ISSUE 119 SUMMER 2020

THE
LOWELL OBSERVER

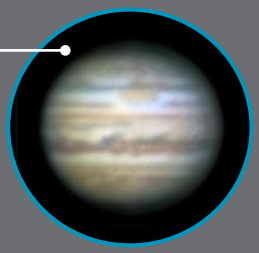
THE QUARTERLY NEWSLETTER OF LOWELL OBSERVATORY

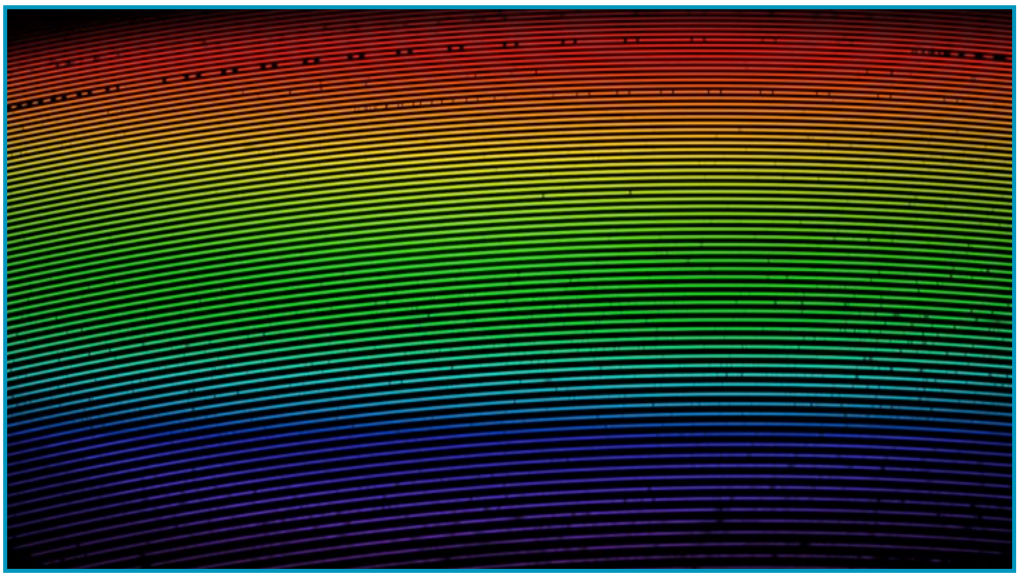
CELEBRATING 125 YEARS

COVID-19 STATUS

As of September 2020, Lowell Observatory entered Phase 1B of reopening, offering Premium Access to small groups with reservations. For updates see **lowell.edu/welcomeback** or follow us on social media.

IN THIS ISSUE





Lowell Observatory Solar Telescope Sees First Light

By Joe Llama, Astronomer

When day breaks in Happy Jack, observing the universe with the 4.3-meter Lowell Discovery Telescope stops until the next evening. That is when Lowell's newest telescope begins a day of observing. Unlike any other in Lowell Observatory's fleet of telescopes, this tiny 0.007-meter telescope wakes up and begins its day of monitoring our nearest star, the Sun. The Lowell Observatory Solar Telescope (LOST) sends sunlight into the EXtreme PREcision Spectrograph (EXPRES), an instrument capable of searching for Earth-sized exoplanets. EXPRES was built by our partner Yale University to search for Earth-sized exoplanets orbiting within the habitable zone of our nearest stellar neighbors.

An exoplanet exerts a gravitational tug on its parent star that instruments like EXPRES measure to infer the presence of an orbiting planet. This method for detecting exoplanets is known as the "radial velocity" method and was used to discover the first-ever exoplanet in 1995. For an Earth-sized planet in the habitable zone of a star like our Sun, the amplitude of that signal is ten centimeters-per-second. EXPRES is one of the first instruments capable of making that incredible measurement.

continued on page 11

Michael West Awarded Fulbright Scholarship

By Kevin Schindler, Historian

"Educational exchange can turn nations into people, contributing as no other form of communication can to the humanizing of international relations."

So wrote the longtime United States Senator from Arkansas, J. William Fulbright. The quote seems especially appropriate in a story about Lowell Observatory Astronomer Dr. Michael West. He is not only a gifted writer, but he is also the recipient of a prestigious scholarship named after Fulbright that will finance West's travels to Finland to share ideas about communicating science.

continued on page 11

DIRECTOR'S UPDATE

By Jeffrey Hall

Take another look at the striking image on the cover. It's a high-resolution spectrum with successive bandpasses stacked one above the other. This is a classic feature of an echelle spectrograph like EXPRES. Another feature of this massive instrument is that we don't have to hang it on the back of a telescope: it sits downstairs with optical fibers feeding it with starlight from LDT and sunlight from LOST. It begins a new era of solar-stellar observations at Lowell.

For 25 years, my colleagues Wes Lockwood, Brian Skiff, and Len Bright have used an identical setup at Lowell's 1.1-meter telescope at Anderson Mesa. The Solar-Stellar Spectrograph (SSS) is, like EXPRES, fed with two optical fibers from the telescope and a solar tracker. The SSS is a valiant beast, but it's 1980s technology and now obsolete. With EXPRES online, SSS will retire.

Before SSS, Wes and Brian performed years of observations of the brightness variations of Sun-like stars, with Brian doing the meticulous work at the old 21-inch telescope near our instrument shop.

Before that program, beginning with work as early as 1950 by lifelong staff member Henry Giclas, several Lowell astronomers searched for decades for solar variability by observing brightness variations in the atmospheres of Uranus and Neptune. EXPRES therefore continues a 70-year observational effort to understand the behavior of our Sun and its stellar siblings. Similar long-term programs are underway at Lowell in other areas of astronomy and planetary science.

Outside the Steele Visitor Center is a sign bearing the old Yogi Berra-ism *You can observe a lot by just watching.* Lowell is singularly well-suited for these sustained programs, and we do them well and with singular persistence. It's incredibly exciting to discover the Universe's hidden patterns. We'll keep it up.

TRUSTEE'S UPDATE

By W. Lowell Putnam

First my best wishes to all of you and my hope that you are well and staying safe. We are indeed, as the Chinese proverb/curse goes, "living in interesting times", and it is challenging to all of us.

All institutions with public programs have been challenged to respond to COVID-19. Lowell Observatory has been fortunate in several ways that point to the uniqueness of this institution:

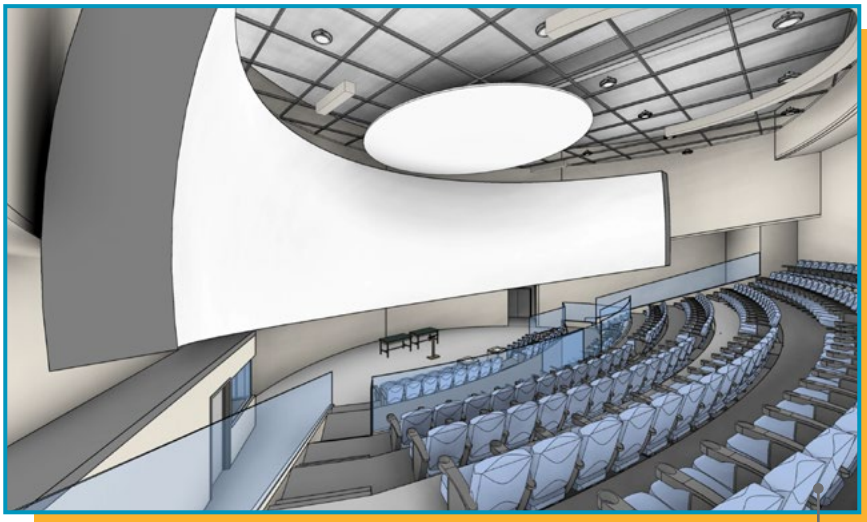
First, we were able to continue our science research with only a limited interruption. Many of our astronomers have a lot of existing data that can be analyzed and re-analyzed. They were able to do this during the period when our own facilities were shut down.

Second, The Trust Under the Will of Percival Lowell (to give it its full name) enabled us to keep all our staff on payroll before we got a PPP loan. The foresight of our founder, his ultimate commitment to this place and the flexibility he gave his successors allowed us to redirect funding very quickly.

Third, the people who work here responded quickly and thoughtfully. With the leadership from Jeff Hall, and a focus on safely continuing our twofold mission, everyone worked very hard to keep this place running well. From our business office team who worked many hours to get our PPP application in quickly, to our technical team who worked out ways to safely operate our telescopes in a pandemic, our public program and marketing folks who pivoted quickly to excellent online programs and now (limited) reopening, our maintenance and grounds crew who improved the campus and made it easier to stay safe, everyone at Lowell focused on ways to keep doing science and talking with the public about what we are learning.

Lastly, our supporters continued to provide critical funding for operations and for our capital projects. Even with challenging economic conditions, support for the observatory remains high, and we are grateful.

This is a special place and my thanks to all for helping us move through this time and keep doing great work.



Architects rendering of the Universe Theater. Credit Johnson Walzer Associates.

Mars Hill Campus Expansion Update

By Dave Sawyer, Technical Project Manager

With the completion of the GODO pedway, the Dyer Telescope upgrades, and the Astronomy Discovery Center (ADC) road preparation work earlier this year, our campus expansion efforts are now focused exclusively on the ADC. Site plans for the ADC are currently in the City review process and are nearing the approval stage. Once those are approved, civil construction plans, which are complete, will be submitted to obtain the permits needed to allow us to break ground. In the meantime, the ADC building plans are moving into the detail design phase with efforts focused on building systems design (e.g. mechanical and electrical), and technology development for the Universe Theater and the Dark Sky Planetarium. We have been working with vendors that specialize in planetarium technology and illumination systems to advance our designs for the theater screens, projection systems, and production equipment to the point where the architectural elements can be finalized.

Kevin Schindler accepts the Viola Award for Community Impact - Organization award.

Lowell Takes Home Viola Awards

By Madison Mooney,
Content Marketing Specialist

The Flagstaff Arts Council's 12th annual Viola Awards were a night to remember, and not just because of the food. Lowell Observatory took home not one, but two Violas: one for Excellence in Placemaking, and another for creating a Community Impact - Organization.

Excellence in Placemaking was awarded to the Giovale Open Deck Observatory (GODO) and accepted by Dave Sawyer, Technical Project Manager. The Community Impact - Organization award was given to Lowell for leadership in the Flagstaff Lunar Legacy 18-month-long event, which marked the 50-year anniversary of the first Apollo Moon landing with a celebration of Flagstaff's role in training the Apollo astronauts. This award was accepted by Kevin Schindler, Lowell historian.

Presenter Andy Garcia, Chair of the City of Flagstaff's Beautification and Public Art Commission (back row left) stands with Team Lowell representatives Dave Sawyer, Jim Cole, Samantha Gorney, and Sarah Burcher with the Viola Award for Excellence in Placemaking.

In addition to helping the Development Department with monthly mailings, volunteer Sherry Nastan was Lowell's first Rotunda Open House greeter. She also assisted with the Native American Astronomy Outreach Program and helped organize and digitize Lowell Discovery Telescope documents.

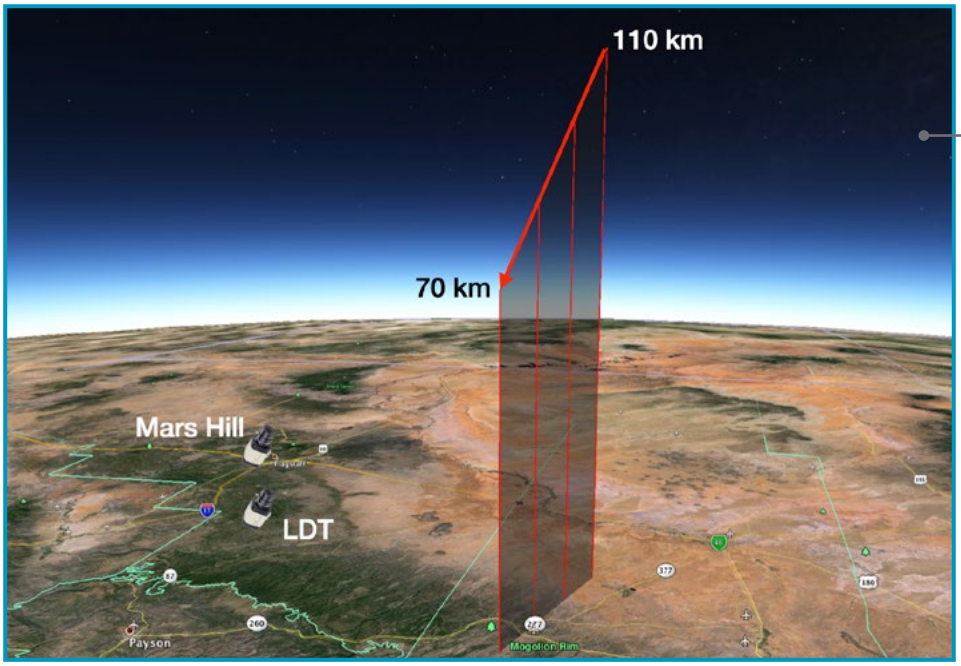
Volunteer Program Hiatus

By Mary DeMuth, Retired Volunteer Coordinator

The Covid-19 pandemic has affected all aspects of work and engagement on Mars Hill. On March 12, Director Jeff Hall announced the suspension of the volunteer program, to coincide with Lowell's temporary closure to the public beginning the following day. Throughout this suspension, the observatory has maintained contact with volunteers and staff with weekly updates from Dr. Hall and an array of online offerings featuring our Public Program, Science, and Marketing and Communications teams. We're looking forward to the day when we can safely reopen, reconvene, and once more enjoy the beautiful Lowell campus and in-person camaraderie with fellow staff, volunteers, and the public!

Become a Catalyst for Astronomical Research

The Slipher Society is several months old and already making a difference! So far, Slipher Society members have funded five Lowell astronomy research projects. With three levels of membership, it's easy to become a part of Lowell's research efforts, gain insider knowledge, and receive rewarding benefits. Learn more at lowell.edu/slipher-society/.



3D trajectory of the Dishchii'bikoh meteor over northern Arizona.

Meteorites Collected from Arizona Fall

By Nick Moskovitz, Astronomer

On the morning of 2 June 2016, residents in the Phoenix area awoke to a spectacular array of tangled clouds that appeared to be contrails from an erratic, high altitude flight. Despite initial media speculation about UFOs, these clouds were in fact the residual dust train from a large meteor, tangled up by high altitude winds. As the morning progressed, firsthand accounts were posted online of an extremely bright meteor that turned night into day, that fragmented as it descended through Earth's atmosphere, and in some locations produced a sonic boom. This collective set of observations suggested that this meteoroid may have been large enough for rocks to have survived to the ground (i.e. meteorites), which motivated my collaborators and me to investigate this event in more detail with data collected at Lowell and elsewhere. Ultimately this analysis led to new insights on the origin of so-called LL chondrite meteorites, which represent a common flavor of Earth-impacting bodies.

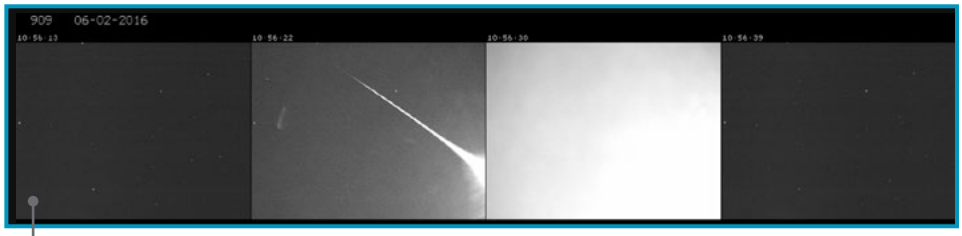
I help to operate a network of video cameras called LO-CAMS (the Lowell Observatory Cameras for All-sky Meteor Surveillance). LO-CAMS is based on a concept originally developed by collaborator Peter Jenniskens from the SETI Institute in Mountain View, California, and employs an array of 16 off-the-shelf security cameras to autonomously record a mosaic view of the night sky at 30 frames per second. Approximately 50 GB of video data are recorded each night, which are processed by software to search for meteors.

In June of 2016 LO-CAMS consisted of two stations, one located on the roof of the Slipher Building on Mars Hill and one connected to the auxiliary building at the Lowell Discovery Telescope. Both stations detected the June 2 event, enabling triangulation of the meteor trajectory. This revealed that the meteoroid impacted Earth's atmosphere at a velocity of about 16 km/s (37,000 mph) and was luminous from an altitude of 107 to 77 km (66 - 48 miles). This trajectory additionally suggested that before impact the meteoroid was on an orbit around the Sun that originated from the inner edge of the main asteroid belt between Mars and Jupiter.

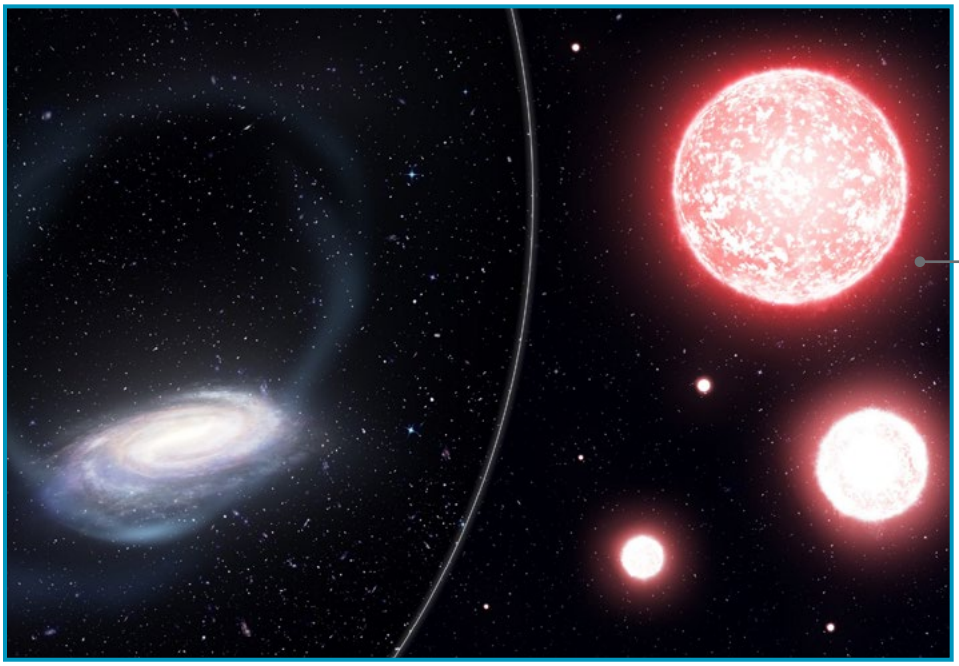
Analysis of these LO-CAMS data as well as additional video from dashboard cameras and publicly available Doppler weather radar data from the National Weather Service (data that are uniquely well suited to detect particles falling through the atmosphere), suggested a likely meteorite fall around 4:00 a.m. near a remote community called Cibecue on the White Mountain Apache Reservation. The prospect of fresh meteorites on the ground initiated discussions with tribal elders to obtain permission for a small group of scientists from Arizona State University to search the possible fall location. After a number of days in difficult search terrain under central Arizona June temperatures, 23 small meteorites were recovered. Based on the suggestion of White Mountain Apache Tribe members, these meteorites have been officially named Dishchii'bikoh Ts'iłsǫǫsé Tsee, which in the Apache language means, "Cibecue Star Stone" (Dishchii'bikoh = Cibecue, Ts'iłsǫǫsé Tsee = star stone).

With meteorites in hand, and numerous observations of the meteor, all pieces were in place to fully characterize this rare event. In a paper recently published in the journal *Meteoritics and Planetary Science*, Jenniskens, Moskovitz and 21 co-authors described these findings with extensive computational and laboratory studies. The Dishchii'bikoh impactor is now believed to have originated from the Flora asteroid family in the Main Belt, the same point of origin of the well-known 20-meter impactor that landed over the city of Chelyabinsk, Russia in February 2013. Both Chelyabinsk and Dishchii'bikoh have been classified as LL-chondrites, a relatively common meteorite type that represent about 10% of all meteorite falls, and are respectively only the third and fourth LL-chondrites to ever be recorded as meteors entering the atmosphere. The impactor itself was likely around 80 cm (3 feet) in size before impact, which makes this a

continued on next page



Time series of still shots before, during, and after the LO-CAMS detection of the Dishchii'bikoh meteor.



Artist's impression of the thin stream of stars torn from the Phoenix globular cluster, wrapping around our Milky Way (left). For the study, the astronomers targeted bright Red Giant stars, to measure the chemical composition of the disrupted Phoenix globular cluster (artist's impression on right). | Credit: James Josephides (Swinburne Astronomy Productions) and the S5 Collaboration.

Strange, Dismembered Star Cluster at Galaxy's Edge

Lowell Press Release

An international team of astronomers, including Lowell Observatory's Dr. Kyler Kuehn, has discovered the remnant of an ancient collection of stars that was torn apart by our own galaxy, the Milky Way, more than two billion years ago. The extraordinary discovery of this shredded 'globular cluster' is surprising, as the stars in this galactic archaeological find have much lower quantities of heavier elements than in other such clusters. The evidence strongly suggests the original structure was the last of its kind, a globular cluster whose birth and life were different from those remaining today.

Our galaxy is home to about 150 globular clusters, each a ball of a million or so stars that orbit in the galaxy's tenuous stellar halo. These globular clusters are old and have witnessed the growth of the Milky Way over billions of years.

The study, published in *Nature*, was led by University of Sydney PhD student, Zhen Wan, and his supervisor, Professor Geraint Lewis, as part of the S5 international collaboration.

Using the Anglo-Australian Telescope in outback New South Wales, this collaboration measured the speeds of a stream of stars in the Phoenix constellation, revealing them to be remnants of a globular cluster that was pulled apart by the gravity of the Milky Way about two billion years ago.

Wan said: "Once we knew which stars belonged to the stream, we measured their abundance of elements heavier than hydrogen and helium; something astronomers refer to as metallicity. We were really surprised to find that the Phoenix Stream has a very low metallicity, making it distinctly different to all of the other globular clusters in the galaxy."

After the Big Bang, only hydrogen and helium existed in any substantial amount in the Universe. These elements formed the first generation of stars many billions of years ago. It is within these and later stellar generations that heavier elements—such as the calcium, oxygen and phosphorous that in part make up bones—were formed.

Observations of other globular clusters have found that their stars are enriched with heavier elements forged in earlier generations of stars. Current formation theories suggest that this dependence on previous stars means that no globular cluster should be found unenriched and that there is a minimum metallicity 'floor' below which no cluster can form. But the metallicity of the Phoenix Stream progenitor sits well below this minimum, posing a significant problem for ideas of globular cluster origins.

Kuehn, one of the founders of the S5 collaboration, remarked, "We can trace the lineage of stars by measuring the different types of chemical elements we detect in them, much like we can trace a person's connection to their ancestors through their DNA. The most interesting thing about the remains of this cluster is that its stars have much lower abundance of these elements than any others we have seen. It's almost like finding someone with DNA that doesn't match any other person, living or dead. That leads to some very interesting questions about the cluster's history that we're missing."

As yet, there is no clear explanation for the origins of the Phoenix Stream progenitor cluster and where it sits in the evolution of galaxies remains unclear. Lewis said: "There is plenty of theoretical work left to do. There are now many new questions for us to explore about how galaxies and globular clusters form, which is incredibly exciting."

METEORITES COLLECTED FROM AZ FALL

continued from previous page

relatively rare event that is only expected to occur for an object of this size once every decade or so over the state of Arizona.

All told the combination of data collected on the Dishchii'bikoh event highlights the power of large integrated data sets that include on-sky observations, public databases, citizen reports, and laboratory analyses. Since 2016 my collaborators and I have deployed additional camera stations at Embry-Riddle Aeronautical University in Prescott, Arizona and Meteor Crater outside of Winslow, Arizona. These, coupled with the recent award of a prestigious National Science Foundation CAREER grant to further expand the LO-CAMS network bodes well for the future of meteor science and meteorite recovery in northern Arizona.

DISPATCHES FROM THE UNIVERSE

A Little Larger Than the Entire Universe

By Michael West, Deputy Director for Science

"We are sealed in our own little melancholy atmospheres, like planets," Jack Kerouac wrote in his diary in 1945.

Kerouac's words provide an apt description of the strange new world we suddenly find ourselves in. Hunkered down in our homes to fend off a global pandemic that has sickened and killed many, we worry about the future and long for the way things were.

It's a stark reminder that our lives are often shaped by things beyond our control.

Albert Einstein understood this. "Everything is determined, the beginning as well as the end, by forces over which we have no control," he wrote. "It is determined for the insect as well as the star. Human beings, vegetables, or cosmic dust, we all dance to a mysterious tune, intoned in the distance by an invisible piper."

Yet even in the face of fear, uncertainty, and grief, the human spirit is remarkably resilient. Despite—or perhaps because of—it all, the world is still a miraculous place.

The Portuguese poet, Fernando Pessoa, said it beautifully:

All of this, inside my heart, is death and the world's sadness.
All of this lives, because it dies, inside my heart.
And my heart is a little larger than the entire universe.

Pessoa died in 1935. His last words, written in pencil one day before his death, were: "I know not what tomorrow will bring."

Nobody knows what tomorrow will bring as the world continues to fight a new microscopic threat unlike any we've seen before. When the night is darkest, it's easy to forget that daylight will surely come again. But as the great naturalist, John Muir, reminded us, "It is always sunrise somewhere."

Deputy Director for Science Michael West

Dr. Jennifer Hanley

Recent Science Grants

Lowell scientists continue to be successful in pursuing grant funding. Two recent examples: Dr. Jennifer Hanley, who was awarded a NASA Solar System Workings (SSW) grant to perform laboratory experiments studying trace chemicals, such as propane and ethylene, in the lakes of Saturn's moon Titan. The grant comes with $667,000 in funds over three years and will support research at Lowell and Northern Arizona University by Hanley, graduate student Anna Engle, Dr. Will Grundy, Dr. Steve Tegler, and Dr. Gerrick Lindberg.

Dr. Joe Llama was awarded two research grants from the National Science Foundation. The proposals, titled EXPRES Search for Low Mass Planets and Observing Exoplanet Atmospheres at High Resolution, will receive $455,000 to fund research projects in collaboration with Dr. Debra Fischer of Yale, Dr. Christopher Johns-Krull at Rice University, and others.

Heidi Larson

By Madison Mooney,
Content Marketing Specialist

Heidi Larson is the Instrument Support Specialist for the Navy Precision Optical Interferometer (NPOI), a highly specialized telescope that represents a collaborative effort between the U.S. Naval Observatory, the Naval Research Laboratory, and Lowell Observatory. Heidi began work at Lowell in the Public Program as an Educator, leading tours and talks around campus. She had just graduated from NAU with a BS in physics and astronomy, and like so many college graduates, she had no idea what her next move would be. Luckily, she had a connection to Lowell through Stephen Levine, who had taught one of her astronomy courses at NAU. Stephen was then the Science Lead at the newly-built Discovery Channel Telescope/DCT (now known as the Lowell Discovery Telescope/LDT), and recommended her for a position as a Telescope Operator.

Nine years later, Heidi is an expert on all things NPOI. She keeps the telescope's complex instruments up and running, maintaining its vacuum and optical systems and troubleshooting any issues that might arise. She keeps things running on the outside of the telescope as well, keeping the grounds clear of snow and weeds.

Of all her contributions to Lowell Observatory, Heidi is most proud of the fact that she was the first official Telescope Operator at the LDT.

Member Spotlight - The Zeigler Family

By Shannon Gonzales, Membership Manager

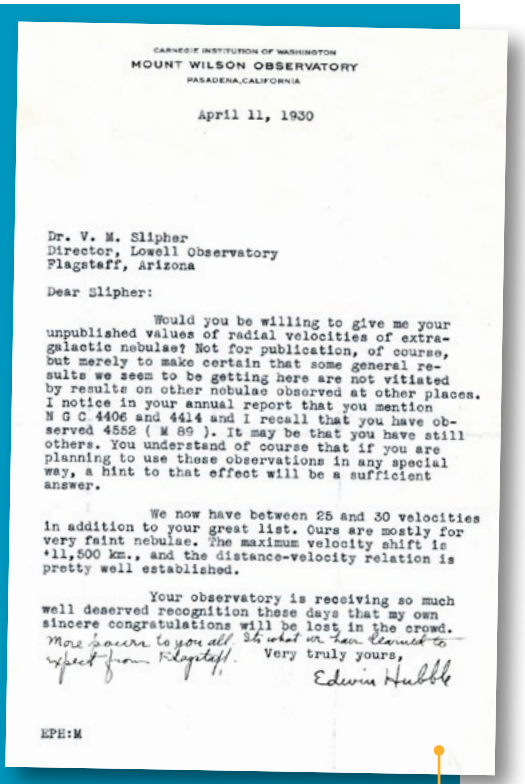
The Zeigler family have been members of Lowell Observatory for six years. Here are some moments that make Lowell Observatory special to the Zeigler family:

"Lowell offers so many unique opportunities for education in the art of astronomy while having fun. Our children, ages seven and 14, love the camps and special events held at Lowell. We have had the opportunity to view sunspots and solar flares in the middle of the day. We have been able to view multiple planets in our solar system through the unique telescopes on the new Giovale Open Deck Observatory. We have been able to listen to beautiful, live music while viewing celestial events through Lowell's telescopes. Our 14-year-old has even been able to operate the McAllister Telescope to show his favorite star cluster, Messier 18, to his family. This has all been possible for our family because of Lowell Observatory. Thank you for bringing science, art, and astronomy to our family."

V.M. Slipher – Edwin Hubble Correspondence

By Lauren Amundson, Librarian/Archivist

The Lowell Observatory Archives collects, preserves, and provides access to records that document the institution's 126-year history. One of our most historically significant collections is a series of letters between Lowell Observatory astronomer Vesto (V.M.) Slipher and Mount Wilson Observatory cosmologist Edwin Hubble. Between 1922 and 1953, they exchanged 50 letters that are now preserved in the observatory's new 8000-square-foot Putnam Collection Center. These letters have been digitized and are available at http://bit.ly/2OBhDpp. Any reproduction of the letters for public use must credit the Lowell Observatory Archives.



CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON OBSERVATORY
PASADENA, CALIFORNIA

April 11, 1930

Dr. V. M. Slipher
Director, Lowell Observatory
Flagstaff, Arizona

Dear Slipher:

Would you be willing to give me your unpublished values of radial velocities of extra-galactic nebulae? Not for publication, of course, but merely to make certain that some general results we seem to be getting here are not vitiated by results on other nebulae observed at other places. I notice in your annual report that you mention N G C 4406 and 4414 and I recall that you have observed 4552 (M 89). It may be that you have still others. You understand of course that if you are planning to use these observations in any special way, a hint to that effect will be a sufficient answer.

We now have between 25 and 30 velocities in addition to your great list. Ours are mostly for very faint nebulae. The maximum velocity shift is +11,500 km., and the distance-velocity relation is pretty well established.

Your observatory is receiving so much well deserved recognition these days that my own sincere congratulations will be lost in the crowd. More power to you all. It's what we have learned to expect from Flagstaff. Very truly yours,

Edwin Hubble

EPH:M

In this April 11, 1930 letter, Edwin Hubble asked V.M. Slipher to share some of his radial velocity data.

Lowell Observatory's Public Program Manager Sarah Burcher (right) shows off the Giovale Open Deck Observatory to SBA's Daniel Nordberg (left) and Michael Vallante.

SBA Visits Flagstaff Businesses

By Kevin Schindler, Historian

The COVID-19 era has put a financial strain on businesses across the country, with company leaders scrambling to come up with funds to cover the cost of operations, including paying employees. One major source of funding for companies—including Lowell Observatory and others in northern Arizona—has been the United States Small Business Administration's (SBA) Payroll Protection Program. On September 9, two SBA officials visited Lowell and other Flagstaff recipients of SBA funding to follow up on the effectiveness and potential future directions of the program.

The Payroll Protection Program provides loans to incentivize businesses to keep their employees on the payroll. If certain requirements are met, these loans may be forgiven. Through more than five million loans, the program has thus far supplied some $500 billion countrywide. More than $100 billion is still available and if Congress approves further spending, that money will be available for additional businesses. Dan Nordberg, SBA's National Director for Rural Affairs, said. "It is not an overstatement to say this is the most consequential economic rescue recovery package that the Congress has ever done."

Mike Vallante is SBA's Associate Administrator for the Office of Field Operations. He joined Nordberg on the Flagstaff tour of businesses. According to a statement they released afterward, more than 11,000 businesses in Arizona alone have received a total of $7 billion, saving some 616,000 jobs. They stated, "These funds were pivotal to local economies, made sure families continued to receive paychecks, and kept hometown businesses afloat."

While in Flagstaff Vallante and Nordberg toured a diverse quartet of businesses, including Lowell Observatory, Aspen Veterinary Clinic, Northland-Rural Therapy Associates, and Proper Meats and Provisions. "In Flagstaff, we were reminded that so much good is happening despite the immense challenges around us," they stated. "People are giving back to the community. Neighbors are helping neighbors. Companies are going the extra mile."

The loans proved critical to supporting business operations. Funding to Lowell Observatory, for instance, provided 11 weeks of payroll for all 116 employees, which enabled the observatory to retain everyone, even part-timers, without a single furlough. And the observatory made the most of this. For example, with the public program closed to the public for regular tours, this meant that educators now had the time to fulfill a longtime goal of developing new virtual programming, which includes interactive presentations and even stargazing and telescope viewing.

Lowell Observatory Director Dr. Jeff Hall said, "This funding allowed us to pivot and diversify our outreach programs in particular in response to the Covid-19 crisis. As a result, these programs will be even stronger and better once we are fully re-opened."

Nordberg explained how the observatory's efforts benefit people far beyond the confines of Mars Hill. He said, "Businesses and organizations like the Lowell Observatory are economic engines for rural communities and often help shape the cultural identity of the towns they serve."

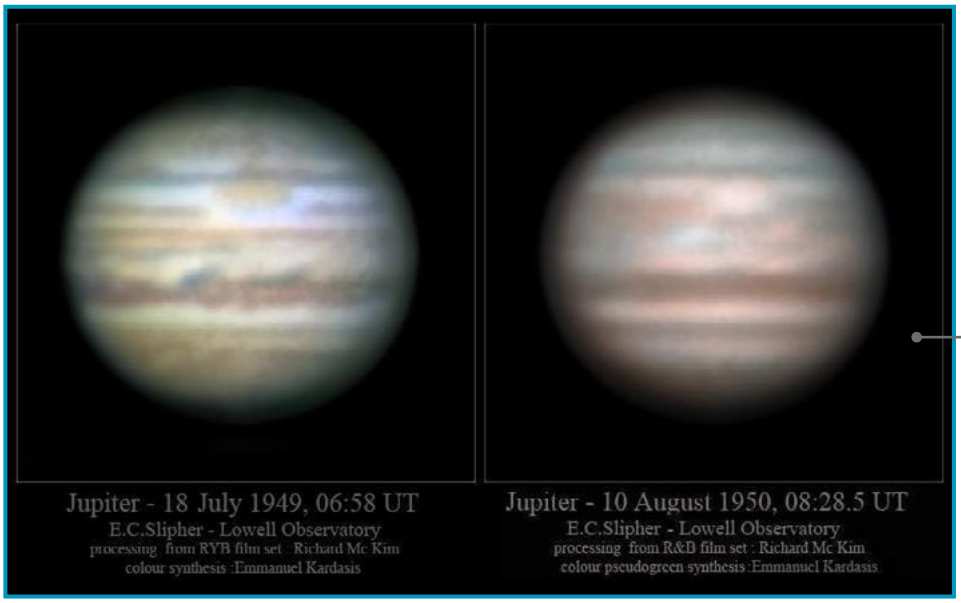
He added, "It was a privilege to visit and hear how the Paycheck Protection Program empowered the observatory to retain their staff and continue providing cutting-edge research and resources for the global science community during this unique time."

The GODO serves as backdrop to the glow-stone-illuminated pathway below and Comet NEOWISE above. Image captured July 18, 2020. | Credit: Jim Cole

Lighting the Way to the GODO

By Samantha Gorney,
Deputy Director for Education

Lowell Observatory's Astronomy Discovery Center, slated to open in 2023, will have several walkways associated with it. Designed to help visitors safely navigate the campus, they will require illumination at night. The lighting plan developed by the master planning team has both pragmatic and playful components. They consist of dark-sky friendly lighting fixtures installed at the required intervals and small, glow-in-the-dark CoreGlow "stones" embedded in the concrete. The concrete pathway at the Giovale Open Deck Observatory (GODO) presented the team with an excellent opportunity to experiment with the stones. Along the length of the GODO pathway, the team incorporated a pattern of glowing rocks designed to resemble a starry night sky. More intricate astronomy-themed designs appear near each entrance to the facility. The result is an almost dreamlike network of walkways, resulting in an even more magical GODO experience.



Synthetic color photos of Jupiter prepared from E.C. Slipher's original negatives. Left, a view from 1949 showing the prominent Great Red Spot (above center) and a yellow color in the equatorial zone; right, 1950 with the white clouds of the 'Hollow' covering the Red Spot. The 1949 image was produced from red, blue, and yellow filter images; the 1950 image was produced from red, blue, and synthetic green images (the latter made from red and blue images). | Credit: Richard McKim and Emmanuel Kardasis.

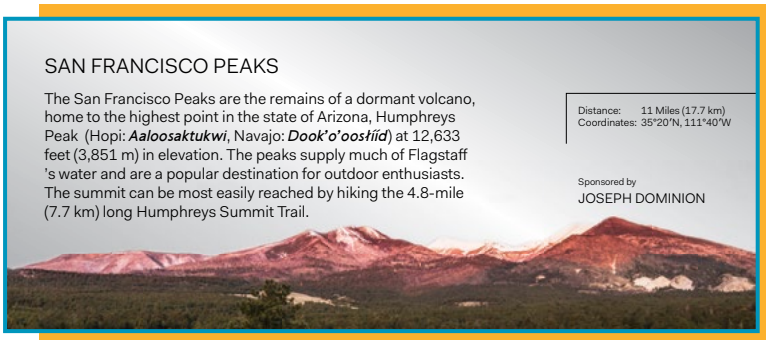
New Planetary Photos from Old Negatives: the Legacy of E.C. Slipher

By Richard McKim, British Astronomical Association

Over five decades Earl C. Slipher obtained tens of thousands of planetary photographs with Lowell's 24-inch Clark refractor. Among those images, some were obtained in moments of excellent definition, and they are the real gems of the collection. Slipher himself published prints of his best work, and realized the value of combining a dozen or so of his sharpest negatives in order to improve the photographic resolution, which in a single image is limited by the size of the silver grains in the photographic emulsion. But in an old fashioned darkroom situation this was always a lengthy and tedious business. Moreover, most of the prints he made were in black and white. Color emulsions were not then fine enough for direct color photography, but by combining negatives taken through red, green, and blue color filters it was possible to make a color print. Again this involved hours of tedious darkroom work, using processes such as the dye transfer technique.

Together with my colleagues Johan Warell and Emmanuel Kardasis, and with the kind cooperation of Lowell Observatory Archivist Lauren Amundson, I have been using modern digital methods for stacking Slipher's best negatives, and combining them electronically to make color images. Had the filter images been taken a few minutes apart, the job would have been fairly easy. But Slipher took several dozen images over a period of about 12 minutes on each photographic plate, and then he had to spend time to change the plate and filter. This means that the planetary features have noticeably rotated between negatives, and any color image made from them would be extremely blurred. The modern electronic solution is to make a map projection of each stacked filter image—like a Mercator map of Earth—and to combine the red, blue, and green 'maps' to cancel out the planet's rotation. The result is then turned back into a planetary image, this time in full color.

I have been working on an analysis of the atmosphere of Jupiter in the years 1949 and '50, when Slipher obtained many images but published almost none of them. The color composites bring out for the first time the lovely colors in Jupiter's atmosphere, as shown in the example from 1949 given here. Some but not all of the belts have a reddish brown color, and the Great Red Spot is obviously orange. The planet's equatorial region is strongly yellowish. These colors were recorded by contemporary visual observers but until today had not been confirmed by the impartial technique of photography. My colleagues and I hope that others will be able to perform similar work on Lowell Observatory's unique treasure trove, and so to put on record Slipher's work in a manner that would have been quite impossible within his lifetime.



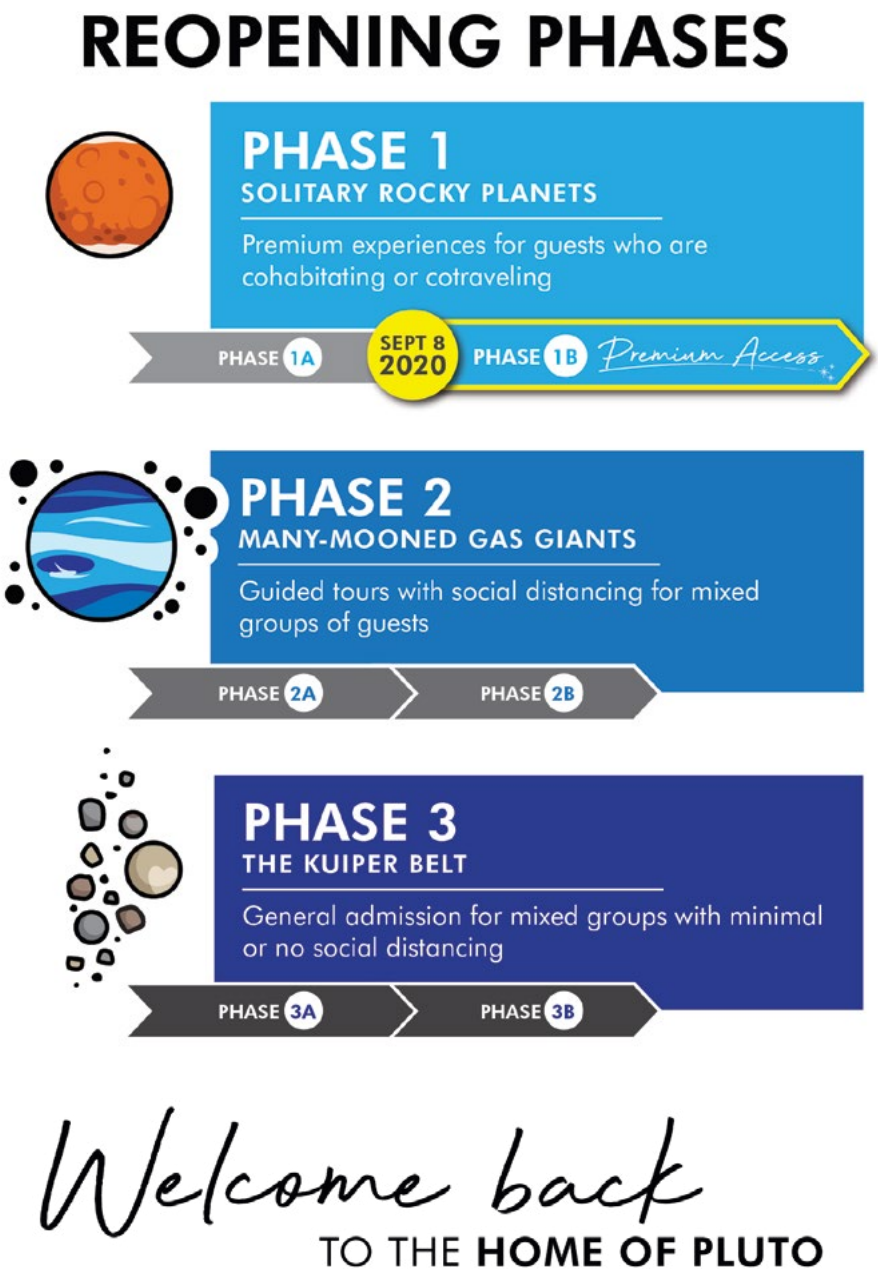
Your donation of $5,000 will sponsor a Horizon Marker and support the ADC. It can be made in multiple payments. Contact Rachel Edelstein at (928) 255-0229 for more information.

Sponsor an Arizona Landmark!

Rooftop "Horizon Markers" point to Arizona landmarks on Lowell's new Astronomy Discovery Center (ADC). Five markers remain. See the list below and claim your horizon marker at: lowell.edu/donate/horizon-markers-for-the-astronomy-discovery-center/

~~Grand Canyon~~
~~San Francisco Peaks~~
~~Mount Elden~~
~~Monument Valley~~
~~Meteor Crater~~
~~Lowell Discovery Telescope~~
~~NPOI/Anderson Mesa~~
Sunset Crater
Wupatki
Canyon de Chelly
Petrified Forest
Walnut Canyon

Markers with a strikethrough are already claimed.



Learn more at lowell.edu/welcomeback

Estate Giving Webinars

On August 21 and 28, the Lowell Development team and Director Dr. Jeff Hall presented two webinars on aspects of giving through estate plans. The first dealt with bequests through wills and trusts, and the second was on using life insurance and retirement accounts to meet philanthropic goals. These webinars were recorded and are now available to all observatory members and to the public on the Lowell Observatory Foundation website. To view them, go to: foundation.lowell.edu.

Supporter Feedback

Compiled by Heather Craig, Marketing Specialist

"That was such a nice Zoom on Wednesday... There's so much to do online if I'm not careful, I could spend hours in front of the screen."

Kori Kody, via email

YouTube Viewer

"This is so cool listening to all the information, I have always enjoyed astronomy."

"This was so wonderful and informative! Thank you Dr. Hall and Dr. Schleicher for putting this together!"

YouTube Viewer

Facebook

"One of my favorite places on planet Earth, can't wait to go back to Lowell Observatory as soon as things are safer for those of us with pre-existing conditions."

Recent Publication

van Belle, Gerard T.; Schaefer, Gail H.; von Braun, Kaspar; Nelan, Edmund P.; **Hartman, Zachary**; Boyajian, Tabetha S.; Lopez-Morales, Mercedes; Ciardi, David R. HST/FGS Trigonometric Parallaxes of M-dwarf Eclipsing Binaries. *Publications of the Astronomical Society of the Pacific*, Volume 132, Issue 1011, id.054201, 21 pp.

See our website lowell.edu/research/recent-publications for more publications

SOLAR TELESCOPE

continued from page 1

However, one main hurdle remains in detecting an Earth-sized planet orbiting in the habitable zone of a star like our Sun. The star itself can induce radial velocity jitter of several meters-per-second, completely drowning the minuscule signal from an orbiting planet. Understanding this jitter has proved extremely challenging since the majority of stellar surfaces cannot be imaged.

That is where LOST offers an exciting solution. The Sun is the only star astronomers can image at high-resolution and at all wavelengths. By feeding sunlight into EXPRES, LOST will observe our Sun just like we monitor other stars at night. By then combining these observations with data from spacecraft that are imaging the surface of the Sun in unprecedented detail, we will revolutionize our ability to characterize the jitter induced from stellar activity.

Beyond the goal of determining the best methods for teasing out the tiny signals from orbiting exoplanets, LOST will continue the quarter-decade effort at Lowell Observatory of measuring the activity of the Sun and Sun-like stars. A better understanding of the full range of behavior exhibited by solar-like stars helps us understand the Sun's likely long-term behavior, lending astrophysical guidance to natural forcing included in terrestrial climate change models. LOST enables us to continue monitoring solar activity into the next solar cycle and beyond.

Adding LOST to the telescope suite means that science observations are happening 24 hours a day at Lowell Observatory. Stay tuned for an update on our search for an Earth twin and other exciting results from Lowell's newest and smallest telescope!

FRONT COVER IMAGE: The first light spectrum of the Sun taken with LOST and EXPRES. The spectrum shows the incredible wavelength grasp and resolution of EXPRES. The dark vertical bands are caused by atoms and molecules in the Sun's atmosphere. | *Credit: Joe Llama*

The Lowell Observatory Solar Telescope is now fully installed next to the Lowell Discovery Telescope and is now routinely observing the Sun. | Credit: Michael Collins

FULBRIGHT SCHOLARSHIP

continued from page 1

West serves as Deputy Director for Science at Lowell and has been a prolific scientist for years. But he is also passionate about communicating science to the public and has accomplished this himself by giving popular lectures, writing inspiring articles for magazines and newspapers, authoring two books, and serving on various professional committees that promote science communication. His career, in fact, traces back to a book written by another science communicator. The book was titled *The Cosmic Connection* and written by none other than Carl Sagan. When West read this volume in high school, he became hooked on astronomy.

The Fulbright Scholarship will support the expansion of West's science communications efforts. He will travel twice to Finland, during which time he will teach courses on Communicating Science with the Public at the University of Turku. The goal is to provide scientists with the tools necessary to become better science communicators.

Each course features eight weekly classes that address different science communication themes, ranging from theoretical aspects such as ethics, cultural connections, and misconceptions, to the nuts and bolts of best writing and speaking (and even photographing and drawing) practices.

West wrote in his Fulbright application, "Communicating science with the public is an increasingly important activity for many scientists, yet few have been trained to do it effectively. In an age of media saturation and information overload, capturing the public's attention requires scientists to think creatively and to embrace new ways of communicating their research to diverse audiences."

West was awarded his Fulbright last December and he originally planned to travel to Finland in 2020 and again in 2021. COVID-19 travel restrictions have forced him to modify this schedule and he now hopes to make both trips in 2021.

When not teaching, West will visit several science facilities to learn current Finnish practices of communicating science. He said, "I'm excited to learn more about Finnish culture and to serve as an ambassador for American culture, embracing the Fulbright spirit of promoting cross-cultural understanding."

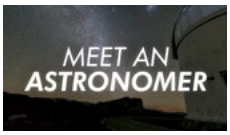
West will supplement his classroom information with lessons learned on these site visits to create a guide to communicating science, which will be a free guide for anyone who wants to use it. West himself will use this to train colleagues at Lowell and will incorporate many of the lessons learned into helping design Lowell's new Astronomy Discovery Center, set to open in 2023.

Lowell Observatory Director Jeff Hall said, "A Fulbright award is a truly prestigious honor, and it's indicative of Michael's stature as a scholar that he received one. This will be a great opportunity for him to expand his work in science communication, and I look forward to seeing the outcome of his work in Finland."

The Fulbright Program is a United States-based, international exchange effort that involves more than 160 countries around the world. It promotes collaboration and goodwill among scholars. Senator J. William Fulbright wrote that the mission of the Fulbright Program is "To bring a little more knowledge, a little more reason, and a little more compassion into world affairs and thereby increase the chance that nations will learn at last to live in peace and friendship." Based on legislation introduced by Fulbright, the program was established in 1946 and, according to its website, awards approximately 8,000 grants per year to scientists, university instructors and administrators, journalists, artists, and others.

FRONT COVER IMAGE: Michael West plans to spend part of 2021 in Finland for his Fulbright Scholarship.

As part of Lowell Observatory's efforts to stay connected and continue our mission of science education, we are providing video resources that include live streams, kids activities, observing tips, educational series, and much more. Visit **lowell.edu/youtube** for our latest videos.

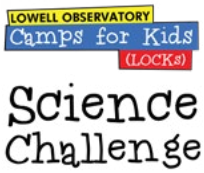


Meet an Astronomer

Meet some of Lowell's astronomers, and the occasional guest astronomer, and hear about their research.

Cosmic Coffee

Explores a different topic in astronomy or planetary science each week.



LOCKs Science Challenges for Kids

Keep kids engaged with STEM with these at-home science challenges. Find them on the LOCKs facebook page: facebook.com/orbitsscience

Interactive Stargazing

Join Lowell Observatory educators at the Giovale Open Deck Observatory for a guided, interactive observing session. Weather-dependent; see YouTube for dates and times.

Mars Hill Almanac

Tune in to see what is happening in the night sky over the next month.

Sagas In The Sky

Explores some of the stories behind the stars in the night sky.

Find us on Social Media!

Facebook.com/LowellObservatory

Twitter: @LowellObs | Instagram: @LowellObservatory

YouTube: lowell.edu/youtube

lowell.edu

LOWELL OBSERVATORY
125 YEARS | 1894 - 2019

The Lowell Observer is published quarterly by
Lowell Observatory, 1400 W Mars Hill Road, Flagstaff, AZ 86001
For comments about the newsletter, contact
Historian Kevin Schindler: kevin@lowell.edu | 928.233.3210
Layout and Design by Sarah Gilbert

FLAGSTAFF ARTS COUNCIL

BBB REVENUES CITY of FLAGSTAFF

Eco-friendly printing by aps