If you heard the words 'neutron star astrophysics', 'Antarctic snails', 'cockroaches', 'phylogenetic algorithms', and 'gamma ray telescopes' lumped together, you might have a little trouble deciphering what they all have in common. However, each phrase represents a research area I pursued as a double major in biology and physics at Georgia Tech (GT). I eagerly explored not only different areas of science, but also different areas of the world. I have studied abroad in Australia during my sophomore year and took a semester during my third year to accompany my professor on her research expedition to Antarctica.

With each experience, I moved closer and closer to finding something I was passionate about, and then I found the field of biomechanics. Now, I can add 'fish swimming' and 'soft robotics' to my eclectic list of words.

Behavioral Biology, June 2013 - June 2014

After taking Dr. Jeannette Yen's behavioral biology course and learning about her field, I joined her lab in my third year to research copepod mating behaviors. As copepods are incredibly tiny and live in relatively massive bodies of water, finding each other to mate can prove difficult. The Yen lab used a laser optical setup to investigate the different mechanisms copepods might use to locate one another. During my time in this lab, I received a Wartell and Brossette scholarship for pursuing studies in both physics and biology. In the fall, Dr. Yen began preparing a spring research expedition to study pteropod (pelagic snail) locomotion at Palmer Station, Antarctica, and who wouldn't agree to miss a semester of school in exchange for this opportunity? During the 7 week expedition in Antarctica the following semester, I interacted with researchers and contractors from across the globe, learned a great deal about funding science expeditions, and gained invaluable field experience. However, I realized studying copepods wasn't for me and decided to explore research options in physics.

Neutron Star Astrophysics, August 2014 - May 2016

Staring my fourth year, Dr. David Ballantyne invited me to join his lab and I worked with him consistently until my graduation. I am proud to say I'm the first undergrad to pursue multiple projects in Dr. Ballantyne's lab, both of which resulted in a co-authored paper[3,4]. For my first project, I modified a section of Dr. Ballantyne's fortran code to accept newly made computational models of neutron star x-ray emission events (superbursts). In addition to the publication[3], I presented this research as a poster in an outreach symposium for high school students[1]. For my second project, I developed Python scripts to model and assess how several new satellites will visualize the same neutron star superburst. With my results, astrophysicists can choose which satellite best fits their needs based on the different characteristics each satellite will best capture. I gained useful experience with Python, data mining, and the processes involved with drafting a publication[4]. Dr. Ballantyne nominated me for the Outstanding Undergraduate Research Award I received last spring.

Telescope Electronics, January 2015 - May 2015

Also in my fourth year, I spent a semester working for Dr. Otte on the Cherenkov Telescope Array project as part of my applied physics major. I translated the signals collected and sent by the photon-detecting chip into useful data and analyzed that data for any signal noise contributed by various components in the electronics setup. The results were disseminated to all the universities involved in the project. I gained valuable experience researching in applied science and working in a multi-institutional collaboration.

Protein Biology, April 2015 - August 2015

After becoming curious about how computer algorithms can help decipher species evolution, I joined Dr. Eric Gaucher's protein lab the summer before my fifth year and worked with a team on a protein phylogeny project. We used a lab-derived fluorescent protein phylogeny to discover how accurately multiple phylogenetic algorithms (e.g. Bayesian, maximum parsimony) recreated not just the genotypes, but also the phenotypes. I developed a qualitative assessment of the protein phenotypes and analyzed the data in combination with quantitative results. I had to grow a great deal as a scientist and learn how to solidify qualitative results when most people expected hard numbers. At the end of the semester, I wrote a thesis for the project and presented a poster at the College of Science Senior Research Symposium[2].

Cockroach Biomechanics, January 2016 - July 2016

My final research experience grew out of a Physics of Living Systems course taught by Dr. Daniel Goldman during my senior year. My classmate, Seth, and I studied cockroach locomotion and decided to pursue the project once the class had ended. I created the electronic circuits and the 'Cockroach Arena', a light-weight, enclosed track that handles the electromyography circuits and wires and can be situated at numerous angles for various experimental inquiries,, and wired the cockroaches while Seth tackled data analysis. During this time, I explored the vast areas of biomechanics research, and I found myself drawn to studying the biomechanics of fish. I reached out to Dr. George Lauder and he encouraged me to apply to his program.

Intellectual Merit

I have research experience from protein biology to astrophysics, and these myriad experiences have given me the tools and skills to bridge the gap between the mechanical and the living. Last year, I submitted an NSF GRFP based on Lauder Lab research and received an Honorable Mention. **Now, as a PhD student in the Lauder Lab at Harvard University, I am pursuing a project using novel soft robotics methods to investigate fish locomotion.** This project has the potential to contribute to robotics, engineering, fluid dynamics, and biology. It is this level of inter-disciplinary research that attracts me the most and to which I have the greatest potential to contribute.

Broader Impacts

Because I was homeschooled, I had the flexibility in my junior year of high school to participate in the Dual-Enrollment program at Gordon State College and I quickly found a position tutoring college mathematics. I loved not only the practice of imparting knowledge, but also the process of changing my techniques to better suite each student. I continued tutoring college students until I left Gordon, and high-school students throughout my first three years of undergrad. During this time, my interest in science communication grew and I sought an opportunity to take my communication skills to the next level.

In my fourth year, I noticed several of my peers often used the phrase "I wish I had known [blank] when I first came to GT." After some initial inquiries, I revived and organized Excellent Adventures (EA), a student-led seminar series meant to fill this knowledge void for under-classmen. Topics in the fall focused on tools and applications, such as LaTeX (my annual talk every fall to start the season), Mathematica, or Set Theory. Spring talks

were focused more on personal interests, with many students presenting on their favorite topics (e.g., the Science of Food, Heliophysics). EA provided many upperclassmen with the essential experience of organizing and teaching a lecture. I am proud to say EA is continuing in my absence, and I plan to present when I return home every year.

During the fall of my senior year, in addition to running EA, I became an upperclassman mentor for the physics freshman seminar, GT1000. This class focused predominately on creating a sense of community among the physics freshmen and building essential academic and professional skills. I taught a 'Resumes, Cover Letters, and CVs' class with the goal of preparing the freshmen to approach professors about research.

Also in my last year, I participated as a College of Science Student Ambassador for a program introducing potential high school students to GT. As the chosen biology and physics ambassador, I spoke with students interested in biology and/or physics about the academic programs, research opportunities, study abroad options, and my experience as a female scientist in the 4th-most male-dominated department at GT (10M:3F in physics).

As a PhD student, I am continuing to grow as science communicator through several different avenues. First, I have established a website and blog. I write not only about my research and my continuing experiences as a grad student at Harvard, but also any topic I want to learn more about. For example, after coming across a random article on tensegrity robotics, something I had never heard about before, I simply had to learn more. In my blog post, "What is Tensegrity Robotics?", I go through how the field was conceived, what tensegrity robotics actually is, and where it falls in the grand scheme of science. I plan to monitor the success of my blog using traffic statistics and feedback.

A fellow graduate student and I are in the process of creating a podcast, 'What Are The Odds?' We are drafting our first episodes where we discuss the statistics and science involved with topics most take for granted, such as fossils or protein folding. The podcast will be made available on various platforms including iTunes, Stitcher, and my website.

Lastly, I am contributing to Science in The News, an established Harvard outreach program, by writing Waves, short essays responding to emerging science articles. My first article, "Foldit players beat scientists in determining a proteins shape," was published earlier this month.

In terms of outreach, I will become involved with the Model Organism Zoo, also run by Science in The News. Graduate students across Harvard borrow lab model organisms (drosophila, mice, zebra fish, etc.) and visit schools across the Boston area, where a diverse selection of students can learn about the way researchers use the organisms in various STEM fields. I hope to one day include my robotic fish in these zoos.

After obtaining my doctorate, I will continue producing amazing science and sharing that science with the world as a research professor, and the NSF GRFP would help me take the first steps in reaching this goal.

Papers & Posters

[1] **Z.Wolf**. Poster, Neutron Star Superburst Modeling, EXPLORE Research Symposium, 2015.
[2] **Z.Wolf**. Poster, mRFP Phylogeny Project, College of Science Senior Research Symposium, 2015.
[3] L. Keek, A. Cumming, **Z. Wolf**, D. Ballantyne, *et al.* MNRAS. 2016.
[4] L. Keek, **Z. Wolf**, D. Ballantyne. ApJ. 2016