

THE LOWELL Observer

THE QUARTERLY NEWSLETTER OF LOWELL OBSERVATORY

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WINTER 2010

Why the LMI?

By Phil Massey

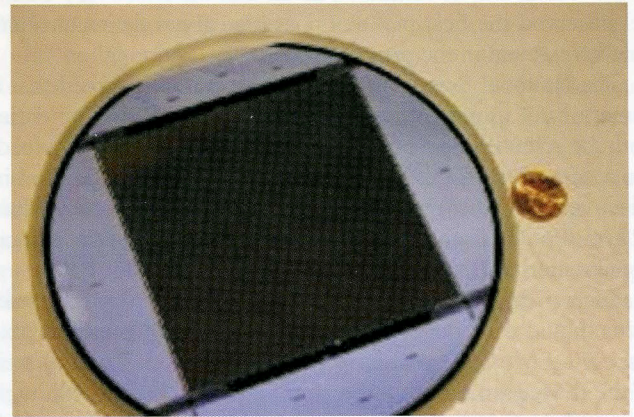
Thanks to a generous grant from the National Science Foundation, Lowell Observatory has embarked on building the Large Monolithic Imager (LMI) as one of the primary instruments for the Discovery Channel Telescope. At the heart of this instrument will be the largest CCD that is possible to manufacture currently. We believe that when this camera is finished, it will be the best CCD camera in the world for certain kinds of research. We thought our readership would be interested in the "backstory" of this camera: why we're building this device, and what it will mean not only for the astronomers at Lowell but for the general public.

Astronomers use a variety of instruments in their research; arguably, none is as fundamental as an optical imager. Such CCD cameras "take pictures", letting the astronomer see what is there. More than that, however, CCD cameras allow us to measure the brightness of objects. By taking pictures through a variety of filters, and measuring the differences, we can often determine the physical properties of interesting celestial objects.

It is inconceivable to have a telescope without an optical imager. In the bad old days, these imagers were "real" cameras, in that the detectors were photographic plates: the same technology your film camera used, except applied to a piece of glass. I spent much of my graduate career developing and analyzing such plates. To convert the darkness of the picture to something quantitative (so that one could measure the relative brightness) required difficult calibration procedures. This is all much easier today with CCD cameras, as these devices are linear in their response to light: the amount of signal one records using them is proportional to the amount of light falling on them, as detailed in Brian Taylor's article in the fall issue of *The Lowell Observer*.

One advantage photographic plates had over modern CCDs is that they could be very large. The typical photographic plate I used when I was an undergraduate was 5 by 7 inches in size, and some were as large as 14 inches on a side. By contrast, the first CCD I used as an astronomer, an RCA 512x312 chip, was 0.6 inches by 0.4 inches in size.

The most common "large" CCDs in use today are 2.5 inches by 1.2 inches in size. In order to cover a larger field of view, modern CCD cameras are usually mosaics of several chips: a common arrangement is two rows of four chips. Such cameras in the Kitt Peak and Cerro Tololo 4-meter prime focus cameras cover 4.8 inches on a side, ginormous by CCD standards, and approaching the size of a small photographic plate. However, such mosaics are not without their disadvantages. There are gaps in between adjacent chips so that when one takes a picture of a region of the sky there are missing strips. One commonly then takes several exposures in a row, moving the telescope slightly to fill in these gaps.



The CCD for the LMI is going to be a lot bigger than a penny. It will cost a lot more, too!

This dithering process is time-consuming in terms of telescope time and also provides a strong limitation for studies of the brightness of extended objects, as the sky brightness is constantly changing.

In addition, if you have a mosaic of eight CCDs in your camera, you basically have eight different instruments each of which has to be calibrated and handled separately for most quantitative studies. Each chip has its own individual response to light. When we analyzed the data for the Local Group Galaxies Survey (data taken with the Kitt Peak and Cerro Tololo Mosaic Cameras) we worked forty times harder than we might have, as there were five dithers with eight chips. It took us two years to fully analyze our data, and even so we were among the first to obtain good measurements with such a device.

When we were talking about the design specifications for the imager for the DCT, it was pretty much everyone's expectation that we would basically duplicate the Mosaic Cameras from Kitt Peak, maybe with some minor improvements. It was Bob Millis (then Lowell Observatory director) who argued otherwise. He had just heard of a newly made CCD
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which took advantage of the entire silicon wafer, about 3.5 inches on a side. While it wouldn't be quite as large as a Mosaic, it would have none of its disadvantages. He argued that a telescope as great as the DCT deserved the best imager in the world, and he reminded us all that the Discovery Channel deserved the best pictures possible given their considerable investment in the project.

The National Science Foundation eventually agreed that a camera built around such a single device had high potential both for scientific and broader impact within society. Indeed, the spectacular images we obtain with the LMI will be used in Discovery Channel programming, which will reach more than 329 million households worldwide, and be used in educational materials distributed to schools.

Such a device is not cheap, especially not the first one. Your digital camera probably has about 10 or 15 million pixels. The LMI CCD will have about 40 million. The full cost of the device works out to be about a penny a pixel, although the vendor, e2v, is kindly assuming about half of that cost. A special coating will make the chip very sensitive over the entire visible spectrum, from the near-ultraviolet to the near-infrared. The LMI will be a very versatile instrument, with two filter wheels permitting 18 filters to be mounted permanently.

We will keep you updated as we make progress on this remarkable device!

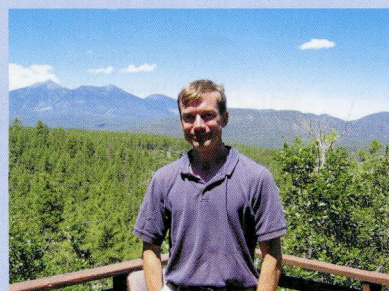
Meet Chuck Wendt, Deputy Director for Advancement

We are pleased to welcome Chuck Wendt to Lowell Observatory. Chuck joined the Lowell staff in September, filling a newly created executive position – Deputy Director for Advancement. He will be overseeing the Observatory's fundraising and outreach programs including marketing and media efforts. "Chuck brings impressive business, marketing and fundraising experience to Lowell and the institution stands to gain tremendously from his skills. Lowell will grow substantially as the Discovery Channel telescope comes on line. Chuck will help our fundraising, marketing, and outreach keep pace with this. I've been pleased with the progress and direction in the short time that he's been here," said Acting Director Jeffrey Hall.



Chuck joins Lowell from Newberry College in South Carolina, where he was Vice President for Institutional Advancement. Prior to his 20 year-career in the non-profit sector, Chuck was the director of marketing and part-owner of Anchor Glass Container Corporation, a Fortune 500 Company.

Chuck can be reached at 928-233-3201 or by email at cwendt@lowell.edu.



Director's Update

by Jeffrey Hall

Some while ago, I was reading a review of a film - it might have been a James Cameron or Jan de Bont - and the critic described the action sequences as *hyperkinetic*. That's not a word I see too often, but it rolls smartly off the tongue and it has been feeling a bit that way around Lowell recently. The science staff has been spectacularly competitive in winning research grants lately, and our scientific activity is humming. The Discovery Channel Telescope is now staffed not only during the daytime construction but at night, as we begin testing the mount's ability to point precisely at selected stars. A fortuitously timed property listing has allowed us to purchase a residence just one mile from the DCT to serve as our astronomers' lodge, and our technical staff is busy with the hardware and software for the new telescope's instruments. augment the Navy Prototype Optical Interferometer, making it capable of studying far fainter objects than it can now.

The high profile of DCT tends to overshadow our existing facilities at Anderson Mesa, but a new effort has just materialized to install four 1.8-meter telescopes to augment the Navy Prototype Optical Interferometer, making it capable of studying far fainter objects than it can now.

Research is the central element of Lowell's mission and it's exciting to see this tremendous growth in our research assets. But we are also a full-bodied non-profit with a thriving outreach effort and with all the requirements of personnel, administration, physical plant, and financial underpinning such an organization requires. Ironically, the vast expansion of our primary mission will undo us if other parts of the observatory do not also grow in the right proportion. Balanced growth is needed not only for the cold budgetary reasons, but for the enjoyment of our visitors, the health of our staff, and the growth of our endowment.

In 2011, we're going to have a lot to say about the DCT. But you will also see major effort in the other areas to preserve the present balanced that makes Lowell such a nice place to be a part of—and which will ensure it ongoing strength and viability.

It's going to be hyperkinetic. And great fun.

The Lowell Observatory Wish List

We are planning many exciting new projects in the coming year and would like to share a short list of some of them. While our wish list is longer than our list of available resources, the items below were selected because they will contribute to our growth and future success. We need your help to bring these projects to fruition through a gift to Lowell Observatory. To discuss these or any other giving opportunities in greater detail, you are encouraged to contact Chuck Wendt, Deputy Director for Advancement, at (928) 233-3201 or by e-mail at cwendt@lowell.edu.

Video Production System - \$18,000.

There is always something happening at Lowell. Whether it's a new discovery, celestial event, or public presentation, there is no shortage of educational content that could be routinely generated. Our astronomers can demonstrate how they model the atmosphere of an extrasolar planet, our engineers can show how they are building a new instrument for the Discovery Channel Telescope, and our archivist can highlight 100 years of scientific discovery, discourse and presentation. Our Friends of Lowell scattered across the globe could more closely follow what we are doing with a regular video series. With a worldwide audience, we will find new Friends of Lowell, as well.

We have received a quote to purchase a TriCaster video production system, cameras and all associated equipment. TriCaster makes a professional-level product that is lightweight, small and portable and can produce, broadcast, record and stream video. It is used by industry heavyweights like Fox Sports, MTV, and VH1.

Projector in the Giclas Lecture Hall - \$19,000.

The projector in the auditorium of Lowell's Steele Visitor Center is used everyday, typically all day, and on most nights. It is used to teach school children, public visitors, and special groups about astronomy; it is also used by visiting astronomers to share their research to our science staff in our colloquium series. Not only must the projector be robust and durable, but it needs to be versatile. Because of the long throw ratio, and the requirement that it be used for wide screen and standard format, it is a very specialized piece of equipment. We have an opportunity to purchase an AVIO projector at a greatly reduced price since it was used as a display model in a showroom.

The projector typically would cost \$37,000, with the lens alone costing \$10,000. We will be able to purchase the projector for \$19,000 and through the generosity of Andy and Charlie White – owners of A/V Domotics and sons of retired astronomer Nat White, the installation will be provided as an in-kind donation.

Pluto Occultation Studies - \$10,000.

In collaboration with astronomers at the Southwest Research Institute, Lowell Astronomer Larry Wasserman has been chasing Pluto occultations all over the planet (see Lowell Observer Issue #87). As Pluto passes in front of a more distant star, Larry watches how the light from the star changes and gains a better understanding of the characteristics of Pluto's atmosphere. With the New Horizons spacecraft scheduled to fly by Pluto in 2015, monitoring Pluto for any changes can help guide the scientific investigations as the craft reaches Pluto. Larry recently received notification that a proposal to study another Pluto occultation was successfully selected to receive funding, but later learned that the funding is not available. A \$10,000 restricted contribution to Lowell research will cover the expenses needed to carry out this investigation.

Remodel Steele Visitor Center Lobby - \$15,000.

"Making the best use of all available space for education and entertainment as well as managing the flow through the lobby are the main objectives for this work," explained Lowell's new Deputy Director for Advancement, Chuck Wendt. "Phase 1 begins with the admissions desk, which should be the first thing visitors see when they walk in the front doors. Not only should they see it, but there should be someone there to immediately welcome them and answer any questions. Our education staff continues to do a heroic job. Often just one person will be selling items in the gift shop, explaining the tour to new visitors, and discussing the weather and prospects for viewing over the phone with a potential visitor."

We have solicited bids to build a new admissions desk, separate from the gift shop, which will include monitors with information as well as videos highlighting recent developments and research.



Thanks to a generous grant from the Motorola Foundation, twenty teachers from the Navajo and Hopi nations participated in Lowell Observatory's Educational Astronomy Program (LEAP) November 5-6. Here, several of the workshop attendees explore motions of the moon during one of the workshop activities.

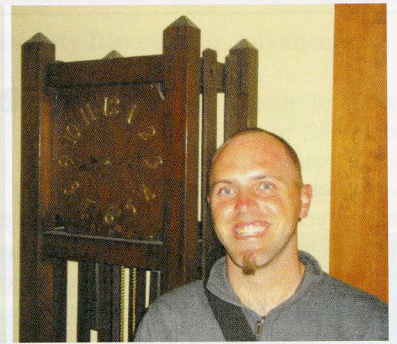
NPOI Update

By Caryn Fitch

Lowell is pleased to announce formalization of a new Contract with the United States Naval Observatory for Operation and Maintenance of the Navy Prototype Optical Interferometer, fondly known as the 'NPOI', for the current U.S. Government's Fiscal Year 2011 (October 2010 – October 2011), and with options for the following four Fiscal Years, (2012 – 2015). The new contract continues the infrastructure and support work that Lowell has provided to the NPOI for nearly two decades, and notably includes the employment of four specialized observers, staff for site engineering and maintenance, and a site manager. This work is in addition to a purchase (via contract) with the Naval Research Laboratory, Code 7200 (Remote Sensing) for construction and installation of long delay lines, three new siderostat stations, and periscope control design, testing and implementation, awarded and begun this past July. While two new contracts with the Navy are exciting developments indeed, there is more: The Undersecretary of the U.S. Navy, Robert O. Work, officially accepted the gift of four 1.8m telescopes from the California Association for Research in Astronomy (CARA) for use by the U.S. Naval Observatory, on November 3, 2010. These long awaited devices, when installed and integrated with the NPOI, will make the instrument one of the most powerful land-based optical interferometers in the world.

For more information on the NPOI, please see Lowell's website, where there is a brief description of the instrument

New Faces in Lowell's Public Program



Three new educators recently joined Lowell's public program staff. They are Todd Gonzales (top photo); and Tom Vitron and Susan Clark (bottom photo).

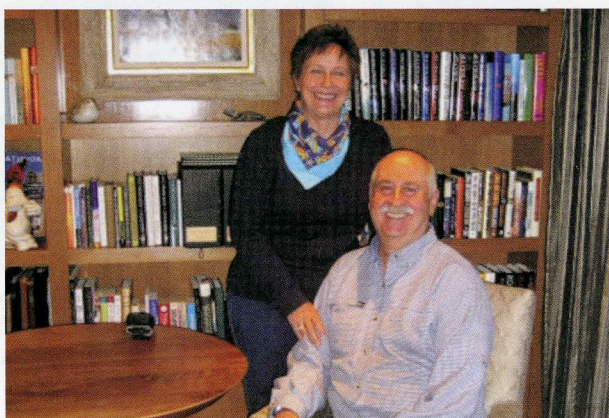


NPOI Aerial

(Photo courtesy of Michael Collier)

First Light Challenge: the Race to First Light!

According to his wife Ginger, John Giovale is a man who loves science and has always been interested in it. "He fell in love with Lowell, with the work that Lowell does, and the people at Lowell Observatory." During his long tenure as an Advisory Board member and Executive Committee Chairman, John got to know Lowell from the inside out. A Lowell Friends member since 1987, he has seen many changes at the Observatory, from the construction of the Steele Visitor Center in 1994, to the establishment of the Millennium Fund, to the Discovery Channel Telescope now headed for first light. He understands the goals and aspirations of the institution well, as does his good friend Bob Millis, former Lowell director, whose career spanned over forty years.



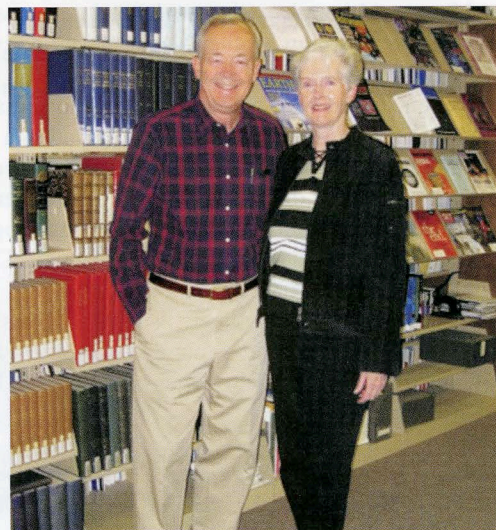
Ginger and John Giovale

John and Ginger, along with Bob and his wife Julie, pledged \$500,000 in a 2008 campaign called the First Light Challenge. This challenge promises a one dollar match for every two dollars raised, with an eventual goal of \$1.5M to be used towards the Discovery Channel Telescope's guider and focus systems, as well as an astronomers' lodge to be located near the telescope in Happy Jack, Arizona. We are over halfway to this goal, with the focus now on securing the location for the lodge and the lodge itself. An offer has been made and accepted on 23 acres across the road from the telescope, which comes with an existing house and barn. Money raised from the First Light Challenge will recover the cost of this property and renovations to the existing house, which includes up to four bedrooms for staff members to lay their heads after long nights at the telescope.

As John puts it, "We're going to have this beautiful instrument and we need the guider so the instrument can be used, but we also need a place for the astronomers to stay. The house can be utilized starting right now by the people who are currently getting the telescope in working order; then the science can kick in as soon as possible, making it easier for our astronomers and astronomers from potential partner institutions who will work out there. Completing the Challenge makes the system work."

We need your help to make the First Light Challenge a huge success!

If you haven't given to the First Light Challenge, or haven't given recently, please consider a gift now! To make a gift, just use the enclosed envelope and note "First Light Challenge" on the check.



Bob and Julie Millis

An Appeal from Bob Millis

Among the things I valued dearly during my 20 years as Director of Lowell were the opportunities to interact with, and often come to know, the many Friends and supporters of the Observatory. Perhaps I, better than anyone, was in a position to realize the profound difference your gifts made to the progress of Lowell over these two decades. And, of all the things we undertook together, nothing was more challenging, important, and frankly downright audacious than the Discovery Channel Telescope. Now, after years and years of dreaming, planning, engineering, building and just plain hard work, completion of the DCT is nearly at hand. But one major goal remains – completion of the First Light Challenge. The Observatory needs your help now more than ever in raising these dollars for an astronomers' lodge at Happy Jack. Please do what you can, and John, Ginger, Julie and I will do what we promised. Together, we can make this happen.

Bob Millis, Director Emeritus

Lowell Friends Enjoy Special Fall Events

In September, we offered a series of tours of Lowell Observatory's Discovery Channel Telescope for members of Lowell at the Pluto Society level and higher. Since the site is small with few parking spaces and there are building code occupancy restrictions, we set aside several dates for morning and afternoon tours in order to accommodate as many of our friends as possible.

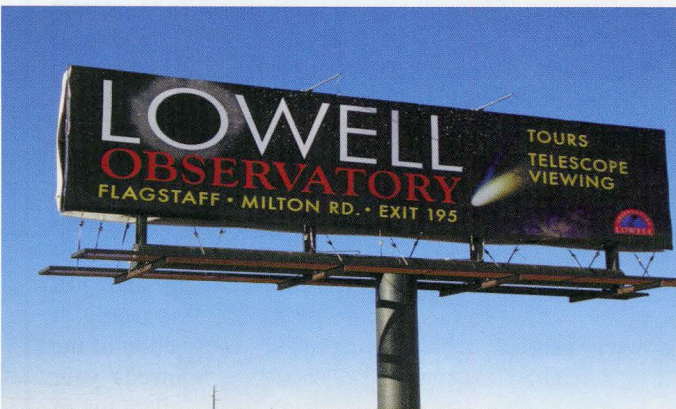
Tours were led by Acting Director Jeff Hall as well as DCT Project Manager Byron Smith and DCT Senior Electrical Engineer Alex Venetiou. Amazingly, we had clear, though windy, conditions for all of the tour dates.

On October 23, tightly sandwiched between two cold and wet days, we welcomed about 100 members of Lowell to Anderson Mesa. Although with two heated tents we were prepared for nearly anything Mother Nature might deliver, the day was delightful and the weather mild.

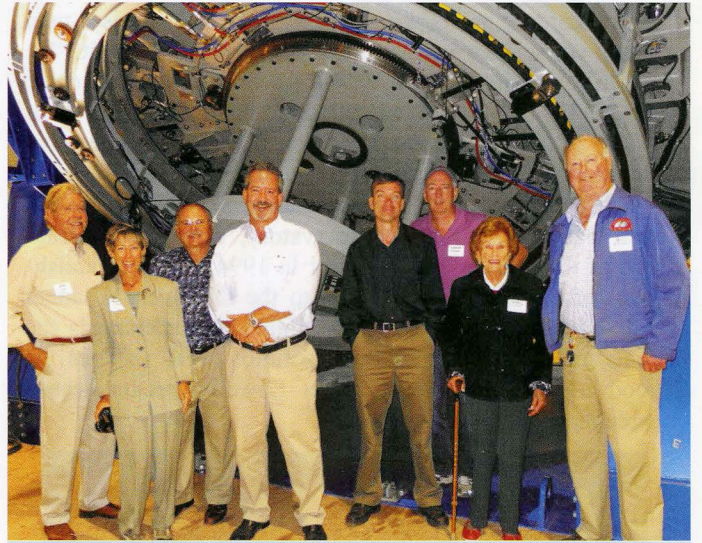
The afternoon started with a silent auction and social hour. Some of the more exciting items up for bid included a guided tour to the bottom of Meteor Crater, donated and delivered by Drew Barringer, a catered dinner donated by Thornager's, and Clark Telescope viewing and an hour-long sightseeing flight donated by pilot Julie Millis (wife of retired Lowell Director Bob Millis). The silent auction raised \$4,446.

During dinner, Lowell astronomer Lisa Prato discussed her work on extra-solar planets and explained her observing run using the 42-inch and 72-inch telescopes on Anderson Mesa.

Lowell Observatory typically organizes two major events per year, one for members at the Primary level (\$100) and above, and the other for members of the Pluto Society level (\$500) and above. For information about Lowell Observatory membership, please call Rusty Tweed at 928-233-3267 or email tweedr@lowell.edu.



In order to increase Lowell's visibility to travelers coming into Flagstaff, we have plunged into the world of billboard advertising. This billboard is located along I-40 westbound, near Winslow, and features an image of comet Hale-Bopp captured by Lowell astronomer David Schleicher.



Members of Lowell toured the Discovery Channel Telescope in September. Shown with the bottom end of the telescope and its cassegrain rotator in the background are (top picture, left to right), Jim Lee, Maxine Tinney, Robert Bob Millis, Scott Lee, Jeff Hall, Lowell Putnam, Kitty Putnam and Bill Putnam.



Left to right, Derald Dougherty, Pinkie Lockett, Willie Hamilton, Aiden McClendon, Jeff Hall, Marsha McClendon, Bob McClendon, and Sean McClendon

Give the Gift of Lowell to Someone You Love

The gift-giving season is already upon us. Have you considered giving a Lowell Observatory membership as a gift this year? You can give something meaningful and useful while benefiting Lowell Observatory at the same time. The recipient of your gift will enjoy all of the benefits of membership, including free admission to Lowell Observatory and 290 other science centers and museums, a subscription to the quarterly *Lowell Observer*, a 10% discount in the gift shop, and other benefits described below. Furthermore, Lowell Observatory is a private, non-profit, 501(c)(3) organization – your contribution will support research, outreach, and historic preservation. Once you determine which level is best for you, use the enclosed envelope to send a check, and tell us where to send the membership. You can also call 928-233-3267 to order with a credit card over the phone.

\$35 – Individual

- Free admission for one person to Lowell Observatory and 290 participating science centers and museums; there is also a 10% discount for students
- A subscription to *The Lowell Observer*, produced quarterly, and,
- A 10% discount on items in our gift shop.

\$60 – Basic

- Benefits listed above, and membership cards that can be used for free admission for 2 adults and their minor children to Lowell and 290 participating science centers and museums
- 2 guest passes for admission to Lowell that you can give to friends or family

\$100 – Primary

- Benefits listed above, and an annual invitation to a special Friends event
- 6 guest passes for admission to Lowell that you can give to friends or family

\$250 – Contributor

- Benefits listed above, and free admission for 4 adults and minor children/grandchildren
- An astronomical calendar and 8 guest passes

\$500 – Pluto Society

- Benefits listed above, and an invitation to an annual Pluto Society event
- a listing in our annual report (optional)

\$1000 – Lowell Associate

- Benefits listed above, and a complimentary evening of private viewing on Percival Lowell's historic 24-inch Clark refracting telescope, preceded by a reception with Lowell's director.

\$2500 – Trustee Circle

- Benefits listed above, and recognition on our donor board displayed in the visitor center
- A tour of the Anderson Mesa research site

\$5000 – Discovery – New level!

- Benefits listed above, and a tour of the Discovery Channel Telescope
- Use of Lowell facilities for a private function.

The gift shop at Lowell Observatory is packed with unique astronomy-themed gifts including telescopes, books, DVDs, toys, locally made hand-blown glassware, hats and more. Spend a day at Lowell making memories to last a lifetime, and take home something to help make many more!





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Lowell Observatory 1400 W. Mars Hill Road Flagstaff AZ 86001 928-774-3358
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2011 Lowell Observatory Special Events

January Regular Hours: M/W/F/Sat 9:00 a.m. - 9:30 p.m.
T/Th/Sun noon - 5:00 p.m.

Wed 5 Flagstaff Night (regular evening hours) - Tonight at 7 p.m., one of our astronomers will give an indoor presentation discussing his/her research. In addition to this presentation, we will feature numerous telescopes set up for viewing throughout the Lowell campus. Flagstaff residents (must show valid drivers license or utility bill) pay only half the regular admission rate.

Sun 16 MLK Star Fest (regular evening hours) This special event will feature indoor programs and numerous telescopes set up for viewing throughout the Lowell campus. The Orion Nebula will be a featured object to view.

Mon 17 School's Out and Kids are Free (9 a.m. - 5 p.m.) Kids activities will be offered throughout the day including science demonstrations, solar viewing, tours, and multi-media presentations; Children must be accompanied by an adult or responsible guardian.

February Regular Hours: M/W/F/Sat 9:00 a.m. - 9:30 p.m.
T/Th/Sun noon - 5:00 p.m.

Wed 2 Flagstaff Night (regular evening hours) — Tonight at 7 p.m., one of our astronomers will give an indoor presentation discussing his/her research. In addition to this presentation, we will feature numerous telescopes set up for viewing throughout the Lowell campus. Flagstaff residents (must show valid drivers license or utility bill) pay only half the regular admission rate.

Fri 18 Pluto Night (regular evening hours) – Pluto was discovered at Lowell Observatory on February 18, 1930. At 7:00 p.m. tonight, Lowell staff will share the exciting story of Pluto's discovery and astronomers' current efforts in trying to understand Pluto and its neighbors. Also, check out the Orion Nebula and other fascinating objects through our telescopes.

Sun 20 Winterfest Star Fest (regular evening hours) This special event will feature indoor programs and numerous telescopes set up for viewing throughout the Lowell campus. The Orion Nebula will be a featured object to view.

Mon 21 School's Out & Kids are Free (9 a.m. - 5 p.m.) Kids' activities, including science demonstrations, solar viewing, tours, and multimedia presentations will be offered throughout the day. Children must be accompanied by an adult or responsible guardian.

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