Personal Statement, Relevant Background, and Future Goals

Growing up with barely literate parents in a country only known for the Galapagos Islands and bananas, pursuing a career in science has been an uphill battle. Being a minority both in Ecuador and in the U.S. has made me aware of the necessity to motivate underrepresented groups to pursue STEM fields through outreach and mentorship. Therefore, my goal is to become a senior research scientist at a U.S. national laboratory, defense, or intelligence agency where I will solve our nation's most challenging national security problems while mentoring minority students to pursue STEM careers.

Throughout my life, I have consistently worked toward becoming a scientist, not only by participating in scientific activities, but also by developing my communication skills and network. In high school, I frequently participated in science competitions, and soon realized that English is the international language of science. Not being my native tongue, I took the initiative to master this language by attending an intensive, four-year, after-school English program at a local college. In addition, I practiced my communication skills by volunteering as a teacher for an introductory English course for children. These experiences not only nurtured my passion for the language, but also built my confidence to create international collaborations. Soon after, I participated in the Youth Ambassadors exchange program sponsored by the U.S. Department of State and visited the U.S. to promote international education and service partnerships. During my visit, I completed a community service project, met with politicians, and visited various schools where I talked to students about Ecuador. Learning about the opportunities for scientists in the U.S. motivated me to apply for the Fulbright's Education USA Opportunity program. My English skills, international experience, and passion for science drove the Fulbright Commission to award me a grant that assisted me in applying to schools in the U.S. and receiving a four-year, full-tuition scholarship at the University of Evansville (UE) in southwestern Indiana.

Becoming an astronaut was my dream career in high school. From my first semester at UE, I started working on making this goal come true by joining the U.S. Launch Initiative rocket team. 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 instrumentation techniques and digital data acquisition as I measured the strain on a cantilever beam produced by the engine's thrust. I related the load on the beam to the engine's acceleration and found the rocket's predicted flight profile. In addition to putting my engineering skills to test, I had an opportunity to motivate children to pursue STEM fields. I visited the Boys and Girls Club of Evansville and held three hands-on engineering events on campus for middle school students who 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 learned how to use AutoCAD thermal desktop.

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 as I was one of only three Latinos in the entire campus. 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. I began by serving as president of the Tau Delta Kappa engineering honor society at UE, as a mentor for the Honors program, and as a physics tutor. In addition to taking honors courses, I have been mentoring minority underclassmen, organizing community service projects, assisting in the recruitment of Latinos to the Honors program, and offering physics tutoring sessions.

My experience at NASA also motivated me to gain further research experience, and my next opportunity to do so was at the Massachusetts Institute of Technology (MIT) during the summer of 2013. As part of MIT's Summer Research Program (MSRP), 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. I designed a model consisting of a pair of storage devices with different rate and storage capacities, which were allowed to exchange, store, or sell energy to the electric grid. The system's scheme of control actions was programmed with a convex optimization package known as CVX. This study showed that installing a large-rate, relatively low-storage capacity device, and a large-storage, relatively low-rate capacity device interconnected can smooth variations in wind power production much more economically than a single storage device with both large storage and rate capacities. Furthermore, this study showed that the device's efficiencies do not have a high impact on the profit obtained with a particular device pair. Although MSRP only required me to present my project to my peers at a poster session at the end of the summer, I took the initiative to communicate the results of my studies to a much larger audience at three undergraduate conferences and published a manuscript in the proceedings of *The National Conference on Undergraduate Research (NCUR)* held in Lexington, KY in April of 2014.

Having met various professors at MIT at the forefront of quantum technologies along with 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. As such, I undertook a yearlong research project that consisted of various experiments studying the quantum behavior of photons. I focused on manipulating 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 (MZI) to manipulate photonic states using free-space optics. Furthermore, I built a coincidence counting module to detect single photon coincidences. 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.

I further immersed myself in quantum mechanics during the summer of 2014 at MIT where I contributed to the development of quantum technology. As a returning MSRP intern, I joined Dr.

Dirk Englund's Quantum Photonics group in the Electrical Engineering Department. Here, I contributed to the development of the first-of-its-kind quantum photonic processor (QPP), which consists of an array of MZIs on a silicon-on-insulator platform. I built a calibration and characterization system for the network of tunable thermo-optical phase modulator drivers that were used to control the processor. The calibration system consisted of a set of multiplexers and a microcontroller where the sequence of control actions was programmed using Python. Calibrating and characterizing the boards allowed for the proper control of the MZIs, which will accelerate the development of linear optical quantum computing experiments on the QPP. I presented the project's results at the MSRP symposium in August of 2014.

My experiences at MIT motivated me to continue pursuing research. As a result, I joined the R&D laboratory of Accuride Corporation, a local wheels manufacturing company to learn important experimental techniques such as electron scanning microscopy and x-ray diffraction to characterize alloys and measure residual stresses for failure analysis. I am currently working on a project to develop a new product and manuscript that will be submitted for publication to a metallurgy journal by 2015.

Because of my experience as a first-generation minority student, obtaining a PhD in electrical engineering and pursuing a career in research are the best ways to motivate underrepresented groups to pursue STEM fields. I am so grateful for the opportunities I have received, and as an effort to give back to my community, I volunteered at a local English-as-a-new-language school helping immigrants of all levels to learn the language during my free time. I realized the needs of these vulnerable groups, particularly their children, regarding their limited access to higher education. As a result, I recently 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 fund college and graduate school. I have visited various churches of Latino concentration in Evansville to motivate Latino students to pursue higher education in STEM fields. In the greater Evansville area there is a large population of low-English-proficient immigrants whose children will be first generation college students. Like I did, they may need some guidance and the comfort of being able to ask questions in their own language. 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 Diocese of Evansville to start a scholarship fund to help at least one Latino student attend college in 2015 and continue this outreach campaign. This information is also available on a YouTube channel and website I created where my personal contact information is 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 graduate 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. During graduate school, I hope to get involved in structured STEM outreach programs such as "Grad Catalyst" at MIT (where I would like to obtain my PhD), and as a professional scientist in programs similar to "HMTech" and "Manos" at Sandia National Laboratory.