Astronomy Camp.

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Aerial view of MGIO

The plane hit a patch of turbulence and I awoke with a start. Wondering where I was, I turned sideways and gazed at the landscape below. I wasn't sure how long I had slept, but it was long enough for a drastic change in scenery to occur. The flat patches of green and gold that had covered the ground had been replaced by mountains and the desolate emptiness of the desert. Everything was the same sandy color and the sight was almost depressing. I had never visited the American southwest before and I found it difficult to believe my eyes.

The turbulence grew more violent as the plane began its descent. Many of the passengers looked uncomfortable and nervous as the plane shook from the power of the air currents created by the surrounding mountains. Although I don't particularly enjoy a bumpy flight, I'm certain that I had a smile on my face. Traveling to Arizona alone had given me a sense of independence. I spent my time

in the air flipping through astronomy magazines and brainstorming ideas for research projects. In the Chicago O'Hare terminal, where my flight had a one-hour layover, I found a quiet table at Starbucks, sipped a latte, and held up a copy of *Unsolved Problems in Astrophysics*.

I couldn't help wondering, though, what the coming week would bring. I was on my way to "Astronomy Camp," an opportunity that I stumbled across in a magazine (*Astronomy* or *Sky and Telescope*). Shortly after reading the article I sent out an application, wrote the required essay, got a few recommendations from high school teachers, and, to my great excitement, was accepted. I would be staying in the astronomers' dormitories at the peak of Mt. Lemmon, 9,300 feet above sea level. There, I would learn how professional astronomers conduct research, how to operate large telescopes, how to take CCD images and how to do spectroscopy, and much more.

After a long descent the plane at last made contact with the runway. Again, I peered out my window. I had expected to see a land of cacti, exotic desert flowers, and possibly even a scorpion or two. Instead the ground was rocky, flat, and barren, resembling the surface of Mars. The only indication that I was still on earth came from an occasional shrub that miraculously sprang forth from the rock and sand. For the first time in the 17 years of my life I had visited a place that made Michigan look like a paradise. As we pulled up to the gate I gathered my belongings and ventured out of the plane and into the Tucson airport. I was met by an Astronomy Camp counselor and a couple other campers. After a trip to the baggage claim we were herded outside to a four-wheel-drive van with room for 13 passengers. The heat outside was intense. Before my trip to Arizona I was assured by many people that, although the temperatures are high, the dry Arizona climate makes it seem cooler. Funny, very funny. It was June 15, 2001 and the temperature of about 110 degrees felt hotter than anything I had ever experienced in Michigan - regardless of high humidity levels. Fortunately, we weren't outside for very long before we were instructed to get into the van. We were on our way to the central campus of the University of Arizona to meet the people who would spend the coming week with us. I had been wondering for quite some time what type of people I would find at the camp. There are very few teenagers that I know personally who would even be interested in such a camp. My question was finally answered when we reached the campus of the University of Arizona about half an hour later. There were 31 campers from 21 states and 2 different countries (India and Mongolia). We were a diverse, motley crew, drawn together by our common love of the night sky.

The director of this camp is Dr. Don McCarthy, a professor of astronomy at the University of Arizona. He is quite a character and enjoys running, electronics, and doing liquid nitrogen tricks in addition to sharing his knowledge of astronomy with others. He was the father figure at camp and despite his advanced degrees preferred for us to address him by his first name, Don. There were several counselors at the camp as well, including a number of graduate students, a NASA employee, and some professors from other universities. The van ride to the top of Mt. Lemmon was long and winding (it took about an hour). At 9,300 feet the climate is quite different than the sweltering heat of downtown Tucson. Instead of an arid expanse of sand, I found myself in the middle of a pine forest. We exited the vans and made our way to the dorms. The short hike left all of us breathless. None of us were used to the low oxygen level found at that altitude.

After we had settled in we were given a tour of the area. There were probably about a dozen white domes scattered around Mt. Lemmon. The three telescopes reserved for us were a 60-inch, a 40-inch, and a Meade LX200 12-inch. At the center of all of this was "the Minnesota building." I'm still not

sure why it was given that name, but it was where we spent most of our time during the day. There was a lounge with couches and a pool table where we ate all of our meals. A TV, conveniently located in the same room, constantly displayed a video of some sort, usually Contact, October Sky, or an educational astronomy video. In another room was a gym where we heard lectures each day on a vast array of topics, ranging from how to rig a Kodak instant camera to take astrophotos to how the universe was formed.

After watching the sunset we piled into the vans to spend our first night observing with the 61-inch (1.54-meter) telescope, located on Mt. Bigelow, a neighboring mountain peak. The theme that year at Astronomy Camp was "let your mind start a journey to a strange New World" from the Phantom of the Opera song Music of the Night. As campers and counselors alike crammed into the area surrounding the telescope all lights inside the dome were turned off. Don played Music of the Night as we watched the dome of the 61-inch open for the first time. Arizona may not be the ideal place to live, but the night skies there are spectacular. That night an eyepiece was put in the 61-inch and we spent many hours observing. The most memorable view I had was probably of Mars, which was at its closest approach to earth at that time. With the 61-inch we saw both polar caps and could even detect variations in color on the Martian surface.

We headed back to our dorms that night excited for what was to come. Our sleep schedule was ideal for a night owl like myself. We worked until about 4:00 am, got up at noon, and analyzed data and attended lectures during the day. After spending our second evening learning how to operate all of the instruments on the four telescopes available, we were able to plan our areas of research. I was part of three different projects: determining the Hubble constant, searching for organic compounds in molecular clouds, and designing a mission to Mars to search for evidence of life. Unfortunately, our observing time was cut short by the early arrival of monsoon season midway through the week. All of the teams however, were able to find enough data to make a presentation to the group on the last day of camp.

To determine the Hubble constant, or the rate, at which the universe is expanding, we used a simple equation discovered by Hubble. The equation is $H = vd$ (the Hubble constant equals the velocity at which an object is receding from us times its distance from us). We determined distances by looking at the brightest elliptical galaxy of a cluster. Apparently, there exists a relationship between the luminosity of the brightest elliptical galaxy of a cluster and its distance. Using one cluster's brightest elliptical galaxy of known distance as a calibrator, we were able to use computer programs to determine the distances of several other clusters after photographing them with the 61-inch. We planned on using spectroscopy to determine the recessional velocities of the clusters. Unfortunately, the monsoons made this impossible and we had to look up the values on the Internet instead. In the end, we came up with a Hubble constant of 68.2 km/s per megaparsec, which indicates that the universe is about 14 billion years old.

Looking for organic compounds in molecular clouds was a bit more difficult. To find good data on a project such as this, more sensitive equipment is necessary than what was available at camp. We hoped to use spectroscopy, but the clouds from the monsoons disrupted our plans. We were able to look at submillimeter (microwave) data taken by one of the counselors of a few molecular clouds. After analyzing the data with computer programs, we found carbon monoxide in a couple clouds. Planning a mission to Mars was somewhat easier, since it didn't involve observing time. We

researched the web and found a variety of techniques to incorporate into our probe that would search for organic compounds and nanobacteria.

LBT during construction

Needless to say, it was a very busy week. We did take a break from our work in the middle of the week to camp in tents on Mt. Graham, where the Submillimeter Telescope, the Vatican Advanced Technology Telescope (VATT), and the soon-to-be-completed Large Binocular Telescope (LBT), are all located. Mt. Graham is four hours away from Mt. Lemmon. On the way there we stopped at the University and toured the mirror lab, where the twin 8.4-meter mirrors for the LBT are being constructed. When we reached our campsite (over 9,000 feet about sea level) we pitched tents and roasted marshmallows. We had hoped to spend the night gazing at the sky - which is supposedly more impressive than the Mt. Lemmon or Mt. Bigelow sky. Sadly, the monsoons had no mercy on us and we spent the night in our tents listening to thunder and hoping that the grizzly bears would stay away.

The following day we toured the three observatories at the summit of Mt. Graham. They were all incredible - especially the LBT. Once the LBT is completed, it will be a world-class observatory - more powerful than the Hubble Space Telescope. The VATT was also interesting. Hanging on the wall near the entrance is a plaque that reads: "This new tower for studying the tars had been erected on this peaceful site so fit for such studies and it has been equipped with a new large mirror for detecting the faintest glimmers of light from distant objects during the XV reign of John Paul II. May whoever searches here night and day the far reaches of space use it joyfully with the help of God."

The Submillimeter telescope was also a sight to see. We were allowed to view the control rooms and the instruments in detail. The highlight of this instrument was standing by as the antenna was opened for us. On our way back to Mt. Lemmon we stopped at the University to hear a lecture on stellar evolution. Once the night had fallen we were in the mountains again, searching for answers to our projects. My week in Arizona at Astronomy Camp was one, which I don't believe I'll ever forget. It was, to me, a preview of what lies ahead in my life. I plan to major in astronomy and physics in college after I graduate from high school in a year. At least now I have an idea of what the lifestyle of an astronomer is really like. The work is hard, the nights are long, the data is hard to get, the weather can be infuriating, and I won't likely become rich. Yet, after spending a week in the mountains of

Arizona studying the heavens I'm even more certain than ever that being an astronomer is the only profession that could make me truly happy, and the one, which I plan to pursue.

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