

Personal, Background, and Future Goals Statement - Rena Aerey Lee

Personal Background: While I am presently pursuing a career in research by conducting observational astronomy, for most of my life I had been previously working towards becoming a medical doctor. As the first of my family born and raised in the states, I have always been motivated to excel in school and work, in order to take advantage of the opportunities that came with their difficult choice to immigrate. Somewhat arbitrarily, I decided to pursue a medical career in late middle school, without giving deep thought to whether it was something I actually wanted. After years of grinding through medical internships, hospital rotations, and pre-med coursework, I stumbled upon a new and unparalleled passion in astronomy, where I discovered an authentic career drive for the first time.

I enrolled in my first astronomy class due to my enthusiasm for the accomplished history of women in astronomy at Vassar College and, initially, not for the subject matter itself. At the time, astronomy as a field remained very unfamiliar to me, and as a first-generation college student, I had not been well-informed of scientific research as a career. However, after taking this first step into astronomy, I dedicated the rest of my undergraduate studies to better position myself to succeed in an astronomy Ph.D. program. I maxed out on credits every semester, self-taught the required physics and maths to keep up in my advanced astronomy courses, learned how to program, and worked several concurrent research and teaching assistantships. It was all well worth the effort, as I successfully completed the astronomy major within two years, as the only student in my graduating class to earn departmental honors in astronomy.

Intellectual Merit: While my first research experiences weren't directly related to my current aspirations in astronomy, they served to provide a foundational skill set required for any discipline of research. While interning at the Division of Clinical Research at Vassar Brothers Medical Center, I became well practiced in data collection and quality assurance, both vital skills in maintaining the large data sets that I have come to work with in astronomy. As a student in cognitive science and neuroscience research methods courses, I have had the opportunity to design, implement, and report on several original experiments, ranging from brain surgery on rats, to autonomous robot design, to EEG recording on humans (which enabled me to co-author my first refereed academic journal article [1]). Throughout these various experiences, I appreciated the freedom to formulate and apply my own solutions to scientific questions, and I started to recognize my affinity for research.

Having excelled in chemistry and physics labs from my time as a pre-med student, I was invited to serve as a teaching assistant (TA) for five courses covering general and organic chemistry and introductory physics. As someone who often relied on TAs for support and guidance, I was proud and humbled to offer the same for my students. In my final year, with an evident enthusiasm for teaching, I was appointed by faculty as the department academic intern (all-course TA) for both of my majors, cognitive science and astronomy. In all, I have provided supplemental teaching support for twelve courses spanning these four fields.

During my final undergraduate summer, I was fortunate to participate in the Boulder Solar Alliance NSF REU, under the mentorship of Dr. Joe Ajello at the University of Colorado's Laboratory for Atmospheric and Space Physics (LASP). We modeled atmospheric evolution at Mars and Venus by measuring UV emissions from common atmospheric gases. As a laboratory aide, I independently operated the Mars Atmosphere and Volatile Evolution Imaging UltraViolet Spectrograph (MAVEN IUVS) and other equipment for data collection. Concurrently, I ran spectral data reduction, calibration, and visualization routines in IDL and MATLAB. This was a transformative experience for me, as it was my first research experience relevant to space sciences, and it cemented in me my current career interests and ambitions. Since my participation in the REU, I have published two papers [2,3] in the *Journal of Geophysical Research (JGR): Planets* and *JGR:*

Space Physics as an official Research Affiliate of LASP's MAVEN IUVS Science Team, one of which I led as the first-author, with another first-author manuscript near-ready for submission. I have also given two presentations at the 2019 AGU Fall Meeting for this research, and will be giving a talk at the 2021 AGU Fall Meeting.

When I came to the University of Hawaii (UH) to pursue my master's degree, I decided to expand my horizons and look beyond our nearest planetary neighbors to study stars and exoplanets. Working with Dr. Eric Gaidos, I have contributed to several observational research projects on M dwarf stars and exoplanets, while also developing my master's thesis. As a principal investigator (PI), I have successfully proposed for over 50 hours of observing time at NASA's InfraRed Telescope Facility (IRTF) and NAOJ's Subaru Telescope at MaunaKea Observatories. I have also served as a co-investigator on additional IRTF projects characterizing young M dwarfs and their planetary systems. As a result of this work I earned co-authorship on two additional refereed publications [4,5].

For my master's thesis, I'm investigating the connections between stellar multiplicity (stars bound to other stars) and rotation among pre-main sequence M dwarf stars, which is part of a larger effort to establish empirical benchmarks for rotation-age modeling of M dwarfs through their lifetimes, led by Dr. Gaidos. In my first year, I was awarded the Bullard Fellowship from the Department of Earth and Planetary Sciences at UH, to support my research. Aside from observational work, I have been analyzing archival data from sources such as *Gaia*, *TESS*, and the *IRTF Archive* to develop an improved membership catalog of the Beta Pictoris Moving Group (BPMG), a nearby young stellar association. This research will result in three papers: 1) an improved isochronal age estimate of the BPMG based on my refined membership catalog, 2) an analysis of M dwarf rotation periods in multi-star systems, and 3) a newly developed python package to readily extract radial velocity measurements from iSHELL (IRTF) spectra. The first of these is in early preparation, and this work will also be presented at the AAS Winter Meeting in January 2022, while preliminary results were presented at the 2021 NExSci Sagan Workshop.

Broader Impacts: During my sophomore year of high school, my single mother lost her job and, as a result of her gambling addiction, we fell upon some hard times. I lived alone in Las Vegas as she moved around trying to find work, up until I graduated. At the time, I failed to grasp the gravity of our situation, until I realized we may not be able to afford my college tuition. Subsequently, I found it difficult to focus on my future education, when my present was so uncertain and turbulent. Fortunately, this experience actually helped me find my way to college, and inspired me to work towards increasing educational access in underserved communities.

I was able to apply to the QuestBridge National College Match for low-income students, at a time when I thought college was completely beyond my financial reach. As a QuestBridge finalist, I was able to bypass application fees and streamline financial aid application processes, for leading schools I had never even dreamt of attending before. This experience made me recognize just how disparate access to educational resources are throughout our country and communities. There were and are many students facing similar and even more burdensome obstacles, unaware of such opportunities, an issue I aim to mitigate through my volunteer work with the QuestBridge Alumni Network. Since graduating from Vassar, I have hosted two *Coffee with QB Strangers* events and regularly attend *Asian and Pacific Islander Affinity Group* meetings to offer support and guidance for other QuestBridge college students. I also intend to host information sessions about the program to eligible high school students, especially those of Native Hawaiian and Pacific Islander descent, who face many intersectional barriers to post-secondary education.

Through my QuestBridge connections, I was introduced to the Transitions Program for low-income, first-generation, and undocumented students, as well as the Urban Education Initiative (VCUEI) at Vassar College. In these communities, I have become intimately familiar with the multifaceted disadvantages many middle- and high-school students face as they navigate academia.

Through my volunteer work with VCUEI, I have become better prepared for public outreach in secondary schools.

Here in Hawaii, I have continued to devote myself to educational outreach and access, in astronomy research and academia at large. This past summer, I mentored two high school students through an intensive astronomy summer camp under the Institute for Astronomy's HI-STAR program. The HI-STAR program also provides support beyond the summer camp, to guide students competing in the statewide science fair, where many HI-STAR scholars have been awarded top prizes for their work. Additionally, I have recently volunteered my time for Honua Scholars, a local organization which empowers students in Hawaii to pursue STEM careers. With Honua Scholars, I plan to provide more general support, such as college application preparation, open tutoring sessions in math and sciences, and other workshops as needed.

In addition to public outreach, I currently serve as the graduate student representative for my department's newly-formed Justice, Equity, Diversity, and Inclusion (JEDI) Committee, with hopes to foster a more welcoming and engaging environment for people of non-traditional identities in academia. Though there is much work to be done, as a start, I have helped to diversify our department's weekly guest research seminars, increasing representation from women and Native Hawaiians in earth sciences. We are also in early planning stages to become an AGU Bridge Program partner institution, eliminate systematic biases in graduate admissions procedures, and modify undergraduate curricula to be accessible to differently abled students. I'm optimistic for the future of this NSF ADVANCE-supported committee, as we strive to create and sustain a better academic community for underrepresented identities at UH at the student, staff, and faculty levels.

Future: As I apply to PhD programs this winter, I remain committed to my current research interest: dwarf stars and their potentially habitable planetary systems. Specifically, I intend to study magnetic field strengths of young M dwarfs to better characterize their ages, surface gravities, and possible implications on planetary environments (described in my research plan). Additionally, I am a co-investigator on a recently awarded *TESS Cycle 4* funding and observing proposal to carry out age-rotation analyses on M dwarfs in the Hyades, alongside Dr. Gaidos, Dr. Jen van Saders at UH's Institute for Astronomy, and Dr. Adam Kraus at the University of Texas, among others. I plan to take advantage of these existing connections at UH and beyond to continue this research and to forge new collaborations within the M dwarf - exoplanet research network.

Outreach is an integral part of my identity as a researcher; I believe there is no greater purpose of a scientist than to proliferate knowledge and foster widespread engagement in their field of research, especially among those who traditionally are not afforded such privileges. As I strive to build myself into an apt and able astronomer, I will remain resolute in my goals to guide other non-traditional students to and through their academic ambitions. As an NSF Graduate Research Fellow, I will be well-positioned to do just that, with the freedom to investigate new and innovative research fronts within my field, and more time to dedicate to outreach. While I'm still learning where exactly I fit into astronomy research - whether that would be as a professor, industry scientist, or other educator, I'm confident that continuing in my graduate studies at UH as an NSF Fellow will be the perfect environment for me to fulfill these responsibilities and grow as a student, researcher, and mentor to others.

References: [1] de Leeuw, J. et al., including Lee, R. A. (2019). *Meta-Psychology*, 3, MP.2018.1481. [2] Ajello, J. M. et al., including Lee, R. A. (2020). *JGR: Space Phys.*, 125, e2019JA027546. [3] Lee, R. A., et al. (2021). *JGR: Planets*, 126, e2020JE006602. [4] Cale, B. et al., including Lee, R. A. (2021). *ApJ*, *accepted 1 Oct 2021*. [5] Gaidos, E. et al., including Lee, R. A. (2021). *MNRAS*, *accepted 14 Oct 2021 (in press.)*