

Ashutosh Mishra

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Profile

Theoretical Physicist

Theoretical Physicist with 4+ years of experience in theory of quantum optimal control, specializing in its application to superconducting qubits. Demonstrated expertise in modelling, simulation, and optimization of many-body quantum systems. Collaborated in a team of researchers and software engineers for the development of optimal control package [ParaQeet](#), based on fast linear algebra and automatic differentiation using JAX. Also experienced with molecular dynamics and modelling of biological processes. Eager to explore application of quantum computing technologies to solve interdisciplinary real-world problems, while carefully accounting the current hardware limitations.

Education

- **Master of Science in Physics** *July, 2021*
Indian Institute of Science Bangalore, India
 - CGPA: 9.0/10.0
 - First class with distinction
- **Bachelor of Science (Research) in Physics** *July, 2020*
Indian Institute of Science Bangalore, India
 - CGPA: 8.8/10.0
 - First class with distinction

Experience

- **Forschungszentrum Jülich GmbH** *Sep 2021 - Present*
Ph.D. Student Jülich, Germany
 - **Supervisors:** Prof. Dr. Frank Wilhelm-Mauch, Dr. Alessandro Ciani
 - **PhD thesis:** Open-loop quantum control for practical superconducting quantum systems (in preparation)

For my PhD, I implemented numerical and analytical open-loop quantum control methods to systems with large Hilbert space and open quantum systems. I demonstrated that:

- * A general framework for open-loop control can be formalized for arbitrary pulse parameterization.
- * A series expansion can be derived which, combined with Lieb-Robinson bounds, provides an efficient method for open-loop control in lattice systems.
- * Using numerical techniques, readout and re-initialization in fixed frequency transmons can be achieved by a *demolition measurement* protocol.

Also, I contribute to the development and maintenance of quantum optimal control package: [ParaQeet](#).

- **Indian Institute of Science** *Aug 2016 - July 2021*
Bachelor's and Master's thesis Bangalore, India
 - **Supervisor:** Dr. Baladitya Suri
 - **Master's thesis:** Estimating errors in two qubit parametric iSWAP gate.
 - * Investigated errors due to frequency crowding in multi-qubit coupler based iSWAP gate implementation.
 - * Performed simulation of 4 qubits and a tunable coupler using Julia.
 - **Bachelor's Thesis:** Input-output theory for qubit measurement in a circuit QED system.

- * Examined input-output relations for one-sided and two-sided cavity model for the readout of a transmon coupled to a resonator.
- * Verified the results by simulation using QuTiP.
- **The Australian National University** May 2019 - July 2019
Research internship Canberra, Australia
 - **Supervisor:** Dr. Ben Buchler
 - Part of visiting scholarship award of *Chennupati and Vidya Jagadish Visiting Scholarship and Fellowship Awards*.
 - * Built a trans-impedance amplifier circuit for a photo-detector used for high speed detection of laser signals.
 - * Studied about quantum memories using electromagnetically induced transparency.

Research projects

- **Efficient analytical gradient evaluation for locally-interacting large multi-qubit platforms** Sep 2024 - Present
Supervisors: Prof. Dr. Frank Wilhlem-Mauch, Dr. Alessandro Ciani (PGI-12) Forschungszentrum Jülich
 - Derived an efficient method for gradient computation during open-loop optimization of lattice-based large multi-qubit systems, and open quantum systems.
- **ParaQeet-A quantum optimal control toolkit with simple parameter management** Dec 2024 - Present
Supervisor: Dr. Alessandro Ciani (PGI-12) Forschungszentrum Jülich
 - Contributed to the development of a semi-automatic differentiation based quantum optimal control package, written in JAX.
- **Demolition measurement protocol for transmon qubits** Sep 2021 - Feb 2024
Supervisors: Dr. Shai Machnes (Qruise GmbH), Prof. Dr. Frank Wilhlem-Mauch (PGI-12) Forschungszentrum Jülich
 - Performed numerical investigation into a combined protocol for superconducting qubit readout, leakage removal and unconditional reset.
- **Estimating errors in two qubit parametric iSWAP gate** Aug 2020 - July 2021
Supervisor: Dr. Baladitya Suri (Dept. of Instrumentation and Applied Physics) Indian Institute of Science
 - Investigated error budget due to frequency crowding in a multi-qubit coupler based iSWAP gate implementation using Julia.
- **Study on effect of heterogeneity and plasticity on cell population under effect of drug** May - Aug 2020
Supervisor: Dr. Mohit Kumar Jolly (Centre for BioSystems Science and Engineering) Indian Institute of Science
 - Mathematical modeling and agent based simulation of cell population under drug treatment and studied the effects of heterogeneity and plasticity.
- **Input-output theory for qubit measurement in a circuit QED system** Aug 2019 - May 2020
Supervisor: Dr. Baladitya Suri (Dept. of Instrumentation and Applied Physics) Indian Institute of Science
 - Derived input-output relations for one-sided and two-sided cavity model for the readout of a transmon coupled to a resonator.
- **Design of optical detectors** May 2019 - July 2019
Supervisor: Dr. Ben Buchler (Dept. of Quantum Science) The Australian National University
 - Built a trans-impedance amplifier circuit for a photo-detector used for high speed detection of laser signals.
- **Study of structure of nano-confined water under electric field** May 2018 - April 2019
Supervisor: Prof. Prabal K Miati (Dept. of Physics) Indian Institute of Science
 - Performed modelling and molecular dynamics simulation of nano-confined water between two sheets of graphene, and studied its behaviour under electric field.

- **Computational identification of potential stop codon read-through candidates in mammalian cell**

Supervisor: Dr. Sandeep Eswarappa (Dept. of Biochemistry)

May 2018 - May 2019
Indian Institute of Science

- Developed automated software suite to analyze large scale mass-spectrometric data for the identification of potential stop codon read-through candidates.

Transferable skills

- **Programming languages:** Proficient with Python and Julia.
- **Software tools:** QuTiP, JAX, Tensorflow, Git, \LaTeX , CI/CD.
- **Teamwork:** Working in a team of researchers and software engineer for the development of software package [ParaQeet](#).

Conferences and academic experience

- Presented a talk on **Gradient evaluation of analytic controls for large Hilbert space** at the American Physical Society (APS) Global physics summit in Anaheim, USA. March 2025
- Presented a talk on **Demolition measurement of transmon qubit** at the Deutsche Physikalische Gesellschaft in Berlin, Germany. March 2024
- Attended the 2022 Arnold Sommerfeld School on **Physics meets AI**, Munich, Germany. Sep 2022
- Teaching assistant for a course on **Quantum Field Theory** in Universität des Saarlandes. Oct 2021 - Feb 2022
- Presented poster at various conferences including the **Superconducting Quantum Algorithms (SQA)**, **AQuTe25**, **Quantum optimal control workshop 2024**, **WE-Heraeus seminar**, **PGI day**, **JUCA day**, and various project meetings. 2022-2025
- Participated in Quantum Hackathons – **QHack 2023** and **QEC Hack ETH Zurich 2023**. 2023

Awards

- **Chennupati and Vidya Jagadish Visiting Scholarship and Fellowship Awards** May - July 2019
Awarded by The Australian National University (ANU) for a research internship at ANU. This scholarship is awarded to up to 4 people each year.
- **Kishore Vaigyanik Protsahan Yojana (KVPY)** Aug 2016 - July 2021
Fellowship instituted by the Department of Science and Technology, Government of India.

References

- **Prof. Dr. Frank Wilhelm-Mauch**
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Theoretical Physics, Universität des Saarlandes, 66123 Saarbrücken, Germany
Email- f.wilhelm-mauch@fz-juelich.de
- **Dr. Alessandro Ciani**
Forschungszentrum Jülich GmbH, Institute for Quantum Computing Analytics (PGI-12), 52425, Jülich, Germany
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Publications

- [1] A. **Mishra**, E. Lupo, F. K. Wilhelm, and A. Ciani, “Efficient analytical gradient evaluation for locally-interacting large multi-qubit platforms”, *In preparation*, 2026.
- [2] A. **Mishra**, A. Simm, M. Wald, A. Ciani, and N. Wittler, “ParaQeet: A quantum optimal control toolkit with simple parameter management”, *In preparation*, 2026.
- [3] A. **Mishra**, F. K. Wilhelm, and S. Machnes, *Demolition measurement protocol for transmon qubits*, 2025. arXiv: [2502.18322](https://arxiv.org/abs/2502.18322).
- [4] S. Sahoo, A. **Mishra**, A. M. Diehl, and M. K. Jolly, “Dynamics of hepatocyte-cholangiocyte cell-fate decisions during liver development and regeneration”, *Isience*, vol. 25, no. 9, 2022.
- [5] S. Sahoo, A. **Mishra**, H. Kaur, K. Hari, S. Muralidharan, S. Mandal, and M. K. Jolly, “A mechanistic model captures the emergence and implications of non-genetic heterogeneity and reversible drug resistance in er+ breast cancer cells”, *NAR cancer*, vol. 3, no. 3, zcab027, 2021.
- [6] L. E. Manjunath, A. Singh, S. Sahoo, A. **Mishra**, J. Padmarajan, C. G. Basavaraju, and S. M. Eswarappa, “Stop codon readthrough of mammalian mtch2 leading to an unstable isoform regulates mitochondrial membrane potential”, *Journal of Biological Chemistry*, jbc-RA120, 2020.