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Searching for Answers in Unknown

I cannot remember the first time I visited a planetarium nor can I tell you exactly how many I have been to, but I can confirm that the general answers to those questions would be “very young” and “many.” As a child, my parents sought to expose me to as many science museums as they could, probably because they wanted me to become some kind of scientist and thought to instill the interest early on. In any museum, my favorite section was always the astronomy exhibit. Most importantly, I always loved the planetarium shows. Over the years I witnessed depictions of the history of our solar system, galaxy, and the universe. I saw documentaries about the two Mars rovers, Spirit and Opportunity, and their immense contributions to our knowledge of the planet’s mysteries. I have learned about the first mission to the moon, the historic landing achieved by Neil Armstrong, a proud professor from our very own University of Cincinnati. As I grew up, I always grabbed the opportunity to study astronomy. By middle school, I was convinced that my future held a career as an aerospace engineer. Throughout middle school and high school, I participated in the astronomy event as part of my school’s Science Olympiad team. However, the astronomy event at the high school level of Science Olympiad was very different than what I had known before. Here, we started actually calculating red shift to estimate the size of deep sky objects and figuring out the elemental composition of stars using baseline spectrographs. This was real astrophysics at its most basic level, and I increased my general knowledge in the subject greatly through competing in the event in Science Olympiad. I competed in the event all four years of high school, but I had decided very early on that aerospace engineering was no longer a realistic career path for me. From experience, I knew that studying the cosmos involved too theoretical an approach to investigation coupled with an immense level of uncertainty, an approach I was definitely not interested in. I recognized that my own future lay closer to home.

Two years into college, immersed in the study of Biology with a concentration in Biomedical Sciences, preparing to go to medical school in a few years, I received a project to study a community that I am not a part of. My mind immediately jumped to astrophysics. Where are those students with whom, had it not been for my own realization of my true goals six years ago, I might actually be studying right now? What opportunities does UC provide for them? What are the goals and practices of these students and how are they different from my own area of study? To begin my research, I first went to the most basic source of information on the subject—UC’s website. UC offers a Bachelors in Science (BS) for those wishing to pursue a career in astrophysics. Membership into the program is standard with most majors in the College of Arts and Sciences; the middle 50% of the 2011-2012 entering freshman class held the following profile: a GPA of 3.044-3.660, ACT score of 21.0-26.0, SAT score of 980-1180, and within the top 32.8% of their high school graduating class (Physics (Astrophysics Concentration)). Interestingly enough, these requirements are the exact same for math majors, biology majors, English majors, and everything else that McMicken College of Arts and Sciences requires of an entering freshman class. Arts and Sciences, the broadest college at UC in terms of the degrees it offers, encompasses both astrophysics as well as my own major, biological sciences. However, these requirements on paper are just the surface of what it would take to actually be an astrophysicist or a biologist, the true requirements for which are much deeper and highly contrasting between the two fields. I realized, even before continuing my research into the astrophysics community at UC that these requirements were simply a baseline and starting point to training to be an astrophysicist, and that from here on, most of the different majors encompassed in this giant college would split into their separate paths. Physics and astrophysics however, actually continue on the same path for almost half of the entire course schedule. Most of the first and second year sequence coincides with the general physics majors, with the exception of “Intro to Astronomy”, an introductory level descriptive astronomy course (Physics (B.S., Astrophysics Concentration)). The first and second year BS sequence for physics majors requires the general Physics and Math requirements that are necessary for studying astronomy. However, once into the third year, the general physics majors and astrophysics majors split paths, the astrophysics majors focusing on upper level courses on astronomy and cosmology (Physics (B.S., Astrophysics Concentration)).

To gain a firsthand perspective, I decided to contact the faculty involved to get an overview of the program before I started my observations. I made contact with Dr. Richard Gass, the Director of Undergraduate Studies in the Physics department, who kindly met me to talk about the program and get me some student contacts with whom I could start my observations. Dr. Gass gave me some very interesting information about the program; there are approximately eighty students studying Physics at UC, about half of whom are pursuing the astrophysics degree (Gass). He gave me the contact information for two prominent students in the program as well as the timings for the Intro to Astrophysics class, which I might be able to observe. Both of the student contacts he gave me are officers in the student organization, Society of Physics Students, which accommodates both physics and astrophysics majors, and who he believed would be able to offer me a firsthand student perspective on the program.

Angela is a senior hoping to go to graduate school after she graduates with a Bachelors in Science in Astrophysics and will study cosmology; she worked with Dr. Michael Sitko on his project studying planetary disks over the summer and feels this area of study is one she might pursue in the future. She is now working on the broader aspect of solar system formation and hopes to go to graduate school to study cosmology. I began my conversation with Angela by asking her about some of the aspects of astrophysics that were different from what people outside of the astrophysics community perceived. She told me that one myth about astrophysics research that particularly irked her was that astrophysicists look at stars through primitive telescopes with eyepieces. Angela told me about her own work which involved logging in to a program on her laptop at home, which connected to a telescope in Hawaii that collected the data and sent the information to her computer. The telescope in question does not even contain an eyepiece (Anonymous). Angela also has a very prominent position in a student organization on campus that unites astrophysics and physics majors. The Society of Physics Students (SPS) is an organization that helps physics students and astrophysics students connect and interact with each other in a student-run academic setting. Many astrophysics and physics majors make use of SPS to get assistance with difficult schoolwork. The organization helps students construct a classroom environment outside of class that places emphasis on the students’ individual needs. Angela mentioned that sometimes the student-student interaction helped in incorporating the learning outcomes more efficiently than the classes themselves (Anonymous). SPS also functions to make undergraduate astrophysics and physics major better members of the physics community as a whole by helping them find experiential opportunities, such as research, around campus as well as through programs that offer research grants.

Ananth spent two years as an astrophysics major before he switched to physics. When I asked him about why he switched from astrophysics to physics, he told me that it was not for any reasons that concerned the material itself but rather that he wanted some different career options than what astrophysics offered (Anonymous). However, he worked at an astrophysics research lab for two years and currently collects data about distant planet systems, and was able to provide very valuable information, especially about the structure of the program and work that students in the program were involved in. Before I delved into his experiences in astrophysics at UC, I was very interested in learning about his outlook on society’s perceptions about astrophysicists. A myth that he particularly wanted to dispel was that astrophysicists were antisocial laboratory addicts that spent all their time pondering deep philosophical unknowns by themselves (Anonymous). Ananth said that finding information about the unknown played an immense role in their work, but the research into the unknown was conducted through known means, which involved immense amounts of collaboration between many different astrophysicists and their research all around the world. While they often worked in the lab alone, the interaction between research organizations was vital in successfully collecting data (Anonymous). During his time as a researcher, Ananth collaborated with professors, lab assistants, and various other specialists throughout the world. Ananth also told me about the variety of different career paths that those with a BS in astrophysics could pursue; these career paths ranged from being a lab assistant, going to graduate school, working at a university, or even becoming an astronaut. He also explained the schedule of a typical student, which was very structured according to their course schedule. This schedule generally involved class, research, and studying (Anonymous).

Undergraduate research in the astrophysics is a vital part of the education of most students studying the subject. Since nearly all of the career paths that astrophysics majors could pursue after completing their BS involve research, it is very difficult to gain a job or graduate school position without having been involved in undergraduate research. Undergraduate research is carried out within astrophysics in several ways. Most students opt to work for one of the astrophysics faculty but there are programs offered through the National Science Foundation (NSF) that give students paid summer research opportunities. Being involved in undergraduate research myself, albeit in a different field, I thought I had a good idea of what the experience was like. I could not have been more mistaken. Angela and Ananth described their research experiences to great detail, at the end of which, I was left quite amazed at how unique astrophysics research was in comparison to research in almost any other field. I was used to the general experiment format that followed the scientific method, the process that involved experimentation to prove or reject a hypothesis. However, in astrophysics, there was often no definite hypothesis formed; research mainly involved collecting data that can add to existing data collected by others. The whole point of the research was to add more information to an existing pool (Anonymous). Astrophysics, unlike most other fields, is one where, at the beginning, people knew nothing. Then one after one, people started adding information about the mysterious cosmos, some of which was later on proved incorrect and then was modified. Thus, information is the most valuable key to studying astrophysics. Angela described one of her projects where she spent an entire section simply documenting the data that the telescope she was observing sent her (Anonymous). Another unique part of the research was the timings that it involved. Observing through telescopes requires some very precise time calculations and must account for both the weather closer to earth that could affect the visibility of the deep sky object in question as well as the time difference between the location of data collection and the location of data reception, which are often several time zones apart. For instance Dr. Sitko, the professor for whom Angela works, observes through a telescope in Hawaii, but receives the data in Cincinnati. Consequently, Angela has spent hours awake in the middle of the night receiving data from a telescope located at the other end of the nation (Anonymous). Most of the research that I am involved with is in stark contrast; rather than understanding a broad concept, I focus on an extremely specific subject matter using materials that I have in my hands. What Angela described was an aspect of research I had no exposure to and was especially intrigued to learn was such a pivotal part of undergraduate research in astrophysics.

Immensely fascinated with research, I wanted to learn about some of the subject matter taught in astrophysics classes. I decided to visit the “Intro to Astrophysics” course taught by Dr. Michael Sitko. This course was taken as part of the junior level sequence for astrophysics majors but was not exclusive to them. When I first walked into the room, I was very surprised at what I saw. Being used to lecture style courses, most of my classes have close to 250 people. However, in the computer lab in Braunstein Hall, I walked into a class of five students. Three of them were third year astrophysics majors and two of them were physics graduate students. Dr. Sitko was helping one of the students with a problem for another class, while the others casually walked in one by one and sat in random locations around the room. The class was not prompt to start on time and had a very casual setup. The students’ behavior in the class was just as interesting as the class itself. Only containing five students, it was quite easy for me to observe each of them individually. Three of them stared at the PowerPoint slides without taking notes while two of them had a notebook out jotting down something maybe once every ten minutes. The boy sitting next to me was eating chocolate covered raisins while casually lounging on his chair. Meanwhile the professor lectured, without the slightest bother in enforcing any kind of classroom discourse. This style of class was very new to me, but reflected the values of the field so clearly. Astrophysics is not about argument or conversation; rather it is about learning more about an unknown, the scope of which extends far beyond what most other fields study. These students were taking in only what they felt was relevant to what they were interested in.

That day’s lecture was about the recognition of cosmic background radiation in the universe through time. The lecture material was organized in a simple PowerPoint presentation. Dr. Sitko started out with the historical perspective and then moved on to the data present relating to the topic. It was especially interesting how data collected through time differed in its quality based on the technology available at that time; every new piece of information contributed to what the next researcher discovered. One thing I was especially fascinated with was how closely the lecture material related to astrophysics research. I saw in action exactly what Angela had described before; Dr. Sitko showed the class a graph of data collected through time by many different researchers, which then formed a comprehensive picture of the reality when put together. It made me realize that the different aspects of astrophysics majors’ study were not separate components of a whole but rather a mixture within the whole that, when put together, revealed new information about the cosmos. This put immense value on past discoveries; the ambition was not always to discover something new, but rather something more about the universe. This particular lecture was especially intriguing to me as it discussed how the physical aspects of what astrophysicists see in the universe could be used to identify those aspects that were not visible. For instance, the unknown aspects were calculated by subtracting the known from a whole in a very technical and formulaic way.

The ultimate goal of astrophysics is to learn more about the universe. The universe is such a large, mysterious place, in which we are only a miniscule part. All the work that astrophysicists engage in gear toward learning more about some aspect of the universe. By adding to existing data and combining different types of data, researchers strive to gain a more comprehensive view of the universe. For students studying astrophysics at the undergraduate level at UC, this specifically means that the program should provide the students with the skills necessary to become contributing members of this large community by allowing them to acquire valuable knowledge and reasoning skills necessary for research of this kind. By learning about this community, I personally gained valuable insight not only into the astrophysics program at UC, but into my own perceptions of the field. I learned several assumptions I had were grossly mistaken. However, I also realized that because of my previous exposure, I was at a better starting point to communicate with this community than most others I know. At the end of the day, I was awed and very humbled by the scope of their endeavors and fully recognized the immense value of investment in this field and the knowledge it could provide about the universe we live in.

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