

# Aroosa Ijaz

QUANTUM PHYSICIST · MACHINE LEARNING ENTHUSIAST · INQUISITIVE SCIENTIST

222 Elm Street, Toronto, ON M5T 1K4, Canada

✉ ijaz.aroosa@gmail.com | 🌐 aroosaijaz.github.io | 📧 Aroosaljaz | 🌐 aroosaijaz | 📄 google scholar

## Work Experience

### 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)
- Developed and deployed a mixed state simulator to PennyLane software to add the ability to simulate noisy quantum circuits
- Developed and deployed the data module to Strawberry Fields software that provides pre-generated Gaussian Boson sampling data for various chemistry, graph optimization and machine learning problems
- Theoretical research on using Gaussian Boson sampling to assess graph similarity for drug development

### 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 MoSe<sub>2</sub>/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 Google cluster data using Python

## Education

### University of Waterloo, Vector Institute

Toronto, Canada

PHD PHYSICS

Sep 2020 - Jun 2024

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

### ETH Zürich

Zürich, Switzerland

PHD PHYSICS - LEFT TO CHANGE TO COMPUTATIONAL 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) GPA: 1.1/5.0 (MAX GRADE: 1.0/5.0)

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: 3.27/4.0 (MAX GRADE: 4.0/4.0)

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

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- 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 MoSe<sub>2</sub>**  
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, ... Fedor Jelezko,  
<https://doi.org/10.1103/PhysRevB.96.081201>. *Physical Review B*

## Awards and Honors

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- 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*

## Community Engagement

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### Physics camp for girls

SPEAKER

*Pakistan*

*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

ORGANIZER

*Global*

*Apr 2021 - Present*

- 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

MENTOR

*Global*

*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

PROGRAM COMMITTEE MEMBER

*Global*

*2020, 2021*

- Review papers submitted to this conference for quality publication

### Canadian Conference for Undergraduate Women in Physics

KEYNOTE SPEAKER

*Toronto*

*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

## Teaching Experience

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### Department of Physics, ETH Zurich

TEACHING ASSISTANT

*Zürich, Switzerland*

*Nov 2016 - Dec 2017*

- Undergraduate Physics Lab: supervised two experiments with eight students every week
- Undergraduate Physics-1: conducted exercise classes, graded assignments and exams

### Department of Physics, Ulm University

STUDENT TUTOR FOR STRUGGLING PEER STUDENTS

*Ulm, Germany*

*Jan 2016 - Mar 2016*

- Tutored 2 master students in Quantum Mechanics
- Tutored 1 master student in calculus and differential equations

### Lahore University of Management Sciences

TEACHING ASSISTANT

*Lahore, Pakistan*

*Sep 2011 - Jun 2014*

- Data Structures, Quantum Mechanics-1, Mechanics, Atomic-Molecular-Laser Physics, Experimental Physics Lab-I

# References

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<b>Prof. Juan Felipe Carrasquilla, Vector Institute, University of Waterloo</b> ☎: +1 519 888-4567    ✉: CARRASQU@VECTORINSTITUTE.AI    📄: GOOGLE SCHOLAR PAGE	<i>Toronto, Canada</i>
<b>Prof. Seth Lloyd, Massachusetts Institute of Technology</b> ☎: +1 617 252 1803    ✉: SLLOYD@MIT.EDU    📄: GOOGLE SCHOLAR PAGE	<i>Massachusetts, USA</i>
<b>Dr. Maria Schuld, Xanadu.ai, UKZN</b> ☎: +1 416 304 9629    ✉: MARIA@XANADU.AI    📄: GOOGLE SCHOLAR PAGE	<i>Toronto, Canada</i>
<b>Prof. Fedor Jelezko, Ulm University</b> ☎: +49 731 50 23 750    ✉: FEDOR.JELEZKO@UNI-ULM.DE    📄: GOOGLE SCHOLAR PAGE	<i>Ulm, Germany</i>