Introduction. My rigorous, multi-disciplinary background in physics, mathematics, and computer science has led me to my research interests in quantum computing and quantum sensing research. I am applying to the Cornell PhD program in applied physics to continue my training in a challenging environment, where I can work on next-generation technology targeting the most impactful problems in the field.

Academic Experience. I graduated last semester with honors with degrees in physics, mathematics, and computer science, awarding me a diverse knowledge base which I have already found to be extraordinarily beneficial in my research projects. For my academic, research, and teaching achievements, **I received the Kandula Sastry award, presented each year to the outstanding student in the physics department.** Following my undergraduate program, I was awarded a fellowship for a funded accelerated masters degree in computer science, with the opportunity to work on my master's thesis in quantum information science.

Research in Nuclear Physics. My first research project at UMass was with Prof. Krishna Kumar for the MOLLER collaboration. An important part of the design of the MOLLER collimation system is the blocking of so-called "two-bounce" particles, where high-energy electrons irradiate various surfaces within the experimental chamber, which themselves can emit problematic background particles. My project involved rewriting an existing software tool to check this condition to support three dimensions. Performance is significantly improved, reducing simulation time from hours to minutes, and automatic import from Geant4 geometry is supported. This tool validates the current design, and greatly shortens the design-feedback loop as changes are implemented. **With financial support from the APS, I presented this work in the CEU session at the 2023 Fall DNP meeting in Waikoloa, HI.**

After learning about ongoing neutrino physics experiments from my PI and my own reading, I wanted to get involved in the nEXO experiment. I joined Prof. Kumar's other group, working on research and development towards a xenon purity measurement system using a laser-driven gold photocathode. We worked on better understanding and optimizing our newly constructed cryostat and gas handling system to measure and characterize signals in gas first, then later in liquid. I worked on assembling, configuring, and calibrating our signal processing chain, consisting of charge-sensitive preamplifiers and shaping amplifier units. **My senior honors thesis, for which I was awarded highest honors upon graduating, was focused on building data analysis tools for these studies.** These had a focus on controlling for noise in the signals, showing both an effective fourier peak-finding based method, and an algorithm that simulates the shaper unit, and can adaptively choose an ideal shaping time.

The next summer, I continued to work with nEXO, with Prof. Andrea Pocar's group on optical studies and SiPM response measurements in liquid xenon. The group uses the Chroma optical simulation framework to model the experiments within the cell. I worked on overhauling the local codebase to support running large-scale simulations, on the order of a trillion photons, which allow us to 'sweep' various optical parameters of materials within the cell. This has enabled ongoing studies to understand how the measurements from the experimental runs ("photon transport efficiency") depend on these, and are informing the group on which cell configurations will produce the best constraints on these parameters. I have integrated tensor cross-interpolation, a recent tensor-network based adaptive interpolation method, which has allowed for much more detailed sweep outputs with much less computation required. I'm now working on integrating updates to further optimize the simulations GPU usage with the Chroma source code. **This analysis work applied to measuring/constraining the properties of Silicon reflectors was presented at a nEXO collaboration light simulation workshop** in October 2024 at McGill University in Montreal, CA.

Research in Quantum Information. After attending a colloquium talk on quantum information theory applied to black holes, I became interested in quantum computation. Coming from just learning about computation/information theory in a CS course, I found the notion of 'abusing' physical laws to break traditional information theory boundaries fascinating. While taking the graduate coursework in the subject, I worked with Prof. Stefan Krastanov on writing a Julia module to efficiently simulate Gaussian quantum states. It provides support for common Gaussian operations (rotate, squeeze, beam-split, homo/heterodyne measurements). This has applications to modelling quantum sensing devices, which are often based on measuring gaussian squeezed states.

For my masters project, I am working with Prof. Gayane Vardoyan and Prof. Krastanov to apply modern machine reinforcement learning techniques to optimize link generation in quantum memory devices. Building off previous work which used heavily simplifying assumptions, I am studying ways to find compact but highly general ways to represent quantum states in this problem so that we may study this process with more realistic noise models.

Why Cornell. I am applying to Cornell because of it's excellent research in quantum information science. Across the broad field, my interests specifically are in development of quantum sensing devices, development of scalabale quantum architechtures for fault-tolerant computing, and novel uses of quantum processing hardware for practical applications. My work with Prof. Krastanov and Prof. Vardoyan has given me a good theoretical backing on the modelling of quantum sensors and communication devices, but I am most interested and excited to move into the experimental side to physically realize these types of systems. The work of professors Nicholas Rivera, Karan Mehta, Peter McMahon, and Or Katz aligns well with these interests. If I am given the opportunity, I look forward to leveraging Cornell's world-class faculty and resources to best prepare myself for my future career in full-time research. I look forward to the unique challenges such a rigorous environment may provide so I can make a meaningful impact on these projects.

Thank you very much for your time and consideration. I look forward to hearing from you.