Ankur **Agrawal**

Quantum Computing and Networking

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Summary

I am a Quantum Research Scientist at the AWS Center for Quantum Networking working towards a quantum safe internet. Full stack-engineer with 5+ years of experience in superconducting qubit design, characterization, quantum measurements, microwave engineering, and data analysis.

Work Experience

Center for Quantum Networking, Amazon Web Services (AWS)

Boston, USA

Quantum Research Scientist, Test and Measurement Team — *Sept. 2022 - Present*

- Built a control stack integrating hardware and device driver repository to control and manipulate the spin and optical properties of a diamond based quantum memory within a newly established lab environment.
- Established uniform protocols and developed a characterization pipeline in collaboration with the fabrication and cryogenic systems team to analyze materials grown under varied conditions.
- Increased the material characterization throughput by a factor of 20 by building a confocal implantation spot detection routine which led to project completion two months ahead of the schedule.
- Achieved a 10-fold reduction in insertion loss for a microwave signal-carrying PCB by leveraging electromagnetic simulations and optimizing cryogenic cable assembly, reducing heat load at the base plate of a dilution refrigerator.

Research Experience

Graduate Research Assistant with Prof. David Schuster and Dr. Aaron Chou

Chicago, USA

Physics Department, The University of Chicago — *June 2017 - Sept 2022*

- Performed a dark photon search 2.78 times faster than conventional methods by initializing a microwave cavity coupled to a transmon qubit in $n = 4$ Fock state using GRAPE based quantum optimal control methods.
- Developed a single photon counter based on a superconducting qubit with an error rate of $1300\times$ lower than the standard quantum limit (SQL) to speed up dark photon searches.
- Designed, fabricated and characterized Josephson Parametric Amplifiers (JPA) which achieved nearly 50% quantum efficiency.
- Built a high-Q ($> 10^6$) dielectric cavity compatible with 14 Tesla magnetic field for axion searches, 20 times improvement over a Copper cavity.
- Benchmarked an open-source RFSoC based qubit controller system (QICK) to approach coherence limited single qubit gate fidelity of 99.93% using randomized bench-marking sequence.

Axion Dark Matter eXperiment (ADMX)

Seattle, USA

Center for Experimental Nuclear Physics and Astrophysics (CENPA), University of Washington — *June 2017 - Sept 2022*

- Performed hot-load measurements (Y-factor method) and investigated the systematic effects of magnetic field and frequency on the noise temperature of cryogenic amplifiers.
- This tool is incorporated into mainline axion experiment for current and future runs, resulted in 4 publications.

Master's Thesis with Prof. Raghava Varma

Mumbai, India

Physics Department, IIT Bombay — *July 2015 - June 2016*

- Designed and simulated the device properties of radiation hard silicon pad detector geometries using simulation tool SILVACO.
- Fabricated and characterized the detectors to obtain the desired I-V characteristics for ALICE experiment at CERN.

Research Internship with Prof. Thomas Peitzmann and Dr. Marco van Leeuwen

Utrecht, The Netherlands

Institute for Subatomic Physics, Utrecht University — *May 2015 - June 2015*

- Studied the effects of radiation damage on silicon detectors due to various ionizing particles for future LHC upgrades.
- Built a computational framework in FLUKA using Non-Ionizing Energy Loss (NIEL) hypothesis and ROOT to estimate the 1 MeV Neutron Equivalent fluence to identify the high radiation dose layers.

Skills

Simulation Tools	Ansys HFSS, Palace, Comsol, MEEP (FDTD), Sonnet, QuTip
Layout Tools	Autodesk Inventor, Gmsh, KLayout, Qiskit Metal
Quantum	Superconducting circuit design and characterization, gates and readout chain optimization, microwave hardware
Programming	Python, Scikit-learn, Collaborative software development with Git, QUA, Instrument drivers

Education

The University of Chicago — *Chicago, USA*

Ph.D. in Physics — *Sept. 2016 - Sept 2022*

- Superconducting Qubit Advantage for Dark Matter (SQuAD)

IIT Bombay — *Mumbai, India*

B.Tech. and M.Tech. in Engineering Physics — *July 2011 - Aug. 2016*

- Master's Thesis - Study of Radiation Damage and Fabrication of Silicon Particle Detectors

Mentorship and Service

2023-	**Peer reviewed for journals - PRX, PRD, EPJ, APL**
2023	**Volunteer, Computer Science Education Weekend, Museum of Science Boston**
2021-2022	**Kester Anyang, Graduate student (Illinois Institute of Technology, Chicago)**
2019-2022	**Ege Halac, High school student (Chicago)**
2021	**Judge, Chicago Area Undergraduate Research Symposium**
2017	**Coordinator, Fermilab 50th Community Open House**
2016-2019	**Teaching Assistant for Undergraduate Physics courses Phys 121, 122, 123, 131**

Selected Presentations

Fermilab Friday Seminar (Invited) — *Batavia, USA*

Dark matter signal enhancement with a superconducting qubit — *March 2023*

ASC 2022 (Invited) — *Honolulu, USA*

Dark matter signal enhancement with a superconducting qubit — *Oct 2022*

APS March Meeting 2022 — *Chicago, USA*

Dark matter signal enhancement with a superconducting qubit — *March 2022*

16th Patras Workshop 2021 — *Virtual*

Superconducting Qubit Advantage for Dark Matter (SQuAD) — *June 2021*

Selected Publications

Stimulated Emission of Signal Photons from Dark Matter Waves

Agrawal, Ankur, Akash V. Dixit, Tanay Roy, Srivatsan Chakram, Kevin He, Ravi K. Naik, David I. Schuster, Aaron Chou

Phys. Rev. Lett. *132 (14 Apr. 2024)*

The QICK (Quantum Instrumentation Control Kit): Readout and control for qubits and detectors

Leandro Stefanazzi, Kenneth Treptow, Neal Wilcer, Chris Stoughton, Collin Bradford, Sho Uemura, Silvia Zorzetti, Salvatore Montella, Gustavo Cancelo, Sara Sussman, Andrew Houck, Shefali Saxena, Horacio Arnaldi, **Agrawal, Ankur**, Helin Zhang, Chunyang Ding, David I. Schuster

Review of Scientific Instruments *93.4 (2022)*

Searching for Dark Matter with a Superconducting Qubit

Akash V. Dixit, Srivatsan Chakram, Kevin He, **Agrawal, Ankur**, Ravi K. Naik, David I. Schuster, Aaron Chou

Phys. Rev. Lett. *126 (14 Apr. 2021)*

Seamless High-Q Microwave Cavities for Multimode Circuit Quantum Electrodynamics

Srivatsan Chakram, Andrew E. Oriani, Ravi K. Naik, Akash V. Dixit, Kevin He, **Agrawal, Ankur**, Hyeokshin Kwon, David I. Schuster

Phys. Rev. Lett. *127 (10 Aug. 2021)*

Niobium coaxial cavities with internal quality factors exceeding 1.5 billion for circuit quantum electrodynamics

Andrew E. Oriani, Fang Zhao, Tanay Roy, Alexander Anferov, Kevin He, **Ankur Agrawal**, Riju Banerjee, Srivatsan Chakram, David I. Schuster

arxiv:2403.00286 *(Mar. 2024)*