Dunjko,
https://doi.org/10.1103/cn64-gs6b. *PRX Quantum*

2025 **More buck-per-shot: Why learning trumps mitigation in noisy quantum sensing**
Aroosa Ijaz, Cinthia Huerta, ... Marco Cerezo, Matthew L. Goh,
https://doi.org/10.1016/j.mtquan.2025.100042. *Materials Today Quantum*

2023 **Does provable absence of barren plateaus imply classical simulability?**
Marco Cerezo, ..., Aroosa Ijaz, ..., Zoë Holmes,
https://doi.org/10.1038/s41467-025-63099-6. *Nature Communications*

2022 **Pennylane: Automatic differentiation of hybrid quantum-classical computations**
Ville Bergholm, ..., Aroosa Ijaz, ... Nathan Killoran,
https://arxiv.org/pdf/1811.04968.pdf. *ArXiv*

2020 **Quantum embeddings for machine learning**
Seth Lloyd, Maria Schuld, Aroosa Ijaz, ... Nathan Killoran,
https://arxiv.org/abs/2001.03622. *ArXiv*

2018 **Realization of an electrically tunable Narrow-Bandwidth atomically thin mirror using monolayer MoSe2**
Patrick Back, Aroosa Ijaz, ... Atac Imamoglu,
https://doi.org/10.1103/PhysRevLett.120.037401. *Physical Review Letters*

2017 **Optical and microwave control of germanium-vacancy center spins in diamond**
Petr Siyushev, Mathias Metsch, Aroosa Ijaz, ... FedorJelezko,
https://doi.org/10.1103/PhysRevB.96.081201. *Physical Review B*

Work Experience

Dahlem Center for Complex Quantum Systems, Freie Universität Berlin
Berlin, Germany

Visiting Researcher *Jan 2024 - April 2024*

- Worked on two research projects on over-parameterized quantum learning models with Prof. Jens Eisert's group

Los Alamos National Laboratory
Los Alamos, USA

Graduate Research Assistant *Oct 2023 - Dec 2023*

- Worked on a research project on classical simulability of quantum learning models

Los Alamos National Laboratory
Los Alamos, USA

Quantum Computing Summer School Intern *June 2023 - Aug 2023*

- Worked on a research project on error mitigation applied to quantum sensing

Xanadu.ai
Toronto, Canada

Quantum machine learning scientist — *Sep 2019 - Aug 2020*

- Theoretical research on variational quantum kernels resulted in a seminal result and a patent (US Patent App. 17/118,004)
- Theoretical research on using Gaussian Boson sampling to assess graph isomorphism for drug development
- Contributed to developing and deploying the **mixed state simulator** in PennyLane to add the ability to simulate noisy quantum circuits
- Contributed to developing and deploying the **data module** in Strawberry Fields. It provides pre-generated datasets from GBS simulations for various chemistry, graph optimization, and machine learning problems
- Contributed to developing and deploying the **sample module** in Strawberry Fields. It provides functionality for generating GBS samples using classical simulators

Xanadu.ai
Toronto, Canada

Quantum machine learning research intern — *May 2019 - Aug 2019*

- Improved community engagement with our software by adding educational documentation and tutorials to PennyLane website
- Development and deployment of additional features and gates to PennyLane qubit simulator

Quantum Photonics Group, ETH Zürich
Zürich, Switzerland

Research Secondment, Prof. Atac Imamoglu — *Nov 2016 - May 2017*

- Conducted low-temperature electrical transport and optical measurements on monolayer MoSe2/graphene/HBN hetero-structures to explore exciton properties in dichalcogenides
- Hetero-structure acted as an electrically tunable atomically-thin mirror; publication in Physical Review Letters

Institute for Quantum Optics, Ulm University
Ulm, Germany

Research assistant, Prof. Fedor Jelezko — *Jun 2015 - Aug 2016*

- Investigated quantum optical effects in the novel single Germanium-Vacancy centers in diamond
- Performed resonant extinction measurements on single Silicon-Vacancy centers in diamond as a high contrast detection technique
- Set up a confocal microscope to characterize synthetic diamond samples

Department of Physics, Lahore University of Management Sciences
Lahore, Pakistan

Research assistant — *Jul 2013 -Jun 2014*

- Computational modelling of different open cavity QED systems in MATLAB and solving their Lindblad equations (with Dr. Ata Ul Haq)
- Computational analysis of doping in Graphene by group IV elements executed in Siesta in Linux environment (with Dr. Fakhar Ul Inam)
- Simulating portable Hallbach NMR Spectrometer in ComSol modeling software (with Dr. Sabieh Anwar)
- Development of Quantum Erasure experiment based on Mach Zender Interferometer for Freshman Physics lab (with Dr. Sabieh Anwar)

Department of Computer Science, Lahore University of Management Sciences
Lahore, Pakistan

Research Intern — *Jun 2012 - Dec 2012*

- Proposing new fault-tolerant data center topologies with higher efficiency and resilience
- Statistical analysis of big data from a Google cluster of 10,000 servers. Designed data structures and a divide-and-conquer algorithm to efficiently process the data in Python.

Awards and Honors

2021-2025 **Vector Research Grant [CAD 6000 / Year]** , Vector Institute for Artificial Intelligence — *Toronto*

2021-2025 **Marie Curie Graduate Student Award [upto CAD 10000 / Year]** , University of Waterloo — *Waterloo*

2021 **Patent: Co-inventor with Seth Lloyd and Maria Schuld: US Patent Application 17,118,004**, Xanadu.ai — *Toronto*

2021 **3rd position**, Xanadu.ai Quantum Hackathon — *Toronto*

2016-2018 **Marie Curie Young Researcher Fellowship [50, 000 Euros / Year]** , ETH Zürich — *Zürich*

2015 **Degree Scholarship [1500 Euros]**, Ulm University — *Ulm*

2014-2015 **Merit scholarship award (not availed) [PKR 219, 000]**, Lahore University of Management Sciences — *Lahore*

2007-2009 **100% Honor Roll Scholarship** , Lahore Grammar School — *Lahore*

Community Engagement

Quantum Barsaat
Lahore

Lecturer — *Aug 2024*

- Quantum Barsaat was a series of workshops on quantum computing organized by QPakistan in collaboration with QWorld.
- Students and learners from all over the country joined in.
- I gave two lectures on quantum states, gates, and computation.
- At the end of this workshop, I participated in a panel discussion where experiences and expectations around graduate admissions, graduate life, and working in the quantum industry were discussed.

International Women's Day Conference — *Global*

Speaker — *Mar 2022*

- Organized by Google's women techmakers and Pakistani Women in Computing (PWiC)
- I talked about advances in QML and tried to identify social factors that lead to the low number of women in Physics at all levels of education and employment.

Physics camp for girls — *Pakistan*

Speaker — *Dec 2021*

- 1200 high school girls from all over Pakistan participated. The camp was aimed at inspiring them about physics and STEM careers
- I gave a talk in urdu about quantum computing and its potential impact on technology and the society we live in.

Quantum Machine Learning meetup — *Global*

Organizer — *Apr 2021 - Apr 2022*

- Once every two months, along with two other enthusiasts, I virtually host a QML researcher and discuss their cutting-edge research

Quantum Computing Mentorship Program, Quantum Open Source Foundation — *Global*

Mentor — *Sep 2020 - Feb 2021*

- This program helps enthusiasts learn about quantum computing software development and research
- I mentored 3 participants in a research project on expressivity of variational quantum embeddings

Quantum Techniques in Machine Learning Conference — *Global*

Program committee member — *2020, 2021, 2022, 2023*

- Review papers submitted to this conference for quality publication

Canadian Conference for Undergraduate Women in Physics — *Toronto*

Keynote Speaker — *2020*

- This was a wonderful opportunity to inspire brilliant young women about Quantum Computing and Quantum Machine Learning! We also discussed challenges and biases women face in research

Skills

Programming Skills	Python, MATLAB, Mathematica, C++, Octave, R
Machine Learning	PennyLane, Qiskit, Cirq, TensorFlow Quantum, Qibo, Qutip, Scipy, Scikit-learn, PyTorch
Languages	English[C2], Urdu[Native], Punjabi[Native], German[A1], Italian [Beginner]

References

Dr. Marco Cerezo, Los Alamos National Laboratory — *Los Alamos, USA*

: +1 505 667 5061 : CEREZO@LANL.GOV : Google Scholar Page

Dr. Maria Schuld, Xanadu.ai, UKZN — *Toronto, Canada*

: +1 416 304 9629 : MARIA@XANADU.AI : Google Scholar Page

Prof. Jens Eisert, Freie Universität Berlin — *Berlin, Germany*

: +49 30 838 51351 : JENSEISERT@GMAIL.COM : Google Scholar Page

Prof. Roger Melko, University of Waterloo — *Waterloo, Canada*

: +1 519 888 4567 : RGMELKO@UWATERLOO.CA : Google Scholar Page

Prof. Seth Lloyd, Massachusetts Institute of Technology — *Massachusetts, USA*

: +1 617 252 1803 : SLLOYD@MIT.EDU : Google Scholar Page

Prof. Juan Felipe Carrasquilla, Vector Institute, University of Waterloo — *Toronto, Canada*

: +1 519 888 4567 : CARRASQU@VECTORINSTITUTE.AI : Google Scholar Page

Prof. Fedor Jelezko, Ulm University — *Ulm, Germany*

: +49 731 50 23 750 : FEDOR.JELEZKO@UNI-ULM.DE : Google Scholar Page