Carl Edward Fields, Jr. - Personal Statement

As the first to attend college from a family that faced significant socioeconomic hardships I felt that it was my duty to excel in my undergraduate career. Learning to succeed in university coming from such a diverse background has been a process that has taught me a lot about myself and helped to further my desire to pursue physics and astronomy. **I wish to pursue a Ph.D. in Physics/Astrophysics followed by pursuit of postdoctoral research and an academic position**. Along my journey, I wish to play an important role in science communication, public outreach, as well as an advocate for educational equality and the advancement of equal representation amongst minorities in science.

Intellectual Merit (Relevant Background)

Early into my undergraduate career I began making strides towards exploring my curiosity for physics and astronomy by looking to become involved in active scientific research. I began contacting professors with whom I was interested in working and inquired about possible research projects. I was delighted to receive a response from Professor Frank Timmes, a theoretical astrophysicist at Arizona State University (ASU). Previous to this exchange, I had no experience in research or computer programming. However, I convinced Prof. Timmes of my diligence and passion for astrophysics and under his tutelage I began learning how to program in object-oriented languages such as `FORTRAN` and C++ by writing one dimensional root solvers, sparse matrix solvers, and chi-square minimization techniques. Development of these skills allowed me to play a role in active scientific research with Dr. Timmes.

My role in the project with Prof. Timmes, consisted of using the 1D stellar evolution code, Modules for Experiments in Stellar Astrophysics (MESA) to investigate the inward propagation of carbon burning flame fronts in intermediate mass stars. This study consisted of evolving a dense grid of stellar models between 6 to 11 solar masses with varying rotational and compositional mixing values. **I gained invaluable research experience from this project including producing publication quality diagrams, manuscript preparation practices, and how to write a scientific paper.** The culmination of this project was a peer-reviewed journal publication entitled, *On Carbon Burning In Super Asymptotic Giant Branch Stars*, ApJ 807, 184, 2015 [1] of which I am the second author.

During this research project, I also participated in many opportunities to present my work which allowed me to develop effective communication skills and to meet faculty whom shared my research interests. I have presented my research at the following programs: (i) 2014 Sigma Xi International Research Conference, where **I was one of two undergraduate students to be awarded a medal for superior poster presentation in the Physics & Astrophysics division**, (ii) the 2015 Conference of the National Society of Black Physicists, wherein **I was awarded the American Astronomical Society (AAS) Beth Brown Memorial prize for best undergraduate poster presentation**, (iii) and the 2015 Joint Institute for Nuclear Astrophysics Frontiers Meeting where I was the only undergraduate student to present my research to a mix of graduate students and faculty.

As my initial work on stellar evolution neared completion, I wished to gain breadth in the topics in which I have conducted research. With this notion in mind, I applied to multiple summer REU programs including the Laser Interferometer Gravitational-Wave Observatory (LIGO) Summer Undergraduate Research Fellowship Program (SURF) at the California Institute of Technology. **I was selected as one of 26 students out of an applicant pool of nearly 1200, to participate in the 2015 LIGO SURF program where I would conduct research in theoretical physics**. My project involved working with Dr.

Alan Weinsten and Dr. Tjonnie Li on simulating the gravitational waveforms generated by binary black hole mergers. This experience taught me valuable data analysis skills while also expanding my research horizons. A manuscript for this project is in preparation.

My current scientific project looks to investigate the uncertainties of nuclear reactions rates in stars that form carbon-oxygen white dwarfs (WDs). The reaction rates used in these models have compounded uncertainties that can affect the final characteristics of the white dwarf [4]. This project is supported jointly by the NSF-funded Joint Institute for Nuclear Astrophysics and the ASU NASA Space Grant Fellowship. Expected research outcomes include the first statistically rigorous study of the final characteristics of WDs. Additionally, this project **will result in a first author journal publication in The Astrophysical Journal**, while also serving in part as my astrophysics senior thesis project through the School of Earth & Space Exploration [2]. While I have made it a priority to engage in active scientific research, I have also been involved in a myriad of activities outside of research that focus on community involvement and developing my skills as an effective communicator.

Broader Impact (Relevant Background)

I am a member of the Society of Physics Students and Astrodevils at ASU. I am also a member and student representative of the National Society of Black Physicists, an elected associate member of ΣΞ (Sigma Xi) national honor society, undergraduate member of the American Physical Society (APS) and elected junior member of the AAS. Involvement in these organizations provide me with opportunities to advocate for educational equality and increased representation in science among minorities. **APS shows that less than 4% of bachelor's degrees in physics from 2006-2008 were awarded to African Americans.**[1] This startling statistic may be a direct result of socioeconomic issues that inhibit access to education in the field of physics and astronomy [3]. During my time at ASU I have taken part in many roles focused on addressing such issues and furthering my experience as an instructor and in giving back to the community as a whole.

Upon entering into ASU, I began participating in Engineering Projects In Community Service (EPICS). EPICS is a multidisciplinary club that aims to use the collective knowledge and skill set of participating students from STEM fields to address issues on a local and global scale. My role in EPICS was co-lead of a team called Mission Mobile Museum, a team which aimed to team up with the non-profit organization, Project C.U.R.E. to spread awareness about their mission to provide free medical supplies to third world countries. This project resulted in a close relationship with local Project C.U.R.E. Chapter and ASU, as well as a Semi-Finalist in the 2012 Dell Social Innovation Challenge.

Following my work with EPICS, I was offered a position as an instructional aide (IA) wherein I taught introductory physics lab courses to non-physics majors. Additionally, I was offered a role as an instructional fellow at Western School of Science and Technology (WSST), a public charter school whose mission is to help promote interest in science and technology in those whom come from low income families or are dealing with other socioeconomic factors. I have taught as an IA at ASU for two full semesters, leading classes of 24 students through topics including introductory kinematics to electricity and magnetism. My experience as an IA has taught me invaluable pedagogical skills that have made me confident in my abilities as an instructor and communicator. My current role at WSST is volunteer Advancement Via Individual Determination tutor, where I help lead small breakout tutorials designed to foster success amongst students struggling with course material during normal class periods.

[1] http://www.aps.org/programs/education/statistics/degreesbyrace.cfm

Beyond my work as an instructor, I am also a participant in the Sundial program at ASU, a peer mentoring program that seeks to foster a diverse community of students and faculty with interest in the physical sciences. Specifically, over the past two years I have been a student mentor for entering physics and astrophysics students. My role as a mentor has ranged form helping the students with coursework, offering advice on studying strategies and how to plan for success as a physics major at ASU. I am actively mentoring astrophysics freshman Tyler Cox by assisting him in developing programming skills to eventually become a participant in scientific research at ASU.

Advancement in science education is also a large part of my educational and academic goals. With the help of my current advisor, **I have created an educational tool called, MESA-Web[2] as a web based interface to the stellar evolution code, MESA**. This project seeks to make it easier to teach astronomy at all levels by allowing users to evolve a stellar model with only an internet connection and valid email address. **Since its inception in June 2015 over 300 users worldwide have benefitted from this effort.** My current role as lead developer is to maintain the server and extend its capabilities to allow for even further utilization amongst instructors around the world.

I feel that my involvement with the community has been broad. I have participated in a multitude of activities to help engage the public and discuss active scientific research such as interviews and video presentations, including a lecture for ASU's AST 111 EdX course, the largest college-credit astronomy course in the world. As an underrepresented minority in the field of astrophysics, I feel it is paramount that students of diverse backgrounds are exposed to scientific research and have an equal opportunity to pursue higher education.

Future Goals

I will continue to develop my skills as a scientist, independent researcher, and effective scientific communicator. **I wish to join the TAPIR group at the California Institute of Technology investigating stellar structure and evolution, core collapse supernovae, and implications for cosmic chemical evolution and gravitational wave radiation**. The era of next generation gravitational wave detectors such as Advanced LIGO is upon us. A new field of astrophysics is in fruition requiring scientists with interdisciplinary backgrounds to address some of nature's biggest, most fundamental questions. Accomplishing these goals will be neither binary nor facile in nature. However, I feel that my passion and unyielding resilience coupled with my insatiable desire to become a scientist has prepared me to achieve these goals. **In closing, I feel that my background in the field of physics and astronomy, my community involvement, and lastly my passion for astrophysics makes me a great candidate for this program.** Receiving this fellowship will allow me to continue on the path towards my educational and career goals while focusing on the science and the education. Thank you for your consideration.

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[1] Farmer, R., Fields, C. E., & Timmes, F. X. 2015, The Astrophysical Journal, 807, 184

[2] Fields et al. 2016, The Astrophysical Journal, in prep.

[3] Norman, D. 2009, in Astronomy, Vol. 2010, The Astronomy and Astrophysics Decadal Survey

[4] Weaver, T. A., & Woosley, S. E. 1993, Physics Reports, 227, 65

[2] http://mesa-web.asu.edu