THE LOWELL OBSERVER

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Lowell Observatory Breaks Ground on Astronomy Discovery Center

Kemper and Ethel Marley Foundation Astronomy Discovery Center Set to Open in 2024

by Kevin Schindler, Historian

Lowell Observatory's vision for its education program is bold and simple: to be the premier public astronomy destination in the world. The observatory took a critical step toward achieving that goal on June 26 by breaking ground on a new 40,000-square-foot, $37.5-million discovery center. The Kemper and Ethel Marley Foundation Astronomy Discovery Center (ADC) will be six times the size of Lowell's current visitor facility and will accommodate greatly increased annual attendance to Lowell's outreach programs.

A few raindrops didn't dampen the enthusiasm of the speakers or onlookers. The 60-minute ceremony included remarks by Flagstaff Mayor Paul Deasy, Coconino County Supervisor Jeronimo Vasquez, and Arizona State Senator Wendy Rogers, followed by a ceremonial sod-turning.

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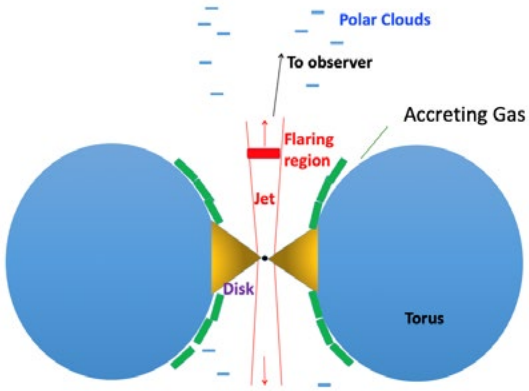

Variability of Emission Lines in Gamma-ray Bright Quasars

By Dr. Svetlana Jorstad, Melissa Hallum, & Dr. Alan Marscher (Boston University)

Blazars—the extraordinarily luminous centers of galaxies where super-massive black holes (BH) are accreting solar masses of gas each year – present astrophysicists with a number of mysteries. One of these is how they radiate gamma rays – the most energetic form of light – at a level higher than any other phenomenon in the universe. Observations with the Lowell Discovery Telescope (LDT) of light at specific wavelengths (emission lines) are helping to understand how blazars produce so many gamma rays.

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DIRECTOR'S UPDATE

On the front page of this issue of the *Observer*, you can see several Lowell staff, generous supporters, and elected officials with the obligatory golden shovels, celebrating groundbreaking of the Astronomy Discovery Center.

In the recent picture below, taken just a few months later, you can see an enormous hole. At the groundbreaking, we were standing roughly where the heavy equipment is, and in short order, our contractor has almost completed the excavation of the ADC's footprint. Soon, we expect the foundation will be in place, and then our wonderful new facility will start to be assembled.

It's been incredibly exciting this summer to see this milestone reached. It is the result of five years of intense discussion, planning, and fundraising. And now, in just another two and a half years, we will be ready to open the doors of what we intend to be the finest public astronomy experience in the world.

I was surprised at how impactful the groundbreaking was for me personally. It's one thing to hold discussions about programming and exhibits and to draw diagrams of buildings and their components. It's another level of reality to see earth being moved and to realize the vision of the past several years is, actually, for real, going to happen.

We are excited to keep sharing with you the progress over the next few years, and I hope that someday, everyone near and far will be able to visit Mars Hill and see what our outstanding team has accomplished. Onward we go!

TRUSTEE'S UPDATE

Mars Hill continues to be a very "happening" place. :) There is a tremendous amount of construction going on the new Kemper and Ethel Marley Astronomy Discovery Center, our research astronomers and their partners are continuing to do tremendous work and our visitor program is working its way back towards being full open. It is good to see more people touring the campus and enjoying their time with our public program guides. This issue of the *Observer* shows all aspects of the Lowell "family" at work: astronomers, staff you normally do not see like Anne LaBruzzo, volunteers, and donors. All of these people help make Lowell a wonderful institution and a great place to work at and visit.

My thanks to all of them and to all of you who help make all this work possible.

Estate Giving

Lowell Observatory and the Lowell Observatory Foundation gratefully accept many types of estate gifts. For more information, please contact Stephen Riggs at 928.255.0186 or sriggs@lowell.edu.

ADC Update *by Dave Sawyer, Technical Project Manager*

In June 2021, the Site Plan for the Astronomy Discovery Center (ADC) was formally approved by the City of Flagstaff and a conditional use permit was granted, which cleared the way for civil construction to begin. The 7-acre site for the ADC was cleared during July and blasting for the building foundation began in August. The blasting operation, which involves drilling a 5x5 foot grid of about 100 holes, filling them with charge, and detonated, is repeated about twice a week. This process continued into October as the team advanced north up the slope behind the Putnam Collection Center. Excavation of the ADC building pad proceeded behind the blasting team to remove many thousands of cubic yards of rock material from the site. Trucking of the material doesn't have to go far as it will be used to create the grades needed for the new ADC parking area.

Excavation of the ADC building pad.

60 SEC ASK AN ASTRONOMER

The Difference Between Occultations, Eclipses, and Transits

by Larry Wasserman, Astronomer

A transit occurs when a small body passes in front of a larger body. The transiting body then appears as a small circle moving across the larger disk of the bigger body. Transits of the larger satellites of Jupiter across the disk of Jupiter occur every few days and are often observed by amateur astronomers. Transits of Mercury or Venus across the disk of the Sun are much more infrequent.

An eclipse occurs when a body passes into the shadow of another body. Well-known eclipses are those of the Moon when it enters the Earth's shadow. The larger satellites of Jupiter also pass into the shadow of Jupiter. These events can easily be observed from the Earth with a small telescope.

An occultation is a bit like a reversed transit. Here the larger body passes over the smaller one so that the smaller body completely disappears for a short time. In most cases, the smaller body is a star and the occulting body can be any object in the solar system. Since a star is effectively a point source, it casts a shadow of the occulting body which is exactly the same size as the occulting body. This can be used to measure the size of the occulter, often an object which is too small to show a measurable disk in even a large telescope. An occultation is the only way astronomers have to accurately measure the sizes of small, distant objects.

It is worth noting that an "Eclipse of the Sun" is technically not an eclipse at all. It is an occultation of the Sun by the Moon as the Moon completely covers up the Sun. •

Recent Publications

Cigan, P., Young, L., Gomez, H., Madden, S., De Vis, P., **Hunter, D.**, Elmegreen, B., Brinks, E., LITTLE THINGS Team, 2021, AJ, 162, 83, Herschel Photometric Observations of LITTLE THINGS Dwarf Galaxies.

Dr. Stephen Levine has created a listing of research utilizing the 4.3-meter Lowell Discovery Telescope. It is based on the Astrophysics Data System (ADS) and is updated regularly. See http://www2.lowell. edu/users/tac/bio/dct_ref_pubs_etal.html.

Levine has also put together a list of work by Lowell Observatory staff: http://www2.lowell.edu/users/tac/bio/LowellObs_staff_pubs_2016topresent_art_a$

Joe Llama and Team Recognized

Dr. Joe Llama and his LOST EXPRES team of undergraduate researchers were awarded the People's Choice Award for the College of Engineering, Informatics, and Applied Sciences at Northern Arizona University's 2021 Virtual Undergraduate Symposium. The team's presentation, "Web Application for Lowell Observatory's Solar Telescope," described their work developing a web interface to access the solar telescope data. Other team members include Austin Bacon, Brooke Caldwell, Jared Cox, Ian McIlrath, and Olivia Thoney.

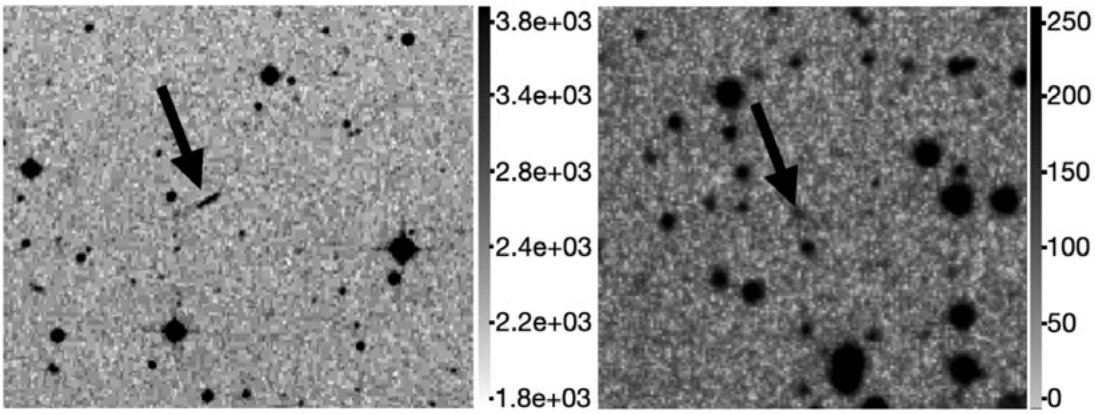
Lowell OBSERVATORY

New Website, Updated Logo Unveiled

During the Advisory Board meeting in June, Dr. Danielle Adams introduced Lowell Observatory's updated logo and new website. Sarah Gilbert created the logo, which is a modernized version of the previous one that features Percival Lowell viewing through the 24-inch Clark Refractor. Miriam Roberts served as project manager in creating the new website, which was financed by an annuity gift by the late Don Trantow, longtime Advisory Board member and observatory supporter. An important feature of the website is an accessibility menu, which makes the site more accessible for the visually impaired. Users can access the menu by clicking on the icon shown here, which appears on all new website pages.

DIGITIZING THE LOWELL PLATE COLLECTION

by Dr. Stephen Levine, Astronomer and Lauren Amundson, Librarian/Archivist



Asteroid Gault on photographic plates from 1984 (left) and 1958 (right); these are 4 and 30 years before the formal discovery of Gault. From Devogèle et al. 2021, MNRAS 505, 245.

For much of human history, astronomical observations were done visually.

The advent of photographic techniques in the late 1800s fundamentally changed the nature of recorded astronomical observations. The photograph could be preserved as a direct record of the observation that could be re-visited at a later date. Access to digital imaging technology starting in the 1980s similarly revolutionized astronomical observing. Digital data can be made easily available over the internet. Photographic data needs to be digitized to be widely accessible; without access there is virtually no use.

Lowell Observatory is home to a collection of more than 50,000 glass plate and film negative images of the sky. The oldest of these astronomical images date back almost to the founding of the observatory and the most recent were taken almost a hundred years later, near the end of the twentieth century. These images are a scientific and historical trove still waiting to be made fully accessible and usable by the broader communities. There are estimated to be more than seven million astronomical photographic plates worldwide; only a modest fraction of those have been digitized and the rest are de-facto unusable.

Astronomical photographs provide a unique window into the local universe, often including pre-discovery observations of solar system bodies.

Astronomical photographs provide a unique window into the local universe, often including pre-discovery observations of solar system bodies. They show us how things were since the advent of the photograph, extending our records 60 to 100 years beyond those of digital imaging in astronomy, which came into widespread use starting about 40 years ago.

More than 700 plates taken at Lowell between 1930 and 1951 were digitized by a team led by Marc Buie as part of a program to help improve the accuracy with which we know the orbit of Pluto in advance of the New Horizons spacecraft encounter with Pluto. Recent work by Maxime Devogèle and his team studied the orbit of the asteroid (6478) Gault, which was discovered in 1988. Searching older, archival plates, they found two earlier images on digitized sky survey plates of Gault, one from 1984 and one from 1958. The latter image extended the known measurements of Gault's orbit by 1.7 times and enabled them to test whether Gault's orbit has been modified by non-gravitational effects.

Deep, wide-field plates can often have over 100,000 detectable and measurable objects. That, coupled with decades of imaging provides opportunities in long term monitoring of celestial objects. Studies of the Luminous Blue Variable star Var C in M33 in Andromeda were greatly aided by photographic data. Without the significant extension in time made possible by the photographic measurements, the almost 40-year period of variation would not be recognizable. In addition to the science uses, markings on plates made by past observers can tell us about how science was done, and what the observers were looking for.

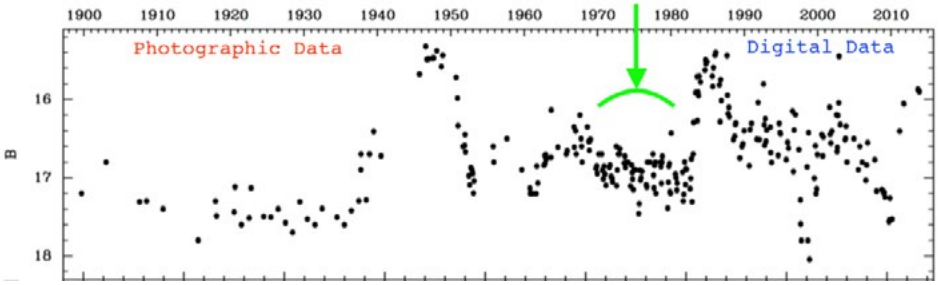
There is urgency to efforts to digitize photographic collections. The originals were fragile to begin with and are degrading with time. The glass is often only 1/16 of an inch thick (or less), even for plates up to 14 inches on a side. The emulsions that hold the actual image are susceptible to damage from moisture, mold, and peeling off the glass. Often, plates were stored in envelopes that left deposits on the plates. Lowell staff have already started the work to re-envelope plates into more stable and safer, long-term storage envelopes. The associated logs were often on acidic paper that is now degrading and may not have been stored with the photographs, possibly losing important information about the

images, reducing the usability of these data. Finally, knowledge and experience handling and working with photographic plates is becoming rarer.

We have begun a long-term program to digitize the Lowell plate collection using commercial flatbed scanners. Flatbed scanner and digital camera technology is relatively mature and capable of recording all or most of the data resident in the plates. This features spatial resolution of five to ten microns with 12 to 15 bits of photometric depth in transmission. Critically, we now have dense and precise enough stellar reference catalogs from the Gaia project so we will be able to calibrate the systematic motion and illumination deviations in the scanners themselves. Our plan is that over the next three to six years, we will digitize the plates, their envelopes and the associated log books. The digital data will then be made available over the World Wide Web.

With the completion of the Putnam Collection Center (PCC), Lowell now has the benefit of a recently finished archival storage facility. The digitizing process will include moving the plates to their new permanent home in the PCC, helping to ensure the long term survival of the original plates and at the same time make these data widely available to everyone. •

Dr. Stephen Levine stands in the plate vault next to the camera and scanner that will be used to digitize the plates.



Monthly averaged brightness measurements for Var C. The green arrow and arc indicate the rough time of transition between photographic data and digital imaging data. From Burggraf et al. 2015, A & A, 581, A12.

Percival Lowell Trust & Lowell Observatory Foundation: Lowell's Two Support Organizations

By Lisa Actor, Deputy Director for Development

When Percival Lowell died, in 1916, he left the majority of his assets in a trust to support Lowell Observatory. The Percival Lowell Trust, governed by a sole trustee, has endured over one hundred years of ups and downs in the stock market, a world war and, most recently, the Great Recession. In 2008, the Trust was not only the largest donor to the building of the Lowell Discovery Telescope, but also served as collateral for the loan that completed it. In 2020, the Trust allowed us to keep all the observatory staff employed through the COVID-19 pandemic. Thank goodness the Trust's corpus can be expended when and where it is critically needed.

For its first 102 years, the Percival Lowell Trust could not receive contributions. That changed in 2018 when the IRS granted the Trust nonprofit status as a 501(c)(3) support organization for Lowell Observatory.

By then, Lowell Observatory had already established a 501(c)(3) support organization. The Lowell Observatory Foundation was created in 2014 by a small group of supporters who felt the observatory would benefit by having a support organization, governed by a board of trustees, to manage Lowell Observatory's permanent endowments. The majority of the foundation's assets are restricted with only a portion–currently 4%–of the corpus expended to benefit Lowell Observatory each year.

Why does Lowell Observatory need two support organizations and how are they different?

The Percival Lowell Trust is managed by a sole trustee and can be used to address any need of the observatory. The Lowell Observatory Foundation is managed by a governing board of nine trustees. Except for a small percentage of its funds, the foundation's assets are permanently restricted. (For more details, go to **foundation.lowell.edu**.)

The two support organizations create the perfect formula for the long-term financial health of Lowell Observatory.

DISPATCHES FROM THE UNIVERSE

THE MILKY WAY IN TEN NUMBERS

by Dr. Michael West, Astronomer

1962: The year Robert Frost published his poem "The Milky Way is a Cowpath." Many different names and mythologies have been given to the Milky Way by cultures around the world. These include "The Birds' Path," "The River of Heaven," and "The Road to Santiago."

80: The percentage of Americans today who can't see the Milky Way where they live because of light pollution.

1610: The year that Galileo Galilei, the great Italian scientist, pointed his telescope at the Milky Way and discovered that this fuzzy band of light is actually made of "innumerable stars."

4 billion: The number of years remaining before the Milky Way collides with its neighbor, the Andromeda galaxy. The two will merge under gravity's pull to become a single, larger galaxy that astronomers have already named Milkomeda.

20: The number of trips the Sun and planets have made around the Milky Way since their birth.

1923: The year Edwin Hubble showed that the Milky Way is just one of countless galaxies scattered throughout the universe. Coincidentally, Milky Way candy bars were created that same year; however, they're named for milkshakes rather than any astronomical connection.

0.001: The fraction of its current orbit around the Milky Way that our solar system has completed since the first *Homo sapiens* appeared on Earth.

1934: The year *Milky Way Railroad* was published. Kenji Miyazawa's short novel tells the story of a lonely boy who suddenly finds himself traveling across our galaxy aboard a magical train. Like Antoine de Saint-Exupery's *The Little Prince*, Miyazawa's tale is filled with wisdom for young and old alike. It has become a beloved classic of Japanese children's literature.

200 billion: The estimated number of stars in the Milky Way Galaxy. Coincidentally, it's also the net worth of Amazon founder Jeff Bezos in dollars.

0: The number of stars you can see at night with the unaided eye that aren't part of our Milky Way Galaxy. For every Milky Way star you can see, there are 30 million others that you can't because they're too faint, too far away, or hidden by cosmic dust. •

The Clark Refractor Turns 125

by Kevin Schindler, Historian

Percival Lowell first peered through the Clark Telescope in July 1896. One hundred twenty-five years later, it stands as one of the world's most storied telescopes. Percival Lowell commissioned it as his main tool for exploring Mars, VM Slipher used it in combination with a spectrograph to detect the expanding universe, and artists working with scientists mapped the Moon in support of the Apollo program in the 1960s. It has also been featured in educational television programming from the 1950s to the present. To celebrate the telescope and its heritage of research, Lowell has been offering monthly livestream programs. These may be viewed for free on the observatory's YouTube page.

24" CLARK REFRACTOR
AT LOWELL OBSERVATORY
1896 125 2021
YEARS

Logo created by Sarah Gilbert

The Dyer Telescope

by Kevin Schindler, Historian

The newest addition to Lowell's stable of public telescopes is the 24-inch Dyer Telescope. It is located in a retrofitted dome that sits about 50 yards to the south of the historic Clark Refractor dome. This structure was previously known as the McAllister Dome, named in honor of John Vickers McAllister—husband of longtime Flagstaff philanthropist Frances McAllister. It was built in 1996 to house a 16-inch telescope previously operated at Northwestern University. That telescope became nearly inoperable and Lowell decided the time had come to replace it.

Public Program Manager Sarah Burcher and Senior Public Program Educator Jim Cole inside the Brian Dyer Dome.

While the structure has been renamed the Brian Dyer Dome, as suggested by its donors to memorialize their friend and businessman Brian Dyer, who unexpectedly died in 2011, the area around the dome continues to honor the McAllister heritage with the name "John Vickers McAllister Public Observing Plaza".

For those with a technical bent, the Dyer Telescope is a PlaneWave CDK24a—a 24-inch (0.61-meter) f/6.5 Corrected Dall-Kirkham astrograph. It covers a 70-millimeter field of view without any field curvature, off-axis coma, or astigmatism. This means guests will enjoy pinpoint focus from the center to the edge of the field of view. The 24-inch aperture matches that of the historic Clark Refractor, though the design of the Dyer results in a much shorter telescope. •

STAFF PROFILE

Anne LaBruzzo

by Madison Mooney, Content Marketing Specialist

In March 2020, Lowell paused its public programming in order to deter the spread of COVID-19. With this decision came a wave of uncertainty about the future of the observatory and its employees. The next month, however, the U.S. government announced the creation of the Paycheck Protection Program (PPP). Financial aid would be provided to qualifying small businesses in the form of a loan, incentivizing them to keep employees on payroll. Though the application process was complicated, requirements were strict, demand was high, and only 20% of applicants would be approved, Deputy Director for Administration Anne LaBruzzo rose to the challenge.

Anne has worked at Lowell for six years, joining the team in June of 2015. She oversees the observatory's business office, where vital operations like human resources, payroll, budgets, and more are carried out. Working closely with Tim Dodt, senior director for commercial banking for a local Alliance Bank, Anne secured not one, but two PPP loans for the observatory, as well as complete loan forgiveness for both. She and Tim communicated daily, going over the loan's requirements and application process. The funds received were much larger than the average PPP loan, allowing Lowell to keep all of its employees, both full-time and part-time, on staff. Though Anne led the charge in securing the loans, she says it couldn't have been done without the support of the entire business office team. Each member played a role in the application process, gathering information and filling out paperwork. This, Anne says, is her favorite part of working at Lowell: everyone is willing to work as a team, not just within their department, but for the good of the observatory overall.

The Kemper and Ethel Marley Foundation is the lead sponsor of the ADC, and Trustee Nancy Ball spoke about how her colleagues' love of astronomy drove the organization's support of the project. She added, "This project will inspire and educate people of all ages, for generations to come, on the beauty and wonder of astronomy."

Mayor Deasy said, "Lowell Observatory embodies the soul of Flagstaff. Flagstaff is STEM City. Flagstaff is the world's first dark skies city. Flagstaff is a pillar of education in the state."

Lowell Observatory Technical Project Manager Dave Sawyer explains features of the Kemper & Ethel Marley Foundation Astronomy Discovery Center.

Key Features of the ADC

The Universe Theater is an immersive, interactive experience where live presenters will lead guests on a journey through space against the backdrop of a two-story, 165-degree main screen and 30-foot overhead screen.

The Dark Sky Planetarium is located on top of the three-floor ADC and will use Flagstaff's famously dark skies as a natural dome. Coconino County Supervisor Jeronimo Vasquez addressed the importance of dark skies, saying, "Coconino County is committed to dark skies and we want to see future generations to also be able to enjoy the skyline the way we do and the stars the way we do."

> **"This project will inspire and educate people of all ages, for generations to come, on the beauty and wonder of astronomy."**

The Curiosity Zone is an exhibit hall designed specifically for children to encourage their natural curiosity about science and math with hands-on experiments such as a rocket-launching station.

The Diverse Universe Exhibit is designed to inspire children to see themselves as future scientists by showing the human side of scientists from around the world–their unique life stories, challenges they have overcome, and more. Just as no two planets, stars or galaxies are alike, neither are the people who study them.

W. L. Gore & Associates is the sponsor of the Diverse Universe Wall. "Sponsorship of the Diverse Universe Wall dovetails nicely with Gore's STEM community focus in Flagstaff, as well as our focus on diversity, equity, and inclusion. We believe diverse views, ideas, and people help strengthen our Enterprise and our ability to innovate and improve lives across the globe," said Jana Kettering, Gore Northern Arizona Community Relations Leader.

In speaking about the importance of the ADC to northern Arizona, Lowell Observatory Director Jeff Hall said, "The ADC will be a huge leap forward in our ability to inspire young and old alike about science and astronomy, and we hope it will be an outstanding resource for Flagstaff and northern Arizona residents as well as the many visitors to our region." •

Front cover image: Turning the ceremonial first spade of dirt are (left to right): Jim McCarthy, Michael Beckage, Jeronimo Vasquez, Wendy Rogers, Jeff Hall, Bill Ahearn, Susan Ahearn, Samantha Gorney, John Giovale, Ginger Giovale, Jamie Coffaro, Nancy Ball, Jeff Zemer, Austin Aslan.

Supporter Feedback

Compiled by Heather Craig, Marketing Specialist

Google Review

An amazing experience. People were friendly and, obviously, our guide was incredibly knowledgeable. If you can, get the VIP experience. Well worth it for the once-in-a-lifetime opportunity.

I was impressed that we were looking through the eyepiece and not at a projection on a screen–great to actually see through the telescope. It was thoroughly enjoyable and we highly recommend it if you are in the area.

Trip Advisor

Steele Visitor Center Comment Box

The tour was spectacular. We were so happy to be back at Lowell, and this was the first time I've seen [the] GODO and the original Lowell telescope. The tour was small–just my family and one other family from Minnesota. Kudos for finding a way to put on these small programs to open the doors to your fans.

MEET MIKE BECKAGE

by Bruce Kosaveach, Philanthropy Manager

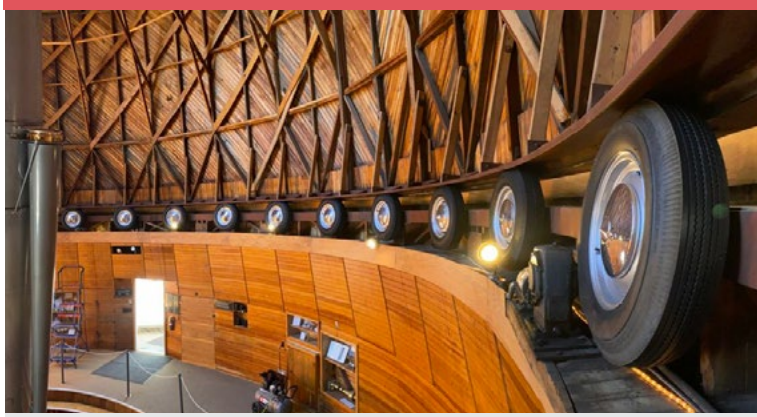
Mike Beckage caught the astronomy bug at age 11 after viewing the moon through a neighbor's telescope. Today Mike organizes star parties and science events for local schools, nature centers, and scout groups. He coordinates monthly "Astronomy Nights" in his hometown of Seal Beach, California.

Mike Beckage readies for a viewing session.

Mike is an electrical engineer and always has had a passion for science and astronomy. In 1990 he co-founded Diversified Technical Systems, Inc., an international electronics and software business headquartered in Seal Beach. DTS provides high-tech sensors and data recording solutions to automobile, aircraft, and spacecraft companies around the globe.

He has built five telescopes and enjoys sharing his love of astronomy with the community and amateur astronomy clubs in southern California. Mike is proud to call Lowell Observatory his "second home" because its mission of research and outreach aligns with his passion for educating the public. He has also helped promote Lowell Observatory by sponsoring two "Astrochat" dinners in southern California featuring Lowell astronomers as speakers.

Mike and his wife Bridget have supported Lowell Observatory for over 21 years. He feels honored to serve on the Advisory Board and to have served on the Board of Trustees for the Lowell Observatory Foundation. Additionally, he has chaired the Advisory Board Executive Committee and been a member of the Technology Committee for over six years. Mike's focus in life is "....doing whatever I can to help feed the hunger for knowledge that is so core to our nation's success". •



Clark Dome Gets New Set of Tires

by Kevin Schindler, Historian

One of the critical—and charming—aspects of the 24-inch Clark Refractor dome is the set of 24 automobile tires on which is rotates. Installed in 1960, this system has served well, save for the occasional tire blowout that halted observing until it could be changed. These generally don't happen anymore, as staff regularly care for and change tires as needed. Earlier this year, for instance, Technical Facilities Manager Jeff Gehring led an effort to replace most of the tires before they wore down anymore. A team from Southern Tire Mart's Flagstaff location brought tire-changing equipment to the observatory and in no time the Clark had a new set of wheels.

MARK YOUR CALENDAR

2024 Eclipse

Where were you for the total solar eclipse on the morning of August 17, 2017? Where will you be for the April 8, 2024 total solar eclipse?

Lowell Observatory is planning a special event somewhere on the center line in 2024. Mark your calendar now to join us. Stay tuned for more information in upcoming issues of *The Lowell Observer*.

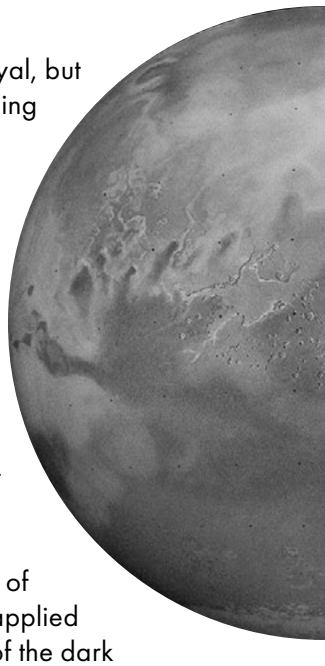
Longtime Lowell supporter Art Storbo operates a telescope at the observatory's 2017 total solar eclipse event in Madras, Oregon.

MARINER MARS GLOBE

by Don Davis, Space Artist

Don Davis with the Mariner Mars Globe.

In 1971, the Moon was being visited and Mars was revealing its secrets. I had done various exotic graphic 'odd jobs' at the U.S. Geological Survey Branch of Astrogeologic Studies in Menlo Park, California. Jack McCauley, then 'Astrogeology' Branch Chief, was enthusiastic about making a globe summarizing the Mariner 4, 6, and 7 photo data and ordered a couple 16-inch chalkboard globes for me to paint on. I was to paint a summary of Mars with the 'classical' albedo markings still prominent in the portrayal, but with the topography emerging in limited rows of close-up images. In the Summer of 1971 I was transferred to the 'Astro' main branch in Flagstaff to work on this Mariner Mars globe and to learn airbrush mapping methods.



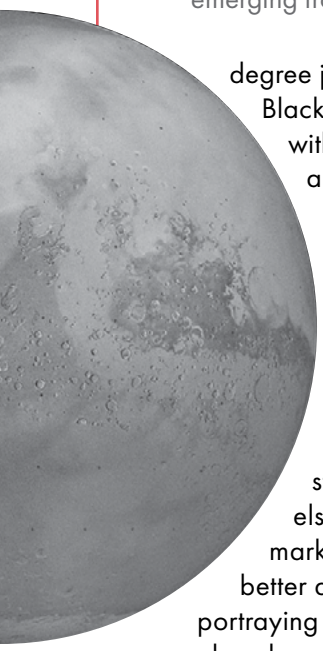
The Mariner Mars globe used similar methods to flat oil paintings on a gessoed masonite board, except on a sphere. Numerous layers of brilliant white gesso were applied and sanded down on top of the dark green original surface. I then carefully marked latitude and longitude '+' marks at the 10

Unearthing a Treasure

by Kevin Schindler, Historian

In 2013, I received a call from Carol Breed-McCauley, widow of longtime USGS geologist Jack McCauley. Carol was cleaning out her garage and found a metal globe among shelves of old science books and other artifacts. She called her friend and former colleague of Jack's, Jerry Schaber, to see if he could help identify it. They concluded it depicted Mars, but exactly when was it created, and by whom, was a mystery. Jerry thought Lowell might like the globe and suggested Carol call me. I immediately drove to Carol's and found her and Jerry with the beautiful black-and-white, 16-inch sphere. We examined it together in the dim light of the garage and didn't find any obvious identifying markers. After listening to them share some old stories, I gratefully took the treasure back to the observatory. With better lighting, I discovered a notation in tiny writing that revealed the globe's creator: space artist Don Davis. I tracked down Don through the Internet and called him, and his voice broke as I told him I had the globe. He hadn't seen it in 50 years and figured it was long gone. Indeed, it was like he just found out that a long-lost relative was still alive. Sometime later, I was scheduled to attend an annual event in Tucson called Spacefest, and I saw that Don was also planning to be there. I took the globe with me (without telling him). When I tracked him down at his booth, I introduced myself as that guy from Lowell and asked if he had a minute to visit the Lowell booth. As he came over, I uncovered the globe from under a sheet and he teared up. With the eyes of an artist and heart of a parent, he lovingly examined his creation and recalled his work with it. Years after that reunion in Tucson, Don has written the accompanying account of the globe.

Carol McCauley and Jerry Schaber in Carol's garage with the Mariner Mars Globe, 2013.



The Mariner Mars Globe was used as context for the initial quadrangle mapping. Here is a section along with the details emerging from the initial Mariner 9 mapping coverage.

degree junctures with a Rapidograph pen. Ivory Black and Titanium White oil paint were used, with thick Lead White for topography highlights and radiograph pen for the related shadows. I drew with red wax pencil grid marks on prints of far-encounter images. At times there was overlap in these images, and I tried to emphasize the features in common between prints and not excessively trust details in any one photo.

Only in the north polar region were we still limited to Earth-based resolution, but elsewhere Mars emerged with the albedo markings so long peered at through telescopes better defined in tantalizing detail. My care in portraying the existing coverage was later vindicated when, here and there, significant topography was seen to emerge just where the albedo details showed related shapes. Several strips of subdued cratered topography emerge from the vagueness.

While painting the globe I was in the room with Pat Bridges and Jay Inge, who were creating airbrush maps. My oil painting the globe in one corner of the room with brushes and pen was quite a contrast to their methods using their whirring Paasche AB airbrushes. Both the AB and the Rapidograph pen were tools I first encountered at the USGS.

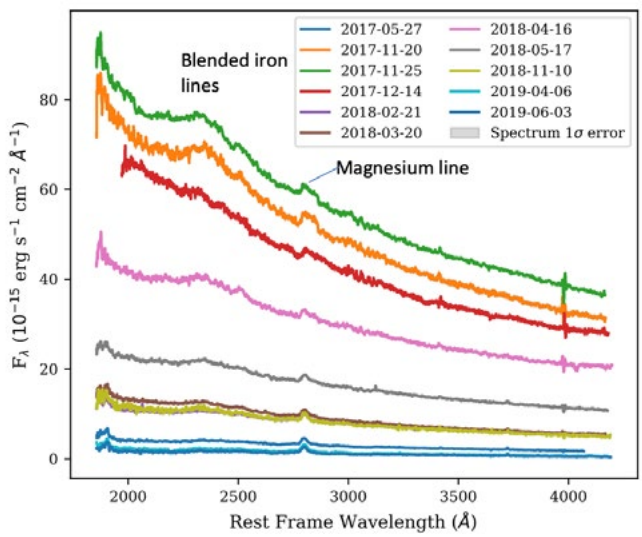
While I was in Flagstaff I also looked at Mars through Lowell's Clark Refractor while Charles Capen was observing, and once saw and drew Mars near opposition through a large reflector during observing breaks of Capen and Gerard De Vaucouleurs. I experienced Mars as never before or since that year, and the oil-painted Mars globe is a memorial of a great time of discovery. It preserves Mars in the act of transitioning from Earth-based to spacecraft studies. •

QUASARS | CONTINUED FROM PAGE 1

Nature can make gamma rays if high-energy electrons, similar to "cosmic rays" that are found throughout our Milky Way Galaxy, collide with visible-light "seed" photons. In blazars, energetic electrons are plentiful, found in jets of particles and magnetic fields, which are propelled outward at near-light speeds from just outside the BH into interstellar space, along the poles of the rotating system. But the source of the seed photons has been difficult to determine. There are photons produced by the hot accreting gas, which is thought to form a disk swirling around the BH. But evidence related to the timing of flares of gamma rays relative to changes seen in the jet (observed in microwave images made with the Very Long Baseline Array) indicates that the site of gamma-ray production is light-years away from the BH. This is well beyond the intense light of the accreting gas.

So, a source of visible-light photons is needed light-years from the BH. One possibility is "polar" clouds that might lie alongside the jets. From that location, flares of UV light that occur when a burst of extra electrons or stronger magnetic fields erupt in the jet would enter the clouds and become absorbed by atoms in the clouds. The "excited" atoms then radiate photons at very particular wavelengths, in the form of emission lines. The cartoon on the front cover sketches the locations of the different features of a blazar.

CONTINUED ON PAGE 12



Spectra (brightness F vs. wavelength) of the blazar Ton599 (z=0.729, where z is the redshift of the blazar's galaxy) in the rest frame obtained on eleven different nights with the DeVeny spectrograph on the LDT. The prominence of the emission lines from magnesium and iron atoms becomes stronger as the brightness of the continuum increases.

Front cover image: Cartoon of a blazar. The green regions contain clouds of accreting gas that produce emission lines during quiescent periods. The polar clouds only radiate emission lines after a flare in the jet.

To search for evidence of such polar clouds, we observed the visible-light spectrum of some blazars with the LDT when there was no flare in progress – the "quiescent" state. At such times, emission lines should come only from the accreting gas within a light-year of the BH. We then repeated the LDT observation several times after a gamma-ray flare was observed – thanks to the excellent LDT capability to perform Target of Opportunity Observations. If polar clouds are present, we expected to see the emission lines become brighter. Since we Earthlings observe blazars almost right down the jet (they beam their light in our direction, so jets pointing at us appear much brighter than those pointing in other directions), there should be little or no time delay between when we see the light from the flare and when we see brightening of the emission lines stimulated by the flare. As can be seen in the LDT spectra shown in Fig. 2, that is exactly what we observed.

However, as is common in astronomy, solving one mystery leads to another. As the emission line from magnesium atoms becomes stronger, it develops a "wing" on the long-wavelength side. Based on the Doppler effect, this corresponds to clouds that are moving away from us at higher speeds than the clouds responsible for the quiescent lines. Since the increase in brightness is caused by clouds close to the near-side jet, the polar clouds must be moving away from us, i.e., toward the BH. We can calculate the speed of this motion to be about 5000 kilometers per second, nearly 2% the speed of light, while the free-fall velocity light years away from the BH is much less than this. So, we have a problem explaining the motions of these clouds. One guess is that they are part of a "back flow" of gas that forms an in-flowing "cocoon" around the jet due to its interaction with the galaxy's interstellar medium. We hope that further observations with the LDT will teach us more about the clouds' motions so that we can test this idea. •

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