New at RCSA

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Studying the Stars
by By Adele Conover

Touring the skies from the Mount Lemmon SkyCenter

Photographs by Jay Rochlin

Imagine exploring space through state-of-the-art telescopes on one of the country's highest peaks, Mount Lemmon, (9,157 feet) in Arizona's Santa Catalina Mountain Range. You might see galaxies 40-million light-years away, or Arcturus, the brightest star in the Constellation Bootes, Saturn and its moons, or closer to home-a mere 1,300 light-years away--the Orion Nebula, or the dwarf planet Pluto, perhaps the north pole of Mars. Or you could track an asteroid, or even discover a new comet as amateur astronomers did here a few years ago.

Over the last 21 years, thousands of adults and teens attending week-long beginning and advanced classes have done just that using the University of Arizona's (UA) world class telescopes. They are all students at Astronomy Camp which is guided by UA astronomer, Don McCarthy, a master of hands-on science education.

This spring, inspired by Astronomy Camp's success, the UA's College of Science and Steward Observatory, with funds donated by the Research Corporation for Science Advancement, Seattle businessman Nick Hanauer and others, launched the Mount Lemmon SkyCenter, a state-of-the-art science center where the public can also taste the thrill of astronomical investigation. The SkyCenter began by offering programs for nighttime viewing for groups of 20 as well as overnight sessions for individuals.

At a June SkyCenter night sky session Boy Scouts from Sierra Vista, Arizona, several adults, and middle schoolers from Arizona and Montana sit in the lecture room of the SkyCenter's Learning Center, a refurbished Army dormitory which also boasts a computer room, a high-tech kitchen, dining area, showers and beds. While dining on a light supper they listened raptly to program coordinator Adam Block, an award-winning space photographer and astronomer. He explained how Polaris, the current North Star, will abdicate its position in 13,000 years when Earth's rotational axis points toward star Vega, when it resumes its place as the Northern pole star -- a position it held 14,000 years ago.

After the group mastered how to use a star chart, Block armed them with binoculars and flashlights and they filed out on the mountain to watch Earth's pink-tinged, blue shadow rising while the setting Sun displayed red and green colors. In the deepening twilight they peered through their binoculars as the Space Shuttle, like a fish in a dark sea, "swam" past a few hundred miles overhead.

As darkness fell, Block led the group inside an immense 40-foot-tall white dome housing the 24-inch telescope and immediately anointed 12-year old Riley Archuleta, from Arizona, as the first Dome Driver. With a little instruction Riley pushed the right buttons and the dome swung open to reveal a large slice of the night sky. Block showed Boy Scout Samuel Chavous how to operate the telescope. Samuel was instructed to sit in the "driver's seat" in front of a digital star chart on the computer screen. He clicked on the screen, typed in "Mars," which directed the huge telescope to alter course and zero in on the Red Planet. Soon Samuel, along with Butte, Montana, high-school freshman Molly O'Brien, 13, and the others lined up to look through the telescope's eyepiece. "This is really cool" said Ryan Archuleta, 13, the dome driver's brother, as he viewed the orange-hued planet. Block said, "See that little white dot at the top-that's Mars' polar cap. The Phoenix Lander is parked not far from there, but of course you can't see THAT."

The impetus for the Mount Lemmon SkyCenter began with a birthday present. In 2001 Seattle businessman and amateur astronomer Nick Hanauer's mother treated him to a week at McCarthy's adult astronomy camp. Inspired by McCarthy, who he considers as "one of the great science teachers on planet Earth," Hanauer started a discussion with the UA Department of Astronomy and Research Corporation for Science Advancement. "Astronomy touches questions of 'Where do we come from?' And 'Who else is out there?' This facility could be a science education goldmine, it can't be duplicated anywhere in the world," he says. UA Dean of Science Joaquin Ruiz says, "Nick was the catalyst and the SkyCenter became the umbrella for many new science education programs in addition to its crowning jewel, Astronomy Camp."

"Astronomy Camp was the prototype for Mount Lemmon SkyCenter," says Research Corporation's President James M. Gentile. SkyCenter's latest programs include DiscoveryDays, weekend events that focus on tree-ring research, Sky Island biogeography, astronomy, hazardous asteroids, ecology and the Phoenix Mars Mission, says Valerie Grindle, executive officer for the observatory.

Astronomy Camp began in 1988 as an outreach science education project of the Arizona Alumni Association. It's a self-sustaining project supported by camper tuition, donations from former campers and Astronomy Camp scholarships. McCarthy, an athletic-looking man in his late 50s, was conducting a session during the last evening of the 2008 beginning astronomy camp for teens. He posed a riddle to the pizza-eating campers: "We have two strings-using a match you can light one end of either and it will burn to the end in a minute but not at a constant rate...How can you time 45 seconds?" The students, ages 11-14, who hailed from all over the country, piped up with questions, guesses and solutions. McCarthy was nodding, encouraging, explaining -- but it was 15-year-old Annie Cherkaev, from Salt Lake City, Utah, who answered: "At the same time light both ends of one string and one end of the other string. When the two ends of the first string meet, light the end of the second string. When the two ends of the second string meet, 45 seconds will have passed." By way of demonstration, McCarthy drew angles on a whiteboard. Camp counselor Janet Howard, (a former AC camper, as are many of the counselors) who is now working with the Jet Propulsion Lab, explained McCarthy's technique, "Don wants to get the campers thinking on their own rather than just accepting some of the science concepts." McCarthy's methods like this have spurred science careers and given campers a gateway to science through astronomy.

But science is always about something new. As the Roman philosopher Seneca wrote in the first century, "Our universe is a sorry little affair unless it has in it something for every age to investigate..." Perhaps one day a curious young Mount Lemmon SkyCenter visitor such as astrophysicist-minded Molly O'Brien or star Astronomy Camp camper Annie Cherkaev will devise a way for humans themselves to park an even more advanced Phoenix Lander on still another planet.

A Revolution in Science Education

Over Research Corporation for Science Advancement's 96 years, it has largely funded research in the physical sciences-astronomy, chemistry, physics-but at the same time it sought to address critical issues in science, including education. As RCSA President James M. Gentile says, "If you want to fund the future of science, research isn't the endgame; you also fund the scholar educator."

To this end, in 1987 RCSA launched the Partners in Science program that paired high- school teachers with a mentor doing cutting-edge research. in the 1990s Research Corporation began the Cottrell Scholar Awards for beginning faculty members committed to excelling at both research and teaching.

Teaching and learning astronomy-especially at the precollege level-has long been a problem. As astronomy teacher/columnist Jeffrey F. Lockwood described in his long-running column "Black Holes to Blackboards" in Mercury Magazine, Nov-Dec 1997:

In 1893, the National Education Association charged a group of educators -- the 'Committee of Ten' -- to examine high school curricula. One of their recommendations was to remove astronomy. This committee endorsed the biology, chemistry and physics sequence that most schools employ today. Given astronomy's relegation, astronomy educators are now as scarce as adults who know what a quasar is. . .

But Lockwood, as a veteran high school astronomy and physics teacher at Sahuaro High School in Tucson, Arizona, persisted. By the 1980s he had already won numerous awards for teaching excellence and had earned a master's degree in secondary science education. Still, he was always looking for new challenges.

In 1987, when Research Corporation launched the innovative Partners in Science program, Lockwood was one of the first award recipients. His mentor was University of Arizona astronomer Don McCarthy, later to be director of Astronomy Camp, the impetus for the Mount Lemmon SkyCenter.

While walking through McCarthy's lab during his first weeks at UA's Steward Observatory, Lockwood says he spotted a foot-high mound of handwritten data sheets. They were temperature readings of a large amount of data recorded by different telescope operators associated with the Multiple-Mirror Telescope (MMT). Nearby, 13-year-old Giovanna Mealer, an intern working with McCarthy, was punching that data into a Mac-Classic computer. As McCarthy explained, "At the time the MMT was considered the largest telescope in terms of "resolution"--the ability to see fine details in the image of an object viewed by the telescope. In order to "phase" the six mirrors associated with the telescopes, we had to adjust the distances that light traveled through each one to within a millionth of an inch. The distances could be affected by temperature variations (expansion/contraction) of the telescope structures." Even tiny temperature changes could result in major changes in image quality.

MMT image by Howard Lester

In addition to the readings on the data sheets, the engineering staff was also looking for heat sources that might be producing the changes. Says Lockwood, "I thought to myself, 'Maybe this project can be a great big homework assignment for my astronomy students.'" After making some 800 copies of the data sheets, he split them up among his 30 astronomy students. "Then I took them on a field trip to the MMT to look at the location of the sensors and had them sketch the layout of the observation floor, the control room, the shutter and any other electrical sources they could find, and for the rest of the semester record the temperature data. I had them graph their results and present them to the MMT staff and McCarthy."

Lockwood says that at the time, he "had two ne'er-do-well students (they got Fs) in the first semester, but they got As and Bs on the MMT project. When I asked one why the difference, he said, 'It was the first chance I had time to really think about and work at solving a problem.'"

"Well," says Lockwood, "I might be onto something-a new way of teaching and learning."

And he was. When he finished his two-year mentorship with McCarthy in the Partners in Science program, Lockwood (with McCarthy's help) obtained additional funding from Research Corporation to further develop his hands-on science program with high school students. Over the next five years, he says, the generous support of RC "totaled five times more than the annual budget at Sahuaro High School (for 40 classes). . . I could hardly believe it!" Lockwood could then start a research class that "allowed my students the time to really dig deeply into a problem to which neither the student nor I knew the answer." He was also able to build an astronomy library at the school and take the students on more research trips.

Every March ('90-'95) during spring break, Lockwood drove a van full of his young researchers to the Lunar and Planetary Conference in Houston, Texas, to present poster papers about their projects. "In a crowd of 600 attending scientists," Lockwood says, "they were the only high school students presenting. Their presentations are the highlight

of my teaching career. . . I watched them in excited pairs defending and explaining their research to hundreds of planetary astronomers who commented favorably and critically about their work."

Lockwood's students also participated in overnight sessions at UA's Mt. Lemmon Observatory telescopes, courtesy of Don McCarthy. During those astronomy all-nighters students took turns manipulating the 40" and 60" telescopes. "Don McCarthy was constantly at my side, giving his time and advice to make astronomy come alive," says Lockwood. "And after a night of actually manipulating the telescopes my students really understood the motions of the stars and celestial coordinates."

During the years 1987-93, Lockwood says, "I was trying to be more of a scientist and Don McCarthy was trying to find a way to become more connected in education and teaching. That's one reason our partnership has been so successful."

In 1993, Lockwood returned to school to earn an Ed.D. as a curriculum specialist at UA's College of Education. McCarthy was one of his dissertation advisers. Although Lockwood left high school teaching in 1999 after 27 years, his "classroom" days and nights continue. With the support of a National Science Foundation grant, he is teaching high school astronomy teachers how to teach research in an ongoing program called "Astronomy Research Based Science Education." Also a textbook author, Lockwood is currently writing a high school curriculum program called "Investigating Astronomy" (ia@terc.edu).

The Lockwood-McCarthy connection is only one example of the partnerships that have developed between mentor and teacher in the Partners in Science program. During RCSA's 13 years with the program, more than 500 teachers at 400 schools were mentored by more than 400 different faculty at 115 colleges and universities. (In 2000, Partners In Science management was transferred to the M. J. Murdock Charitable Trust but Research Corporation continues to be involved.)

"If we're going to replenish the pool [of scientists] in the United States, we can't do it by chance-we'd better be pretty intentional about it," says Gentile.

-- Adele Conover

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