**Notes for all editors - PLEASE READ BEFORE EDITING**

* Thank you for taking the time out of your day to provide comments on my graduate school materials. I recognize that your time is important, and I am very grateful for any feedback you can provide
* Please, be honest. If something sucks, let me know. I want to showcase the best representation of me to these schools. If that is not present here, I want to know about it.
* There are three sections of my personal statement. I would like to make this statement as concise as possible. Two pages is my maximum length

**Notes for editors who are unfamiliar with the structure of a personal statement**

* **Opener** - I would like to be brief here, so there are really only two parts of this section
  + Introduce the field I am interested in and what I want to contribute to it
    - For me, that is the study of gravitational waves, cosmology, or quantum information science. Most schools that I am applying to will have more than one of these programs, so imagine each statement below to be layered on top of each other (cosmology statement, GW statement, QC statement).
  + Articulate why school xxx is the school to make this contribution to science
    - This is all very school specific, but I will tailor each statement to each school, starting from my cookie-cutter blurb below
* **Prior research experiences** - This is the meat of this statement.
  + In each research experience, I am trying to convey the following
    - What the project was about - from both the birds eye view and my contributions
    - What I actually did in the project
    - Challenges I overcame during the project
    - What I am taking away from the experience
  + In general, I would like to make each of these research blurbs as concise as possible while maintaining the structure in the bullet point above
  + I am considering including some small student research projects in astronomy that were 1 week-1 month long, but I currently feel that they do not have the same scope as some of the other research experiences I have contributed to. If you disagree, please let me know. I would love to include them, but feel that it may be fodder compared to my other experiences.
* **Closing** - conciseness is key here again
  + I want to describe why the school is a good fit for me, and why I am a good fit for the school.
  + I will point out some professors and current projects that align with my interests. This will be school specific, but I have a cookie-cutter statement here.
  + I will then reiterate that I will work hard for the school and move on to bigger and more ambitious things, if given the opportunity to study at the school

**Opener**

**GWs**

**Cosmology**

**QC**

**School ABC**

**Research experiences to write about**

I sought out research opportunities within the first month of arriving at Wheaton College. I elected to stay at school during my first winter break to build solid-state lasers under the guidance of my advisor, **Prof.** **John Collins**. The meticulous endeavor of laser development, operation, and characterization offered my first experience observing and exercising the techniques and methods used in professional physics research.

The skills I sharpened under the tutelage of Professor Collins were readily applied the following summer when I began an internship at NASA Langley Research Center. The remote sensing division of Langley was in the early stages of developing a secure laser communication system for use on the International Space Station and beyond. **Dr. Brian Walsh** laid out a plan to build and demonstrate a proof-of-concept mid-infrared laser to monitor the atmosphere. I developed a ray transfer analysis model to predict the characteristics of a Gaussian beam from varying optical components and resonator specifications. Subsequently, I performed spectroscopy on the resonator components to determine the transmission and reflection of different components once the model was complete. I built and tested a near-infrared pump source while the mid-infrared medium of the laser was being sent to the lab. Despite having less than a week to operate the mid-infrared component of the laser, I proved the feasibility of the design using photothermal sheets. The study was a success, offering a lesson in developing the foundational work in the early stages of a research project. Properly utilizing the time before I could enter the next phase of the project provided me with the tools to excel under pressure.

I shifted my focus towards astronomy during the Fall of 2017, partnering with **James Synge of Google** and **Prof. Dipankar Maitra** **of Wheaton College** to install and maintain a robotic telescope at Wheaton College. Project PANOPTES is a citizen science project, centered around a low-cost, robotic exoplanet telescope designed to detect exoplanets using transit photometry. While PANOPTES is designed to be a standalone, weatherproof unit, I installed a non-weatherproofed telescope inside an observatory dome to study the limitations and adjustments necessary for dome installation. I found that several attempts at integrating existing dome-control software to the PANOPTES codebase resulted in imperfect dome closure and water damage to the inside of the dome. After adjusting the dome sensors, I ensured complete opening and closing commands, in synchronization with the PANOPTES telescope and a weather sensor. In the following winter, I aligned the telescope to enable observation using the PANOPTES telescope. In the spring of 2018, I presented project PANOPTES alongside my other team members and recruited potential collaborators at the Northeast Astronomy Forum 2018, in Suffern New York. Throughout the installation, maintenance, and alignment of PANOPTES, I resolved various technical problems to enable observational astronomy for my college and the wider exoplanet community.

Motivated to study beyond planets and stars, I spent the Summer of 2018 as an REU research assistant at Rutgers University-New Brunswick under **Prof. Emeritus** **Carlton “Tad” Pryor**. Pryor’s research group focuses on using observations of dwarf spheroidal galaxies in the Milky Way galaxy to determine if dwarf spheroidals move coherently in streams through the galactic halo. While Hubble observations had previously been the primary tool for discovery, we were interested in using data obtained from the Gaia survey satellite. I searched for tidal disruptions in different dwarf spheroidal galaxies using Gaia’s second data release from April 2018. I developed a data pipeline for different dwarf satellite galaxies, designed a photometric filter host stars, and created a surface density profile to directly search for tidal disruptions. I struggled to implement these filters with Boötes I due to its low declination being contaminated by the galactic plane. To test a similar galaxy with higher galactic declination, I observed a tidal disruption in the dwarf spheroidal Carina. I presented the results of this study in an oral presentation to the Rutgers University Physics department and the Wheaton College Physics department. I also presented a poster on this work during the Rutgers summer research symposium and during the 234th meeting of the American Astronomical Society in St. Louis, Missouri. During my summer at Rutgers, I learned how to develop data analysis tools for studying galactic evolution.

During the Spring of 2019, I challenged myself in a new discipline and a new country: biophysics while studying abroad at the University College London (UCL). In collaboration with **Prof. Thanh Nguyen** and the Royal Institution (RI) of Great Britain, I developed novel viral diagnostic methods using ferromagnetic nanoparticles. The Thanh research team is conducting interdisciplinary research on the design and synthesis of nanomaterials for biomedical applications. Our student research group was interested in lowering the limit of detection of different nanoparticles deposited onto different nitrocellulose membranes. I organized the structure of our group and coordinated between RI and our group, prepared membrane samples to specification, and designed the analysis procedure for thermal camera data. While designing the test apparatus, I recognized that satisfying University training standards for a higher energy laser source would be untenable given our restricted timeline. To remedy this, I pivoted our research scheme to a lower energy laser that could be operated immediately with the oversight of a previously trained Ph.D. candidate. This expedited our data acquisition to a reasonable timeframe and enabled a complete analysis of different nanoparticle concentrations. I lead-authored a report on this study which received the highest marks from UCL faculty and presented a poster with my research team during a symposium. In leading our research group, I experienced firsthand the importance of effective communication at all levels of a collaboration, how to remain flexible to accommodate experimental changes while still satisfying project goals, and how to apply tools in different disciplines to solve complex problems.

During my time at UCL, I took my first course on cosmology. This motivated my honors thesis, where during my senior year I conducted a joint honors thesis with **Prof.** **Amélie Saintonge** of UCL and **Prof. Dipankar Maitra** of Wheaton College. The Saintonge group is interested in studying galaxy formation and evolution through radio surveys of cold gas and dust. I focused on using spectroscopy from the xCOLD GASS and JINGLE surveys to determine a relationship between hydrogen emission and the galactic properties of molecular gas and dust. I designed a linear Markov-chain Monte-Carlo (MCMC) sampler to analyze survey data and determine constraints on dust and cold-gas scaling. Upon cross-correlation of the derived calibrators with similar galaxies from the Sloan Digital Sky Survey (SDSS), I discovered the calibration was unaffected by star-formation rate and stellar mass, but dominated by an inclination dependent-reddening trend. To account for this within the calibration, I generalized the MCMC sampler to N-dimensions and further constrained the calibrations by ~0.3 dex. I authored and presented a report on my work to Wheaton College and UCL peers and faculty in May 2020, receiving the highest marks from my committee. During this research project, I designed machine learning models to best approximate galaxy evolution, searched for biases within the model, and further refine the model for more precise constraints on galactic evolution.

I joined the Astronomical Instrumentation Team (AIT) at the Massachusetts Institute of Technology in November 2020, under **Gábor Fûrész;** principal research scientist and technical lead, and **Rob Simcoe**; faculty lead, professor of physics, and director of the MIT Kavli Institute for Astrophysics and Space Research. AIT is building the LLAMAS instrument for the Magellan Telescopes at Las Campanas Observatory in Chile. LLAMAS is an integral field spectrograph with the capability of spatially resolved spectroscopy of z<0.5 galaxies, rapid follow-up observation of LSST identified transients at z<1, refined galaxy cluster observations at z>1, and gas flows in the z=2-3 circumgalactic medium. I assembled optical mounts and ground support equipment, designed and printed temporary mounting fixtures, and tested diffraction gratings to ensure they met optical-design requirements. My principal responsibility was integrating the fiber run of the spectrograph. I found that my attempts to bond optical fibers with the required precision using DC servo motors were too slow to meet our project deadlines. To remedy this, I wrote LabView code to allow for simple motor control through a computer interface, accelerating a critical path process to satisfy our timelines and maintain the precision needed to satisfy our science goals. While I continue to contribute to the integration of LLAMAS cameras and spectrograph elements today, the instrument is scheduled to be installed at Las Campanas Observatory in July 2022.

In parallel to LLAMAS, I have been developing software tools to support a research proposal for AIT, concentrating on using solar spectrophotometry to make conclusions about the impacts of photosphere and chromosphere events. Using these insights, we would like to identify and eliminate the effect of sunspot and plage events on the radial-velocity signal. To perform a preliminary study, AIT has installed a multi-channel solar spectrometer at Lowell Observatory in Flagstaff Arizona. I created data analysis tools, developed a data pipeline, and organized meetings between AIT members and external collaborators. At first, I struggled with developing a data pipeline that maintained compatibility with all of the observations, as their file structure was constantly being diminished to balance the high data volume. After diligent iteration, I constructed a robust and flexible data pipeline with the capability to accurately represent solar observations. This pipeline enabled detailed analysis of several solar events in the second half of 2021, resulting in **mention here if this results in any publications - revise by september/october**. While developing analysis tools and a data pipeline, I learned firsthand the critical nature of efficient infrastructure in support of a scientific venture.

**Wheaton student research projects - I could include some small (1 week-1 month) student research projects that I completed during Fall 2017 - should I?**

**Close**