Personal Statement, Relevant Background, and Future Goals

I saw in my nephew's eyes the day that we welcomed him to life a trace of determination. My family says that I was born with this same resolute stare. From little jobs like sweeping the chicken cages to cleaning up the fridge, my family loves telling stories of how I always did my best at everything. There are many things I am passionate about, but I try to be dedicated to those that bring value to my life: I focus on the general themes of my education and ethics. My everyday activities that contribute to these concentrations are eating vegetarian, doing my best in school and research, and perhaps most acknowledgeable, are my outreach efforts. Navigating the paths of science as a minority student has made me aware of the necessity to motivate underrepresented groups to pursue STEM fields through outreach activities and mentorship. In fact, my goal is to become a senior research scientist at a U.S. national laboratory, defense, or intelligence agency where I can mentor and motivate minority students to pursue STEM careers while solving our nation's most challenging national security problems.

I realize now that my outreach efforts really began back at home, in a low-income city of Ecuador. Although constantly struggling to be the first of my class, my efforts frequently appointed me the opportunity to participate in math, physics, and chemistry competitions. However, it wasn't until I participated in a poetry-in-English competition that my teachers recommended I start taking English classes at a college in town. Such experience sparked in me a deep interest in the language and drove me to volunteer teaching an introductory English course for children. This experience not only nurtured my passion for the language, but also brought many unexpected opportunities. I participated in an exchange program sponsored by the U.S. Department of State called Youth Ambassadors. As a 16-year-old Youth Ambassador, I visited the U.S. for first time to promote international education and service partnerships. During my visit, I volunteered for a non-profit organization in Washington DC preparing meals for people with life-challenging illnesses. In addition, I visited various schools in Boise, Idaho where I talked to first-graders and high school students about Ecuador. In addition, thanks to the Fulbright Commission selecting me as an Opportunity fellow, I was able to apply and receive a four-year, full-tuition scholarship at the University of Evansville (UE).

Though becoming an astronaut was my goal in high school, the most aspirational career I could ever imagine in Ecuador was to join the oil industry. However, from the first semester at UE, I started working on making my scientific aspirations come true. My interest in space served as my motivation to join the rocket team at UE. As part of this team, I measured the thrust of a model rocket engine and used these results to predict the flight profile of the actual rocket the team designed for the competition at NASA's Marshall Space Flight Center in 2012. As a sophomore, I taught myself how to use strain gauges and LabVIEW as the experiment I performed consisted of attaching the rocket engine to the end of a cantilever beam. By measuring the strain on the beam produced when the engine was ignited, I was able to relate the load on the beam to the engine's thrust and acceleration, and numerically integrate the data to find the rocket's predicted flight profile. In addition to putting our engineering skills to test, we had an opportunity to motivate children to pursue STEM fields. We visited the Boys and Girls Club of Evansville and held three hands-on engineering events on campus for middle school students where they learned to make paper rockets propelled by air pressure.

One step closer to becoming an astronaut, I joined NASA's Goddard Space Flight Center during the summer of 2012 where I supported the Magnetospheric Multiscale Mission (MMS).

MMS investigates how the Sun and Earth's magnetic fields interact in a process known as magnetic reconnection. My project consisted of determining the solar radiation impact on the MMS's spacecrafts and payload during their mission orbit. I determined the critical tilt angle of the spacecrafts with respect to their central axis, which helped to prevent the payload from overheating. During my time at NASA, I taught myself the fundamentals of radiation processes in space, and also learned how to use AutoCAD thermal desktop, the standard tool for thermal design. Interacting with scientists and observing real-world applications of science opened my eyes to the elegance of physics, particularly quantum physics. One of the most important conversations I had at NASA was with Dr. Harold White, lead inventor of Q-thrusters, a thruster that uses the quantum vacuum fluctuations to propel spacecrafts. The peculiarities of such bizarre physics inspired me to learn about other fields where quantum mechanics was used as the building block of novel technologies. Immediately after returning to school, I took a modern physics course where my curiosity for quantum physics matured. In addition to being a great learning experience, my time at NASA made me aware of how underrepresented in the sciences and engineering Latinos are. I realized that becoming a scientist could no longer be a self-centered endeavor, but it was my duty to use science and engineering as the means to encourage more Latinos to pursue STEM fields. Therefore, I have been serving as the president of the Tau Delta Kappa engineering honor society at UE, as a mentor for UE's Honors Program, and physics tutor. In addition to taking honors courses, I have been mentoring minority underclassmen, organizing various community service projects for engineering students, assisting in the recruitment of Latinos to the university's Honors Program through webinars and phone calls, and offering private tutoring sessions for physics students. Talking about my experience at NASA has been an important tool to get these groups interested in STEM fields.

I spent my second and third summers in the U.S. as an MIT Summer Research Program (MSRP) intern. The first summer, I joined Dr. Konstantin Turitsyn's group in the Mechanical Engineering department where I investigated how wind power can be incorporated into the electric grid to maximize profit based on fluctuating electricity prices. My model consisted of a pair of storage devices with different rate and storage capacities, which were allowed to exchange energy, store it, or sell it to the electric grid. The optimization of control actions of the storage devices was achieved with a convex optimization package known as CVX. Oftentimes, I found myself alone in the lab for 10 to 20 days, putting my dedication, independence, and self-motivating traits to the test. It was a difficult summer, but I wouldn't take it back for anything. I learned so much about the project, but perhaps more importantly, about my capabilities as a researcher. In hopes to communicate my enthusiasm about this project, I presented my results at three undergraduate conferences, and they are now published in the proceedings of *The National Conference on Undergraduate Research (NCUR)* held in Lexington, KY in April of 2014.

Up until then, I did not have the opportunity to be involved in research where I could study quantum phenomena. Nevertheless, having met various professors at MIT working on the development of quantum technologies, and my increasing interest in this field motivated me to stay an extra year as an undergraduate student to complete a physics degree in addition to my engineering degree. Furthermore, staying in school for an extra year served to gain more research experience, and as such I decided to undertake a yearlong research project at my home institution where I served as the team leader for my senior capstone team. This project consisted of various experiments that studied the quantum behavior of photons, focusing on concepts such as entanglement, distinguishability, and various manipulations of photonic states using single photons resulting from spontaneous parametric down-conversion. As an essential part of this

project, I taught myself the fundamentals of quantum mechanics and built a Mach Zehnder interferometer to manipulate photonic states using free-space optics. Furthermore, I built a coincidence counting module to detect single photons. I also presented the results of these experiments at three undergraduate conferences, winning an award at one of them, and these results too are published in the proceedings of *NCUR*, held in Lexington, KY in April of 2014.

Although my senior project introduced me into the field of quantum mechanics, it wasn't until the summer of 2014 when I finally did research that contributed to the development of quantum technology. As a returning MSRP intern, I joined the Quantum Photonics group in RLE and worked under Dr. Dirk Englund. Here I participated in the development of the first-of-its-kind quantum photonic processor (QPP), which consists of an array of Mach Zehnder interferometers on a silicon-on-insulator platform. My project consisted of building a calibration and characterization system for the network of tunable thermo-optical phase modulator drivers that were used to control the processor. The calibration circuit consisted of a set of multiplexers and a teensy microcontroller where the sequence of control actions was programmed using Python. Calibrating and characterizing the boards allowed properly controlling the MZIs, which will accelerate the development of linear optical quantum computing experiments on the QPP. I presented the results of this project at the MSRP symposium in August of 2014.

The University of Evansville is not a research institution. However, thanks to the assistance of my mentors at NASA and MIT, I am convinced that obtaining a PhD and pursuing a career in science and engineering are the best way to contribute to society. I am so grateful for the opportunities I have received. Therefore, as an effort to give back to my community, I started volunteering at a local English-as-a-new-language school helping immigrants of all levels to learn the language. I have learned the needs of these vulnerable groups, particularly their children, and their limited access to education. In hopes to help change this reality in my community, I have started an outreach campaign called "Yo También Puedo: Preparing Latinos for Higher Education". This program is geared toward documented and undocumented Latinos in the U.S. and provides information in Spanish and English about how to go and how to fund college and graduate school. I have visited various churches of Latino concentration in Evansville to give talks and motivate Latino students to pursue higher education in STEM fields. In my community, there is a large population of low English proficient immigrants whose children will be first generation college students. I realize that they too may need some guidance and the comfort of being able to ask questions in their own language. Although many of the participants are only interested in taking the first step towards bachelors, my campaign also includes information on fellowships and summer research opportunities. In addition, I have started a collaborative effort with various local businesses and the dioceses of Evansville to start a scholarship fund to help at least one Latino student to go to college in 2015, and to continue this outreach program after I leave Evansville. Lastly, this information is also available on a YouTube channel and website I have created where my personal contact information is also available to anyone who is interested in having a mentor.

I hope to pay forward all of the efforts taken on my behalf as I continue my grad school and professional careers at a national lab, defense, or intelligence agency. I am aware of the STEM promoting educational programs available at various universities and government laboratories. Therefore, receiving the NSF Graduate Research Fellowship, in addition to being an honor, will give me the flexibility to train as a researcher while continuing to motivate minorities to pursue STEM fields. I hope to get involved in structured STEM outreach programs such as "Grad Catalyst" at MIT, "HMTech" and "Manos" at Sandia National Lab, or other similar programs.