Discovering the Universe at Astronomy Camp

Research and fun go hand-in-hand during the University of Arizona's summer Astronomy Camp.

By Elena Saavedra Buckley

The silhouette of Kitt Peak National Observatory is prominent in this double-exposure of sunset during the transit of Venus on June 5, 2012. Astronomy Campers used four of the telescopes shown here. Copyright David A. Harvey Photography; used with permission.

There's a saying I've heard in multiple forms, but the basic premise is this. No matter where you are, you can look up at the Moon and know that someone, somewhere else in the world, is looking up at the same one.

If you happened to gaze at the Moon in late June during the past few years, chances are a group of teenagers was looking at it too. These teens, though, were probably looking at it a bit differently — with giant telescopes on a high peak in Arizona.

They were attending Astronomy Camp, a nine-day summer program held at Kitt Peak National Observatory near Tucson, Arizona. I had the privilege of being one of those teenagers this past year at the Advanced Teen camp, and I know I'll never look at the Moon, or the rest of the sky, in the same way.

Astronomy Camp sounds fairly straightforward, and it is. It's a summer haven for kids interested in studying the cosmos. One might think, though, that the camp is for those who grew up around telescopes and whose first word was "Andromeda." This presumption, which I previously shared, is fortunately wrong.

My Path to Astronomy

My interest in astronomy began only a year before I traveled to Kitt Peak. I have always been interested in science, but it was rarely serious compared to my dreams of being a concert pianist or prize-winning poet. In 2012, though, I attended a creative writing camp in rural Ohio, and I couldn't stop crafting pieces about the motion of the Sun and fictional gas giants.

That August, the Curiosity Rover landed on Mars, and I stayed up with the scientists at the Jet Propulsion Laboratory — thanks to live-streaming video. I knew I wanted to study space the minute the rover's tires touched the red dirt. Just by spending time thinking about the stars and our place among them, I felt as if I was decoding my brain, understanding how it was meant to work.

The same year, I bought a six-inch reflecting telescope, subscribed to *Astronomy* magazine, and Googled "astronomy camp." Applying to the Kitt Peak camp was next. I descended the stairs of the University of New Mexico's science library a few times after school and wrote my application essay through the eyes of a fictional assistant to astronomer Fritz Zwicky. But even though I had leather-bound records of Zwicky's supernova data on my desk, there was still a level of connectivity with astronomy I hadn't reached. Many levels, in fact.

Those levels weren't far away, though, and they grew closer as I wrapped up school after receiving my acceptance e-mail. The thought of going to a science camp mildly terrified me at first — the only summer programs I was familiar with were woodsy music camps and poetry workshops held on college campuses. An atmosphere like Kitt Peak was foreign. I knew, though, that even if my fellow campers could identify every visible star or build a telescope from found materials, we would connect somehow. After all, we all saw the same Moon each night.

I packed a down jacket and pants (against my summer tendencies), and threw my headlamp in my suitcase, new batteries included.

Welcome to Kitt Peak

At the airport, a battered, coffee-stained "Astronomy Camp" sign greeted me. Two blonde, bubbly counselors named Shae and Chrystin immediately handed me a nametag emblazoned with the Eagle Nebula. The first people I met were from Virginia, Washington, Ohio, and Texas, and they were playing a viciously competitive game of cards. On the highway to the observatory, I spent time talking with one camper about the French horn. Making friends wasn't hard, especially when the majority of attendees had read Brian Greene's *The Elegant Universe and* could sing most of *The Phantom of the Opera*.

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A fine view of the Observatory complex can be had from the public viewing gallery of the Mayall telescope. The 90-inch Bok reflector is in the immediate foreground; the McMath-Pierce solar telescope is to the far upper left. *[Paul Deans]*

My mild concerns dissolved by the time the road began winding between granite boulders, climbing its way up the mountain.

Kitt Peak sprawls over a ridge in the Quinlan Mountains southwest of Tucson. Bright white among the fuzzy, deep green of the trees, the buildings look like chess pieces scattered along the curved asphalt. During my time on the mountain, it seemed like a telescope was built each day — I saw a new dome around every building, and it was incredible to think that each could angle towards the sky, make observations, and help astronomers understand the cosmos that surrounds our planet.

The two instruments that anchor the observatory are the Mayall 4-meter reflector, housed in a stoic, monstrous dome (and the setting of a Kitt Peak-themed murder mystery written by Katie, a fellow camper), and the McMath-Pierce solar telescope, a long pillar angled into the ground that looks like it could grow legs and crawl down the face of the mountain.

After settling into our dormitories and acquainting ourselves with Kitt Peak's layout, we gathered at the Bok 90-inch telescope, one of the instruments we frequented during our nine-day stay. The building that houses the 90-inch reminded me of what a secret library should look like, albeit lacking shelves of books. They were replaced by the 90-inch itself, a powerful instrument with a towering frame that swung around the sky with a deep, smooth rumble. My friend Shayna described the feeling of standing next to the telescope well. "It's like seeing a dinosaur skeleton at a museum. You're never quite ready for it, and it's a bit beyond comprehension."

That first night we viewed Arcturus, the Snowball Nebula, and Saturn through the 90-inch's occasionally used eyepiece (instead of spectrometers or CCDs operated from the control room, instruments we would become familiar with during the camp). The view of Saturn, unlike my six-inch scope's blurry, rice-grain-sized image of the planet, was clearer than my imagination. The shadow of the rings, pronounced sharply against the gas giant's sphere, kept my eye glued to the eyepiece.

The dome of the 4-meter Mayall telescope dominates the peak. For scale, note the people and vehicles at the base of the structure. *[Paul Deans]*

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Off To Work We Go

Astronomy Camp, while broad and varied, focuses on research projects the campers lead and carry out. When it came time to choose ours from a long list of desirable choices, my friends and I stuck together and chose to study exoplanet transits and the typing of Kepler stars. Once our names were assigned to specific astronomical happenings, we suddenly felt like real astronomers. Together, we used the 90-inch telescope and the WIYN 0.9-meter, and for nine days we secretly became the kings and queens of stars and orbiting bodies outside our solar system.

Our research began at 12:30 am on a Wednesday morning. After spending time memorizing summer constellations and eating bagels, we made our way to the 90-inch, blindly finding our way along the winding asphalt road, Tucson twinkling softly to the east. I constantly used my headlamp's red light when navigating our way from the dorms to the 90-inch. My nighttime identity slowly became superhero-like, as though Kitt Peak in crimson was the result of a bite from a radioactive space bug.

During one of our tours, Don McCarthy (Astronomy Camp's Director) describes the components of the McMath-Pierce solar telescope, an instrument that extends deep into the ground. *[Wayne Schlingman]*

With six in our star-typing project, the control room of the 90-inch was always filled with chairs, notebooks, and people, one of whom was probably asleep at any given moment. Despite our sometimes unbearable tiredness, being in that dimly lit, wood-paneled room felt important, as if we were at the source of never-ending information. With the guidance of Kate Brutlag Follette and Patrick Sheehan, graduate students at the University of Arizona and top-notch control-room companions, we learned to take biases, flats, and darks, find our target stars with online databases, position the telescope just right, and modify the spectra we collected with black body light curves.

Even for tasks as ultimately simple as typing stars, it felt like massive amounts of work had to be put in, and we had Patrick reduce data on the carpeted floor as we collected more. The control room's instruments — the double-monitor computers, the fuzzy television showing the 90-inch's field of view, the old-school buttons and switches used to slew the telescope — began to feel like extensions of our arms after just hours of work. Although what we knew was dwarfed by what we had to learn, we made instant connections with the stars above our heads. As we analyzed our data and compared the spectra to those of known stars, the Kepler objects we studied seemed closer, as if they sat right outside the atmosphere. Our data collection ended as the Sun rose, and we watched it from the McMath-Pierce, our star a fluorescent pink as it crept past the horizon.

To work on our data and project presentations, we often gathered in groups around the computers in the Research-Based Science Education Room. *[Wayne Schlingman]*

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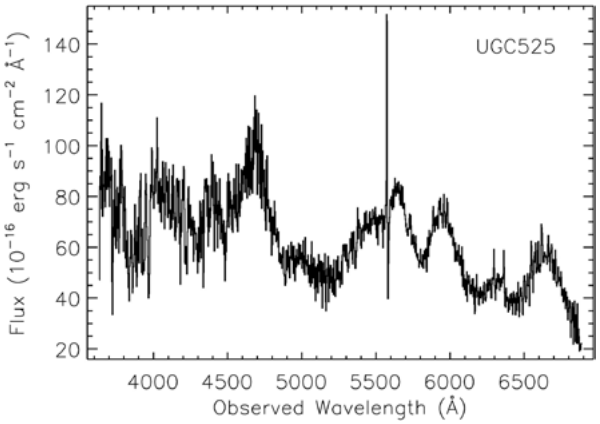


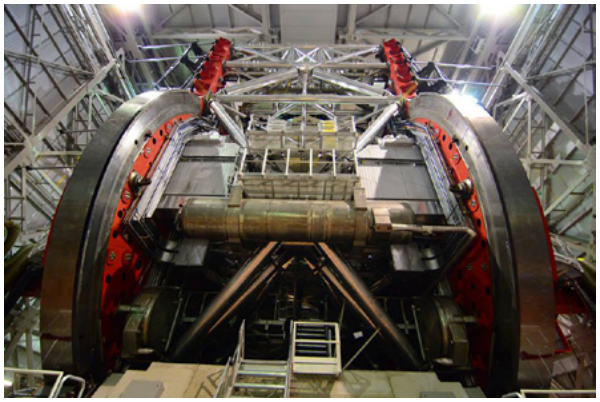
Working as a team with Doug Leonard (San Diego State University), we were the first group to classify the spectra of two brand new supernovae (types Ia and IIP). Shown above is the spectrum we obtained of PSN J00513484+2943149 (type Ia) using the 90-inch B&C Spectrometer. All Campers' names were cited in the international CBET telegram (CBET 3573) and in The Astronomer's Telegram. We experienced the excitement of modern research as well as the pressure to produce quick results.

We worked on our exoplanet project, with help from counselors Vanessa Bailey, Kate, Patrick, and others, using two telescopes: the WIYN 0.9 meter telescope, just a short drive from the 90-inch (a drive that sometimes included Rice Crispy Treats and hot chocolate), and the Roll-Off-Roof observatory, a 16-inch instrument located on a rooftop deck that resembles an empty hot tub. While the mirrors of the WIYN and the Roll-Off-Roof are smaller in diameter than other instruments on the mountain, the data we collected was no less astonishing.

Unlike taking single exposures of stars to type them based on their spectra, mapping the light curves of stars with transiting exoplanets requires continuous observing and data collecting as the planet passes by its host star. The very real time constraints of astronomy arose when we scrambled to locate a star before its planet began to transit, a process that involved ten people pointing to various places in the telescope's field of view and the finder chart. ("That has to be it." "No, look at that speck of fuzz, I swear that's this galaxy over here.") We eventually mapped the stellar light curves for two stars with planets (TrES-3b and Qatar-1b), calculated their radii, and learned about their suns. It took most of the camp to complete our projects.

Visiting the Large Binocular Telescope

In addition to our research, Astronomy Camp gave us insight into the lives of astronomers via visits to the University of Arizona's Mirror Lab and the Large Binocular Telescope (LBT) on Mount Graham, one of the largest optical telescopes in the world. While leaving our projects stagnant for one night pained us, the LBT visit did not disappoint. It did the opposite.



The Large Binocular Telescope uses two 8.4-meter mirrors supported by a massive structure. *[Wayne Schlingman]*

A long drive up the mountain led us to the LBT, a colossal building surrounded by forest. The scientists of the LBT and the other two telescopes on the peak — the Submillimeter Telescope (SMT) and the Vatican Advanced Technology Telescope, also known as the "pope scope" — waved as our white vans rolled up the dirt roads.

We slept in the lobby of the LBT that night, sleeping bags lined up tightly against the walls, but not before a tour of the facility. Just as the name suggests, the LBT is composed of two mirrors, both 8.4 meters across, that work together to gather immense amounts of light. Standing on the rotating building's floor, the telescope towered above us — it filled the space to its edges, and the red metal of the frame dominated our vision. Many telescopes I've seen, if placed

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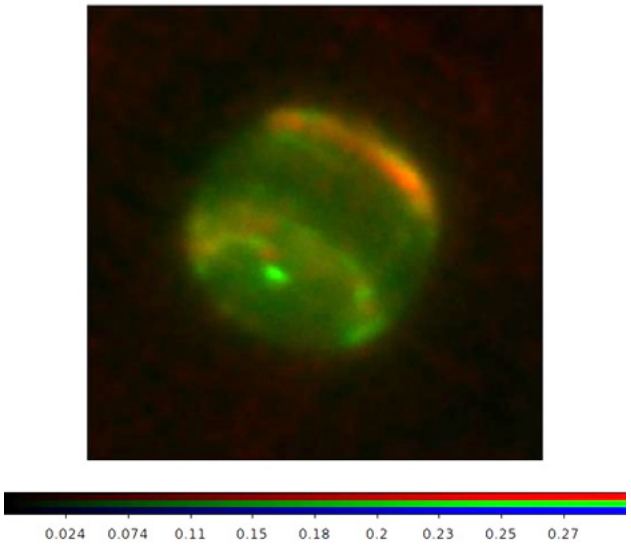
next to the LBT for comparison, would likely be mistaken for screws.

On our tour, the building started to gradually spin. The dome opened slowly, letting a dim light sneak through the widening gap, while the LBT moved its huge body like a sentient being. A fire had burned many of Mt. Graham's highest trees, leaving them black and scrawny, and the air was grey with ash and wispy clouds. It looked dystopian, and we were in the only oasis.

That night we ate spaghetti prepared by our surrogate parents (Ann and Wyatt Schlingman, amateur astronomers and two of our counselors), worked on projects, took power naps, and toured the LBT and SMT control rooms, looking at both the instruments themselves and the data being collected. The astronomers in the SMT — Yancy Shirley, a University faculty member, Brian Svoboda, a graduate student, and telescope operator Bob Moulton — quickly converted me to a radio astronomy fan with their intricate mapping of regions of cosmic gas. Those at the LBT, all sitting behind monitors, seemed to control the world around them.



Before Camp, we arranged with Arizona astronomers to image weather patterns on Neptune in the near-infrared using the LBT's adaptive optics system. Even though we observed through very thick clouds, the resulting image had high resolution (0.04 arcseconds) and showed active storms and cloud bands that had not been witnessed for several years. *[Courtesy Vanessa Bailey and Andy Skemer.]*

I unfortunately went to sleep too early, before my friends Jordan and Justin made a second, exciting trip into the LBT control room late at night. There, the astronomers attempted to observe Neptune. This task is difficult for any telescope no matter the size, and it was likely painstaking to create a decipherable image of the gas giant with the abundance of ash and clouds in the air. Somehow, though, the LBT succeeded, capturing Neptune through multiple filters. The feat was remarkable and resulted in three dreamy images of the planet. The fact that the LBT was able to see distinct clouds in the Neptune's atmosphere, despite those on Earth, emphasized the telescope's awesome abilities.

Combining Research and Fun

The drive back to Kitt Peak signaled the latter half of the camp and the approaching day of departure. We continued with our projects, collecting data on a total of six stars and two transiting exoplanets with the help of some amazing counselors. In addition to our research, we split up into different groups to work on two camp-wide projects: designing a hypothetical space station and preparing for debates against other teams on real, important, space-themed topics — the future of NASA

One night, before beginning research for our projects, we make vanilla, chocolate, and Dippin' Dots ice cream using liquid nitrogen as a coolant and aerator! *[Justin Griggs]*

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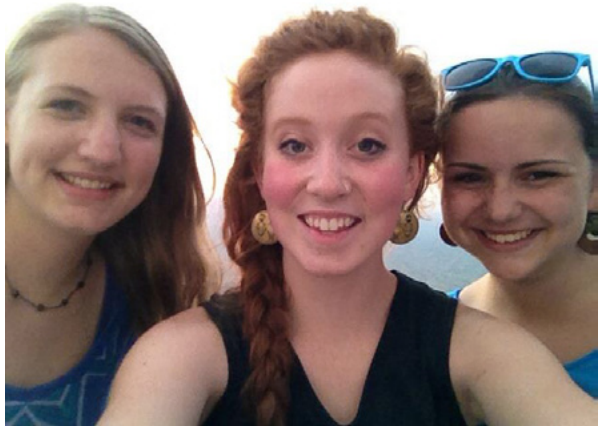

Flanked by fellow selfie-lovers Emma and Shayna, I often took advantage of Kitt Peak's perfect spots for sunset viewing and image capturing. *[Elena Saavedra Buckley]*

manned missions and the search for intelligent extraterrestrial beings. I still think about my group's space station, a torus orbiting the asteroid Ceres, and daydream about living on it.

While Astronomy Camp was filled with research and welcome work, some of the most valuable memories I made were with my friends. It can be hard to find people to talk with about quasars, SpaceX, or telescopes, but it can be even harder to find people with whom you still get along after projects, late nights, and problem solving.

During those nine days, we sang. We talked about astronomy and everything besides astronomy, and we stayed up way too late. We made liquid nitrogen Dippin' Dots, and we took a barrage of selfies during sunsets. Most often, we'd lie on our backs staring up at the darkest skies we knew, helping each other learn the constellations. But sometimes we were just silent, trying to feel the movement of the giant rock we call our home planet underneath us.

Astronomy Camp let me solidify my love for the sky, but it also demystified my concept of the study of it. Being an astronomer is hard, complex work, but it is a crucially important field — one we young people, interested in space, can have an impact on. As long as we're under the same Moon, we can study it and what's beyond and always feel connected by looking outward. ✪

The beautiful Milky Way looms over Kitt Peak. Sometimes we'd just lie outside at night and stargaze. *[Wayne Schlingman]*

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