THE LOWELL Observer

THE QUARTERLY NEWSLETTER OF LOWELL OBSERVATORY ISSUE 84 FALL 2009

Greetings from Lowell Observatory's New Director

By Eileen Friel

Eileen Friel, incoming Lowell Observatory Director, observing last December at the WIYN telescope in Tucson. Dr. Friel assumed leadership of Lowell Observatory early this summer, after a 12-year career with the National Science Foundation.

Nantucket is a wonderful place, frozen in the past by an unexpected and permanent decline in the whaling industry and so perfectly preserved that, to go for a walk on a foggy morning, is to step back in time. My husband and I lived on Nantucket for five years, when I served as director of the Maria Mitchell Observatory. It was delightful. Even so, we could be so busy managing productive undergraduates, as well as public and educational summer programs, that visitors had to remind us to relish where we were.

I was always grateful when they did that.

Now that I'm at Lowell, I sometimes feel like one of those visitors, and want to remind everyone around me of what an extraordinary place this is. But there is an interesting twist. There was only one Nantucket to be reminded of. There are many Lowells. There is science. There is history. There is the wonderful tradition of Lowell artists, from the founder with his writing and photography, to all the painters and photographers, ceramicists and sculptors who fill the staff today. There is the future with the "people's telescope," as some are already calling the remarkable DCT. There's an endless supply of new instruments and science projects of all kinds. There's all of Mars Hill, and how it might someday be preserved, interpreted, and developed. There's outreach and the web and education and leadership in the scientific community. There are dozens of Lowells, each with its claim to primacy.

Outside Flagstaff, Lowell is best known for the science done here. People think of it as one of the world's great private observatories, where astronomers have incredible freedom, work very hard, and produce extraordinary results.

Things look different on Mars Hill with the Slipher Building and the Clark 24" telescope and the years of tradition. Here, it is easy to lose the sense of science, in much the same way that it is easy to miss the charm of Nantucket. That is a pity, just as it is a pity to be so lost in our science that we lose our sense of the past, or our awareness of our surroundings, or the pleasure of the company of the marvelous people with whom we share this place.

So I hope you'll forgive me if, from time to time, I shake my head and laugh and tell you just how beautifully Kitty organized our annual staff party, the Lobsterfest, or what a fine talk Ted Dunham gave on Kepler, or how lovely the woods are after it rains, or how much I'm looking forward to having an echelle spectrograph on the DCT, or what a nice job the docent did last night when she explained just how long it would take to drive to Alcor, or…

So please forgive me for pointing out the obvious to people who've been here much longer than I. Forgive me because, to be honest, I hope I never stop doing it. Sometimes the obvious good is the hardest to see. Sometimes, it is the most important.

INSIDE THIS ISSUE

Storm on Titan

By Henry Roe

On April 14, 2008, graduate student Emily Schaller walked across the campus of Caltech to file her dissertation with the Graduate Office. At that moment, I sat in my office at Lowell Observatory working through some e-mail while the previous night's images of Titan taken with the Gemini North 8-m telescope on Mauna Kea downloaded to my computer. My computer would then automatically process the data and display the final images for my inspection.

Rather, the computer should have been processing the data. It wasn't, though. Instead, error messages were popping up where no errors should be. It seemed my carefully developed and painstakingly refined system was having a hard time finding Titan in the images.

I pulled up one of the raw images of Titan.

For a minute or two, all I could do was stare at the image. It showed the largest, brightest storm we had ever seen on Titan with Gemini. The storm was so bright it had saturated the detector and befuddled my automated data reduction pipeline (Figure 1).

Titan is Saturn's largest moon and a major finding of Emily's graduate thesis was that its strange atmosphere had been unusually calm for several years with only occasional wispy clouds. She and I were pretty sure this calm couldn't last and have worked together since 2003 to lay a trap for Titan and catch exactly this type of event. (See article in the Winter 2007 Lowell Observer for an earlier update on this program.)

Observing Titan with Gemini on the night of April 13-14 was part of that strategy. The previous night our monitoring program detected unusual cloud activity on Titan with NASA's Infrared Telescope Facility (IRTF), a smaller telescope also on Mauna Kea. That activity suggested that some interesting weather might be brewing. Even so, the size of the storm surprised us and the events that played out over the next month were so unusual that we've just published a paper describing them in *Nature* (Schaller et al. 2009, 460, pp. 873-875).

Saturn's largest moon Titan resembles Earth in many of the processes that are active on its surface and in its atmosphere. While the materials are sometimes alien on Titan, these processes are familiar. For instance, Titan's clouds, rain, and surface liquids are all made of methane rather than water, but the processes of methane cloud formation, rainfall, and evaporation from lakes all have analogies here on Earth. Most water-based hydrologic or meteorologic processes here on Earth have directly analogous methane-based processes on Titan. Although Mars and Venus are both terrestrial planets like Earth and are both closer in size to Earth than Titan, from the point-of-view of these planetary processes on the surface

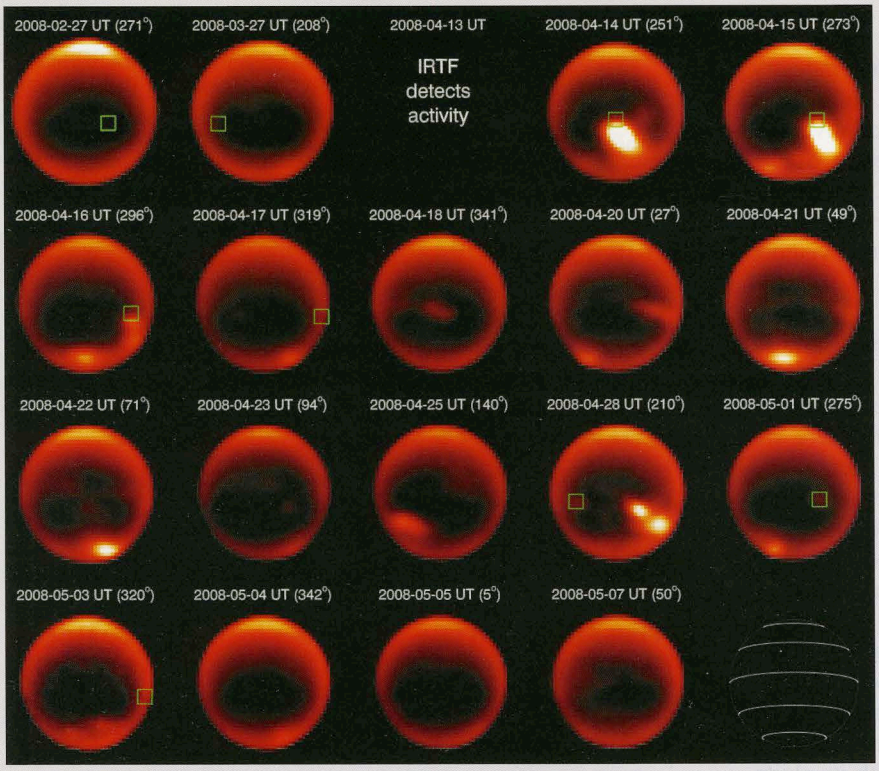


Figure 1:
The events on Titan of April 2008 are shown here in images taken with the Gemini North 8-m telescope. These images are taken in a filter that obscures Titan's surface, but highlights the bright clouds. Aside from the variable clouds, Titan's high stratospheric haze is also apparent in every image. For instance, on 2008-03-27 UT there were essentially no clouds present and the image shows only the haze. The dates are noted in Universal Time (UT) and therefore the observations of 2008-04-14 (UT) were taken on the night of April 13-14 local time in Hawaii. The green box indicates where the initial storm originated. One Titan rotation is 16 Earth days long and the original storm rotates to the night-side of Titan after a few days. The central longitude of Titan is indicated for each image after the UT date. At the same time cloud activity, triggered by atmospheric waves emanating from that original event, start up at both the south pole and in the equatorial region. On 2008-04-28 the wave has circled Titan and triggers more cloud formation in the original storm, significantly enhancing its brightness. By early May Titan's atmosphere had mostly calmed down.
Credit: H. Roe (Lowell Observatory) and Gemini Observatory

and in the atmosphere, Titan stands out as the most similar body to Earth in our Solar System.

Titan has seasons for the same reason as Earth: Titan's axis of rotation is tilted over 26.4 degrees, just three more degrees than Earth. Titan's year, however, is much longer. One Titan year lasts 30 Earth years. We've only had the technology to observe Titan's methane weather directly for about a decade and our campaign to study the weather in detail began only about five years ago. Titan's northern vernal equinox occurred in August 2009. Imagine trying to understand Earth's complicated weather from only having seen January, February, and part of March and you can see why we are planning to continue to observe Titan for decades to come.

The events of April 2008 demonstrated the value of our multi-telescope approach. By using smaller telescopes, such as the 3-m IRTF in this case, to monitor cloud coverage on Titan nightly, we can better and more efficiently allocate our precious and limited Gemini observing time to focus on Titan when Titan is most active. (Thanks to the generosity of the Mt. Cuba Astronomical Foundation we are currently constructing a new robotic 0.5-m telescope on Mars Hill that will monitor Titan's total cloud coverage more continuously than we can with any of the larger telescopes on Mauna Kea. A future *Observer* will give more details about this new facility.)

These events also demonstrated why ground-based observations of Titan are so crucial, even with the Cassini spacecraft in orbit about Saturn. Cassini flies by Titan every few weeks, but has limited ability to observe Titan in between those flybys. In the spring of 2008 Cassini flew by Titan on March 25th and then did not visit Titan again until May 12th. In Cassini images from that latter flyby a few faint strange looking clouds remain, but for the most part Cassini missed entirely the events of the previous month.

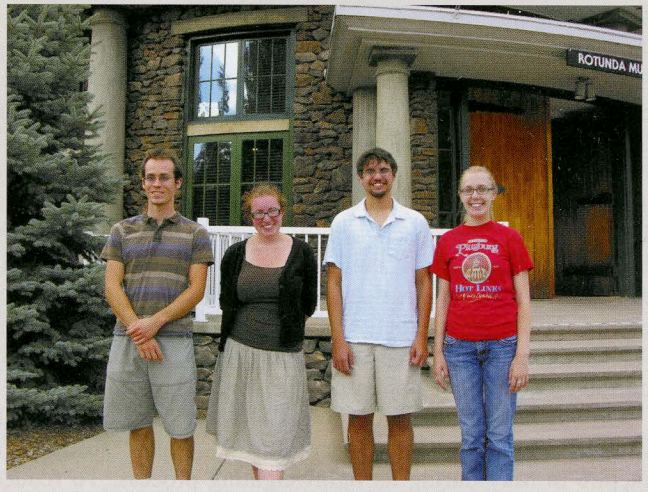
Most importantly, the events of April 2008 gave new insight into how and where clouds form on Titan.

That initial storm of April 13-16 was convective and violent enough to kick off waves in the atmosphere, just as a dropped stone generates waves on the surface of a pond. These waves, technically known as Rossby waves, then traveled throughout Titan's southern hemisphere and triggered cloud formation elsewhere, including at the south pole and in the equatorial regions. By April 28 UT, the wave had circled Titan and caught up to the original storm, triggering new cloud formation and a brightening of the storm.

These were the first observations of wave activity in Titan's atmosphere and demonstrated convincingly that a strong enough punch to the atmosphere in one location on Titan can trigger cloud formation anywhere in the same hemisphere. This overturned a recently developed understanding of Titan that held that the equatorial region is a dry desert and should never see clouds or rainfall, while the polar regions should be wet in early summer and dry the rest of the year. These observations demonstrate that clouds, and presumably rainfall, do occur at the equator and can occur out of season at the poles. Further, this helps solve the mystery of what process could have formed the dry streambeds and channels seen at Titan's equator by Cassini and its lander probe Huygens. Researchers had begun to invoke underground springs, geysers, or other even stranger geologic features, but these observations show that methane rain showers are the likely source of the liquid that cut those streambeds.

The biggest remaining mystery from April 2008 is: What was the original trigger? What could have punched the atmosphere so hard as to set off one of the biggest storms yet seen on Titan? The most likely two possibilities are seasonal atmospheric dynamics or some type of geologic activity on the surface. The atmospheric dynamics possibility requires just the right combination of winds shifting around on Titan, which could happen. From Cassini images there is strong evidence that Titan's surface is still active, with cryovolcanoes, mountain formation and erosion, and possibly even plate-tectonics on a small scale. Any of these processes could release enough subsurface methane into the atmosphere to kick off a storm of the size we saw. Curiously, the surface region where the storm initiated (shown by a green box in Figure 1) remained bright for weeks. With further observations of Titan over the next few years, we'll be able to distinguish between these scenarios as our network of telescopes captures more of Titan's unusual weather.

REU Students at Lowell Observatory Summer 2009



Lowell Observatory was host to four Research Experiences for Undergraduate students this summer. From left to right: Nick Wilsey from Truman State University who worked with Deidre Hunter, Kathryn Neugent from Wellesley College who worked with Phil Massey, Edward Schwieterman from Florida Institute of Technology who worked with Matthew Knight, and Allison Youngblood from Wellesley College who worked with Lisa Prato.

DCT Update

By Jeff Hall

Construction workers have spent the summer putting the outside panels, shutters, seals, and finishing touches on the DCT dome.

Since the last update in the Observer, progress on the DCT has been going in increasingly rapid and visible fashion. The most obvious progress is the work on the dome, which is now nearing completion. Mechanical Engineer Heather Marshall has been more or less living out at the Happy Jack site, overseeing installation of the dome, and work has been proceeding remarkably smoothly. During one of my visits out to the site, one of the contractors was expressing satisfaction at how smoothly everything was going together, which speaks well of both the manufacturer of the components as well as the skill of the workers assembling the seven-story structure. Until recently, the facility was not visible until one headed up the dirt access road to the site, but it is now impossible to miss as one approaches the site along Lake Mary Road from Flagstaff.

As of this writing, the dome is fully assembled, and the crews are working on the interior seals and electronics. The shutters – the large panels that slide apart to create the viewing slit – are functional, and are shown during one of their tests in the picture to the right. In November, we will conduct tests of the full functionality of the dome, including rotation. This is all part of the acceptance testing, the process of checking each requirement and ensuring it has been met.

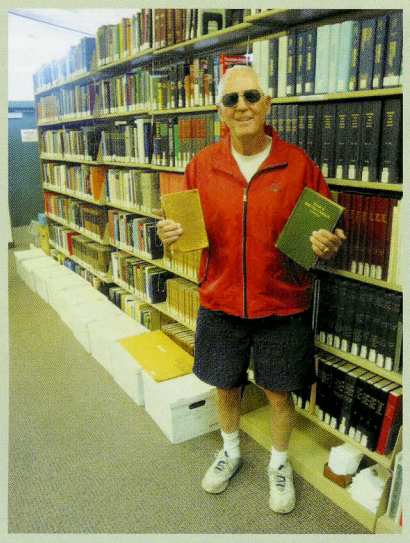
On other fronts, we are moving forward from our setback with the 1.4-meter secondary mirror, which suffered a fracture in May during its lightweighting process. To reduce the mass of the mirror, we need to drill holes in the back of it, creating a honeycomb appearance. Unfortunately, during the lightweighting, a bit too much force by the drilling tool fractured a large chunk of the face of the mirror, rendering it unusable. After much consideration, we decided the best way forward was another try with the same procedure. The company doing the lightweighting has revised the program that controls the drilling tool, and the new mirror blank is now at their facility. Following lightweighting, it will travel to Baltimore for final figuring and polishing, before being delivered to the site in 2010. While the mirror breakage may sound like a major delay, the rapid turnaround on the new mirror, combined with rearrangement of other tasks, has not set the project schedule back.

We are also nearing an interesting and complex phase of the project in which the completed mirror cell – the structure that will support the 4.2-meter primary mirror – will be ready for testing with the support system, consisting principally of 120 actuators that will apply force to the back of the mirror to maintain its shape as the telescope moves. For testing purposes the cell will be equipped with a mirror simulator, and we anticipate that assembly and testing will be done right here in Flagstaff, at one of the hangars at Pulliam Airport. This work should begin in December, and shortly thereafter, components of the mount, as well as the finished primary mirror itself, will arrive at the Happy Jack site.

To keep all of you in the loop as things progress, we have introduced weekly updates on the telescope project on the front page of our DCT site. You can find it at http://www.lowell.edu/dct. In addition to the main news items, you can also read a weekly in-depth feature about a specific part of the DCT, as well as take an extensive photographic tour of its development.

The DCT shutters in the open position, showing the viewing slit.

Mars Collection Donated



Robert Bruner, who has been collecting Mars-related books for more than 60 years, drove with his wife Judy from his home in Denver with 10 boxes of books for the Lowell Observatory Library and Archives. The collection consists of rare books from the 1800s, a wealth of titles specifically dealing with Mars from the 20th century, and a fabulous collection of science fiction and children's books with the same theme. The collection has been cataloged, and has already been put to good use by a visiting researcher from Wales this summer.

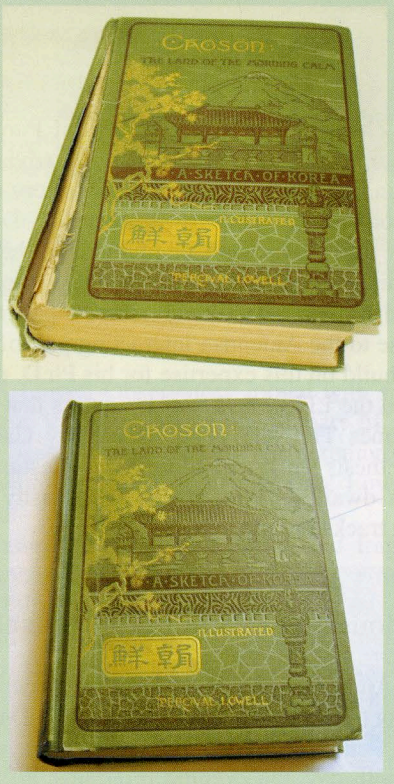
Rare Books Receive TLC From Lowell Friends

By Rusty Tweed

Some of Percival Lowell's books are doing much better now that they have been under the temporary care of Barbara and Kent Robinson. The Robinsons were attending a Friends of Lowell event in June when they met our librarian and archivist Antoinette Beiser. During the visit, Antoinette learned of Barbara's lifelong interest in books, and in particular, of restoring and repairing old or damaged books. She invited them to stay and take a tour of the Observatory's collections the following day. After their visit, the Robinsons returned to Prescott with a handful of books needing repair work, including Lowell's *The Evolution of Worlds*, published in 1909 and the extremely rare *Choson: Land of Morning Calm*, published in 1885.

In her shop, Barbara Robinson demonstrates the application of wheat paste in preparation of removing the spine material.

Barbara's avocation is named Butterfly Book Restoration service, and she generously offered to take the books under her care and repair them. She said that none of the books were beyond hope, in comparison to others she has worked on. The Lowell books were moderately damaged, each requiring between one and two hours of work. The work included repairing the spines and the hinges that connect the cover to the body of the book. The old spine material was removed using wheat paste to loosen the material before scraping it off. Barbara pointed out that "unfortunately the spine on *The Evolution of Worlds* was split and the book was in two pieces." In this case she had to "cut into the spine with a Dremel tool, creating shallow grooves through which twine was glued in place. The twine was then fanned out and secured underneath the end papers to stabilize the book."



Pictures showing the condition of *Choson: Land of Morning Calm*, by Percival Lowell published in 1885, before and after restoration work.

Most recently Kent and Barbara have embarked on a different historic book project: they have started to inventory the collection of books that have remained untouched for decades along the catwalk in the Rotunda Museum on Mars Hill. They estimate there are 1,300 books in the collection and the project will require many trips to Lowell over the course of several months to catalogue them all. We greatly appreciate their generous contribution of time and expertise to help the Observatory preserve its significant history. If you are interested in supporting projects like this, please contact me at 928-233-3267.

New Predoctoral Student Joins Lowell Observatory Staff

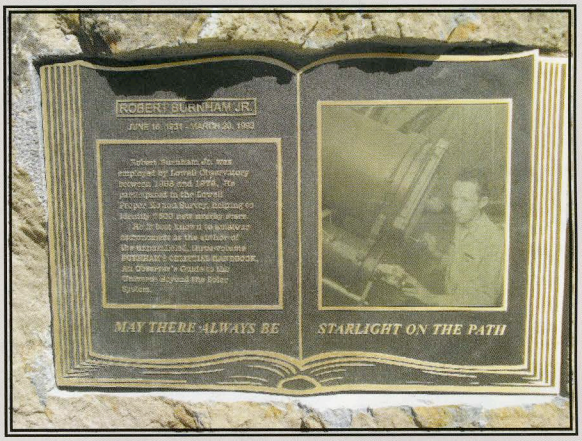
Hongxin Zhang is a graduate student at Purple Mountain Observatory in Nanjing, China, where his advisor is Dr. Yu Gao. Hongxin has come to Lowell Observatory as part of the Lowell Predoctoral Program to work with Dr. Deidre Hunter. Hongxin has experience with population synthesis of broad-band colors used to reconstruct the star formation histories of galaxies, and he has recently submitted a paper that applies this technique to the Antennae interacting pair of galaxies. He proposes to build on this expertise for his Ph.D. thesis project, applying it to the LITTLE (Local Irregulars that Trace Luminosity Extremes THINGS (The HI Nearby Galaxy Survey) data set. His thesis work will address the question of why star formation in dwarf galaxies tracks the density of old stars better than it tracks the gas.

Free Admission Day at Lowell Observatory!

On Sunday, August 16, we offered a new special event in our Steele Visitor Center – Free Admission Day at Lowell Observatory, sponsored by the Robert Ayers Sciences Fund. For both day and evening programs, all visitors were admitted for free and the response was overwhelming – more than 800 people showed up!

We invite you or your business to sponsor a Free Admission Day at Lowell. We hope to continue this program on the third Sunday of the month beyond the initial three-month commitment from the Robert Ayers Science Fund. Through your sponsorship, you'll enhance the image of your business through your association with Lowell Observatory and you'll provide a benefit to the community by supporting an educational family activity. We will also include your business name and logo in our promotional materials for the event. If your business is interested in sponsoring a Free Admission Day at Lowell, please call Rusty Tweed at 928-233-3267.

Celebrating the Life of Robert Burnham, Jr.



A close-up of the Robert Burnham, Jr. Memorial Plaque on the Pluto Walk

On Saturday August 15, about 50 people converged at Lowell Observatory to celebrate the life of Robert Burnham, Jr. (1931-1993), former Lowell Observatory employee and author of the classic publication, *Burnham's Celestial Handbook.*

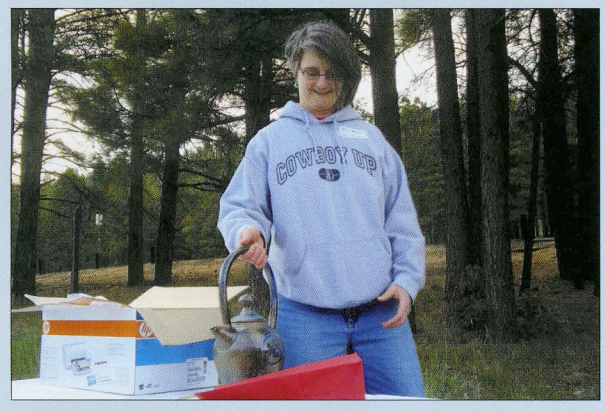
At 2:00 p.m. Lowell director Eileen Friel welcomed visitors in the Giclas Lecture Hall. She was followed by Burnham's niece, Donna Courtney, who read a poem written by Burnham years ago. Tom and Jennifer Polakis, responsible for organizing the celebration, then talked about the Burnham Memorial Project and the Burnham Plaque.

Tony Ortega, the journalist who brought the Burnham story to light years ago and the present editor of the Village Voice, flew in from New York and highlighted some of the fascinating aspects of Burnham's life. Former colleague and office mate Norm Thomas discussed the professional impact of Burnham's work, and Thomas' son Bruce spoke about his time as a boy at Lowell Observatory and his friendship with Burnham. Former colleague and neighbor Nat White then shared some humorous stories of his interactions with Burnham. The formal portion of the program was completed when Tom and Jennifer Polakis presented a scholarship for the study of astronomy by a recent graduate of Prescott High School to amateur astronomer Marilyn Unruh of Prescott, who represented the school. The group, which included members of several regional astronomy clubs, then went to the Pluto Walk to dedicate the Burnham Plaque.

From left: Burnham's sister Viola Courtney, Tony Ortega, Donna Courtney, Eileen Friel, Nat White, Norm Thomas, Bruce Thomas, and Jennifer and Tom Polakis stand by the Burnham Plaque on the Pluto Walk.

Volunteering at Lowell Observatory

Our volunteers are important members of the Lowell team. We currently have two dozen talented individuals with backgrounds ranging from retired teachers, family therapists, and retired astronomers, to current college and high school students. In the past year, these volunteers have worked in the Business Office, Library and Archives, Outreach Program, and the grounds, helping preserve historic documents, presenting educational programs to visitors, maintaining the beautiful appearance of the grounds, and answering phones. Of course, our valued Advisory Board members also volunteer their time.



Kris Naylor, nighttime docent, was named Lowell Observatory Volunteer of the Year. Here, Kris opens her thank you gift, a ceramic tea kettle made by retired Lowell groundskeeper Jerry McGlothlin.

We are now in the process of expanding the volunteer program to include nearly all aspects of Observatory operations. Anyone with carpentry or machining skills, for instance, or experience with proposal writing or computer programming, are most welcome. If you would like to increase your participation with Lowell Observatory and become a volunteer, please fill out an application online at: http://www.lowell.edu/employment/content/forms/volunteer.pdf or contact Kevin Schindler (928-233-3210; e-mail kevin@lowell.edu).

About 100 Lowell staff and family weathered chilly conditions at Lake Mary for our annual Volunteer Appreciation Picnic.

Verkamp Meteor Moved To Lowell Observatory

Local Flagstaff luminaries who helped celebrate the installation of the new Verkamp Meteor exhibit include (left to right) Flagstaff Mayor Sara Presler; former U.S. Magistrate Judge Steve Verkamp; Barringer Crater Company President and Chairman of the Executive Committee of the Lowell Observatory Advisory Board Drew Barringer; and former Arizona State Senator John Verkamp, who with brother Steve, are grandchildren of John G. Verkamp.

On June 5 Lowell Observatory joined with special guests to dedicate the Verkamp Meteorite as part of a permanent exhibit in the Steele Visitor Center. The ceremony was held in conjunction with the annual meeting of the Lowell Advisory Board in June.

The Verkamp Meteorite is a 535-pound fragment of the nickel-iron meteorite that created Meteor Crater approximately 50,000 years ago. A century ago, mining engineer Daniel Moreau Barringer spent much money and time searching for the original impactor. It wasn't until many years later that scientists better understood the dynamics of impacts and realized that the majority of the original impacting body vaporized, leaving only fragments behind.

Some time in the early 20th century, Grand Canyon curio seller John G. Verkamp acquired the meteorite. For the next century, the rock was on display at the Verkamp Store in Grand Canyon Village. Last year, the Verkamps closed the store and, with the help of Advisory Board member Drew Barringer, grandson of Daniel Moreau Barringer, found a permanent home for the rock at Lowell Observatory.

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2009 Public Program Fall Special Events

October *Regular public hours: daytime 9 AM-5 PM; M/W/F/Sat nights 5:30 PM-9;30 PM*

October 5-31 Special exhibit in the Rotunda Museum: *The Art of Shonto Begay.* Open day and evening public hours.

Wed 7 **Flagstaff Night** *(regular evening hours)*
Tonight at 7 p.m., astronomer Wes Lockwood will give a talk on the scientific and economic importance of controlling light pollution. Telescope viewing will also be available, with Jupiter the featured object. Flagstaff residents (must show valid drivers license or utility bill) pay only half price for entrance into our regular evening programs.

Sun 11 **Autumn Star Fest** (*regular evening hours)*
This event will feature indoor programs and numerous telescopes set up for viewing throughout the Lowell campus. Jupiter is the featured object.

Sun 18 **Free Admission Day at Lowell** (regular daytime and evening hours) Sponsored by the Robert Ayers Science Fund, all are admitted free. In the evening, enjoy indoor programs and outdoor telescope viewing. If your business is interested in sponsoring a Free Admission Day at Lowell, please call Rusty Tweed at 928-233-3267.

Tues 20 **Orionid Meteor Shower** (*regular evening hours)*
Indoor programs will focus on meteor showers such as the upcoming Orionids. Also, telescope viewing, with Jupiter as the featured object.

November *Regular public hours: daytime noon-5 PM; M/W/F/Sat nights 5:30 PM-9:30 PM*

November 4-30 Special exhibit in the Rotunda Museum: *Don Bendel Art Exhibit,* which is open during day and evening public hours.

Wed 4 **Flagstaff Night** *(regular evening hours)*
Tonight at 7 p.m., docent Klaus Brasch will give a talk *Life in the Solar System.* Telescopes will also be set up for viewing Jupiter. Admission same as Flagstaff Night above.

Sun 8 **November Star Fest** (*regular evening hours)*
This special event will feature indoor programs and numerous telescopes set up for viewing throughout the Lowell campus.

Wed 11 **School's Out & Kids Are Free** (*9 AM to 5 PM)*
The Observatory will be open for kids' activities throughout the day including science demonstrations, telescope viewing of the sun, Space Theatre programs, and tours of the Pluto Dome. Children must be accompanied by an adult or responsible guardian.

Mon 16 **Leonid Meteor Shower** *(regular evening hours)*
Indoor programming will focus on meteor showers. Also telescope viewing with Jupiter as the featured object.

25, 27, 28 **Thanksgiving Star Fest** *(regular evening hours)*
This event will feature indoor programs and numerous telescopes set up for viewing throughout the Lowell campus.

27, 28 **Thanksgiving Weekend Celebration** (9 AM to 5 PM)
Extended daytime hours with indoor programs and special tours including stops at the Pluto Telescope dome.

The Lowell Observer is published quarterly by
Lowell Observatory, 1400 W. Mars Hill Road, Flagstaff, AZ 86001
For comments about the newsletter, contact Antoinette Beiser, Editor, asb@lowell.edu
 ISSN 1054-0059