

THE

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# LOWELL OBSERVER

THE QUARTERLY NEWSLETTER OF LOWELL OBSERVATORY

HOME OF PLUTO

This beautiful 2013 image of the Sun is from NASA's Solar Dynamics Observatory. Taken in far ultraviolet light, it shows the myriad contorted, looping structures associated with the Sun's magnetic field. The bright spot on the left limb is a powerful flare. Credit: NASA/SDO/AIA.



## Understanding the Sun and its Solar Siblings

By Jeff Hall

Hello, everyone! Usually I'm writing you from the Director's column, and I'm typically occupied these days with budget spreadsheets or dark-sky matters. But a long time ago in a galaxy far, far away, I joined Lowell as a postdoctoral research fellow, working with Wes Lockwood on a program that is still underway today.

For 24 years, Wes and I, along with Brian Skiff and Len Bright, have been observing the steadily changing activity of our Sun and about 100 of its closest stellar siblings. "Activity" means things like sunspots (or starspots), flares, prominences, and other manifestations of the ever-changing magnetic fields that permeate stellar interiors and atmospheres. In the Sun, this activity rises and falls in a relatively steady cycle about 11 years long—the familiar sunspot cycle. We see similar activity cycles in many (but not all) Sunlike stars.

Here at Lowell, we observe the Sun and stars using a spectrograph at our 1.1-meter (42-inch) Hall Telescope at Anderson Mesa. Analysis of critical spectral lines allows us to discern the

activity cycles even in distant stars, for which we can't image individual activity features as we can for the Sun. We have colleagues at Tennessee State University who observe the brightness changes of the same stars using a flotilla of robotic telescopes at an observatory south of Tucson. Comparison of the activity data with the brightness data lets us examine how changing activity affects the overall energy output of the Sun and stars like it.

So, what's the point? There are two principal scientific drivers.

First, we want to understand the physics of activity cycles. We know the basics: the bulk motions (rotation,

Continued on page 11

## Clyde Tombaugh's Offer Letter from Lowell

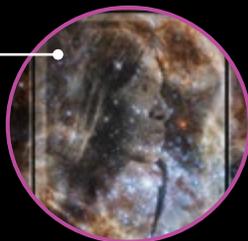
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## DIRECTOR'S UPDATE

By Jeffrey Hall

I have a voicemail on my phone. Well, I have quite a few, but this one is from last April. I don't usually keep them that long, but I'll never delete this one.

It's from Pat Roemer, who you read about in the Fall 2016 *Observer*. She died in April, and in December, we received a check with the bulk of her estate gift to Lowell. It is now in the Foundation, where it will provide support in perpetuity for Lowell research, a desire Pat expressed to me personally and in her last phone message. That same week in December, we received a magnificent pledge from the Phoenix-based Kemper and Ethel Marley Foundation: \$1.4 million in support of several projects, including ongoing research by Lowell astronomers at the

Discovery Channel Telescope. It was such a pleasure for me to speak with Pat last year before she died, and to write the Marley trustees a note thanking them for their extraordinary generosity.

But that week also brought back to mind another gift. Back when the DCT was a hole in the ground and we were earnestly fundraising for it, I opened an envelope from a lady named Rosemary. Inside was a check for \$10, and a wish for good luck building our new telescope. I wrote her a note, too. Luke 21:1-4 is an old tale, but it wears well.

To all who help keep our research programs humming and tens of thousands of eyes peering through the Clark Telescope: thanks, and enjoy the *Observer*. We're delighted to stay in touch with you. 📧



## TRUSTEE'S UPDATE

By W. Lowell Putnam

We are all part of a continuum of life, history, and the future. This issue brings some sad news in the passing of several wonderful people who helped people who have helped shape Lowell Observatory and who will continue to shape it for years to come. It also reminds us of the surprising (and sometimes unexpected) moments that can lead to great discoveries. A few years ago, someone told me, "Finding Pluto was a fluke. Percival Lowell was looking for a ghost, and Clyde Tombaugh found it

for him." Maybe so, but if not for the drive and persistence of both Percival and Clyde, would America ever have been credited with discovering a planet? It was Vera Rubin's persistence over years of study that proved dark matter existed. I urge you to also read about Peter Collins and how much he helped the science efforts at Lowell. Last Fall, the *Observer* had an article about the life and work of Pat Roemer, and we are now fortunate to have support from her estate to help future research here at Lowell.

As the fifth Trustee of this great institution, the ongoing contributions of so many people over the years is a reminder that we all can make a difference, not just in our lifetimes, but in how we help the next generation.

*...if I have seen further, it is by standing on ye shoulders of giants*  
- Sir Isaac Newton 📧

## Eclipse Event in Lieu of Gala

In lieu of our annual gala, this year's fundraising efforts will be focused on the Lowell Observatory Solar Eclipse Experience in Madras, Oregon. As a member, you will receive free admission to this once-in-a-lifetime experience. See the next page for more info. We hope to see you there!



The Nissan 350Z next to Big Red, Percival Lowell's 1911 Stevens-Duryea.

## Mike Beckage Wins Auction for Stern Car

Alan Stern's "second fastest vehicle" has a new owner. Long-time Lowell Observatory supporter and advisory board member, Michael Beckage, now drives the 2006 Nissan 350Z. He purchased the sports car during an auction to benefit the observatory's annual fund. "I'm a big fan of Alan, of Pluto, and of Lowell Observatory," said Beckage. "So I'm delighted to own Stern's car."

Alan Stern purchased the red sports car the year *New Horizons* began its trip. It was the only car he drove for the entire flight to Pluto. The *New Horizons* PI donated the 350Z to Lowell Observatory for an end-of-year fundraising auction. "*New Horizons* would never have happened without the pioneering work that took place at Lowell Observatory early in the last century," said Stern. "I hope Mike will one day donate the car back to Lowell, so it can sit beside Percival Lowell's Stevens-Duryea on Mars Hill."



LOWELL OBSERVATORY  
**SOLAR ECLIPSE**  
EXPERIENCE | 2017

## August 21, 2017 Lowell Solar Eclipse Experience Update

With less than four months left until the Moon's shadow races across the United States at more than 1,000 mph, Lowell Observatory's eclipse planning team is working on educational partnerships with the Jefferson County School District, the Science Channel, and Madras' own eclipse event, Solarfest. Madras High School has provided a beautiful performing arts center where Lowell astronomers and educators will present their stories of science. These programs will bookend the eclipse itself, which attendees will observe from the school's nearby football field. Part of the partnership with the school district involves Lowell Observatory educators helping students with curriculum support, as well as access to our astronomers during the event.

Program schedule, ticket information, a weekly blog, sponsorship information, and other information about the Lowell Solar Eclipse Experience is available at a dedicated event website:

[www.lowellsolareclipse.com](http://www.lowellsolareclipse.com)

For Facebook users, follow the Lowell Observatory Solar Eclipse Experience 2017 event page.

Participants in the DCT session at the AAS meeting (left to right): Michael West (Lowell), Lisa Prato (Lowell), Brad Cenko (NASA Goddard), Philip Muirhead (Boston U.), Julie Skinner (Boston U.), Gerard van Belle (Lowell), Jeff Hall (Lowell), Debra Fischer (Yale), Kevin Hardegree-Ullman (kneeling, U. Toledo). Not pictured, Suvi Gezari (U. Maryland).



## DCT, Dark Skies Take Center Stage at AAS Meeting

By Kevin Schindler

Lowell Observatory scientists were at center stage during the 229th meeting of the American Astronomical Society (AAS), held this past January in Grapevine, Texas. Two programs in particular highlighted Lowell's leadership in the astronomical community. On the first day of the meeting, Director Jeff Hall helped lead a three-hour workshop with other scientists and a lighting engineer, discussing strategies for protecting dark skies. As a follow-up to this, the AAS Council announced a three-part resolution on light pollution, endorsing the International Astronomical Union's (IAU)

Resolution B5, "in Defense of the Night Sky and the Right to Starlight"; supporting Report 2-A-16 of the American Medical Association (AMA) detailing effects of LED lighting on humans and the environment; and calling on all AAS members to protect dark skies in their communities.

The following day, Deputy Director for Science Michael West chaired the session, "Science with the Discovery Channel Telescope and Beyond." This well-attended program featured nine presentations by astronomers from Lowell and DCT partner institutions. 

## Annual Fund

Lowell's Annual Fund donations support STEM-based camps for kids and other outreach efforts that inspire future generations of scientists. Your donations to Lowell Observatory also support our innovative exhibitions that educate, entertain, and inspire nearly 100,000 visitors each year, including 12,000 school children. Donations also fund cutting-edge astronomical discoveries using the DCT, our world-class 4.3-meter telescope. Lowell astronomers continue to make new discoveries. 2016 was an amazing year for Lowell Observatory, and with your help 2017 will be even better. Thank you for your generous gifts!



## The Rich Comet History at Lowell Observatory, Part 2

By Joseph Marcus (Continued from Issue 109, Winter 2016 *Lowell Observer*)

As an extension of the successful search for Lowell's Planet X, which resulted in the discovery of Pluto in 1930, Henry Giclas published observations and positions of comets from the mid-1930s onward in *Astronomische Nachrichten*, *Astronomical Journal*, and other outlets. With the accession of Brian Marsden to the directorship of the International Astronomical Union (IAU) Central Bureau for Astronomical Telegrams in 1967, Giclas represented Lowell Observatory conspicuously to the world comet science community with his frequent contributions of comet observations and positions to the IAU Circulars. His last published comet observation was of Earth-grazing C/1983 J1 (Sugano-Saigusa-Fujikawa), made from the Anderson Mesa station. Giclas was then 72 years old. He discovered a number of comets in his long tenure, including 84P/Giclas. According to Giclas, by 1975, the Lowell Observatory archives held more than 2,400 photographic and spectrographic plates of 170 different comets.

Ted Bowell was also active in comet observation and astrometry, beginning in 1980, the year he discovered the notable comet C/1980 E1, a new comet which manifested icy grains and CN gas production at large distances from the Sun. Bowell also initiated and directed the Lowell Observatory Near Earth Object Search (LONEOS), which used a fully automated, 0.6-meter Schmidt telescope at

Anderson Mesa. LONEOS was a fearsome search program, netting 289 near-Earth asteroids. The 42 comets discovered by this program make it a world leader in comet discoveries. Larry Wasserman and Brian Skiff have worked in this program, and 13 of the comets discovered in this program bear Skiff's name. Most of the comets are otherwise known more generically as "LONEOS."

Since the mid-1970s, Lowell Observatory has been an international leader in narrowband comet photometry. Former Director Robert Millis and astronomer David Schleicher worked in a collaboration led by Michael A'Hearn of the University of Maryland and with Peter Birch of Perth Observatory in Australia (which provided southern coverage). They have accumulated a database of production rates of dust and various gases (CN, C<sub>2</sub>, C<sub>3</sub>, and NH, among others) which is sufficiently voluminous to divide comets into taxonomic types. Schleicher continues to expand the database at Lowell Observatory today. Earlier, Millis and Schleicher determined the complex rotation period of 1P/Halley.

A number of post-doctoral fellows have worked productively with Schleicher at Lowell Observatory. Tony Farnham, now at the University of Maryland,

Image of Comet Hale-Bopp captured in 1997 by Ralph Nye.

worked on imaging, morphology and photometry of C/1995 O1 (Hale-Bopp). Laura Woodney, now at California State University, San Bernardino, did imaging, morphology and spectroscopy of various comets and now specializes in the enigmatic comet 29P/Schwassmann-Wachmann. The most recent post-doc, Matthew Knight, has become a research scientist at the University of Maryland. While at Lowell Observatory, he worked on photometry, production rates, coma morphology, and nucleus light curves. With Schleicher, Farnham and others, he has determined that the rotation of 10P/Tempel 2 has been increasing over the last quarter century. He also helped lead the comet ISON (C/2012 S1) observing campaign and analyzed the unusual light curve of this sungrazing comet as seen in the coronagraphs aboard the SOHO satellite. He and Schleicher recently determined the rotation period of the tiny earthgrazing comet 252P/LINEAR.

A'Hearn, who was a member of the Lowell Observatory advisory board, was principal investigator for the "Deep Impact" spacecraft mission to excavate comet 9P/Tempel 1. The mission was extended to fly by comet 103 Hartley 1. The science retrieved from these missions has been significant. Lowell-associated cometary astronomers have been actively involved in ground-based observations of comet 67P (Churyumov-Gerasimenko) (Snodgrass et al 2016), the target of the ESA/NASA Rosetta space mission, in which A'Hearn has been an active investigator.

In summary, Lowell Observatory has had a rich history of comet observation and science which continues robustly to this day. This has provided fertile ground for the establishment of an endowment to support comet science at Lowell. ☺



Dave Schleicher with some of his students and collaborators on comet research at Lowell: Matthew Knight, Susan Lederer, Laura Woodney, Schleicher, and Allison Bair. November 2014 DPS meeting in Tucson.

LOWELL OBSERVATORY  
FLAGSTAFF, ARIZONA

January 2, 1929

Mr. Clyde W. Tombaugh,  
Burdett, Kansas,  
Dear Mr. Tombaugh;

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Your letter of December has been duly received. And we note your eagerness to get into actual observatory work. We are more in need of help now than ever before and we are willing to have you come here on trial, for a few months at least, because we feel that you should be able to make yourself useful in some capacity about the Observatory. We suppose you have had some experience in photographic work or that you are willing to make a special effort to make yourself acquainted with it and with such other work about the Observatory as may from time to time be required. For a while at least help is needed about the janitor work etc., and it seems to us you should be able to make yourself really useful to us. Under the circumstances that we have not been able to see you and discuss matters with you and we have not yet been able to confer with people who know you, it is not possible for us to offer you at this time any definite or permanent place. But from your letter I am sure that you appreciate the situation and that you are willing to come on the offer of a few months employment that will at the same time enable you to show that you can make yourself useful to the Observatory in its work. I am sure I do not need to tell you that there are lots of hard work and a good many long and some uncomfortable hours at night with the instruments. But if one is interested in the work and is not averse to working hard there are compensations in it aside from the living it affords. There are other things to be sure which one can do and find better pay; but to us interested in astronomy they do not have the satisfying interest that we find in the study of this science.

You may come as soon as you conveniently can. If you need money advanced to meet traveling expenses you might telegraph us if desirable to save time. We think you ought to be able to earn the higher wage that you mentioned in your letter. It will probably be possible to arrange a room for you here at the Observatory which would save paying room rent in the town, and it would be more convenient especially when doing night work. We can go over these matters better after you arrive, but I thought you might care to bring *if convenient* some bedding and linen with you if you knew such would be useful to you. Of course any such can be got here that may be needed. The room will have the more necessary furniture including bed and mattress. The Observatory is about a mile from the business part of town. If you will let us know what train you will arrive on we will meet it, or you can telephone us from the station here.

With best wishes, I am,

Very sincerely yours

V. M. Slipher

## Clyde Tombaugh's Offer Letter from Lowell

Years after leaving Lowell Observatory in the mid-1940s, Clyde Tombaugh moved to Las Cruces, New Mexico, where he spent the latter part of his career teaching astronomy at New Mexico State University. Today, the university's library houses the majority of Tombaugh's personal and professional papers—some 150 linear feet. This collection is a treasure trove for Tombaugh scholars and includes such gems as this January 2, 1929 letter from Director V.M. Slipher offering Tombaugh a job at Lowell.

Aside from astronomy work, Tombaugh was expected to make himself "useful" in other ways to the observatory, as evidenced by this portion of Slipher's offer letter: "For a while at least help is needed about the janitor work etc. and it seems to us you should be able to make yourself really useful to us."

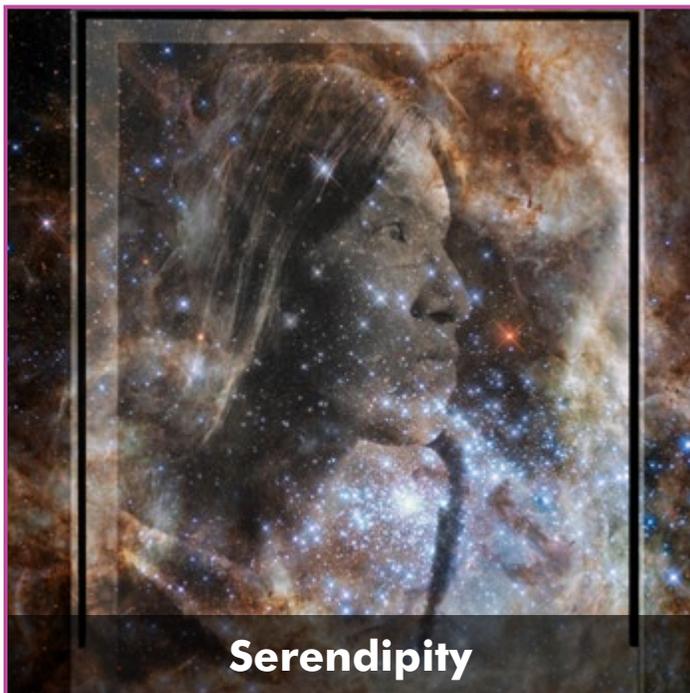


## America's Observatory

Lowell Observatory has been featured in several recent popular astronomy magazines. In the November, 2016 issue of *Sky and Telescope*, Bill Sheehan marked the centennial of Percival Lowell's death with a review of Lowell's career in astronomy. Michael West wrote about cannibal star systems for the cover story of the December, 2016 edition of *Astronomy*. Kevin Schindler discussed Percival Lowell's long-term impact on astronomy in the April, 2017 issue of *Astronomy*.

Lowell Deputy Director for Science Michael West has been studying cannibal galaxies for years. He summarized some of this work in *Astronomy* magazine.

## DISPATCHES FROM THE UNIVERSE



## Serendipity

By Michael West

Sometimes opportunities come in the most unexpected ways. It's all about serendipity.

Serendipity means to find good fortune when you're not looking for it. An Englishman named Horace Walpole coined the word in 1754. In a letter to a friend, Walpole mentioned a pleasant discovery he'd made by chance. "This discovery," he wrote, "is almost of that kind which I call Serendipity, a very expressive word." Walpole explained that the word was derived from a Persian fairytale called *The Three Princes of Serendip*, in which the three princes "were always making discoveries, by accidents and sagacity, of things which they were not in quest of."

Serendipity has always played a role in science. In 1928, for example, Alexander Fleming noticed that mold growing in his pile of unwashed petri dishes had killed neighboring bacteria. He'd stumbled upon penicillin, an accidental discovery that has since saved countless lives. Other instances of scientific serendipity include the invention of the microwave oven, the discovery of Uranus, and the creation of Velcro.

"One thing I've learned in my life is that one must be prepared to meet

entirely unexpected things," said Dutch astronomer Jan Oort at age 70.

Many astronomers stumbled upon their careers by chance.

In his memoir, astronomer Robert Kraft wrote, "My childhood upbringing in no way suggested that I would become an astronomer, but accidents of fate pushed me in the direction of science, and I have benefited greatly from being in the right place at the right time."

In 1907, Harlow Shapley, one of the great names in 20th century astronomy, enrolled at the University of Missouri with the intention of becoming a journalist. When he arrived, however, he discovered that the university's new journalism department wouldn't open for another

year. Shapley said that he ended up in astronomy simply because it was one of the first subjects he came across in the university's course catalog while searching for something else to study, after rejecting archaeology because it was too difficult to pronounce. It was a moment of happenstance that changed his life.

Even the titles of astronomers' memoirs often reflect the role that serendipity played in their lives: *Astronomer by Accident*, *An Accidental Career*, *A Serendipitous Journey*, and *An Astronomical Life Salted by Pure Chance* are just a few examples. Dorrit Hoffleit, director of Nantucket's Maria Mitchell Observatory from 1957 to 1978, titled her memoir *Misfortunes as Blessings in Disguise*.

Is it possible to cultivate serendipity, or can we only count on blind luck and the capriciousness of life?

"Accidents happen—there's nothing mystical about them," say Thor Muller and Lane Becker, authors of the 2012 best-selling book *Get Lucky*. "But it's our practical ability to take advantage of the best accidents that transforms these from forgettable moments into incredible opportunities."

The great nineteenth century microbiologist Louis Pasteur agreed, suggesting that one way to do this is to stay alert to new opportunities. "Chance favors only the prepared mind," he said. Breaking out of the routine, meeting new people, going outside one's comfort zone – all are ways of opening ourselves to possibilities that lie beyond our limited imaginations and carefully constructed plans.

In the end, fate is what you make of it, and serendipity can be a game changer. As the nineteenth century English novelist George Eliot once said, "It's never too late to become what you might have been." 

## 2016 Employee and Team of the Year

In December 2016, Trustee W. Lowell Putnam honored Samantha Gorney, Lowell's Outreach Manager, as our Employee of the Year. The outreach programs are thriving under Samantha's leadership, enjoying our highest attendance ever in 2016. Mr. Putnam also awarded our Team of the Year honor to our IT staff, C.J. von Buchwald-Wright and Scott Do, for their outstanding work maintaining and steadily improving the very large and complex IT system Lowell relies upon so heavily. Congratulations, Samantha, C.J., and Scott!

From left to right: Employee of the Year Samantha Gorney, Team of the Year staff members C.J. von Buchwald-Wright and Scott Do.



Ted Dunham (left) looks on as Peter Collins points to a computer screen during a SOFIA flight.

Our close friend and colleague Peter Collins passed away suddenly on January 16, 2017. Peter grew up on Long Island and developed an early interest in astronomy. He went to Harvard for a time but became consumed with software, working on data from an early orbiting ultraviolet observatory, after which he worked with the MMT (Multiple Mirror Telescope) on Mt. Hopkins, south of Tucson. Then he worked in the commercial arena in San Diego, eventually finding his way to Flagstaff and finally to Lowell. During his career Peter discovered three novae visually, a testament to his observational skill, patience, and tenacity.

Peter's day job, so to speak, was to develop software, but he almost always worked nights because of his love of astronomy, visual observing in particular. Peter was originally hired at Lowell in 2006 to work on the robotic software for the 0.9-meter (31-inch) telescope but moved on a couple of years later to work on control software for our SOFIA instrument, HIPO, and instrument control software at Anderson Mesa and the DCT. Because of Peter's night schedule, attention to detail, and amazing ability to write scripts, he generally was the first to know if there was a power, network, or computer problem anywhere in our system, or which observer had made what mistake where, when,



## Remembering Peter Collins

By Ted Dunham, with special thanks to Len Bright

and what they should do to fix it. Very often Peter would call to explain and fix a problem before the observer quite knew what was happening. An exception would be if he had taken a little time out to leave his lair in the Slipher Building to do his visual observations of variable stars, search for novae, or watch passing satellites.

In addition to his work here at Lowell, Peter flew many times on SOFIA for HIPO and SOFIA commissioning work, and for occultation and exoplanet transit observations. Our most recent SOFIA observation was a highly successful Pluto

occultation observation flown out of New Zealand in June, 2015, just two weeks prior to the *New Horizons* flyby. Peter will be missed by our SOFIA colleagues as he is here.

Peter was also our friend—a selfless, kind, and generous soul who taught us much about software, life, and what really matters. He read widely, was always an interesting conversational partner, and was a keen observer of nature (and human foibles). Peter was a firm believer in the value of an uncomplicated life. Those of us who knew Peter are lucky to have a little bit of his spirit living on inside us. 🍷



The four 8-meter telescopes on Cerro Paranal  
Credit: Jeff Hall

## Astronomy in Chile

A Lowell Observatory expedition spent eight days in Chile last November on a Director's Astronomy Tour. The group, which included Trustee W. Lowell Putnam, Director Jeff Hall, members of the observatory's Director's Opportunity Network, Friends of the Observatory, and Deputy Directors Michael West and Lisa Actor, visited the Gemini South Observatory's 8-meter telescope and the European Southern Observatory's Very Large Telescope, an array of four 8-meter telescopes on Cerro Paranal.

The trip included wine and pisco tasting in the Elqui Valley and ended with a star party in the Atacama Desert. Views of the southern hemisphere night sky included the Magellanic Clouds—two irregular dwarf galaxies orbiting our Milky Way.



## Pluto Telescope and Dome Renovation

By Kevin Schindler

This past January, Instrument Scientist Ted Dunham and Director of Technical Services Ralph Nye led a crew that removed the Pluto discovery telescope from its dome. This was the first major step in the yearlong renovation of the facility. Ted and Ralph are joined in this effort by archival restoration specialist Peter Rosenthal, woodworker Glenn Hill, machinist Jeff Gehring, and facilities manager Dave Shuck.

The Pluto Telescope and its dome date back to the late 1920s, when Lowell Observatory recommenced the search for founder Percival Lowell's theoretical "Planet X". In the nine decades since,

some areas of the dome have rotted, a few of the telescope parts have worn out, and the others need to be cleaned or stripped and repainted. The renovation will address these issues, as the project plans include replacing part of the dome wood and weatherproofing the entire facility. The crew will also repair and clean the telescope control mechanisms, photographic plate holders, and other accessories. In addition, Lowell staff will add new educational exhibits to the dome.

The renovation comes two years after a similar effort on Lowell's historic 24-inch telescope. Like that instrument, the lens of the Pluto Telescope, measuring 13-inches

(Left) Ralph Nye and Peter Rosenthal prepare the tube of the Pluto Telescope to be lifted out of the dome. (Below) A crane hoisting the tube out of the dome.



in diameter, was crafted by the Alvan Clark and Sons telescope making firm of Cambridge, Massachusetts. The dome of the Pluto Telescope was designed and built in 1928-1929 by instrument maker Stanley Sykes, who followed the same basic plan his brother Godfrey had devised for the 24-inch telescope dome back in 1896.

The Pluto Telescope and dome renovation will cost \$155,000, all of which Lowell's development team has raised through crowdsourcing, private donations, and grants. The Veritas Endowment Fund and Crystal Trust made leadership contributions, and a Kickstarter funding drive resulted in donations from around the world. 🌐



### A Letter from Lisa Actor

I'm writing from high atop Mars Hill to express our gratitude! Thanks to you, we experienced a record fundraising year in 2016, with \$5.1 million in gifts pouring in. A record number of you pitched in with your memberships and annual fund gifts, your gifts for the Pluto Telescope Restoration Campaign, Space Guard Academy, IGRINS, our Navajo-Hopi astronomy outreach program, and other projects.

Thank you! We could not continue our long tradition of world-class research and astronomy education without you. We appreciate having you join us in celebrating our cherished past and our exciting present as we plan for the future.

— Lisa Actor, Deputy Director for Development



### Astronomy Comedy

by Jury Judge (Educator Briana Jameyson)



## Vera Rubin 1928-2016

By Deidre Hunter

Dr. Vera Rubin, astronomer at the Carnegie Institution of Washington, D.C. and long-time friend of Lowell Observatory, died on December 25, 2016.

Vera's work revolutionized our view of the universe. It began in 1962 when she had her students in statistical astronomy at Georgetown University use star catalogues to derive the speed of stars orbiting the center of the Milky Way Galaxy. The speed of the stars depends on the force of gravity and hence amount of mass in the galaxy, and so stars should rotate more slowly in the outer parts of the galaxy. Instead, they found that the orbital speed was constant with radius. This was a complete surprise, and the results were met with disbelief. However, Vera listened to what the data were telling her, rather than being blinded by what was expected. Over the next decade she demonstrated that flat rotation curves were a common feature of spiral galaxies. The implication is that there must be a great deal of matter we can't see in galaxies, and this came to be known as "dark matter."

I will always cherish Vera's pure joy in asking and pursuing the answers to questions about the universe. She would get very excited about observing and analyzing data, and had no patience for

astro-politics. I remember one observing run on Kitt Peak when the 84-inch dome wouldn't move and we couldn't point the telescope. Most people would have quit at that point, but Vera wasn't about to waste telescope time. So we took spectra of the night sky as it passed overhead. She reduced the data and, as was characteristic of her, carefully examined every spectral feature. She found two that she couldn't identify and pored through lists of spectral transitions and talked to people until she identified them.

But Vera was much more than her scientific achievements. Vera was a trailblazer and she broke down barriers for the rest of us. When she started her career, women weren't allowed to observe at Palomar Observatory, but in 1965 she was the first woman to observe there under her own name. Twenty years later we were observing at Las Campanas where all of the observers on the mountain that night were women. What an evolution!

Vera Rubin at Lowell's 69-inch (now 72-inch) Perkins Telescope in 1965 with the Carnegie DTM spectrograph and Kent Ford's image tube. Credit: Carnegie Institution, Department of Terrestrial Magnetism.

Her entire life, Vera was tenacious and unrelenting about promoting women in science, and she was always happy to help young people.

Vera was a mom of four kids and had a husband who was also a scientist. They navigated the complexities of juggling two careers and family like other people. Vera and Bob loved children and Bob would entertain our daughter Rita with funny hats and toys when we visited. Once when Vera came to dinner after an observing run at Kitt Peak, she held a napkin over the floor and let it drop. She asked Rita, then a toddler, what that demonstrated. Vera was referring to gravity. Rita responded, "Littering."

For me personally, Vera demonstrated that a woman who was as cheerful, warm, generous, and down to earth as she was could be a successful astronomer. We all lost an unparalleled friend, mentor, colleague, advocate, and scientist with her passing. 🍷



Three generations of astronomers (left to right): Deidre Hunter, Megan Johnson, and Vera Rubin at the Kitt Peak National Observatory Mayall Telescope and echelle spectrograph in April 2009. Credit: Daryl Willmarth.

## MIT Camp Returns to Lowell

The MIT Astronomy Field Camp recently completed its three-week stay at Lowell Observatory. The six undergraduate students from MIT and Wellesley College kept up a busy schedule of research work with mentors, attending colloquia and weekly science discussions, tours of the DCT, Anderson Mesa, and Naval Observatory Flagstaff Station (NOFS), local sightseeing and hiking on the weekends, as well as talking with Lowell Observatory staff members over dinner.

The students this year were Jonathan Hurowitz (junior in mathematics and geology, worked with George Jacoby), Mikael Kalin (junior in mechanical engineering and physics, worked with Jim Clark), Patrick McClure (junior in physics, worked with Marc Murison of USNO), Casey Melton (sophomore in astrophysics, worked with Deidre Hunter), Megan Russell (senior in physics, worked with Joe Llama), and Hannah Taylor (senior in physics, worked with Deidre Hunter).

Returning this year in the role of Teaching Assistant was Anicia Arredondo, while Amanda Bosh was again the field camp instructor. Amanda, who attended field camp as a student in 1986, is a senior lecturer at MIT and adjunct astronomer at Lowell Observatory.



(Left to Right) First row: Mikael Kalin, Hannah Taylor, Anicia Arredondo (TA), George Jacoby. Middle row: Amanda Bosh, Megan Russell, Deidre Hunter, Casey Melton. Back row: Marc Murison, Patrick McClure, Jonathan Hurowitz, Joe Llama, Jim Clark



Travis Brown (right) works with teachers at last fall's Navajo-Hopi teacher workshop at Lowell.

## Navajo-Hopi Program Marches On

Lowell is in the middle of another year of the Navajo-Hopi Astronomy Outreach Program and we could not do it without support from individuals and foundations. Thanks to the APS Foundation for a \$36,000 grant to this year's program. We also received generous grants from the O.P. and W.E. Edwards, Thomas R. Brown Family, Southwestern, and John F. Long foundations. You can still donate to help us reach full funding and continue this wonderful program for Native American students and teachers.

## George Jacoby Featured for Astro Chat

The red rocks of Sedona were the setting for another successful Astro Chat. George Jacoby, Deputy Director of Technology, amazed participants with his past experiences and lessons in spectroscopy. Rob Schottland and Betty Morgan graciously hosted the event. Stay tuned for more Astro Chats in Flagstaff.

## Recent Publications



Keep up with our astronomers' research by reading their recent publications. Below is just one example of their work. See our website for more.

**Schleicher, David G.; Knight, Matthew M.** The Extremely Low Activity Comet 209P/LINEAR During Its Extraordinary Close Approach in 2014. *The Astronomical Journal*, Volume 152, Issue 4, article id. 89, 9 pp.

Image: Neugent/Massey/Lowell Obs./NSF

See our website: [www.lowell.edu/research/recent-publications](http://www.lowell.edu/research/recent-publications) for more publications

THE SUN AND ITS SOLAR SIBLINGS  
Continued from page 1

subsurface convection, and equator-to-pole flows of plasma) of the Sun or a star like it create a self-sustaining magnetic dynamo that drives the rise and fall of activity. But the details of how this happens are poorly understood.

Second, there is compelling circumstantial evidence linking periodic, multi-decade lulls in the solar activity cycle to significant changes in terrestrial climate. The last such period was in the second half of the 17th century, and since we didn't have many satellites in orbit back then, we don't have any quantitative measurements of what happened to the Sun's brightness. Non-cycling stars may provide that link. Observing the patterns of their activity-brightness variations may help us infer the Sun's behavior both in the past, as well as in the future. This is of particular interest right now, since the present solar cycle is

quite weak, and there is evidence to suggest we may be entering an extended period of weak cycles or—as a few astronomers have posited—another extended solar minimum. What might its effects be on our already changing climate: amplifying? mitigating? spatially complex or more homogenous? We'd like to know, and to do so, we need to better understand our star.

It is a pleasure working on a long-term project like this: I love studying patterns that reveal themselves only over time, and trying to understand this little slice of nature. It's also a project outstandingly suited to Lowell. Extensive surveys and long-term projects like this one lie in the realm of what we call time domain astronomy, one of Lowell's unique and powerful research strengths. We can do work here that almost no one else in the world can, and it's thrilling to be part of it. 

Lowell's 1.1-meter Hall Telescope. Like most telescopes, it supports multiple instruments. Our large, heavy spectrograph is on the floor below the observing level, fed from the telescope by an optical fiber.



Evening picture of Lowell Observatory's DCT dome.  
Credit: Michael West



## Marley Foundation Supports Lowell Science, Facilities

The Kemper and Ethel Marley Foundation of Phoenix is supporting Lowell Observatory's research and education efforts with a three-part grant totaling \$1.4 million. The largest fraction of monies will support 70 nights of research by Lowell astronomers with the observatory's Discovery Channel Telescope (DCT). The remainder will pay for facility upgrades and long-range planning efforts.

Lowell is undergoing an unprecedented period of growth in both its research and education efforts. Lowell's DCT is operating at full capacity and, thanks in part to this funding from the Marley Foundation, astronomers at Lowell are kicking off a new era of exploration with projects ranging from the study of exoplanets and characterization of asteroids and comets, to deciphering the evolutionary history of stars and galaxies.

Meanwhile, public interest in the observatory and its educational programs has skyrocketed, with record numbers of people visiting Lowell for the second consecutive year. Current visitor and support facilities need to be expanded to accommodate this growth and, with the guidance of some of the world's leading consultants, the observatory is nearing completion of a facilities master planning effort to meet these needs. The Marley Foundation funding will cover all consultant and architect fees, as well as help to finish the electrical upgrade of the observatory's 100-year-old Slipher Building that houses both educational programs and research offices.

The Slipher Building was constructed in 1916, with the upper floors added in 1923.



## RECURRING EVENTS

**Meet an Astronomer** | Every Saturday evening, subject to astronomer availability. Check website for featured astronomer.  
(7 - 10 p.m.)

**2<sup>nd</sup> Friday Science Night** | **MAY 12** (Chemistry I), **JUNE 9** (Chemistry II) | **JULY 14** (Electricity and Magnetism I)  
Show at 6 p.m.

### MAY

**TUE 13 | Eta Aquarid Meteor Shower**  
(6 p.m.) Family-friendly meteor shower activities  
(7 p.m.) Lecture about the source of the meteor shower and viewing tips

**SUN 28 | Holiday Star Fest**  
(10 a.m. - 10 p.m.) Hours extended until 10 p.m.

**MON 29 | School is Out and Kids are Free**  
(10 a.m. - 5 p.m.) Minors must be accompanied by an adult

### JUNE

**FRI 30 | Asteroid Day**  
(10 a.m. - 10 p.m.) Family-friendly asteroid-themed activities

### JULY

**FRI 13 | Delta Aquarid Meteor Shower**  
(6 p.m.) Family-friendly meteor shower activities  
(7 p.m.) Lecture about the source of the meteor shower and viewing tips

For more special event information visit:  
[www.lowell.edu/outreach/special-events](http://www.lowell.edu/outreach/special-events)



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