

## **Carl Edward Fields, Jr. - Previous Research and Scholarly Productivity**

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, of which I am the second author.

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 Weinstein 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 project looks to investigate the uncertainties of nuclear reactions rates in

stars that form carbon-oxygen white dwarfs. The reaction rates used in these models have compounded uncertainties that can affect the final characteristics of the white dwarf. This project is supported jointly by the NSF-funded Joint Institute for Nuclear Astrophysics (JINA) and the ASU NASA Space Grant Fellowship. Expected research outcomes include the first statistically rigorous study of the final characteristics of white dwarfs. 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 ASU.

### **Publications and Presentations**

While I have made it a priority to engage in active scientific research, I have also been involved in many opportunities to present my work and to aide in the development of my skills as an effective communicator. Highlights of these experiences include: (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 JINA Frontiers Meeting where I was the only undergraduate student to present my research to a mix of graduate students and faculty. A complete list of my publications and presentations are given below.

### **Publications**

6. *On Pre-Supernova Structures with MESA*, R. Farmer, F. X. Timmes, **C. E. Fields**, I. Petermann, L. Dessart, and M. Cantiello, *The Astrophysical Journal*, In Prep.
5. *Testing The Strong-Field Dynamics of General Relativity Using Compact Binary Mergers*, **C. E. Fields**, A. Weinsten, T. G. F. Li, & M. Isi, *American Journal of Undergraduate Research*, In Prep.
4. *The Sensitivity of Nuclear Reaction Rates in Carbon-Oxygen White Dwarfs*, **C. E. Fields**, R. Farmer, I. Petermann, C. Iliadis, & F. X. Timmes, *The Astrophysical Journal*, In Prep.
3. *On The Origin of The Elements: The Spectacular Role of White Dwarfs*, **C. E. Fields**, R. Farmer, I. Petermann, & F. X. Timmes, 227<sup>th</sup> Meeting of the AAS, Abstract #144.01

2. *On Carbon Burning in Super Asymptotic Giant Branch Stars*, R. Farmer, **C. E. Fields**, & F. X. Timmes, *The Astrophysical Journal*, 807, 184, 2015
1. *The Evolution of Carbon Burning Flames Inside Super-Asymptotic Giant Branch Stars*, **C. E. Fields**, R. Farmer, & F. X. Timmes, APS March Meeting 2015, Abstract #V1.288

### **Presentations**

8. 227<sup>th</sup> Meeting of the American Astronomical Society, Poster Session, January 2016, *On The Origin of The Elements: The Spectacular Role of White Dwarfs*
7. School Of Earth & Space Exploration, Arizona State University, Presentation, April 2015, *On Carbon Burning in SAGB Stars*
6. JINA-CEE Frontiers in Nuclear Astrophysics Meeting, Poster Session, March 2015, *On Carbon Burning in SAGB Stars*
5. American Physical Society 2015 March Meeting, March 2015, Poster Session, *The Evolution of Carbon Flames Inside Super Asymptotic Giant Branch Stars*
4. Conference of The National Society of Black Physicist, February 2015, Poster Session, *On Carbon Burning in SAGB Stars*, Awarded AAS Beth Brown Memorial Prize - Best Undergraduate Poster Presentation
3. National Collegiate Research Conference, Harvard, January 2015, Poster Session, *The Evolution of Carbon Flames inside Super Asymptotic Giant Branch Stars*
2. Sigma Xi International Research Conference, November 2014, *The Evolution of Carbon Flames inside Super Asymptotic Giant Branch Stars*, Awarded medal - Superior Poster Presentation, Physics & Astrophysics Division
1. VU-EDGE Ph.D. Pre-VU Recruitment Event, Vanderbilt, Invited Talk, October 2014, *The Evolution of Carbon Flames inside Super Asymptotic Giant Branch Stars*