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My name is Shuhul Mujoo, and I'm writing to express my interest in summer research with your group. As an undergraduate at Caltech majoring in applied physics, I would love this chance to help conduct research towards the fields of quantum matter and engineering. I am available in the summer from June to August in person, full time.

I am extremely passionate about conducting research in the fields of quantum matter and engineering. Ever since I learned about quantum computing, I have become invested in a strong belief that quantum computers are a key step towards the future. Having worked with quantum error correction codes, and algorithms like Grover's and Shor's, I know quantum coherence can be tough to achieve. I have published a paper on a fault tolerant quantum communication algorithm, built on the quantum teleportation of a CNOT gate. Moreover, I am enthusiastic about the potential applications to advanced quantum algorithms (Q-KNN and quantum neural networks).

At Caltech, I have taken relevant courses: quantum mechanics (Schrodinger's equation, fully solved hydrogen atom, density matrices, identical particles, etc.), statistical mechanics (Ising model in 1d, van der waals gasses, mean field theory, Ornstein-Zernike theory, renormalization group, etc.), semiconductor devices (lithography, atomic force microscopy, etc.) and photonics (polarization, interference, lasers, etc.).

I am interested in both quantum hardware and software. I have strong research, mechanical, electrical, and software engineering skills, as well as extensive experience with quantum computation.

I have research experience at Leiden University, where I worked under Professor Michiel de Dood, on Superconducting Nanobridge Single Photon Detectors (SNSPD's) and completed a project on the 3-omega method for measuring the thermal conductivity of supercooled substrates. I learned some superconducting physics: BCS Theory, Coherence Length, London penetration depth, DC Josephson and Meissner Effects, Type I & II Superconductors, Ginzburg-Landau theory. I independently deposited a 10 μm gold wire on a SiO2 substrate, spin coated 2 layers of PMMA, did E-Beam lithography, evaporation deposition and development, and finally wire bonding to test in a cryostat. I also created an op amp subtractor circuit, removed noise with Lock-in amplifier, simulated circuit in LTSpice, used LABView, pyVISA, and pyMeasure for automation.

Additionally, I have completed an internship as a quantum engineering intern at Rigetti Computing where I coded circuit simulation software to calculate Hamiltonian specs and qubit frequencies. My main task was to port Julia code to Python through test driven development. For this, I created tensor operation and eigensolver code (advanced numerical methods in linear

algebra, rayleigh quotient iteration, etc.). I learned more in depth about superconducting quantum computing (josephson junctions, transmons, Cooper pair boxes, quasiparticles, Tc, EJ/EC ratio, readout resonators, chip fabrication, etc.). The internship was a great experience and I had a lot of fun working together with the other interns.

I have knowledge of Quantum Computing Concepts at a fundamental level, having published a paper on quantum algorithms. I am proficient in coding in both Python and Java. I have the ability to design and develop quantum hardware components. I have a strong understanding of quantum algorithms (Grovers, Shor's algorithm, etc.), and have extensive experience with Q# and qiskit. I have written a paper on Quantum K Nearest Neighbors. I developed implementations of Novel Enhanced Quantum Representation (NEQR) and Quantum Teleportation (QT) algorithms. After being challenged by the unavailability of Quantum RAM while creating an implementation of quantum computing subroutine (Amplitude Estimation), one of my life goals is to help invent and develop Quantum RAM.

Another one of my experiences is an internship at the Search For Extraterrestrial Intelligence (SETI) Institute. I completed a research project and a final presentation on Gas Temperature Prediction For Accretion Disks. I coded simulations using Fortran and Python, and worked with Mathematica. I went through the entire machine learning workflow, from cleaning (exponent overflows), to training (64 neuron 3 layer RELU) architecture, to testing (3d input space plots and precision recall curves).

Additionally, I wrote a research paper (https://arxiv.org/abs/2209.08608) on Simultaneous Localization and Mapping (SLAM), specifically a novel loop closure detection detection system that integrates geometric and human salient features. Building off the state of the art system, ORB-SLAM, I was able to improve the algorithm in organic environments where there were few features. I then tested my localization algorithm on a robot that I built for a robotics competition. With the improved accuracy, my robotics team won first place in California and became a world finalist.

Please let me know if there are any opportunities available. I am extremely passionate about quantum science and engineering!

Sincerely, Shuhul